

IBM System Storage TS3500 Tape Library with ALMS



Introduction and Planning Guide

IBM System Storage TS3500 Tape Library with ALMS



Introduction and Planning Guide

Note!

Before using this guide and the product it supports, read the information in “Safety and environmental notices” on page xiii and Appendix B, “Notices,” on page 221.

Edition Notice

This edition applies to the *IBM System Storage TS3500 Tape Library with ALMS Introduction and Planning Guide* and to all subsequent releases and modifications until otherwise indicated in new editions.

© Copyright IBM Corporation 2008, 2011.

US Government Users Restricted Rights – Use, duplication or disclosure restricted by GSA ADP Schedule Contract with IBM Corp.

Read this first

This is the seventh edition of the *IBM System Storage TS3500 Tape Library with ALMS Introduction and Planning Guide* (June 2011). This guide is published specifically for the TS3500 Tape Library with the Advanced Library Management System (ALMS).

What's new in this edition (June 2011)

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 (GA32-0593-05). The following information is new in this 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® System Storage® 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 System Storage 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 System Storage 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 e-mail 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.

Contents

Read this first iii

What's new in this edition (June 2011)	iii
Sixth edition (June 2010)	iii
Fifth edition (March 2010)	iii
Fourth edition (September 2009)	iii
Third edition (December 2008)	iv
Second edition (November 2008)	iv
First edition (September 2008)	iv
Send us your feedback.	iv

Figures ix

Tables xi

Safety and environmental notices xiii

Safety notices	xiii
Environmental notices	xiv
Laser safety and compliance	xiv
Class II laser product	xiv
Class I laser product	xv

About this publication xvii

Who should read this book	xvii
Terminology used in this book	xvii
Related information	xvii
Publications about the TS3500 Tape Library	xvii
IBM i, System i, and i5/OS source	xviii
IBM Power Systems and System p source	xviii
IBM System z source	xviii
Other sources	xviii
Authorized suppliers of bar code labels	xx
Data storage values	xxi

Chapter 1. Introduction 1

Overview	1
Structure of the library	3
Dual accessors and service bays	7
High density technology	9
Components of the library	12
Structure of the shuttle complex	15
Supported tape drives	17
LTO Ultrium tape drives	18
3592 tape drives	20
Supported tape cartridges	25
Compatible servers and software	26
Supported device drivers	28
Using mtlib for communication.	28
Attachment interfaces	30
Fibre Channel interface	31
Small Computer System Interface	31
FICON and ESCON interfaces	32
Mixing drives in frames	34
Mixing drives in a logical library	35
Mixing media in drives	37

Multi-Path Architecture	40
Library sharing	41
Using multiple logical libraries	43
Using multiple control paths	44
Advanced Library Management System	45
Dynamic partitioning	46
Transparent addition or removal of storage capacity	47
Configuration of storage capacity without disruption	47
Using virtual I/O slots	47
Cartridge assignment policy	48
Insert notification setting	49
Power structure of the TS3500 Tape Library	50
Frame control assembly and dual ac power.	50
Enhanced frame control assembly	51
Control path failover, data path failover, and load balancing	51
Expanded I/O capacity	53
Increasing capacity	54
Capacity expansion feature for Model L32	54
Intermediate, Full, and Capacity On Demand features for Models L22, L23, L52, and L53	55
High Density Capacity On Demand	55
Web interface.	56
TS3500 Tape Library Command Line Interface.	57
IBM Tape System Reporter	57
Remote support	58
Remote support through a modem	59
Remote support through a system console	60
Remote support security	63
Methods of cleaning drives	69
TapeAlert support	69
SNMP messaging	70
SNMP audit logging	71
SMI-S support	72
Secure Socket Layer (SSL) functionality	74
Storage Authentication Service	74
IPv6 functionality	76
IPv4 and IPv6 address formats	76
Drive performance	79
Library performance	83
Inventory times	83
Mount performance and cartridge move time	84
Import and export performance with virtual I/O slots	86
HD frame performance considerations	87
Shuttle complex performance considerations	88

Chapter 2. Physical planning specifications 89

Height and length of library.	89
Library placement	89
Physical specifications for Models L22 and D22	90
Physical specifications for Models L23 and D23	91

Physical specifications for Models L32 and D32	92
Physical specifications for Models L52 and D52	93
Physical specifications for Models L53 and D53	94
Physical specifications for HA1 Frame	95
Physical specifications for Model S24	96
Physical specifications for Model S54	97
Floor requirements	98
Delivery route	99
Delivery and Subsequent Transportation of the Equipment	99
Security	100
Move restraints	100
Clearance specifications for the library	101
Clearance specifications for models of the Library	101
Clearance specifications for the shuttle complex	105
Routing Fibre Channel cables through the top of a frame	106
Routing cables through the top for installations on a solid floor	109
Fire suppression for the Library	109
Fire suppression for Models L32 and D32	109
Fire suppression for all other models	110
Running cables, wiring, and pipes between frames	112
Environmental specifications	113
Acoustical specifications	113
Acoustical specifications for Models L32 and D32	114
Acoustical specifications for Models L22, D22, L52, and D52	114
Acoustical specifications for Models L23, D23, L53, and D53	114
Power and cooling requirements	115
Power and cooling specifications for Models L22, D22, L32, D32, L52, and D52	115
Power and cooling specifications for Models L23, D23, L53, and D53	116
Power requirements for frames	117
Power requirements for remote support features	120
Power cords for Models L32 and D32	121
Power cords for Models L22, D22, L52, and D52	124
Power cords for Models L23, D23, L53, and D53	125

Chapter 3. Standard features of the library 129

Elements in the library	130
Feature codes for elements in the library	131

Chapter 4. Using Ultrium media 141

Overview of Ultrium Media	141
WORM functionality for tape drives and media	141
Ultrium data cartridge	143
Ultrium cleaning cartridge	145
Ultrium diagnostic cartridge	147
Ultrium bar code label	148
Guidelines for using Ultrium bar code labels	149
Setting the write-protect switch on an Ultrium tape cartridge	151
Handling Ultrium tape cartridges	152

Provide training for using Ultrium tape cartridges	152
Ensure proper packaging of Ultrium tape cartridges	153
Provide proper acclimation and environmental conditions for Ultrium tape cartridges	154
Perform a thorough inspection of Ultrium tape cartridges	154
Handle the Ultrium tape cartridge carefully	155
Examples of problems with Ultrium tape cartridges	156
Repositioning or reattaching a leader pin in an Ultrium cartridge	157
Repositioning a leader pin in an Ultrium cartridge	157
Reattaching a leader pin in an Ultrium cartridge	159
Environmental and shipping specifications for Ultrium cartridges	163
Disposing of Ultrium tape cartridges	164
Ordering additional Ultrium cartridges and media supplies	165
Ordering bar code labels for Ultrium cartridges	167

Chapter 5. Using 3592 tape drive media. 169

Overview of 3592 media	169
WORM functionality for 3592 tape drives and media	171
Capacity scaling and segmentation	172
3592 data cartridge	174
Cartridge memory in 3592 tape cartridges	176
3592 cleaning cartridge	177
3592 diagnostic cartridge	179
3592 bar code label	179
Guidelines for using 3592 bar code labels	181
Guidelines for using Silo-style bar code labels	181
Setting the write-protect switch on a 3592 Cartridge	183
Handling 3592 tape cartridges	184
Provide training for using 3592 tape cartridges	184
Ensure proper packaging of 3592 tape cartridges	184
Provide proper acclimation and environmental conditions for 3592 tape cartridges	184
Perform a thorough inspection of 3592 tape cartridges	185
Handle the 3592 tape cartridge carefully	185
Repositioning a leader pin in a 3592 cartridge	185
Environmental and shipping specifications for 3592 cartridges	188
Disposing of 3592 cartridges	189
Cartridge quality and library maintenance	189
Ordering 3592 media supplies	189
Ordering 3592 media supplies by using the 3599 tape media method	190
Ordering 3592 media supplies by using part numbers	192
Ordering supplies for repairs	193
Ordering 3592 bar code labels	194

Chapter 6. Using the Fibre Channel interface 195

Overview of Fibre Channel interface. 195
Physical characteristics of the Fibre Channel interface 195
Cables and speeds of Fibre Channel drives 196
Supported topologies. 197
 Two-node switched fabric topology 198
 Two-node direct connection topology 199
Fibre Channel addressing 199
LUN assignments 202
Using World Wide Names 202
 Using persistent binding to ensure SCSI ID assignment 203
 Using zoning to isolate devices and enhance security 203
Connectors and adapters 203
Connecting the library to IBM i, System i, and iSeries 204
Sharing drives on a Storage Area Network 205

Chapter 7. Frame capacity 207

Capacity of Model L22, D22, L23, D23, and S24 Frames 207

Capacity of Model L32 and D32 Frames 208
Capacity of Model L52, D52, L53, D53, and S54 Frames 209

Chapter 8. Tape encryption overview 211

Managing encryption. 212
 Planning for application-managed encryption 213
 Planning for system-managed encryption 214
 Planning for library-managed encryption 215
Configuration prerequisites for encryption. 215

Appendix A. Accessibility 219

Accessibility features for the *IBM System Storage TS3500 Tape Library Introduction and Planning Guide* . 219

Appendix B. Notices 221

Notices 221
 Trademarks 222
 Electronic emission notices 223

Glossary 227

Index 245

Figures

1. Laser safety caution label	xv	29. Types of receptacles for power cords used by models L32 and D32 of the TS3500 Tape Library.	123
2. The TS3500 Tape Library	2	30. Types of receptacles for power cords used by Models L22, D22, L52, and D52 of the TS3500 Tape Library	125
3. Frames in the IBM System Storage TS3500 Tape Library	6	31. Types of receptacles for Models L23, D23, L53, and D53 of the TS3500 Tape Library	127
4. Location of service bays in the TS3500 Tape Library	7	32. FC 9989 cable positions	128
5. Cartridge slots in the service bays of the TS3500 Tape Library	8	33. Elements in the TS3500 Tape Library	130
6. The HD frame (left) and top-down view of row in an HD frame (right)	10	34. The IBM System Storage LTO Data Cartridge for Ultrium 3 tape drives	141
7. Components of the IBM System Storage TS3500 Tape Library	14	35. The IBM System Storage LTO Data Cartridge	144
8. TS3500 Tape Library shuttle complex	16	36. Sample bar code label on the LTO Ultrium 2 Tape Cartridge	149
9. Attaching the TS3500 Tape Library to the System z server (mainframe host)	34	37. Setting the write-protect switch on an Ultrium tape cartridge	151
10. Examples of methods for mixing Ultrium drive types in a logical library	36	38. Tape cartridges in a Turtle Case	153
11. Examples of configurations for sharing an IBM System Storage TS3500 Tape Library	42	39. Double-boxing tape cartridges for shipping	154
12. Tape System Reporter data flow.	58	40. Gap in cartridge seam	155
13. Remote support system console connection diagram.	62	41. Leader pin in the incorrect and correct positions in an Ultrium tape cartridge	157
14. Attachment of the system console to the TS3500 Tape Library and the 3953 Tape System for remote support	64	42. Placing the dislodged leader pin into the correct position	158
15. External communication connections to the TS3500 Tape Library control system	67	43. Rewinding the tape into the cartridge	158
16. The SNMP messaging system	71	44. Leader Pin Reattachment Kit	159
17. Storage Authentication Service overview	75	45. Attaching the leader pin attach tool to an Ultrium tape cartridge	160
18. Location of restraining points	101	46. Winding the tape out of the Ultrium tape cartridge	161
19. Size of operator and service clearances for the IBM System Storage TS3500 Tape Library, Models L22, D22, L23, D23, L52, D52, L53, D53, S24, S54, and the service bays	103	47. Removing the C-clip from the leader pin	161
20. Size of operator and service clearances for the IBM System Storage TS3500 Tape Library, Models L32 and D32	104	48. Attaching the leader pin to the tape	162
21. Shuttle complex dimensions and clearances	106	49. Components of the IBM TotalStorage 3592 Enterprise Tape Cartridge	169
22. Opening for routing Fibre Channel cables from servers through the top of a frame	107	50. Components of the IBM TotalStorage 3592 Enterprise Tape Cartridge	175
23. Opening the cable access door at the top of a frame	107	51. Leader pin in proper position in the 3592 cleaning cartridge (the cartridge door is manually retracted)	178
24. Positioning the Fibre Channel cable inside the frame	108	52. Characteristics that identify the 3592 cleaning cartridge	178
25. Positioning the Fibre Channel cable outside the frame	108	53. Door of the 3592 cleaning cartridge	179
26. Allowable area for mounting fire-suppression equipment (top view of Model L32 or D32 frames).	110	54. Sample bar code label on the IBM TotalStorage 3592 Enterprise Tape Cartridge	181
27. 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)	111	55. Setting the write-protect switch on the 3592 Tape Cartridge	183
28. Location for routing fire-suppression equipment between frames	112	56. Leader pin in the incorrect and correct positions in a 3592 tape cartridge	186
		57. Placing the dislodged leader pin into the correct position.	187
		58. Rewinding the tape into the cartridge	187
		59. Three possible locations for encryption policy engine and key management.	213

Tables

1.	Authorized suppliers of custom bar code labels	xx	32.	Physical characteristics of the TS3500 Tape Library, Models L52 and D52	93
2.	Comparison of binary and decimal units and values	xxi	33.	Physical characteristics of the TS3500 Tape Library, Models L53 and D53	94
3.	Percentage difference between binary and decimal units.	xxi	34.	Physical characteristics of the HA1 frame (service bay A)	95
4.	TS3500 Tape Library configurations	2	35.	Physical characteristics of the TS3500 Tape LibraryModel S24	96
5.	TS3500 Tape Library frame models	4	36.	Physical characteristics of the TS3500 Tape Library, Model S54	97
6.	Tape drives that are supported by the TS3500 Tape Library	17	37.	Clearance requirements for the TS3500 Tape Library.	102
7.	Features of the 3592 tape drive	20	38.	Equipment environment specifications for the IBM System Storage TS3500 Tape Library	113
8.	Capacity of Ultrium tape cartridges.	25	39.	Noise emission values for the IBM System Storage TS3500 Tape Library, Models L32 and D32	114
9.	Capacity of 3592 tape cartridges.	25	40.	Noise emission values for the IBM System Storage TS3500 Tape Library, Models L22, D22, L52, and D52 filled with Ultrium tape drives or 3592 tape drives	114
10.	Mixing drives in the physical frames of the TS3500 Tape Library	35	41.	Noise emission values for the IBM System Storage TS3500 Tape Library, Models L23, D23, L53, and D53 filled with Ultrium Tape Drives or 3592 tape drives	114
11.	Compatibility among Ultrium tape drives and tape cartridges	37	42.	Electrical characteristics of the IBM System Storage TS3500 Tape Library frame models.	117
12.	Cartridges that are compatible with 3592 tape drives	38	43.	Power consumption of TS3500 Tape Library frame models, power consuming features, and drive canisters.	117
13.	Differences between DPF and CPF	52	44.	Sample calculation of total library power consumption and cooling requirements.	119
14.	Mixing I/O stations among frames of the TS3500 Tape Library	54	45.	Power requirements for remote support features	120
15.	Requirements for remote support (the Call Home feature)	59	46.	Specifications for 200–240 V ac power cord used with the IBM System Storage TS3500 Tape Library, Models L32 and D32	122
16.	Desktop and rack mountable TS3000 System Consoles	60	47.	Specifications for 100–127 V ac power cords used with the TS3500 Tape Library, models L32 and D32	123
17.	System console components	62	48.	Specifications for power cords used with the IBM System Storage TS3500 Tape Library, Models L22, D22, L52, and D22	124
18.	Remote support capabilities	63	49.	Specifications for power cords used with the IBM System Storage TS3500 Tape Library, Models L23, D23, L53, and D53	125
19.	Port Information for firewall environments	66	50.	Feature codes for the models of the TS3500 Tape Library	131
20.	Required upgrade for those frames providing Ethernet attachment to the SMI-S Agent	73	51.	LTO WORM cartridge capacities	142
21.	Embedded SIM-S Agent Profiles	74	52.	LTO Ultrium diagnostic cartridge and tape drive compatability	147
22.	Performance specifications of the Ultrium tape drives	79	53.	Environment for operating, storing, and shipping the LTO Ultrium tape cartridges	163
23.	Performance specifications of the 3592 tape drives	80	54.	Ordering Ultrium cartridges and media supplies	165
24.	Average block locate time from load point for 3592 Tape Cartridge in 3592 tape drives	81			
25.	Mount performance and move time for drives in a TS3500 Tape Library without dual accessors and without HD frames	85			
26.	Mount performance for drives in a TS3500 Tape Library with dual accessors but without HD frames.	85			
27.	Specifications for imports per hour and average I/O station drain time for a TS3500 Tape Library using one active accessor	86			
28.	Specifications for imports per hour for a TS3500 Tape Library with dual active accessors and I/O Stations in both accessor zones	86			
29.	Physical characteristics of the TS3500 Tape Library, Models L22 and D22	90			
30.	Physical characteristics of the TS3500 Tape Library, Models L23 and D23	91			
31.	Physical characteristics of the TS3500 Tape Library, Models L32 and D32	92			

55.	Authorized suppliers of custom bar code labels	167	63.	Default Loop IDs and their associated AL_PAs for drives with single or dual ports	199
56.	Types of IBM 3592 TotalStorage Enterprise Tape Cartridges	170	64.	Valid Loop IDs and their associated AL_PAs for Ultrium tape drives and 3592 tape drives in the IBM System Storage TS3500 Tape Library.	201
57.	Environment for operating, storing, and shipping the IBM TotalStorage 3592 Enterprise Tape Cartridge	188	65.	Quantity of storage slots in L22, D22, L23, D23, and S24 frames	207
58.	Descriptions of 3599 tape media features	190	66.	Quantity of storage slots in Model L32 and D32 frames	208
59.	Ordering 3592 media supplies by using part numbers	193	67.	Quantity of storage slots in Model L52, D52, L53, D53, and S54 frames	209
60.	Authorized suppliers of custom bar code labels	194	68.	Tape drive configuration for encryption	216
61.	Supported cable distances	196			
62.	Choosing the port and topology through which your Fibre Channel connection can be made	198			

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:



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.
	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...
	<p>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)</p>

Sample caution notices follow:

Caution

The battery is a lithium ion battery. 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, a router, or a 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 xv for an example of the label.

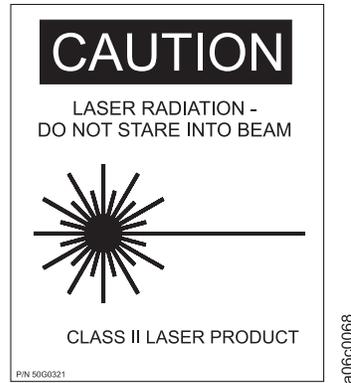


Figure 1. Laser safety caution label

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 System Storage TS3500 Tape Library, 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 227 for definitions of terms, abbreviations, and acronyms in this publication.

Related information

Refer to the following publications and sources for additional information about the TS3500 Tape Library and its associated products.

To view the IBM System Storage TS3500 Tape Library Information Center, go to:

Note that 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/>

Also note that the most up-to-date information is available at the IBM System Storage TS3500 Tape Library Information Center. To view this information center, go to:

<http://publib.boulder.ibm.com/infocenter/ts3500t1/v1r0/index.jsp>

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 System Storage TS3500 Tape Library Introduction and Planning Guide*, GA32-0559
- *IBM System Storage TS3500 Tape Library with ALMS Operator Guide*, GA32-0594
- *IBM System Storage TS3500 Tape Library Operator Guide*, GA32-0560
- *IBM System Storage TS3500 Tape Library 3584 Maintenance Information* (provided with the TS3500 Tape Library)
- *IBM System Storage TS3500 Tape Library SCSI Reference*, GA32-0561
- *IBM System Storage TS3500 Tape Library with ALMS Tape System Reporter User's Guide*, GA32-0589

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/series/>.

IBM Power Systems and System p source

For information about the IBM Power Systems and System p, visit the web at <http://publib16.boulder.ibm.com/pseries/index.htm>.

IBM System z source

For information about the IBM System z servers, visit the web at <http://www.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://www.ibm.com/storage/lto>. Under IBM System Storage TS3500 Tape 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*, GA76-0148
- *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 System Storage 3592 Tape Drives and TS1120 Controller Operator Guide*, GA32-0556
- *IBM System Storage 3592 Tape Drives and TS1120 Controller Introduction and Planning Guide*, GA32-0555
- *IBM System Storage TS1120, TS1130, and TS1140 Tape Drives Maintenance Information*
- *IBM System Storage 3592 Tape Drive SCSI Reference*, GA32-0562
- *IBM System Storage TS3000 System Console (TSSC) Maintenance Information*
- *IBM Virtualization Engine TS7700 Series Introduction and Planning Guide IBM Virtualization Engine TS7700, TS7700 Cache Controller, and TS7700 Cache Drawer*, GA32-0567
- To search the IBM Virtualization Engine TS7700 Information Center, visit the Web here: <http://publib.boulder.ibm.com/infocenter/ts7700/cust/index.jsp>
- *IBM Virtualization Engine 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/resourceink>. 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 www.redbooks.ibm.com. Search on REDP-3580.
- *IBM System Storage 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/resource-library.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 listed in Table 1.

Attention: The IBM System Storage 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)* 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 which allow end 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
Notes:	
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 System Storage TS3500 Tape Library, machine type 3584, also 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

This topic describes the IBM System Storage TS3500 Tape Library, 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 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.

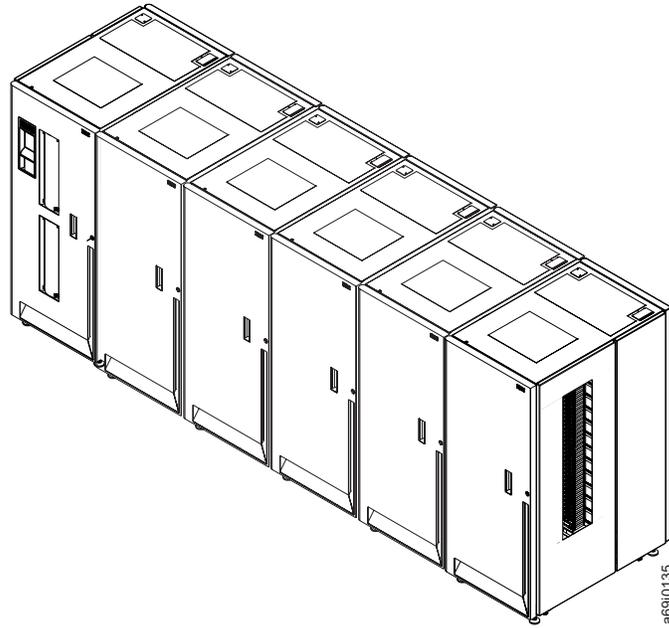


Figure 2. The TS3500 Tape Library

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) or Storage Management Initiative - Specification (SMI-S) standards-based software
- 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	30 PB (26.65 PiB)
L32, D32, and S54	Ultrium tape drives	> 20 000	30 PB (26.65 PiB)
L2x, D2x, and S24	3592 tape drives	> 15 000	60 PB (53.3 PiB)
L5x, D5x, S54, and SC1	Ultrium tape drives	> 300 000	450 PB (399.68 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	Ultrium tape drives	> 300 000	450 PB (399.68 PiB)
L2x, D2x, S24, and SC1	3592 tape drives	> 225 000	900 PB (799.36 PiB)

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 5 or 3592 E07 tape drives. In addition, the figures for libraries with Model SC1 (shuttle connection) are based on the maximum shuttle complex configuration.

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 25. 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

This topic defines base and expansion frames and describes 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	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> Might require L23 model conversion OR installation of FC 1700¹
L23	Base frame	Short	3592	Up to 12 drives and up to 260 cartridges	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> Optionally configured as service bay B Might require D23 model conversion OR installation of FC 1701¹

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	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> Might require installation of FC 1700¹
D32	Expansion frame	Long	LTO Ultrium	Up to 12 drives and up to 440 cartridges	<ul style="list-style-type: none"> Might require installation of FC 1701¹
L52	Base frame	Short	LTO Ultrium	Up to 12 drives and up to 287 cartridges	<ul style="list-style-type: none"> Might require L53 model conversion OR installation of FC 1700¹
L53	Base frame	Short	LTO Ultrium	Up to 12 drives and up to 287 cartridges	<ul style="list-style-type: none"> Equipped with the enhanced frame control assembly
D52	Expansion frame	Short	LTO Ultrium	Up to 12 drives and up to 440 cartridges	<ul style="list-style-type: none"> Optionally configured as service bay B Might require D53 model conversion OR installation of FC 1701¹
D53	Expansion frame	Short	LTO Ultrium	Up to 12 drives and up to 440 cartridges	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> Optionally configured as service bay B Optionally equipped with a shuttle station

Note:

1. Prerequisite for any frame with a node card installed in a library string with code level 9500 or higher.

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 System Storage 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.

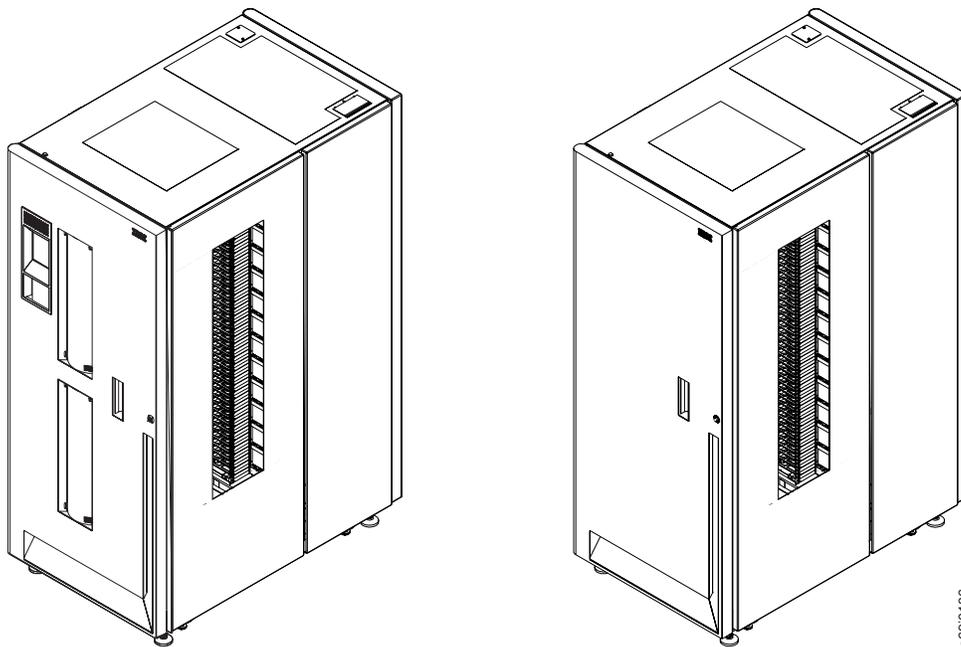


Figure 3. Frames in the IBM System Storage TS3500 Tape Library

Dual accessors and service bays

This topic describes 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 utilizing an additional accessor. The additional 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.

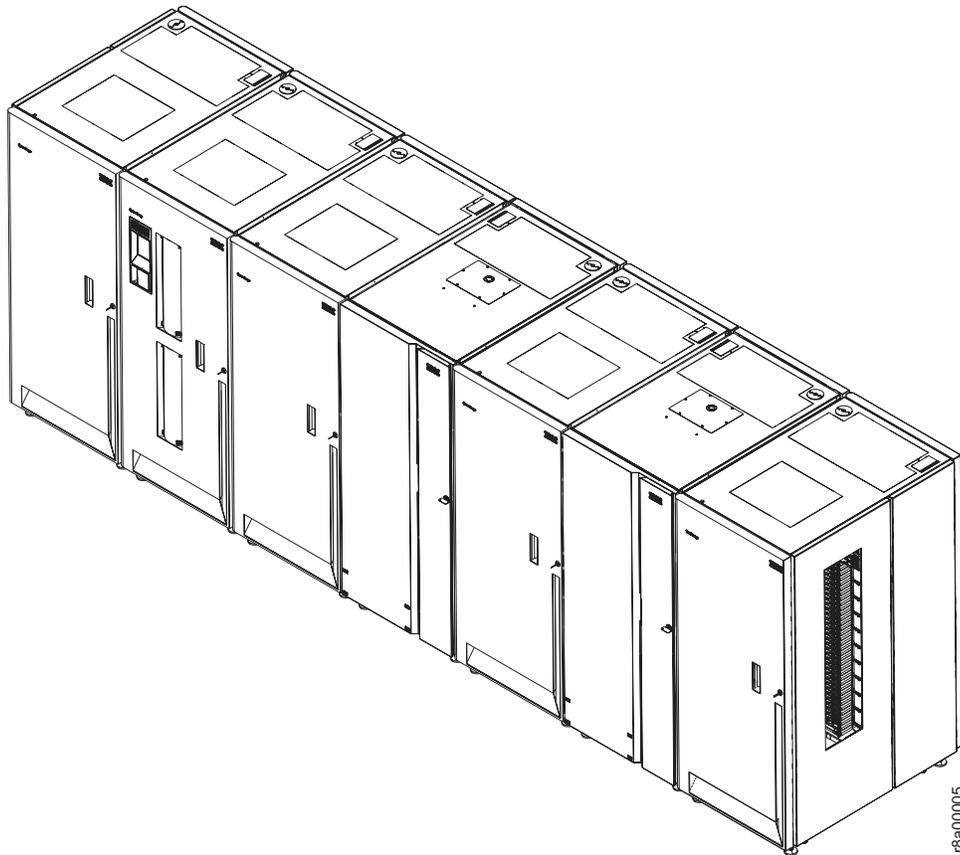


Figure 4. Location of service bays in the TS3500 Tape Library

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 System Storage TS3500 Tape Library 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.

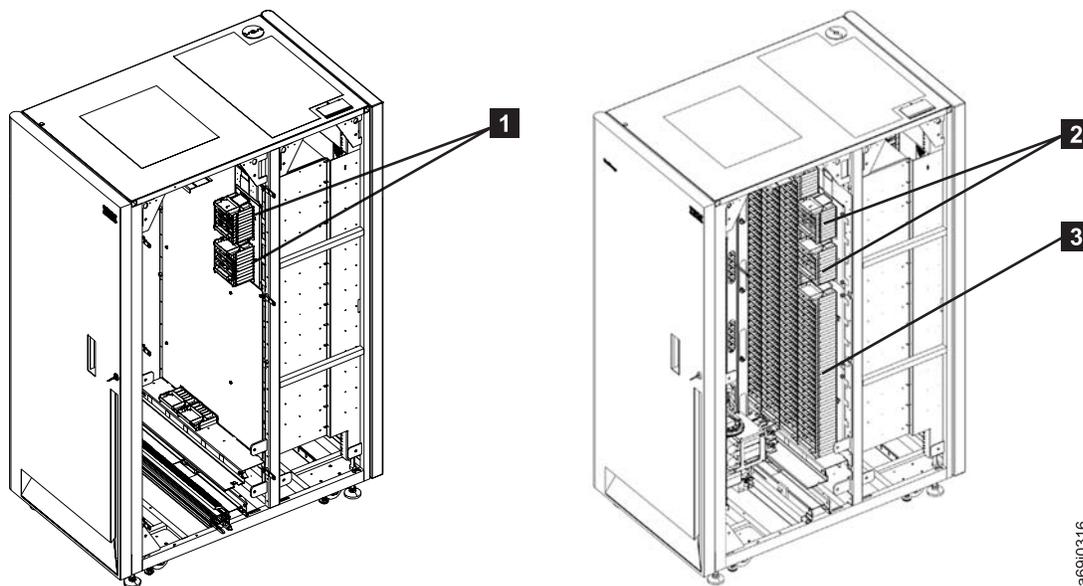


Figure 5. Cartridge slots in the service bays of the TS3500 Tape Library

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:

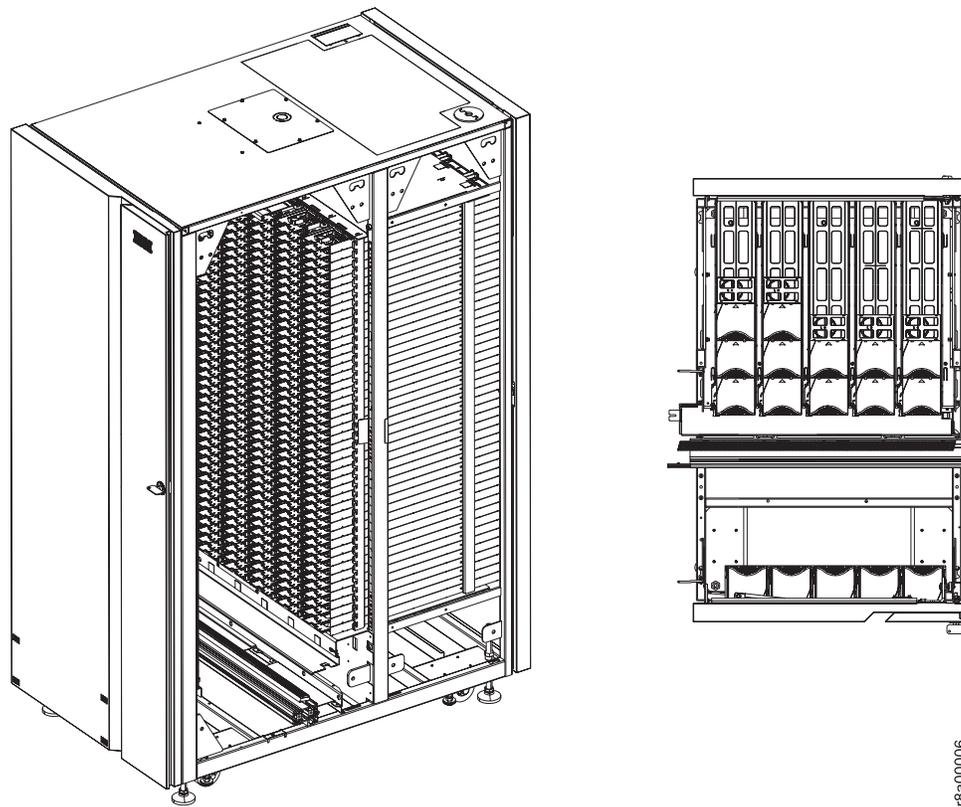
- If you convert an existing HD frame from a service bay to an expansion frame, a Capacity on Demand feature (1645 or 1646) is required in order to use the full capacity of the frame. If an HD frame is ordered to be used as service bay B, it does not require a Capacity on Demand feature.
- In order to 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 83.

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 Ultrium 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 Ultrium (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 Ultrium cartridge. The single-deep slots on the door side of HD frames are referred to as Tier 0 slots. On the left, Figure 6 on page 10 shows the inside of an HD frame from the side. On the right, Figure 6 on page 10 shows a top-down view of one row of an HD frame with cartridges in Tiers 0 (door side), 1, 2, and 3.



r8a00006

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

Attention: The HD slots have a constant force spring for maintaining forward pressure on the tape cartridges. Use caution when 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 Ultrium 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. In order 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 you to utilize the storage space available in the remaining tiers. For more information, see “High Density Capacity On Demand” on page 55.

Note: These numbers represent raw capacity and do not reflect actual recommended capacity. It is recommended that actual capacity does not exceed 99% of the raw capacity due to the need to maintain unused slots in order to perform a *shuffle* operation.

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. For more information about HD frames and library performance, see “Library performance” on page 83.

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 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.
- 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.

Components of the library

This topic describes 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 System Storage TS3500 Tape Library 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.

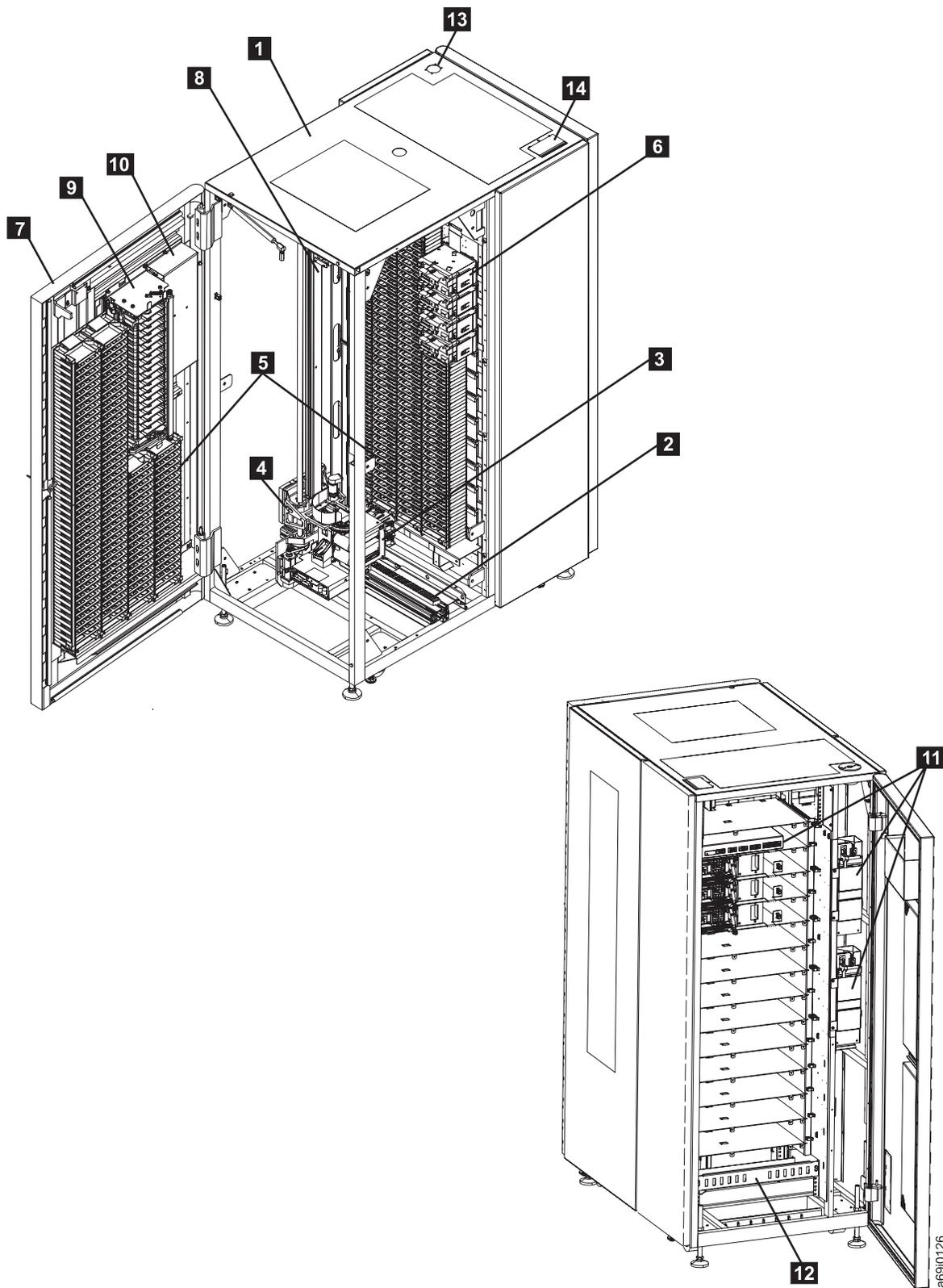


Figure 7. Components of the IBM System Storage TS3500 Tape Library. The front of a Model L53 is shown at the top. The rear of Model L53 is shown on the bottom.

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.

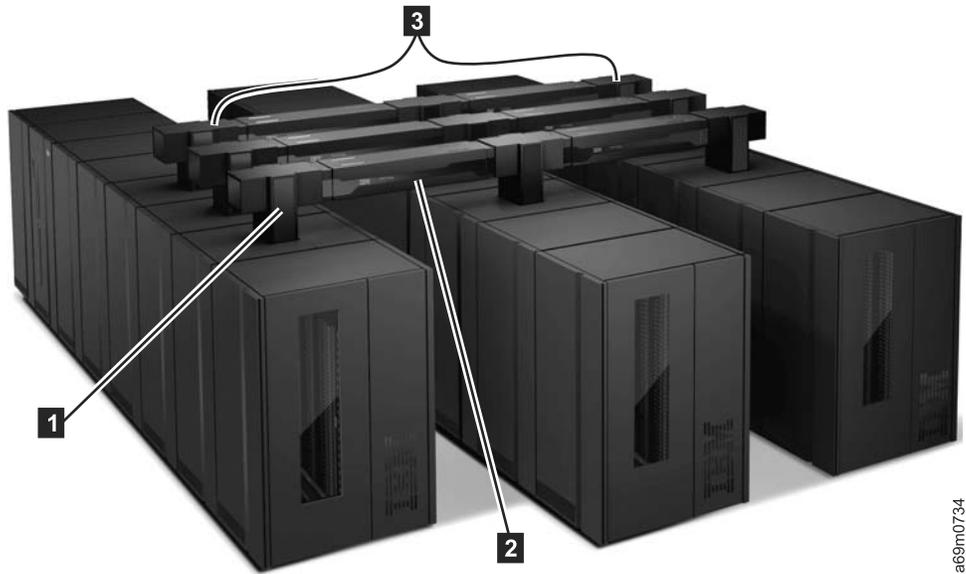


Figure 8. TS3500 Tape Library shuttle complex

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 or eRMM, 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 System Storage 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 System Storage 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 System Storage 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 System Storage 3588 Tape Drive Model F3A	2 Gbps Fibre	80 MB/s	400 GB (372.53 GiB)	
IBM TotalStorage 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 TotalStorage 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 System Storage TS1140 Tape Drive ¹	8 Gbps Fibre	250 MB/s	4 TB ⁴ (3.6 TiB) 1.6 TB ³ (1.46 TiB)	Also known as the 3592 Model E07
IBM System Storage TS1130 Tape Drive	4 Gbps Fibre	160 MB/s	1 000 GB ³ (931.32 GiB) 640 GB ² (596.05 GiB)	Also known as the 3592 Model E06 or EU6
IBM System Storage TS1120 Tape Drive	4 Gbps Fibre	100 MB/s	700 GB ³ (651.93 GiB) 500 GB ² (465.66 GiB)	Also known as the 3592 Model E05

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 TotalStorage 3592 Tape Drive Model J1A	2 Gbps Fibre	40 MB/s	300 GB (279.39 GiB)	Withdrawn from marketing as of September 2006
Notes:				
<ol style="list-style-type: none"> 1. In order to support Ultrium 5 or TS1140 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. JA/JW cartridge 3. JB/JX cartridge 4. JC/JY 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 System Storage 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 System Storage TS3500 Tape Library with ALMS Operator Guide*.

LTO Ultrium tape drives

There are five generations of Linear Tape-Open (LTO) Ultrium tape drives. The newest of these drives, the IBM System Storage TS1050 Tape Drive Model F5A, is a dual-ported drive that facilitates 8 Gbps Fibre Channel connectivity. This drive is also known as the Ultrium 5 tape drive and is differentiated by its model number 3588 F5A.

Note: In order to support Ultrium 5 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 five generations of LTO Ultrium drives are listed below:

- IBM System Storage TS1050 Tape Drive (8 Gbps, dual ports)
- IBM System Storage TS1040 Tape Drive (4 Gbps, single port)
- IBM System Storage TS1030 Tape Drive Models F3B (4 Gbps, single port)
- IBM System Storage TS1030 Tape Drive Models F3A (2 Gbps, single port)
- IBM TotalStorage LTO Ultrium 2 Tape Drive (2 Gbps, single port)
- IBM TotalStorage LTO Ultrium 1 Tape Drive (1 Gbps, single port)

You can identify all Ultrium 2 and newer 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 000764L5 is an Ultrium 5 cartridge; a cartridge with a VOLSER of 000764L4 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 newer 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 newer 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 211. 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 212.

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 79 for Ultrium tape drive performance specifications.

3592 tape drives

There are four generations of 3592 tape drives: TS1140 (Model E07), TS1130 (Models E06 and EU6), TS1120 (Model E05), and J1A. Each generation of drive offers an increased data rate and increased native capacity from the previous model, in addition to other enhancements. All generations of 3592 tape drives offer 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 for details about these and other 3592 tape drive features. For information about encryption, refer to Chapter 8, “Tape encryption overview,” on page 211.

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 and TS1140 tape drives (3592 Models E06 and E07) 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 shows the basic features of each generation of the 3592 tape drive. Refer to “Drive performance” on page 79 for additional 3592 tape drive performance specifications.

Table 7. Features of the 3592 tape drive

Feature	3592 tape drives			
	TS1140 (Model E07)	TS1130 (Model E06 or EU6)	TS1120 (Model E05)	Model J1A
Native sustained data rate	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)	650 MB/s (E07 format)	350 MB/s (E06 format)	280 MB/s (E05 format)	120 MB/s (J1A format)
Native Capacity	4 TB (3.64 TiB) ¹ 1.6 TB (1.46 TiB) ² 500 GB (465.66 GiB) ⁵	1 000 GB (931.32 GiB) ² 640 GB (596.05 GiB) ³ 128 GB (119.21 GiB) ⁴	700 GB (651.93 GiB) ² 500 GB (465.66 GiB) ³ 100 GB (93.13 GiB) ⁴	300 GB (279.39 GiB) ³
Write-once-read-many (WORM) capability	Yes			

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

Capacity scaling and short cartridge	Yes			
Read/write capability	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 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, 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 400 MB/s		Maximum interface burst transfer rate of 200 MB/s
	Supports N and L ports with autoconfigure			
Encryption	All TS1140 tape drives are encryption capable	All TS1130 tape drives are encryption capable	With feature code 9592 or 5592	Not supported
Notes:				
1. Using JC/JY media				
2. Using JB/JX media				
3. Using JA/JW media				
4. Using JJ/JR media				
5. Using JK 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. 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 172. For a complete matrix of read and write compatibility 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 System Storage 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, and JC media types. For the exact Mode Select commands and settings necessary to invoke scaling, refer to the *IBM System Storage TS3500 Tape Library SCSI Reference*.

WORM

The 3592 tape drives support write-once-read-many (WORM) behaviors and format attributes. Four WORM cartridge types are supported: JW (full length), JR (short length), JX Extended WORM cartridge (for TS1120, TS1130, and TS1140 tape drives), and JY Advanced WORM cartridge (for TS1140 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). 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 211. 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 System Storage TS3500 Tape Library with ALMS Operator Guide*.

Firmware for each model of 3592 tape drive (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 cartridges

Supported tape cartridges	Native capacity	Compressed capacity ¹
IBM System Storage LTO Ultrium-5 1500 GB Data Cartridge	1 500 GB (1396.98 GiB)	3 TB (2.73 TiB)
IBM System Storage LTO Ultrium-4 800 GB Data Cartridge	800 GB (745.06 GiB)	1 600 GB (1 490.12 GiB)
IBM TotalStorage LTO Ultrium-3 400 GB Data Cartridge ²	400 GB (372.53 GiB)	800 GB (745.06 GiB)
IBM TotalStorage 3589 Ultrium Tape Cartridge Models 028 and 029 ³	400 GB (372.53 GiB)	800 GB (745.06 GiB)
IBM TotalStorage 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. Compressed capacity at 2:1 compression
2. This cartridge is for the Ultrium 3 tape drives with or without write once read many (WORM) capability.
3. 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
E07 tape drive format ²	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	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)

Table 9. Capacity of 3592 tape cartridges (continued)

3592 tape cartridge	Media type	Native capacity	Compressed capacity ¹
E05 tape drive format ⁴	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}	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. Compressed at 3:1 compression
2. JA, JJ, JW, and JR 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.

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 media” on page 169. For additional information about Ultrium tape cartridges, refer to “Overview of Ultrium Media” on page 141.

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

This section identifies ways to determine the servers and software that support the TS3500 Tape Library.

The TS3500 Tape Library is supported by a wide variety of servers, operating systems, and adapters. These attachments can change throughout the life cycle 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 Ultrium tape drives, visit the web at <http://www.ibm.com/storage/lto>. Under IBM System Storage TS3500 Tape 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.
- 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

This section identifies ways to determine the latest device drivers for the drives and robotics of the TS3500 Tape Library.

IBM provides device driver support for the Ultrium tape drives, 3592 tape drives, and the robotics in the TS3500 Tape Library. The device drivers also provide support for application-managed encryption on AIX, Windows, Linux, Solaris, and HP-UX platforms, and for system-managed encryption in Open Systems, on AIX, Windows, Linux, and Solaris platforms.

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 **Storage Systems** from the **Product Group** list.
2. Select **Tape Systems** from the **Product Family** list.
3. Select **Tape device drivers and software** from the **Product Type** list.
4. Select the appropriate driver option based on your operating system from the **Product** list.
5. Select the correct version from the **Version** list (if applicable).
6. Select the correct platform from the **Platform** list.
7. Then click **Continue**.

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> .

Using `mtlib` for communication

This section describes the `mtlib` program, which facilitates communication between the TS3500 Tape Library and the IBM TotalStorage 3494 Tape Library, IBM TotalStorage Virtual Tape Server (VTS), or IBM Virtualization Engine TS7700 Series.

The `mtlib` program is a command-line interface that was originally designed to control the 3494 Tape Library. It comes as part of the 3494 device driver, similar to the way the `tapeutil` utility comes with the SCSI tape device driver.

The `mtlib` program provides an interface from the server to a 3494 Tape Library, and also to the virtual tape drives and cartridges within an attached VTS or TS7700 Virtualization Engine.

The `mtlib` program has recently been enhanced to also work with SCSI tape libraries, such as the TS3500 Tape Library installed with only 3592 tape drives. Some customers have written `mtlib` scripts to work with the 3494 Tape Library. If a customer with a 3494 Tape Library decides to migrate to the TS3500 Tape Library, this `mtlib` enhancement will ease the migration.

Existing customer scripts that use the `mtlib` program require no changes, or minor changes, depending on the functions of the 3494 Tape Library that are used. For example, there is no *category* concept in SCSI tape libraries, so any `mtlib` command that references categories might need to be changed.

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

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 Virtualization Engine Model TS7740), then to the TS3500 Tape Library
- Through a TS7700 Virtualization Engine Model TS7740 with integrated library manager (code level 8.5.0.x and higher), then to the TS3500 Tape Library with frame model L23 or D23 equipped with 4 Gb Fibre Channel switches (feature code 4872 or 4873) or 8 Gb Fibre Channel switches (two of feature code 4875)

Note: In order to support 8 Gb Fibre Channel switches, the TS7740 must be at code level 8.20.0.x or higher.

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

This section describes Fibre Channel technology and where to find additional information for drives that use a Fibre Channel interface.



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 Ultrium tape drives, visit the web at <http://www.ibm.com/storage/lto>. Under IBM System Storage TS3500 Tape 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.

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 System Storage TS3500 Tape Library SCSI Reference*.

FICON and ESCON interfaces

This section describes 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 System Storage TS1120 Tape Controller Model C06 (3592 C06)
 - IBM TotalStorage 3592 Tape Controller Model J70 (3592 J70)
 - IBM TotalStorage 3494 Virtual Tape Server Model B10 (3494 B10)
 - IBM TotalStorage 3494 Virtual Tape Server Model B20 (3494 B20)
 - IBM Virtualization Engine TS7740 (code level 8.4.1.x and earlier)
- Through an IBM Virtualization Engine TS7740 with integrated library manager (code 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 4 Gb Fibre Channel switches (feature code 4872 or 4873) or 8 Gb Fibre Channel switches (two of feature code 4875). In order to use the 8 Gb Fibre Channel switches, the TS7740 must be at code level 8.20.0.x or later.

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 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*. For additional information about attaching the IBM System z server to the TS3500 Tape Library through the IBM Virtualization Engine TS7740, refer to the *IBM Virtualization Engine TS7700 Series Introduction and Planning Guide IBM Virtualization Engine TS7700, TS7700 Cache Controller, and TS7700 Cache Drawer* or the *IBM Virtualization Engine TS7700 Information Center*. Refer also to the *IBM System Storage TS3000 System Console (TSSC) Maintenance Information* and the *IBM System Storage TS3000 System Console (TSSC) Maintenance Information* guides.

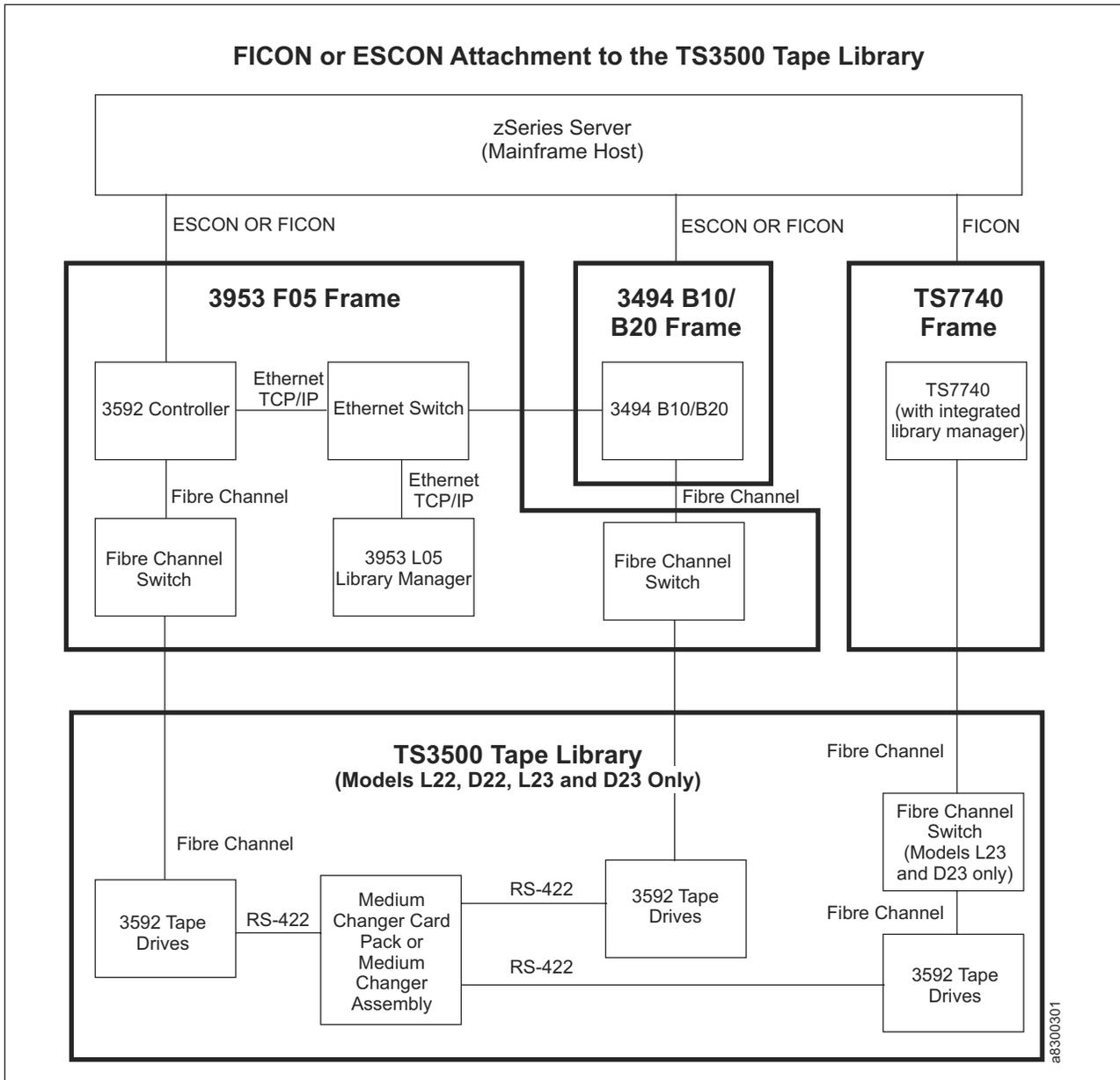


Figure 9. Attaching the TS3500 Tape Library to the System z server (mainframe host)

Mixing drives in frames

This section contains 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 215.

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 5 tape drives	No	No	Yes†	Yes†	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
TS1140 tape drive	Yes†	Yes	No	No	No
TS1130 tape drive	Yes†	Yes	No	No	No
TS1120 tape drive	Yes	Yes	No	No	No
3592 J1A tape drive	Yes	Yes	No	No	No

† This configuration requires an xx3 model conversion or the enhanced node card(s) feature (FC 1700 or 1701).

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 215.

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.

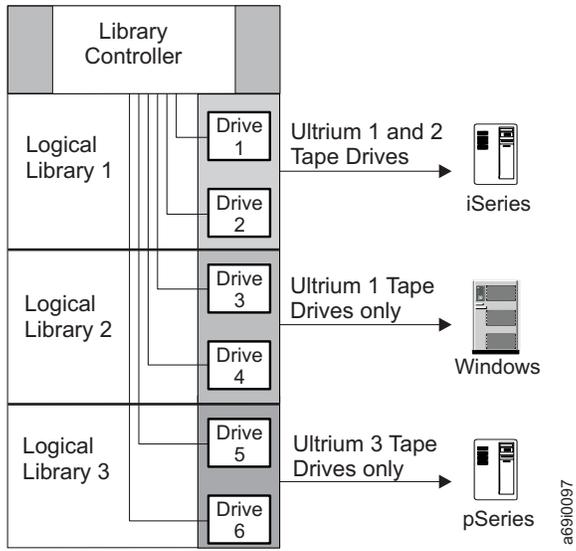


Figure 10. Examples of methods for mixing Ultrium drive types in a logical library

Mixing media in drives

This section contains 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 000764L5 is an Ultrium 5 cartridge, a cartridge with a VOLSER of 000764L4 is an Ultrium 4 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 5 (F5A)	Ultrium 4 (F4A)	Ultrium 3 (F3A/ F3B)	Ultrium 2	Ultrium 1
IBM System Storage 1500 GB LTO Data Cartridge (xxxxxxL5)	R/W	Not compatible	Not compatible	Not compatible	Not compatible
IBM System Storage 1500 GB LTO WORM Data Cartridge (xxxxxxLV)	R/W	Not compatible	Not compatible	Not compatible	Not compatible
IBM System Storage 800 GB LTO Data Cartridge (xxxxxxL4)	R/W	R/W	Not compatible	Not compatible	Not compatible
IBM System Storage 800 GB LTO WORM Data Cartridge (xxxxxxLU)	R/W	R/W	Not compatible	Not compatible	Not compatible
IBM System Storage 400 GB LTO Data Cartridge (xxxxxxL3)	Read only	R/W	R/W	Not compatible	Not compatible
IBM System Storage 400 GB LTO WORM Data Cartridge (xxxxxxLT)	Read only	R/W	R/W	Not compatible	Not compatible

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

Cartridge Type	Drive Type				
	Ultrium 5 (F5A)	Ultrium 4 (F4A)	Ultrium 3 (F3A/ F3B)	Ultrium 2	Ultrium 1
IBM System Storage 200 GB LTO Data Cartridge (xxxxxxL2)	Not compatible	Read only	R/W	R/W	Not compatible
IBM System Storage 100 GB Data Cartridge (xxxxxxL1)	Not compatible	Not compatible	Read only	R/W	R/W

Notes:

- In order to support Ultrium 5 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	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	
JC, JY ¹ , JK	EEFMT4 (encrypted E07)	R/W	Reformat	Not supported	Not supported	Not supported	Not supported	Not supported
	EFMT4 (E07)	R/W	R/W	Not supported	Not supported	Not supported	Not supported	Not supported
	EEFMT3 (encrypted E06)	R/W	Reformat	Not supported	Not supported	Not supported	Not supported	Not supported
	EFMT3 (E06)	R/W	R/W	Not supported	Not supported	Not supported	Not supported	Not supported
JB, JX ¹	EEFMT3 (encrypted E06)	R/W	Reformat	R/W	Reformat	Reformat	Reformat	Not supported
	EFMT3 (E06)	R/W	R/W	R/W	R/W	Reformat	Reformat	Not supported
	EEFMT2 (encrypted E05)	Read only	Reformat	R/W	Reformat	R/W	Reformat	Not supported
	EFMT2 (E05)	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	R/W	Reformat	Reformat	Reformat	Reformat
	EFMT3 (E06)	Not supported	Not supported	R/W	R/W	Reformat	Reformat	Reformat
	EEFMT2 (encrypted E05)	Not supported	Not supported	R/W	Reformat	R/W	Reformat	Reformat
	EFMT2 (E05)	Not supported	Not supported	R/W	R/W	R/W	R/W	Reformat
	EFMT1 (J1A)	Not supported	Not supported	Read only	Read only	R/W	R/W	R/W

Notes:

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

Multi-Path Architecture

This topic explains Multi-Path Architecture feature of the TS3500 Tape Library, which allows Open Systems applications to share the library's robotics.

The TS3500 Tape Library features the storage area network (SAN)-ready Multi-Path 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 Multi-Path 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 for Ultrium 1 and Ultrium 2 tape drives if your application does not support the mixing of Ultrium 1, Ultrium 2, Ultrium 3, Ultrium 4, and Ultrium 5 tape drives and media in the same logical library. The Multi-Path Architecture is compliant with the following attachment interfaces:

- Small computer system interface (SCSI)
- Fibre channel

The Multi-Path 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. I/O slots are shared on a first come, first served 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 2003 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 Ultrium 2 tape drives and cartridges from Ultrium 4 tape drives and cartridges, or 3592 tape drives and cartridges, for applications which 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 Multi-Path 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

This section describes ways that you can configure the TS3500 Tape Library 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 pSeries® application and a Windows application) and multiple homogeneous applications (for example, the same application run by several pSeries servers).

From the library's web interface or operator panel, you can 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.

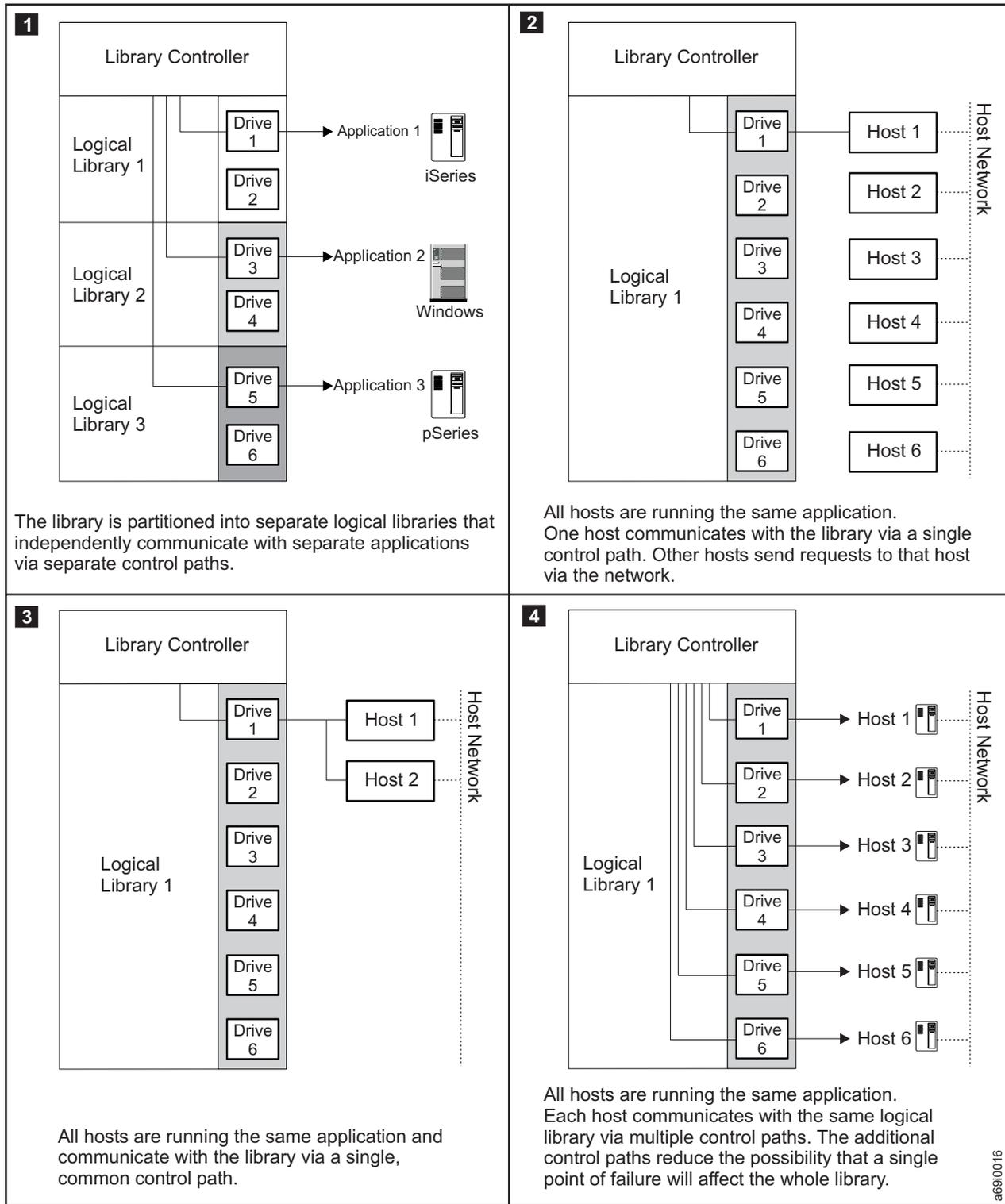


Figure 11. Examples of configurations for sharing an IBM System Storage TS3500 Tape Library. Lines from one or more drives to the library controller represent control paths.

Using multiple logical libraries

To maximize your investment, you can use multiple logical libraries to share the physical TS3500 Tape Library between applications or to support mixed drive types for any application. The sections that follow give guidelines for both processes.

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

- Tape drives
- Storage slots
- Input/Output (I/O) slots
- Cartridge accessor

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 Ultrium 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. However, a logical library cannot include both LTO and 3592 elements. That is, you must configure LTO and 3592 elements (drives, storage slots, I/O slots, and grippers) into separate logical libraries.

A frame that uses Ultrium 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 System Storage TS3500 Tape Library 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 215.

To create or change the configurations for your TS3500 Tape Library, see the *IBM System Storage TS3500 Tape Library with ALMS Operator Guide*.

With automatic cleaning, any appropriate cleaning cartridge can be used to clean a drive in any configured logical library, even if the cartridge resides in a different logical library.

The following sections describe two uses for multiple logical libraries.

Using multiple logical libraries for library sharing

Multiple logical libraries are an effective way for the TS3500 Tape Library to simultaneously back up and restore data from heterogeneous applications. For example, 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, and commands from Application 3 (about Department C) in Logical Library 3. In this configuration, the storage slots and drives in each logical library are dedicated to that library and are not shared among other libraries. Commands issued by the applications travel to the library through three unique control paths. Thus, the data processing for Department A is confined to the storage slots and drives in Logical Library 1, processing for Department B is confined to the storage slots and drives in Logical Library 2, and so forth.

Using multiple logical libraries for mixed drive types

For applications that do not support mixed drive types and media in the same logical library, the TS3500 Tape Library can use partitioning and multiple logical libraries to keep them separate. For example, you can partition Ultrium 5, Ultrium 4, Ultrium 3, Ultrium 2, and Ultrium 1 tape drives and their media into multiple and separate logical libraries.

Using multiple control paths

With the TS3500 Tape Library, in addition to creating multiple logical libraries, you can also configure any logical library to have more than one control path. When you configure additional control paths, additional library sharing configurations and availability options are made possible. Access to the logical library is on a first-come, first-served basis and 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. IBM recommends that you disable RSM to use this feature.

To add or remove additional control paths, see the *IBM System Storage TS3500 Tape Library with ALMS Operator Guide*.

The sections that follow describe two potential uses for multiple control paths.

Using 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 a high voltage differential (HVD) small computer system interface (SCSI) Ultrium 1 tape drive, IBM supports single drive configurations so that every HVD Ultrium 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 Ultrium 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.

Using multiple control paths for control path failover

The TS3500 Tape Library offers an optional control path failover feature that enables the host device driver to resend the command to an alternate control path for the same logical library.

Advanced Library Management System

This section explains the Advanced Library Management System (ALMS), which 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.

The capabilities of ALMS include:

- 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

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 can be placed in the file folder by using the Drive Assignment screen of the Tape Library Specialist Web interface. Cartridges can also be placed in the file folder, based on their volume serial (VOLSER) numbers and by using one of the following methods (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 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 System Storage TS3500 Tape Library with ALMS Operator Guide*.

The primary and backup copies of VOLSER assignment and physical location of cartridges are stored in non-volatile 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

With the Advanced Library Management System (ALMS) enabled in the TS3500 Tape Library, 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 in 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 System Storage TS3500 Tape Library 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

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.

Using virtual I/O slots

This section describes the benefits of using virtual input/output (I/O) slots.

When the Advanced Library Management System (ALMS) is enabled, you can enable virtual I/O slots in the TS3500 Tape Library so that the library automatically queues all cartridge moves between the I/O station and the storage slots. This 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 given 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. In this way, the library enhances its import and export capabilities.

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 the operator fills the I/O station with cartridges, he must wait for the I/O station to be cleared before he is able to insert additional cartridges, which means he is waiting 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 may need to export a large number of cartridges from the library. However, after the I/O station is filled, he must wait for the operator to physically remove cartridges from the entire I/O station before he 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 will maintain 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 49.

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 86.

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” 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 System Storage TS3500 Tape Library 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 Virtualization Engine 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 System Storage 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 System Storage TS3500 Tape Library 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 line 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 line cord capabilities.

The two power structures are compatible among frames in the same library.

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 line cords which connect to two independent branch power feeds. The line 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 Ultrium 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 DPF and CPF

Characteristic	CPF	DPF and Load Balancing for Ultrium 2 and newer 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	Y ⁴	Y	Y
Target-side failover	Y	Y ⁹	Y
IBM device driver required	Y	Y	Y
Operating systems supported	AIX ^(R) , SuSE Linux ^(TM) , Red Hat Enterprise Linux, Solaris, Windows, HP-UX, Asian UX	AIX, SuSE Linux, Red Hat Enterprise Linux, Solaris, Windows ⁶ (DPF only), Asian UX	AIX, SuSE Linux, Red Hat Enterprise Linux, Solaris, Windows ⁶ (DPF only), HP-UX, Asian UX
Order feature to obtain license key	Y	Y ^{7, 8}	N
SCSI attachment supported	Y	N ⁵	N
Fibre Channel attachment supported	Y	Y	Y

Table 13. Differences between DPF and CPF (continued)

Characteristic	CPF	DPF and Load Balancing for Ultrium 2 and newer tape drives	DPF and Load Balancing for 3592 tape drives
<p>Notes:</p> <ol style="list-style-type: none"> 1. SMC = SCSI-3 Medium Changer Specification (library) 2. SSC = SCSI-3 Stream Commands (drive) 3. LUN = logical unit number 4. Y = Yes 5. N = No 6. Load balancing is not supported on Windows 7. For Ultrium 2 tape drives, DPF and load balancing do not require a license key on AIX. 8. Ultrium 4 and newer tape drives do not require license keys at the host when configuring Data Path Failover. 9. DPF includes target-side failover for the dual-ported Ultrium 5 tape drive. 			

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

Note: The control path failover feature for Ultrium tape drives is activated by a license key that you enter at the library operator panel. The data path failover feature for Ultrium 1, Ultrium 2, and Ultrium 3 tape drives is activated by a license key that you enter at the host. For Ultrium 4 and newer 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 Ultrium Device Drivers Installation and User's Guide*.

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 "Using 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 207.

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 207.

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 207.

Web interface

This section gives basic information about the IBM System Storage 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 end 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 System Storage TS3500 Tape Library with ALMS Operator Guide*.

TS3500 Tape Library Command Line Interface

This topic describes the TS3500 Tape Library Command Line Interface (CLI) program, which 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

This section describes the IBM Tape System Reporter application and how it works in supported environments.

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 your 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, and E07) and from LTO Ultrium 2 and newer Ultrium tape drives.

The ccSARS data is available from 3592 E05, Ultrium 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.

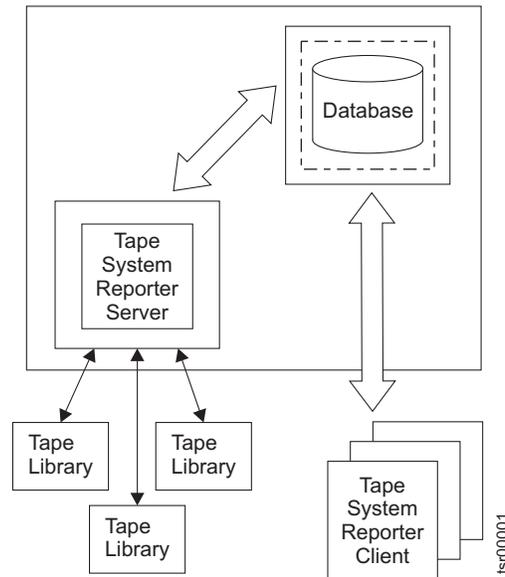


Figure 12. Tape System Reporter data flow

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 System Storage TS3500 Tape Library with ALMS 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

This section describes the types of remote support that the TS3500 Tape Library and its drives use to detect and solve problems.

Optional remote support is available for the TS3500 Tape Library through its Call Home capability. The Call Home feature uses a modem connection or a 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 may 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 may 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 information about the machine (library), including 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, and any machine-detectable features such as additional I/O stations, capacity expansion, and so forth. In the case of a Problem Call Home, the library also sends any trace files that are related to the problem.

Problem Call Home

The TS3500 Tape Library or one of its drives detects a problem and the library performs a Call Home operation to create a Problem Management Record (PMR) in the IBM Remote Technical Assistance Information Network (RETAIN). This is a single page of text data that enables the Support Center or the Service Representative to access 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 in order to ensure proper Call Home functionality. 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 library's operator panel. 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.

For more information, see:

- “Remote support through a modem”
- “Remote support through a system console” on page 60
- “Remote support security” on page 63
- “Power requirements for remote support features” on page 120

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 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)

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

Quantity of IBM Tape Products with Remote Support Capability	Requirement
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

This section describes remote support to 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 IBM TS7700 Virtualization Engine, 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. 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
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	L22, L23, L32, L52, L53	No	Customer rack-mountable TS3000 System Console (TSSC) (provides a TS3000 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 ³ in approved countries or an external modem that is supported by the TSSC server)

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 2733 provides an internal modem that is installed in the TSSC. Refer to "Feature codes for elements in the library" on page 131 for details and a list of supported countries.

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.

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.)

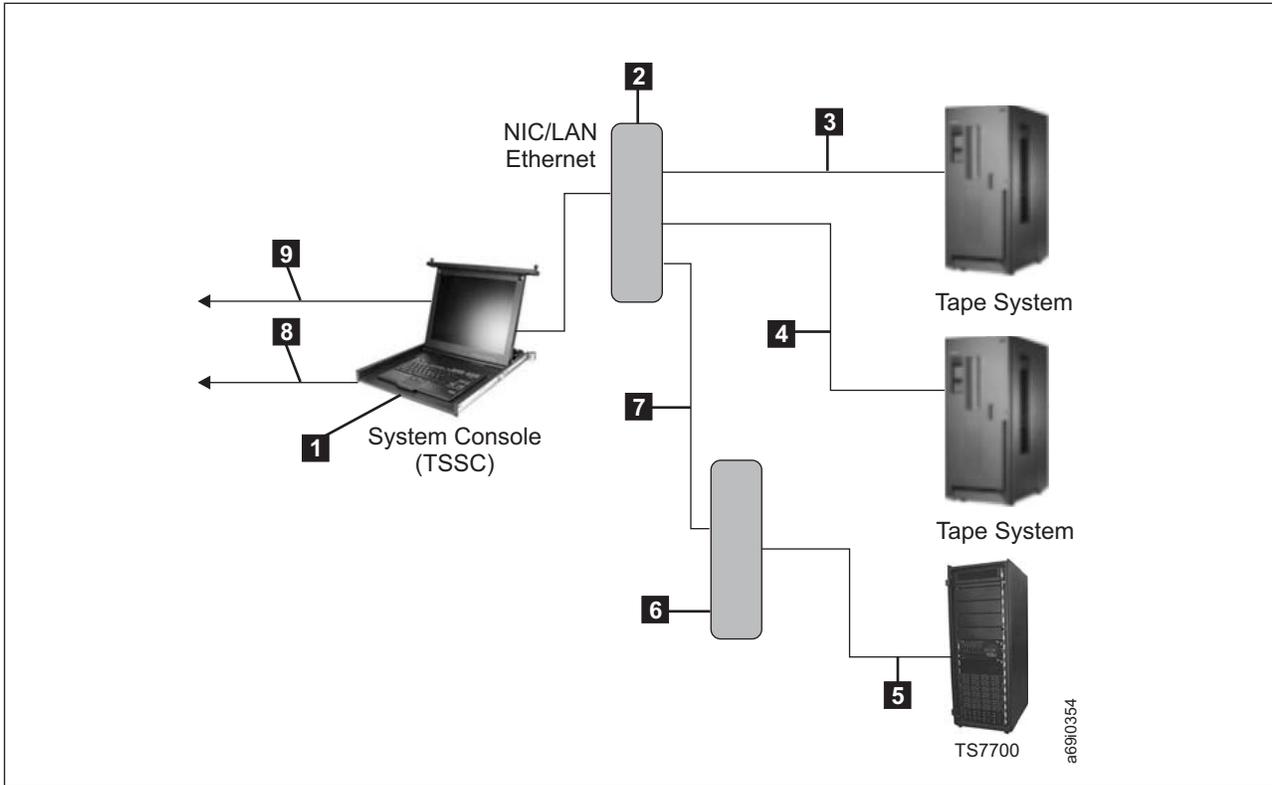


Figure 13. Remote support system console connection diagram

Table 17. System console components

- | | |
|---|--|
| 1 System console including KVM and 1U server (FC 2732) with internal modem (FC 2733) | 6 Ethernet switch expansion FC 2714 |
| 2 Ethernet switch supplied with FC 2732 | 7 Cable supplied with FC 2714 |
| 3 Cable supplied with FC 2732 | 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 utilize wellness checking, daily log file storage, or code image broadcast.

Table 18. Remote support capabilities

Customer site	Call Home events	<ul style="list-style-type: none"> • Error initiated • Heartbeat (regular interval) • Test
	System console support capability	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • Code image broadcast • Call home event log review • End-of-call completion report
IBM support	System console remote access	<ul style="list-style-type: none"> • Authenticated, secure remote access • Simultaneous call in and call home • Data transmission (TCP/IP) supported
	IBM call home database	<ul style="list-style-type: none"> • 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

This section describes the security design for remote support for the TS3500 Tape Library through a system console.

The TS3000 System Console (TSSC) provides Ethernet connectivity to all attached systems through a private internal network. 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 ports: HTTPS: Port 443 HTTP: Port 80, and DNS: Port 53.

Figure 14 on page 64 shows an overview of network connectivity.

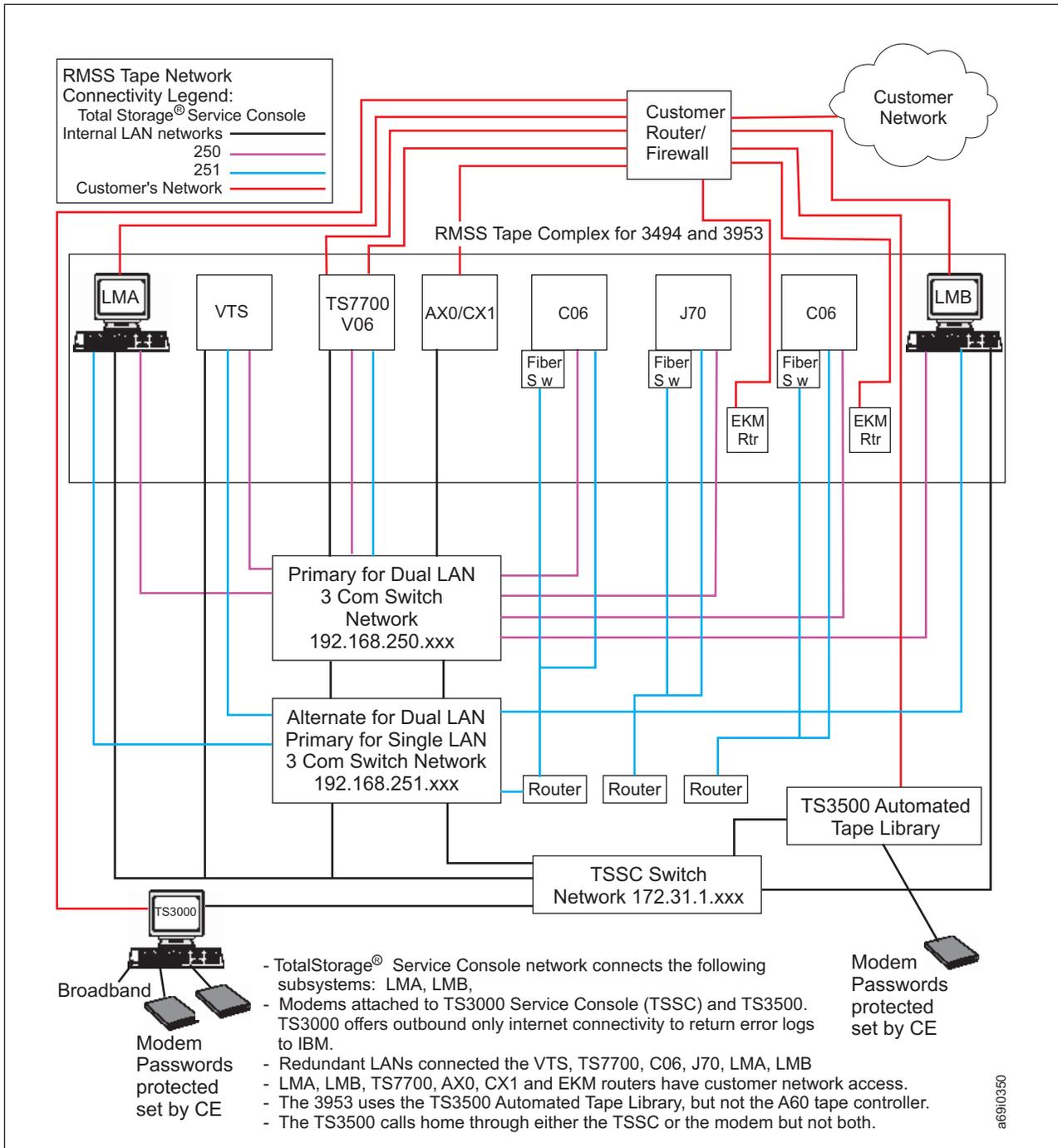


Figure 14. Attachment of the system console to the TS3500 Tape Library and the 3953 Tape System for remote support

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 may 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 which establishes connections only to RETAIN[®].

Dial In security features

Dial in is used by IBM Service Representatives to logon to 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 the modem connection. The optional Ethernet connection restricts all incoming traffic. Separate log ons are required for access to each of the Attached Systems.

Note: 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. The default is to disable remote call in. When remote call in is enabled, the default is to enable it for 24 hours.
- 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 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 19 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 19. Port Information for firewall environments

Function	Port	Direction (from library)	Protocol
Library Operations	3494	Bi-directional	TCP/IP
TotalStorage [®] Specialist	80	Inbound	TCP/IP
SNMP Traps	161/162	Bi-directional	UDP/IP
Encryption key manager	1443	Outbound	SSL
Encryption key manager	3801	Outbound	TCP/IP

Note: The TS3000 System Console uses the following ports: 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 19 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 System Storage Tape Library Specialist (IBM's Enterprise Storage Resource Management solution).
- Ports 161 and 162, which are the standard ports for sending SNMP traps. The tape library can be configured to send traps to SNMP target machines in the case of operator interventions, if so desired. 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 Tape Library through a system console

This section describes remote support security for the TS3500 Tape Library through a system console.

Figure 15 illustrates all of the external communication connections to the TS3500 Tape Library control system.

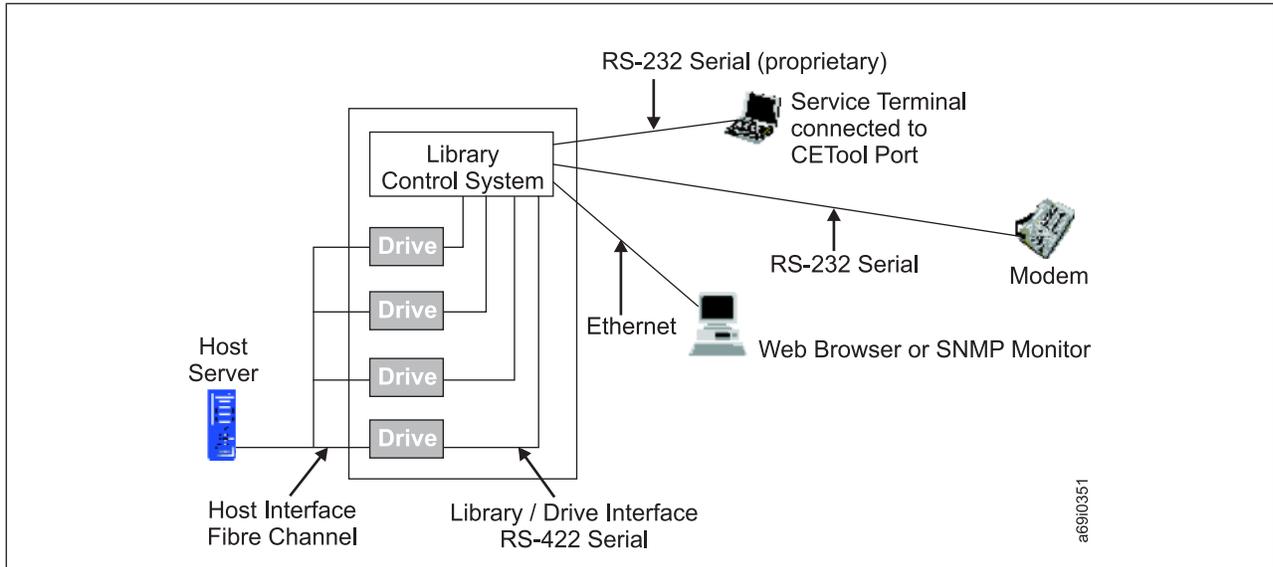


Figure 15. External communication connections to the TS3500 Tape Library control system

Access to read and write data to and from tape cartridges is only available on the host interface (Fibre Channel or SCSI). The host interface is provided by the drives. The library communicates with the drives through the Library/Drive Interface. The Ethernet port, modem port, and CETool 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 System Storage TS3500 Tape Library 3584 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 Tape Library Specialist Web interface 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, and these roles have lower levels of access than the administrator. In addition, when password protection is enabled, the Tape Library Specialist Web interface also provides an option to authenticate through the Storage Authentication Service (SAS). See the section about Web security in the *IBM System Storage TS3500 Tape Library 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 code. However, since the library and drives ignore any code they do not recognize, the only exposure is to loading down level code.

These security concerns can be addressed by utilizing the password, user role, and authentication features provided by the Tape Library Specialist Web interface and also by enabling SNMP audit logging. When SNMP audit logging is enabled, the library sends notifications when certain events occur in the library. For more information, refer to “SNMP audit logging” on page 71.

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

- Backup 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 System Storage TS3500 Tape Library 3584 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 TS3500 Tape Library must be kept clean to prevent errors 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 has been 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). For more information, see the section about automatic cleaning in the *IBM System Storage TS3500 Tape Library with ALMS Operator Guide*.

Manual cleaning

Manual cleaning requires that you select a menu option from the library's operator panel or Tape Library Specialist Web interface to perform cleaning on one or more of the tape drives. Manual cleaning is always supported, regardless of whether automatic cleaning is enabled or disabled. For more information, see the section about performing a manual cleaning operation in the *IBM System Storage TS3500 Tape Library with ALMS Operator Guide*.

TapeAlert support

This topic gives an overview of the TapeAlert technology, which is supported by the IBM System Storage TS3500 Tape Library.

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 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 System Storage TS3500 Tape Library with ALMS Operator Guide*.

SNMP messaging

This section describes the Simple Network Management Protocol (SNMP), which allows the TS3500 Tape Library to send alerts over a LAN network to a monitoring server.

Occasionally, the TS3500 Tape Library may 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^(R)) can be used to send e-mail 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 71 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 operator panel.

Figure 16 on page 71 shows the flow of SNMP communication from the library over the Ethernet local area network (LAN) to an SNMP monitoring server.

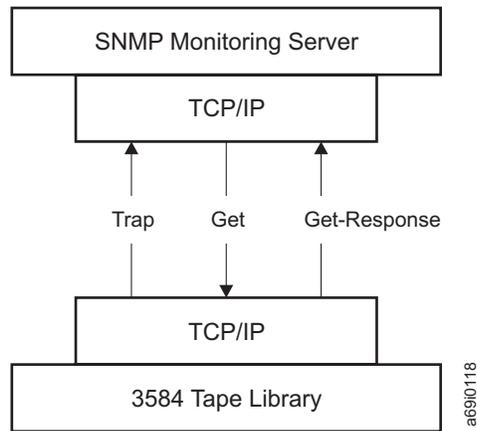


Figure 16. The SNMP messaging system

For information about interpreting an SNMP trap or using SNMP MIBs to monitor your library, see the appropriate sections in the *IBM System Storage TS3500 Tape Library 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 **Storage Systems** from the Product Group menu.
2. Select **Storage Software** from the Product Family menu.
3. Select **Software and Solutions** from the Product Type menu.
4. Select **All others** from the Product menu and click **Continue**. The IBM Support Portal window displays.
5. Under **Choose your products**, select **Hardware** → **System Storage** → **Tape systems** → **Tape autoloaders and libraries**.
6. Select **3584 Tape Library**.
7. Under **Choose your page**, select **Downloads** and click **Continue**.
8. Under **Downloads and fixes**, select **IBM 3584/TS3500 UltraScalable Tape Library SNMP MIB Files**.
9. Select the appropriate download. Windows users select **SNMP MIB 3584-MIB.zip**. Unix users select **SNMP MIB 3584-MIB.tar**.

SNMP audit logging

This topic describes the Simple Network Management Protocol (SNMP) audit logging, which 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 20. 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 System Storage TS3500 Tape Library 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 21. 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). SSL is a protocol for transmitting private documents through the Internet. SSL 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, 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

This topic describes the Storage Authentication Service (SAS), which is an option for web login requests on the TS3500 Tape Library.

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 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 higher. 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

Figure 17 shows an overview of the Storage Authentication Service.

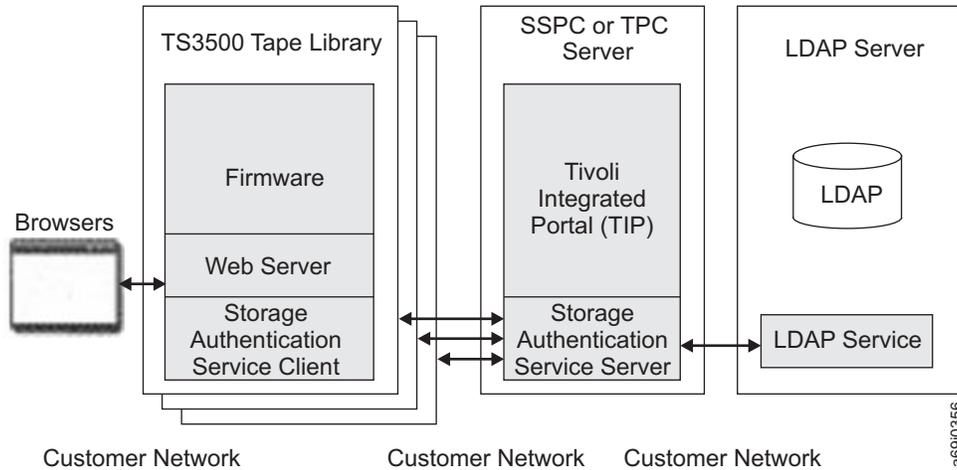


Figure 17. Storage Authentication Service overview

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 userid 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 may 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 the user belongs to. 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 both IPv4 and IPv6 format. 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

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. Examples of valid IPv4 addresses include:

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

Here is an example of 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 two formats:

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

An IPv6 (Normal) address has the following format: *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.

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)

Here is an example of 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.

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 prefix lengths (IPv6)

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 will attempt to find that address on the local link. If the system is on a different network, the packet is sent to a gateway which will then route the packet to the correct IP address. This is called Classless-InterDomain Routing (CIDR).

In IPv4, the subnet mask 255.255.255.0 is 24 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 4 octets like it is in IPv4, it is expressed as an integer between 1-128. 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.

Drive performance

This topic gives performance data for Ultrium and 3592 tape drives.

Table 22 provides drive performance of the Ultrium tape drives with different media. Table 23 on page 80 provides drive performance of the 3592 tape drives. Table 24 on page 81 provides additional information for 3592 media.

Table 22. Performance specifications of the Ultrium tape drives

Performance Parameter	Tape Drive				
	Ultrium 5	Ultrium 4	Ultrium 3	Ultrium 2	Ultrium 1
Sustained data rate (native) ¹	140 MB/s (with L5 media)	120 MB/s (with L4 media)	N/A	N/A	N/A
	120 MB/s (with L4 media)	80 MB/s (with L3 media)	80 MB/s (with L3 media)	N/A	N/A
	80 MB/s (with L3 media) ²	35 MB/s (with L2 media)	35 MB/s (with L2 media)	35 MB/s (with L2 media)	N/A
	N/A	N/A	20 MB/s (with L1 media)	20 MB/s (with L1 media)	15 MB/s (with L1 media)
Sustained data rate (compressed at 2:1 compression)	280 MB/s (with L5 media)	240 MB/s (with L4 media)	N/A	N/A	N/A
	240 MB/s (with L4 media)	160 MB/s (with L3 media)	160 MB/s (with L3 media)	N/A	N/A
	160 MB/s (with L3 media) ²	70 MB/s (with L2 media)	70 MB/s (with L2 media)	70 MB/s (with L2 media)	N/A
	N/A	N/A	40 MB/s (with L1 media)	40 MB/s (with L1 media)	30 MB/s (with L1 media)
Maximum sustained data rate (at maximum compression)	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	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	160 MB/s (Ultra160)	80 MB/s (Ultra2)
Burst data rate for High Voltage Differential (HVD) SCSI drives	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
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

Table 22. Performance specifications of the Ultrium tape drives (continued)

Performance Parameter	Tape Drive				
	Ultrium 5	Ultrium 4	Ultrium 3	Ultrium 2	Ultrium 1
Notes: N/A = not applicable.					
1. All sustained data rates are dependent on the capabilities of the interconnect (for example, an Ultra SCSI bus is limited to less than 40 MB/s).					
2. Read only					

Table 23. Performance specifications of the 3592 tape drives

Performance parameter	Tape Drive				
	TS1140 Tape Drive	TS1130 Tape Drive	TS1120 Tape Drive	3592 Model J1A Tape Drive	
Sustained data rate (native) ¹	250 MB/s (E07 format)	160 MB/s (E06 format)	100 MB/s (E05 format)	40 MB/s (J1A format)	
		140 MB/s (E05 format)			
	160 MB/s (E06 format)	70 MB/s (J1A format)	50 MB/s (J1A format)		
Compressed sustained data rate (at maximum compression)	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	400 MB/s		200 MB/s	
Load-to-ready time	15 seconds	13 seconds		19 seconds	
Unload time	24 seconds ²	23 seconds ²		21 seconds	
Maximum rewind time	Not supported	55 seconds (100% scaled JA)	66 seconds (100% scaled JA)	77 seconds (100% scaled JA)	
	72 seconds (100% scaled JB)		90 seconds (100% scaled JB)	Not supported	
	76 seconds (100% scaled JC)	Not supported	Not supported	Not supported	
	Not supported	18 seconds (20% scaled JA)		18 seconds (20% scaled JA)	
	24 seconds (20% scaled JB)				Not supported
	26 seconds (20% scaled JC)	Not supported	Not supported	Not supported	
Average rewind time	Not supported	29 seconds (100% scaled JA)	35 seconds (100% scaled JA)	Not supported	
	38 seconds (100% scaled JB)		47 seconds (100% scaled JB)	Not supported	
	42 seconds (100% scaled JC)	Not supported	Not supported	Not supported	
	Not supported	11 seconds (20% scaled JA)		Not supported	
	15 seconds (20% scaled JB)				Not supported
	17 seconds (20% scaled JC)	Not supported	Not supported	Not supported	

Table 23. Performance specifications of the 3592 tape drives (continued)

Average block locate time from load point	See Table 24
Notes:	
1. All sustained data rates are dependent on the entire data path (host system to tape drive).	
2. 40 seconds after encryption key change	

Table 24. 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
	TS1140 tape drive	TS1130 tape drive	TS1120 tape drive	3592 J1A Tape Drive	
JA cartridge type - 100% scaled	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])
JA cartridge type - 20% scaled	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	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	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])

Table 24. 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
	TS1140 tape drive	TS1130 tape drive	TS1120 tape drive	3592 J1A Tape Drive	
JC cartridge type (100% scaled)	40 seconds	Not supported	Not supported	Not supported	JC cartridge type at full, unscaled capacity (EFMT4 and EEFMT4 4 TB [3.64 TiB])
JC cartridge type (20% scaled)	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])
JJ cartridge type	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	Not supported	Not supported	Not supported	Advanced Economy - short length (EFMT4 and EEFMT4 500 GB [465.66 GiB])
JW cartridge type	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	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	Not supported	Not supported	Not supported	Advanced WORM (EFMT4 and EEFMT4 4 TB [3.64 TiB])

Table 24. 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
	TS1140 tape drive	TS1130 tape drive	TS1120 tape drive	3592 J1A Tape Drive	
JR cartridge type	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 an encryption key to read the first block accessed on the cartridge.
2. Encrypted format is referred to as EEFMT2 (for E05), EEFMT3 (for E06), and EEFMT4 (for E07).

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 System Storage TS3500 Tape Library with ALMS Operator Guide*.

Library performance

This section explains how performance values, such as cartridge inventory times, mount performance, and cartridge move time, are obtained for the TS3500 Tape Library.

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. Thus, the performance values show the relative performance of the systems and may not be absolute indicators of performance in your specific environment.

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 System Storage TS3500 Tape Library 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 25 shows the mount performance and average move time for a TS3500 Tape Library without dual accessors and without HD frames.

Table 25. 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 26 shows the mount performance for a TS3500 Tape Library with dual accessors but without HD frames.

Table 26. 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:

- Active frames are all frames in a dual-accessor library except service bay frames.
- 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 TotalStorage 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 87.

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 27 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 28 shows imports per hour in a TS3500 Tape Library with dual active accessors and virtual I/O slots enabled, but without HD frames.

Table 27. 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:

- 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 27 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 28. 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 28. 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
<p>Notes:</p> <ol style="list-style-type: none"> Active frames are all frames in a dual-accessor library, except for service bays. The following library setup was used to obtain the stated performance data: <ul style="list-style-type: none"> ALMS and virtual I/O slots are enabled Cartridge assignment policy is setup for each logical library No HD frames 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 28 on page 86 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 library

Each frame of the TS3500 Tape Library has a set of casters and four leveling jackscrews. The casters and leveling jackscrews that attach to the TS3500 Tape Library affect its height. The nominal height from the bottom of the jackscrews to the top of the frame is 1840 mm (72.4 in.) and can be varied by ± 40 mm (± 1.6 in.). The shipping height of the library (on its casters and with jackscrews raised) is 1800 mm (70.9 in.). The height of a frame with a shuttle connection is 2275 mm (89.57 in.)

Refer to the following physical specifications section for detailed information by frame model. To calculate the length of your fully configured library or fully configured shuttle complex, see the section about clearance specifications for models of the TS3500 Tape Library.

Library placement

This topic provides recommendations for library placement.

In order to ensure optimal performance, the TS3500 Tape Library must be placed in a location that meets the requirements presented in this guide. In addition, it is recommended that you keep the following items away from the tape library in order to avoid damage to the library, tape drives, and tape media:

- Equipment that may produce airborne dust, particulate pollution, or corrosive fumes, such as laser printers, ultrasonic humidifiers, and ionizers

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 29. 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 30. 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 31. 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 32. 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 33. 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 34. 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 35. Physical characteristics of the TS3500 Tape Library Model 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 36. 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 section specifies the required conditions of a floor on which a TS3500 Tape Library is installed.

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 jackscrews to the following specifications:

- Maximum allowable variance must not exceed 7 mm (.27 in.) per 76 mm (3 in.).
- Maximum out-of-level condition must not exceed 40 mm (1.6 in.) 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 exerted by the leveling jackscrews
- Up to 211 kilograms per square meter (43.4 pounds per square foot) of overall floor loading

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

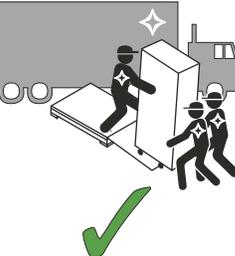
Delivery route

This section defines the conditions of the route by which the TS3500 Tape Library will be delivered.

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

 > 500 lbs. (> 227 kg.)		<p>Use Only Professional Movers!</p> <p>يجب الاستعانة بخبرات نقل متخصصة</p> <p>Utilizar somente transportadores profissionais</p> <p>Faire appel à des professionnels seulement pour déplacer l'équipement.</p> <p>只能使用专业搬运机</p> <p>Maak gebruik van professionele verhuizers</p> <p>Faites exclusivement appel à des déménageurs professionnels</p> <p>Nur professionelle Transportunternehmen mit der Durchführung beauftragen.</p> <p>Να μετακινείται μόνο από επαγγελματίες μεταφορείς</p> <p>העזרו במובילים מקצועיים בלבד</p> <p>Csak hivatásos szállítóval költöztesse</p> <p>Avvalersi solo di trasportatori esperti</p> <p>機器を移動する際には専門の業者に依頼してください。</p> <p>전문 운송 인력만이 이동시킬 수 있습니다.</p> <p>Należy korzystać wyłącznie z usług wyspecjalizowanych firm.</p> <p>El traslado del equipo debe realizarlo personal especializado</p> <p>Trebaju raditi samo profesionalni transportni radnici</p> <p>Použite pouze profesionální stěhováky</p> <p>Brug kun professionelle flyttefolk.</p> <p>Käytä vain ammattitaitoista kuljetusliikettä</p> <p>Utstyret må kun flyttes av godkjent flyttepersonell</p> <p>Contacte apenas transportadoras profissionais</p> <p>Используйте только профессиональных грузчиков</p> <p>Na presun použite len profesionálov</p> <p>Använd endast professionell flyttpersonal</p>
 Use Only Professional Movers!	 ✓	at6910332

Only professional movers or riggers should transport the equipment. The customer should prepare his environment to accept the new product based on the installation planning information provided, with assistance from an IBM Installation Planning Representative (IPR) or IBM-authorized service provider. In anticipation of the equipment delivery, the final installation site should be prepared in advance such that professional movers or riggers can 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, the customer will need to make arrangements to have professional movers or riggers return to finish the transportation at a later date. The customer is also responsible for using professional movers or riggers in the case of equipment relocation or disposal. The IBM-authorized service provider will only perform minimal frame repositioning within the computer room, as needed, to perform required service actions.

Security

This topic recommends where to locate the TS3500 Tape Library to ensure controlled access. It also discusses the library's locking mechanisms.

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.

You are responsible for the physical security of the library, the cartridges contained within the library, and shelf-resident cartridges. 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 keylock. The keylock is the same for every front door, and the keys are shipped with the library. The library's rear door has a different keylock. The keylock is the same for every rear door and the keys are shipped with the library.

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

Data security is the responsibility of the application program controlling 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, will cause the operator panel to lock. For more information, see the *IBM System Storage TS3500 Tape Library with ALMS Operator Guide* and refer to the sections about enabling or disabling security for the operator panel and locking and unlocking the operator panel.

Move restraints

This section discusses the location of points on the TS3500 Tape Library that you can use to restrain the unit from potential movement (such as an earthquake).

Should you want to restrain the TS3500 Tape Library from potential movement (for example, from earthquake), restraining points are located at the bottom of the unit (see **1** in Figure 18 on page 101). Affix restraints to each of the four points (two on each long side) and secure the library as needed. Figure 19 on page 103 and Figure 20 on page 104 show the locations of the four points. The restraint points provide threaded holes, thread size M10.

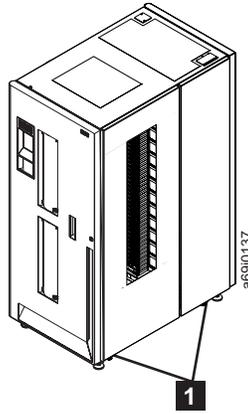


Figure 18. Location of restraining points. Two restraining points are located on each long side of the library.

Clearance specifications for the library

This section describes the space that is required for you or IBM Service Representatives to use or work on the TS3500 Tape Library.

Plan for appropriate clearances around your TS3500 Tape Library to allow space for you and IBM Service Representatives to use and work on it. 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) 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 2-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 could impede pedestrian traffic. As you plan clearances, be sure to consider leaving additional room on the right end of the library (as you face the front door) 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.

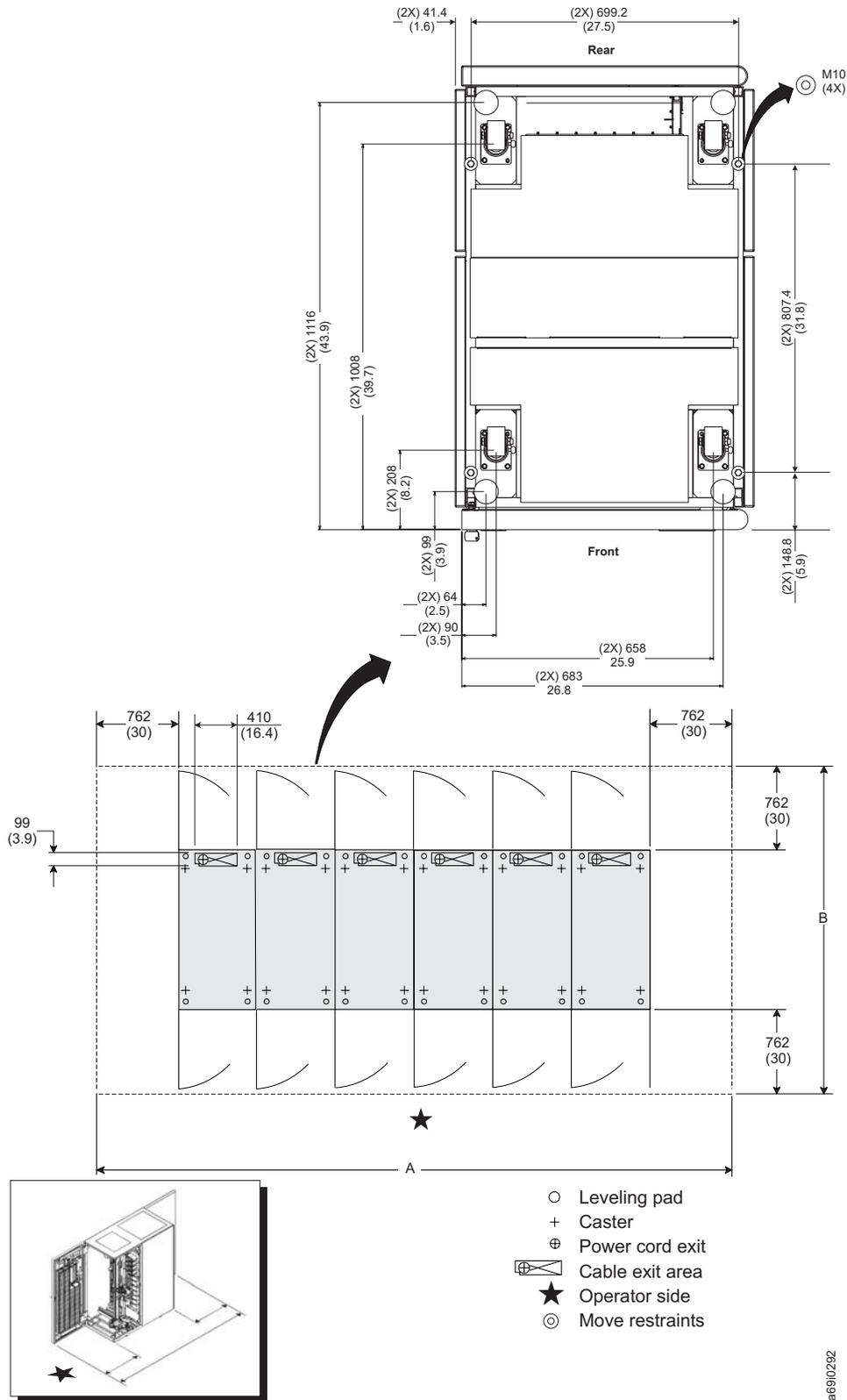
Table 37 on page 102 shows the length of the TS3500 Tape Library both with and without service bays and including side clearances; Figure 19 on page 103 shows the location of the clearances for Models L22, D22, L23, D23, L52, D52, L53, D53, S24, S54, and the service bays. Figure 20 on page 104 shows the location of the clearances for Models L32 and D32.

Table 37. 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 19 on page 103 or in Figure 20 on page 104 (Not Including Service Bays) (see Notes 1, 2, and 3)	Length of A in Figure 19 on page 103 or in Figure 20 on page 104 (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 19 on page 103, 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 20 on page 104, 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.



a6910292

Figure 19. Size of operator and service clearances for the IBM System Storage TS3500 Tape Library, 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.

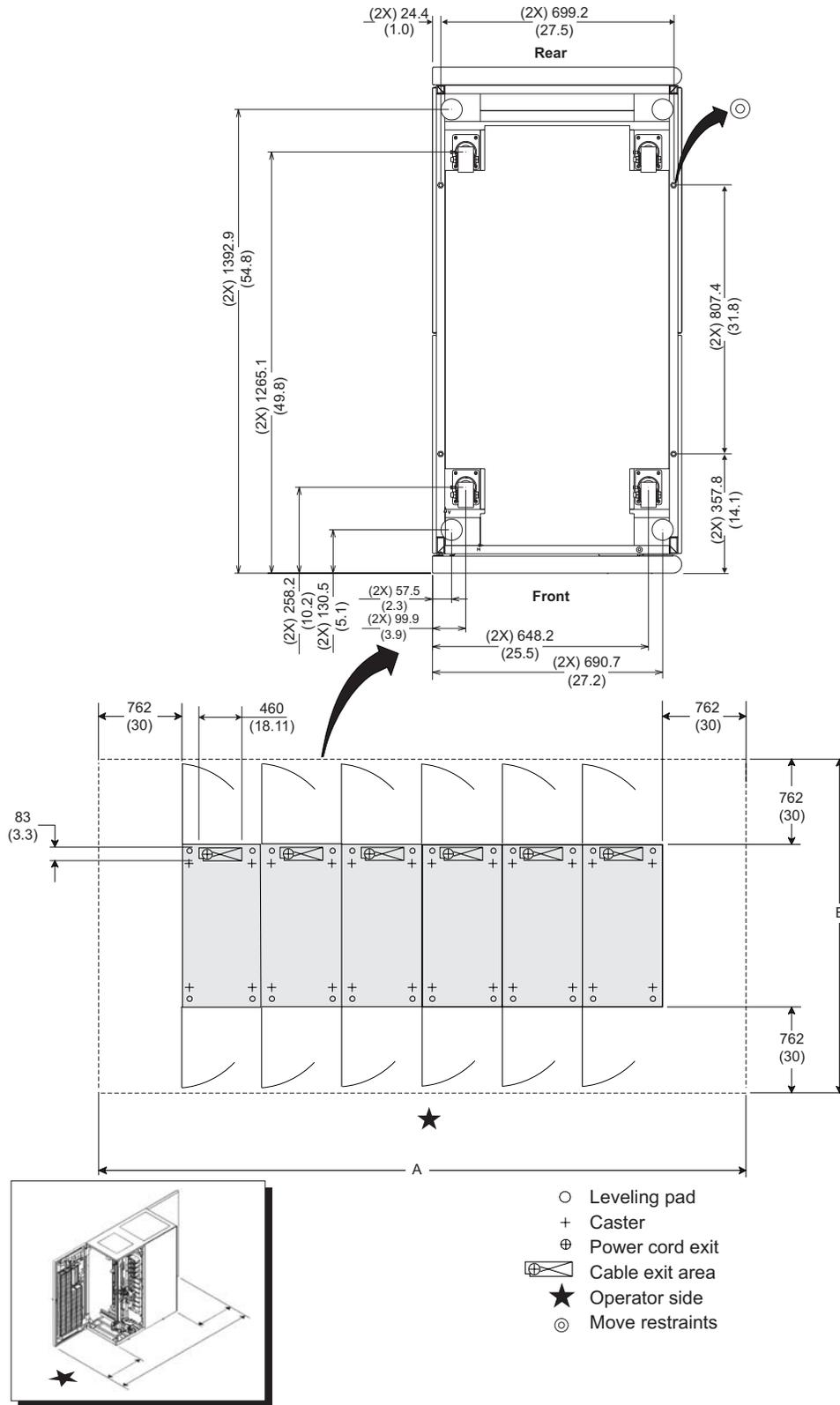


Figure 20. Size of operator and service clearances for the IBM System Storage TS3500 Tape Library, Models L32 and D32. The top measurements are in millimeters; the bottom measurements are in inches. The service clearance area (and operator clearance area at the front of both frames) is denoted by dotted 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
- Fire-suppression system and position of ceiling-mounted sprinkler heads

Figure 21 on page 106 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 21 on page 106, 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.

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:

$$\text{Maximum offset in X} = 0.13 \times A$$

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 101.

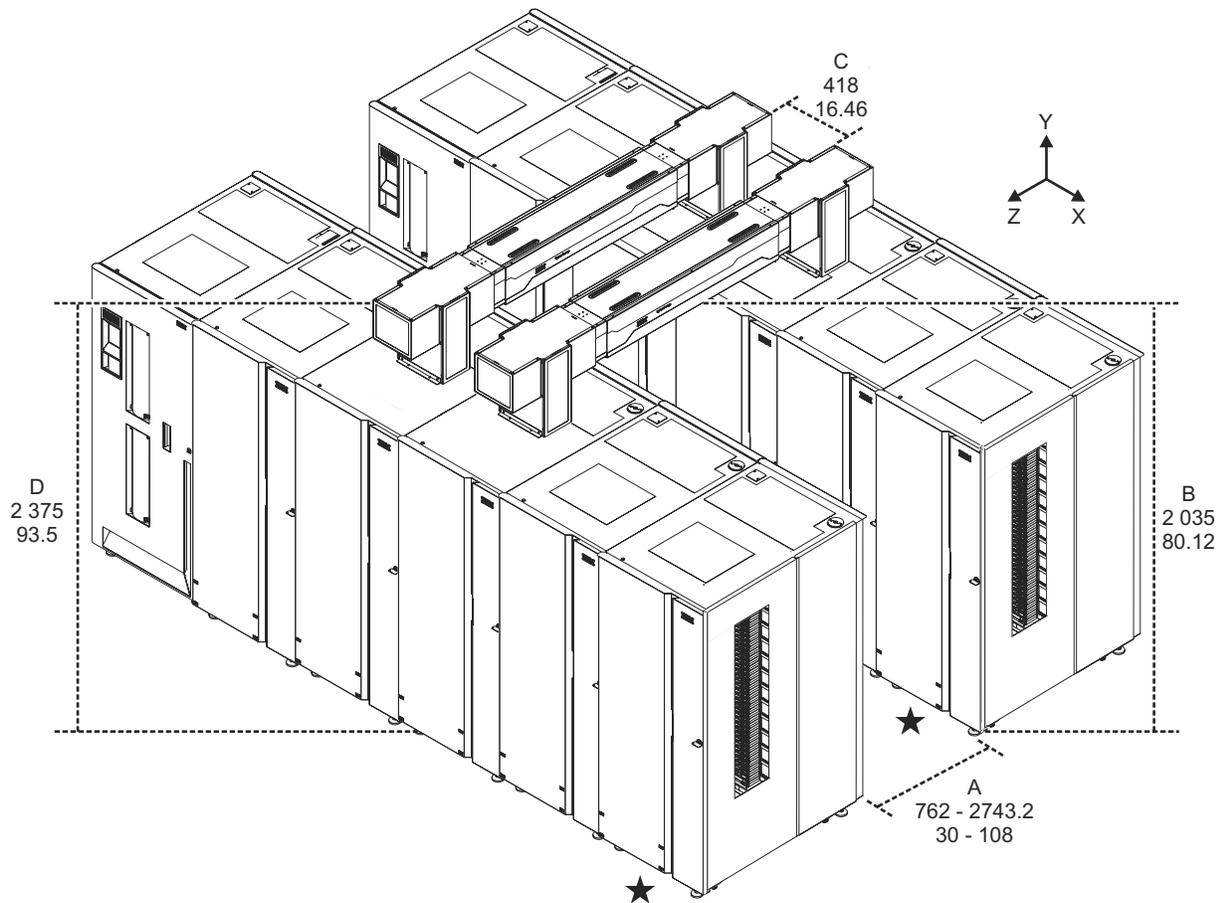


Figure 21. Shuttle complex dimensions and clearances

Routing Fibre Channel cables through the top of a frame

This section describes how to route Fibre Channel cables from servers through the top of a frame in the TS3500 Tape Library.

As an alternative to routing Fibre Channel cables from servers to the bulkhead at the bottom rear of the TS3500 Tape Library, you can route the cables through the top of the library frame (see **1** in Figure 22 on page 107).

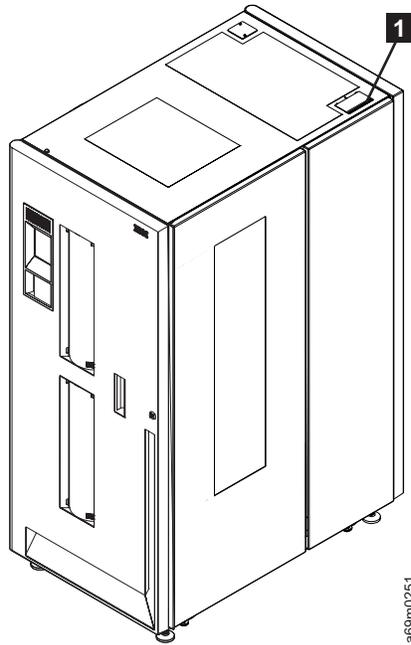


Figure 22. Opening for routing Fibre Channel cables from servers through the top of a frame

To route the cables through the top of a frame, perform the following procedure.

1. Open the cable access door at the top of the frame (see **1** in Figure 23).

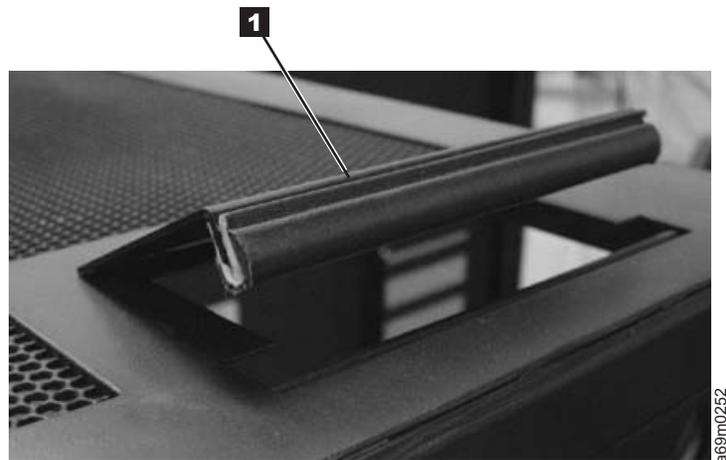


Figure 23. Opening the cable access door at the top of a frame

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 Velcro 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 24 on page 108

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.

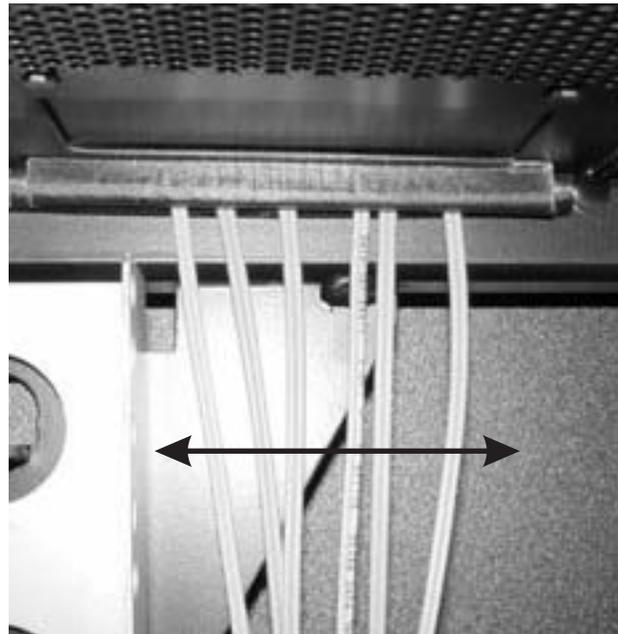


Figure 24. Positioning the Fibre Channel cable inside the frame

7. Position all of the Fibre Channel cables outside the frame as shown in Figure 25.



Figure 25. 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

This section gives information about the placement of power cables through the top of a TS3500 Tape Library that is installed on a non-raised 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 System Storage TS3500 Tape Library Maintenance Information* guide.

Fire suppression for the Library

This section discusses how the TS3500 Tape Library is constructed to allow third-party installation of fire-suppression equipment.

Attention: A fire-suppression system is the responsibility of the customer. The customer's own insurance underwriter, local fire marshal, or a local building inspector, or both, should be consulted in selecting a fire-suppression system that provides the correct level of coverage and protection. 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 allows for mechanical connections to permit third-party installation of fire-suppression equipment. When deciding whether to implement fire-suppression equipment, refer to your local and national standards and regulations.

The sections that follow describe the fire-suppression design for all frame models.

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 26 on page 110). 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 26 on page 110) and do not interfere with library components.

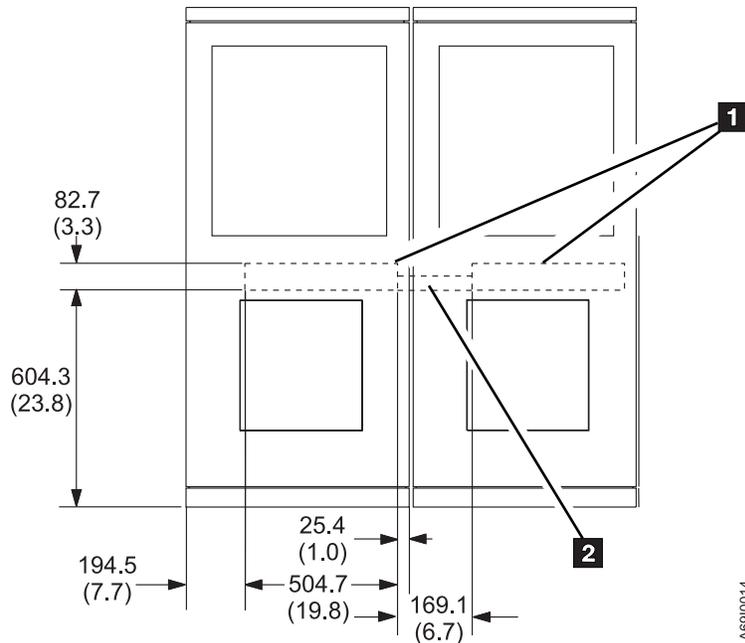


Figure 26. Allowable area for mounting fire-suppression equipment (top view of Model L32 or D32 frames)

Fire suppression for all other models

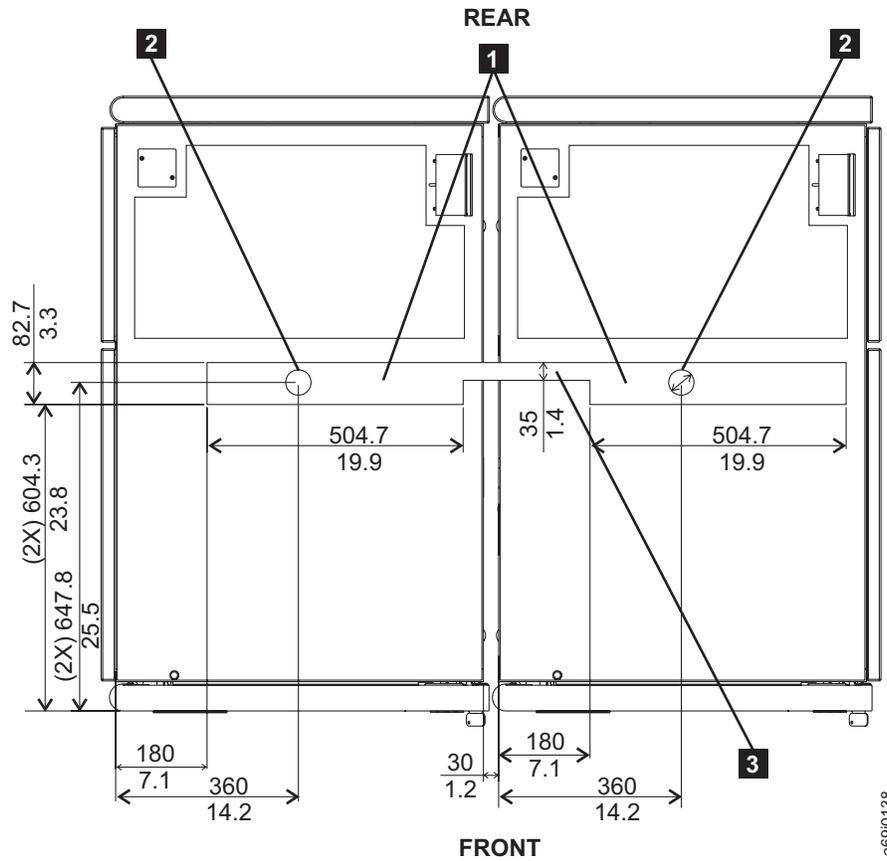
This section describes the tape library frame features provided for a fire suppression system.

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 27 on page 111). 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 27 on page 111) 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 27 on page 111) and do not interfere with library components.



a6990138

Figure 27. 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)

Running cables, wiring, and pipes between frames

This section describes how to run cables, wires, and pipes between frames in the TS3500 Tape Library.

Figure 28 shows a side view of the area available to run cables, wiring, and pipes between frames of the TS3500 Tape Library. The area is a triangular section that is 81 mm (3.2 in.) wide by 140 mm (5.5 in.) long (see **1** in Figure 28). Your fire-suppression mechanical equipment must fit within the allowable area or be installed outside the library.

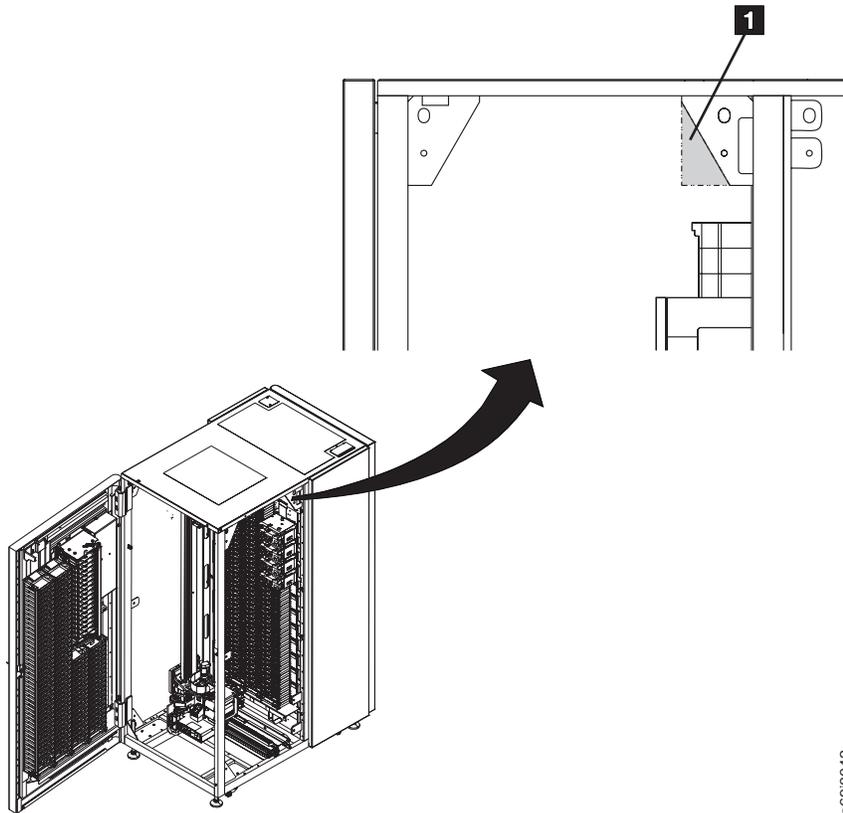


Figure 28. Location for routing fire-suppression equipment between frames

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 in.) below the top of the frame.

Route gaseous system piping with discharge nozzles on the top of the frames or inside the frames, below the top of the frame and within the 175-mm (6.9-in.) specification. The discharge nozzles can extend vertically no lower than 175 mm (6.9 in.) 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

This section provides a table of environmental specifications for the TS3500 Tape Library.

The TS3500 Tape Library is compliant with the environmental guidelines set by the American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE). The information in Table 38 is excerpted from *Thermal Guidelines for Data Processing Environments*, published in 2004 by ASHRAE.



Attention: The environments in Table 38 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 Ultrium Tape Cartridges or IBM TotalStorage 3592 Enterprise Tape Cartridges, refer to their environmental and shipping specifications. Then, adjust the operating environment for the library accordingly.

Table 38. Equipment environment specifications for the IBM System Storage TS3500 Tape Library

Product operation ^{1, 2}						Product power off ^{2, 3, 4}			
Dry-bulb temperature (°C)		Relative humidity (%) Non-condensing		Maximum dew point (°C)	Maximum elevation (m)	Maximum rate of change in °C per hour	Dry-bulb temperature (°C)	Relative humidity (%)	Maximum dew point (°C)
Allowable	Recommended	Allowable	Recommended						
15 to 32 ^d	20 to 25	20 to 80	40 to 55	17	3050	5	5 to 45	8 to 80	27

Notes:

- Product equipment is powered on.
- Tape products require a stable and more restricted environment (similar to Class 1). Typical requirements: minimum temperature is 15°C, maximum temperature is 32°C, minimum relative humidity is 20%, maximum relative humidity is 80%, maximum dew point is 22°C, rate of change of temperature is less than 2°C/h, rate of change of humidity is less than 5% RH per hour, and no condensation.
- Product equipment is removed from the original shipping container and installed but not in use, e.g., during repair, maintenance, or upgrade.
- Derate maximum dry-bulb temperature 1°C/300 m above 900 m.

Acoustical specifications

This section introduces acoustical specifications for the TS3500 Tape Library.

For the purposes of acoustical specifications, 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 39. Noise emission values for the IBM System Storage TS3500 Tape Library, Models L32 and D32

Declared Sound Power Level L_{WAd}		Mean A-weighted Sound Pressure Level at the 1 m (Bystander) Positions $\langle L_{pA} \rangle_m$	
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 40. Noise emission values for the IBM System Storage TS3500 Tape Library, 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 $\langle L_{pA} \rangle_m$	
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 41. Noise emission values for the IBM System Storage TS3500 Tape Library, 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 $\langle L_{pA} \rangle_m$	
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 two power structures are the frame control assembly, which is used by models L22, D22, L32, D32, L52, and D52, and the enhanced frame control assembly, which is used by models L23, D23, L53, and D53.

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 121
- “Power cords for Models L22, D22, L52, and D52” on page 124

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 or 4875) 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 127 for more information.

When ordering FC 1950 for a frame, customers must also order one of the line cord features (FC 9954, 9955, 9956, 9957, 9958, 9959, 9966) that are specifically for use only with FC 1950. Each 995x or 9966 line 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

This topic describes the power requirements for frames in the TS3500 Tape Library.

Table 42 lists the electrical characteristics for the TS3500 Tape Library frame models.

Table 42. Electrical characteristics of the IBM System Storage TS3500 Tape Library frame models

Electrical characteristic	Rating ²	
	Models L23, D23, L53, D53	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 43 lists the power consumption of the TS3500 Tape Library models, power consuming features, and drive canisters.

Table 43. 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	5	142	202
D23, D53 ^{1,2}	5	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

Table 43. Power consumption of TS3500 Tape Library frame models, power consuming features, and drive canisters (continued)

FC 1950 PDU	5	17	17
FC 4872 TS7700 backend 4 Gb switches (2x)	0	113	113
FC 4875 TS7700 backend 8 Gb switches (2x)	0	86	86
Tape Drives⁶			
TS1120 (3592 Models E05 and J1A)	0	27	42
TS1130 (3592 Model E06)	0	17	46
TS1140 (3592 Model E07)	0	23	50
TS1030 (LTO 3588 F3B)	0	20	34
TS1040 (LTO 3588 F4A)	0	18	36
TS1050 (LTO 3588 F5A)	0	12	28
Notes:			
<ol style="list-style-type: none"> 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 43 on page 117 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 44 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 44. 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	TS1130	1	5	142	202
			10	0	40	70
			10	0	170	460
D23 (with FC 1451 ²)	1515	TS1130	4	20	412	412
			24	0	96	168
			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:				25	1302	2511
Total cooling requirement (kBtu/hr):				0.1	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 45 lists the power requirements for the devices that comprise remote support.

Table 45. 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
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 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 46 on page 122 lists the 200–240 V ac power cords and Table 47 on page 123 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 29 on page 123 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 46
- Phases: 1
- Wires: 3

Table 46. Specifications for 200–240 V ac power cord used with the IBM System Storage TS3500 Tape Library, 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 47
- Phases: 1
- Wires: 3

Table 47. 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 29 and match the number that is beside each receptacle to the number in each table.

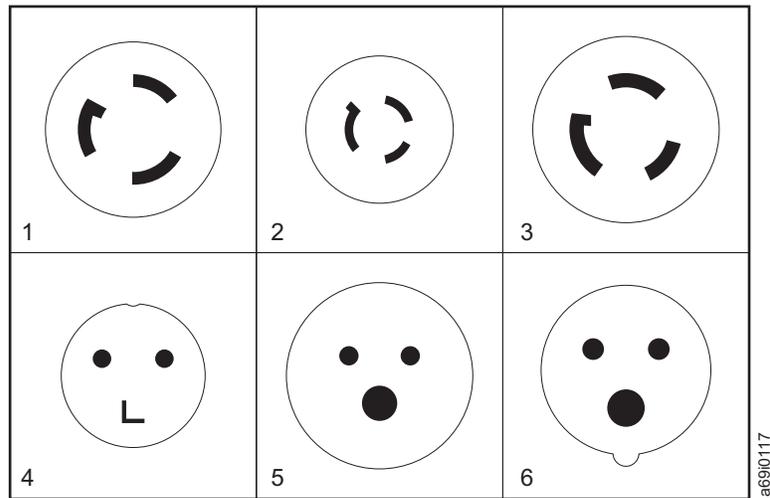


Figure 29. Types of receptacles for power cords used by models L32 and D32 of the TS3500 Tape Library

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 30 on page 125 and match the number that is beside each receptacle to the receptacle number listed in the table.

Table 48. Specifications for power cords used with the IBM System Storage TS3500 Tape Library, Models L22, D22, L52, and D22

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)

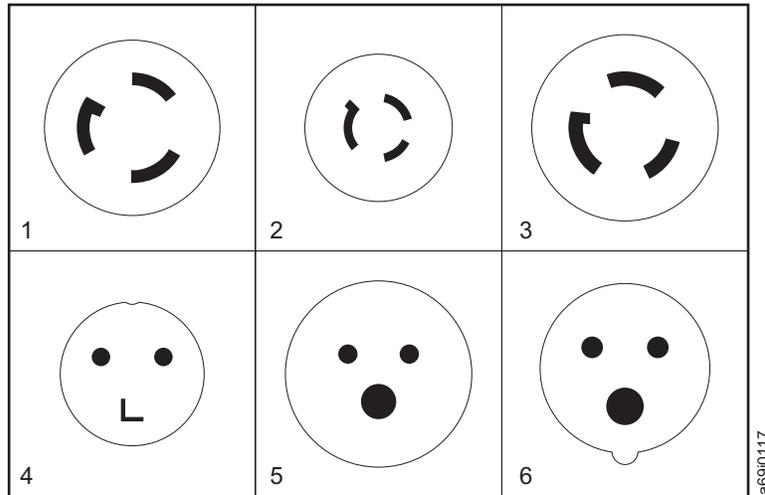


Figure 30. Types of receptacles for power cords used by Models L22, D22, L52, and D52 of the TS3500 Tape Library

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 31 on page 127 and match the number that is beside each receptacle to the receptacle number listed in the table.

Table 49. Specifications for power cords used with the IBM System Storage TS3500 Tape Library, 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 49. Specifications for power cords used with the IBM System Storage TS3500 Tape Library, 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 49. Specifications for power cords used with the IBM System Storage TS3500 Tape Library, 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:

- Each feature code ships two power cords so that dual power is supported.

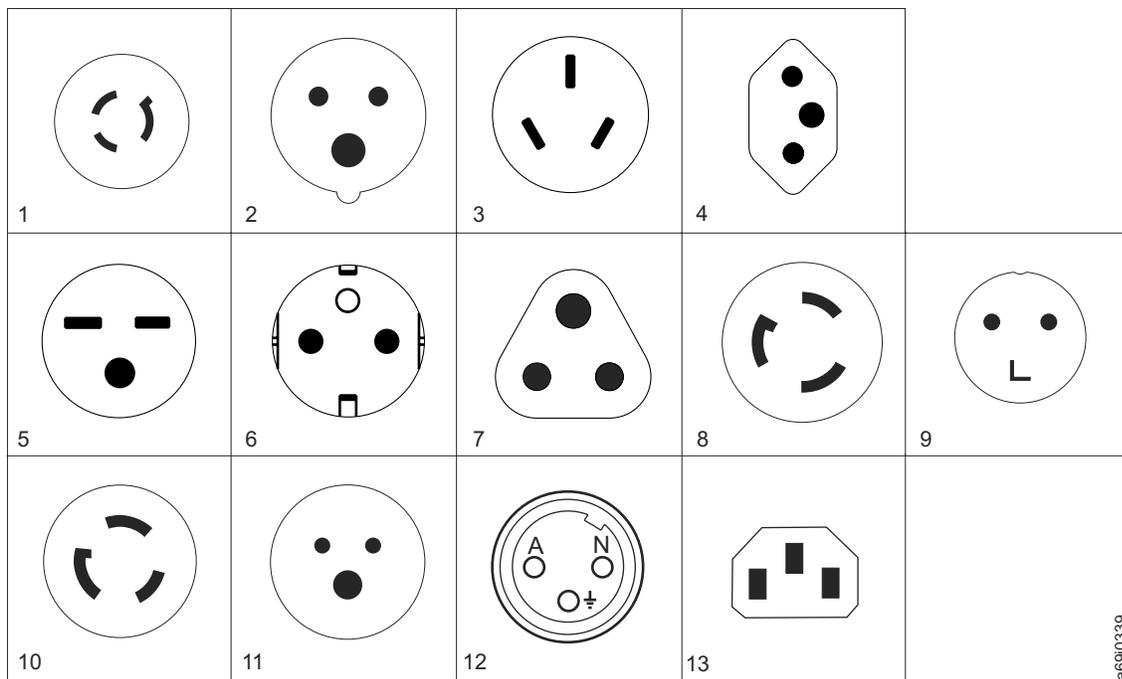


Figure 31. Types of receptacles for Models L23, D23, L53, and D53 of the TS3500 Tape Library

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 32 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.

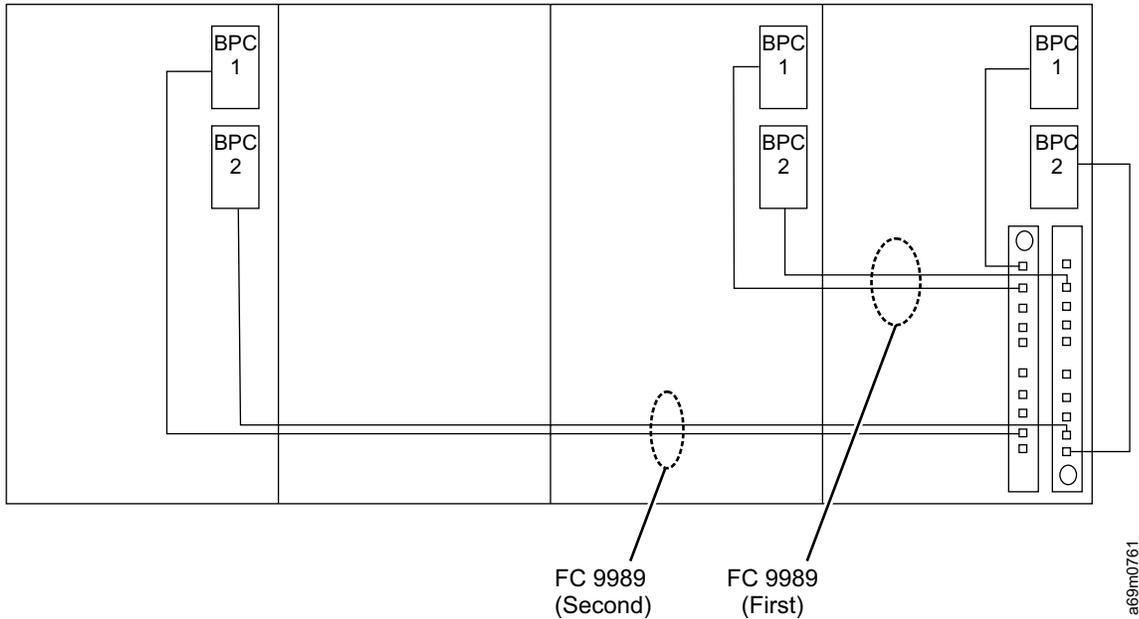


Figure 32. FC 9989 cable positions

Recommended customer circuit breakers for Models L23, D23, L53, and D53

This topic provides the recommended maximum and minimum circuit breaker ratings for frame models L23, D23, L53, and D53.

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 topics in this section present the elements of the TS3500 Tape Library and the associated feature codes for those elements.

When ordering the TS3500 Tape Library, you can use feature codes to perform the following actions:

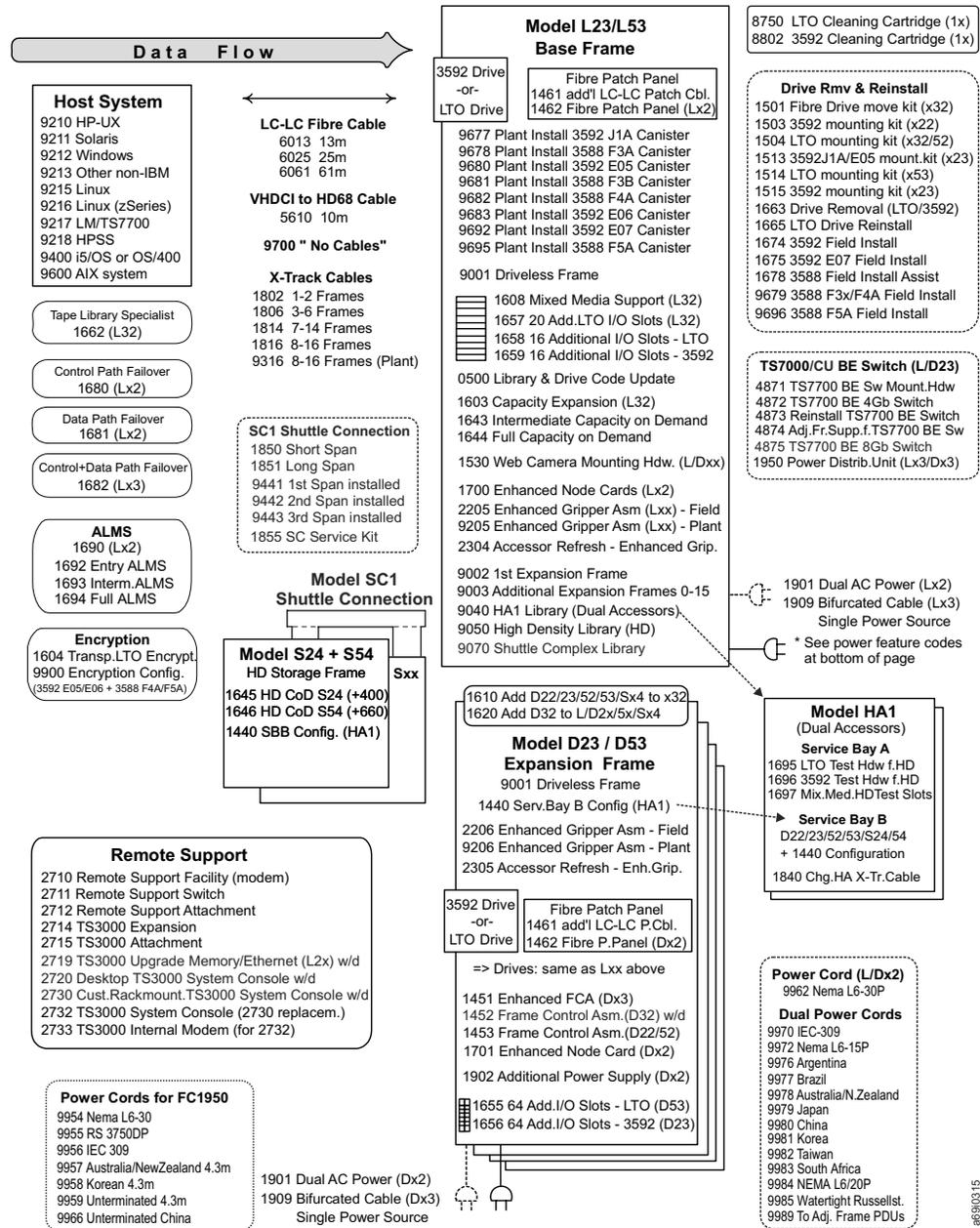
- Specify plant or field installation of tape drives
- Specify host configurations
- Identify the specific attachment type
- Order open systems device drivers

Elements in the library

This section provides a flowchart of the elements that are available for a TS3500 Tape Library.

Figure 33 shows the elements in the TS3500 Tape Library. Depending on the model of the library, different features are available.

Figure 33. 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 50 lists the feature codes for the models of the TS3500 Tape Library.

Table 50. 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, 23}	D32	No	Frame control assembly (does not apply to D22, D23, D52, or D53 models)
1453	D22, D52	No	Frame control assembly (does not apply to D23, D32, or D53 models)
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 50. 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	System Storage 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 Tape Drive field install
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 50. 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 50. 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.)
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	L22, L23, L32, L52, L53	No	TS3000 Expansion (This feature provides two cables to connect one machine and an Ethernet switch to increase quantity of machines that can attach to the TSSC (FC 2720, 2730, or 2732) for service.)
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	L22, L23	No	TS3000 Upgrade (This feature provides additional memory and an Ethernet adapter.) Prerequisite: When attaching to a TS7700, FC 2720 is required.
2720 ²¹	L22, L23, L32, L52, L53	No	Desktop TS3000 System Console (TSSC) (This feature provides the desktop console, Ethernet switch, cable, and connectors to connect one machine to an IBM-supplied modem for enabling remote enhanced service.)
2730 ²²	L22, L23, L32, L52, L53	No	Customer rack-mountable TS3000 System Console (TSSC) (This feature provides the TS3000 server, keyboard, display, mouse, bifurcated cables, connectors, 115 V ac cables, and Ethernet switch for customer-provided 19-inch rack.)
2732	L22, L23, L32, L52, L53	No	Rack-mountable TS3000 System Console (TSSC) (This feature provides TS3000 server, keyboard, display, mouse, and Ethernet switch. This feature replaces FC 2730 and includes the console upgrade previously provided as FC 2719.) Prerequisite: If using modem call home, FC 2733 is required in qualified countries. Refer to FC 2733 for additional information.
2733 ¹⁹	L22, L23, L32, L52, L53	No	TS3000 Internal Modem (This feature provides an internal modem in the TS3000 server and enables IBM to gain remote access.) Corequisite: FC 2732
4871	L23, D23	No	TS7700 4 Gb Fibre Channel backend switches mounting hardware Prerequisites: FC 1950 and FC 9217
4872 ²⁰	L23, D23	No	TS7700 4 Gb Fibre Channel backend switches (Two switches are provided per feature.) Prerequisite: FC 4871
4873	L23, D23	No	Reinstall TS7700 4 Gb Fibre Channel backend switches Prerequisite: FC 4871
4874	L23, D23	No	Adjacent frame support for TS7700 4 Gb Fibre Channel backend switches

Table 50. 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.)) Prerequisites: FC 1950 and FC 9217
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).
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
9218	L22, L23, L32, L52, L53	No	Attached to HPSS

Table 50. Feature codes for the models of the TS3500 Tape Library (continued)

Feature Code	Model	CSU	Description
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
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)

Table 50. Feature codes for the models of the TS3500 Tape Library (continued)

Feature Code	Model	CSU	Description
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.
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.

Table 50. Feature codes for the models of the TS3500 Tape Library (continued)

Feature Code	Model	CSU	Description
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 System Storage TS3500 Tape Library 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, or FC 9692.)
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 125 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. Feature code 2720 was withdrawn from marketing on October 31, 2008.
22. Feature code 2730 was withdrawn from marketing on January 15, 2010.
23. Feature code 1452 was withdrawn from marketing on December 31, 2010.

|
|

Chapter 4. Using Ultrium media

The section introduces information about using Ultrium tape media.

The IBM System Storage TS3500 Tape Library automates the storage and movement of IBM LTO Ultrium Tape Cartridges.

Overview of Ultrium Media

This section describes Ultrium media.

Within the TS3500 Tape Library and subject to certain restrictions, the Ultrium tape drives use the following cartridge types:

- IBM System Storage 1500 GB LTO Data Cartridge (Ultrium 5 cartridge without WORM capability)
- IBM System Storage 1500 GB LTO WORM Data Cartridge (Ultrium 5 cartridge)
- IBM System Storage 800 GB LTO Data Cartridge (Ultrium 4 cartridge without WORM capability)
- IBM System Storage 800 GB LTO WORM Data Cartridge (Ultrium 4 cartridge)
- IBM System Storage 400 GB LTO WORM Data Cartridge (Ultrium 3 cartridge)
- IBM System Storage 400 GB LTO Data Cartridge (Ultrium 3 cartridge without WORM capability)
- IBM System Storage 200 GB LTO Data Cartridge (Ultrium 2 cartridge)
- IBM System Storage 100 GB LTO Data Cartridge (Ultrium 1 cartridge)
- IBM System Storage Universal LTO Cleaning Cartridge
- IBM System Storage LTO Cleaning Cartridge
- Diagnostic cartridge

Figure 34 shows the IBM TotalStorage LTO Ultrium Data Cartridge.

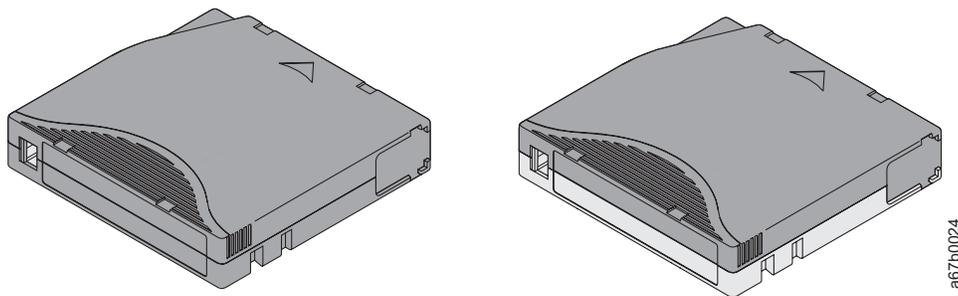


Figure 34. The IBM System Storage LTO Data Cartridge for Ultrium 3 tape drives

WORM functionality for 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 Ultrium 3 and newer tape drives include the WORM feature, which is supported by the IBM System Storage LTO WORM Data Cartridge (formerly the IBM TotalStorage 3589 Ultrium Tape Cartridge Models 028 and 029). All IBM

Ultrium 3 tape drives with firmware levels of 54K1 or higher and all newer Ultrium drives support the WORM function. An Ultrium 3 or newer tape drive with WORM capability can recognize WORM-compatible media. Information and the required drive firmware can be found at:

<http://www.ibm.com/servers/storage/support/1to/3584/downloading.html>

The IBM System Storage LTO WORM Data Cartridge is only for use on Ultrium 3 and newer 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 newer 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 3589 LTO WORM data cartridge provides the following capacities:

Table 51. LTO WORM cartridge capacities

Cartridge type	Native capacity	Compressed capacity (2:1)
Ultrium 3	400 GB (372.53 GiB)	800 GB (745.05 GiB)
Ultrium 4	800 GB (745.05 GiB)	1 600 GB (1490.12 GiB)
Ultrium 5	1 500 GB (1396.98 GiB)	3 TB (2.73 TiB)

Ultrium data cartridge

This section describes the capacity, construction, operation, and components of the IBM LTO Ultrium Data Cartridge.

The IBM Ultrium 5 cartridge is burgundy with a silkscreen label on the top that specifies "Ultrium 5 - 1500 GB." The IBM Ultrium 4 cartridge is green with a silkscreen label on the top that specifies "Ultrium 4 - 800 GB." The IBM Ultrium 3 cartridge is blue-gray. The IBM Ultrium 2 cartridge is purple, and the Ultrium 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:

- Ultrium 5 and Ultrium 5 WORM cartridges have a native data capacity of 1 500 GB (1396.98 GiB) (3 TB [2.73 TiB] at 2:1 compression)
- Ultrium 4 and Ultrium 4 WORM cartridges have a native data capacity of 800 GB (745.05 GiB) (1.6 TB [1.46 TiB] at 2:1 compression)
- Ultrium 3 and Ultrium 3 WORM cartridges have a native data capacity of 400 GB (372.53 GiB) (800 GB [745.05 GiB] at 2:1 compression)
- Ultrium 2 cartridge has a native data capacity of 200 GB (186.26 GiB) (400 GB [372.53 GiB] at 2:1 compression)
- Ultrium 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 Ultrium tape drives use a linear, serpentine recording format. The Ultrium 5 drives read and write data on 1 280 tracks; the Ultrium 4 drives read and write data on 896 tracks; the Ultrium 3 drives read and write data on 704 tracks; the Ultrium 2 drives read and write on 512 tracks; and the Ultrium 1 drives read and write on 384 tracks. Ultrium 1 and Ultrium 2 drives read and write eight tracks at a time. The Ultrium 5 drives read and write 16 tracks at a time. The Ultrium 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 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 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 Ultrium tape drive and cartridge compatibility, refer to "LTO Ultrium tape drives" on page 18.

Figure 35 on page 144 shows the IBM System Storage LTO Data Cartridge and its components.

- | | | | |
|----------|----------------------|----------|----------------------|
| 1 | LTO cartridge memory | 4 | Write-protect switch |
| 2 | Cartridge door | 5 | Label area |
| 3 | Leader pin | 6 | Insertion guide |

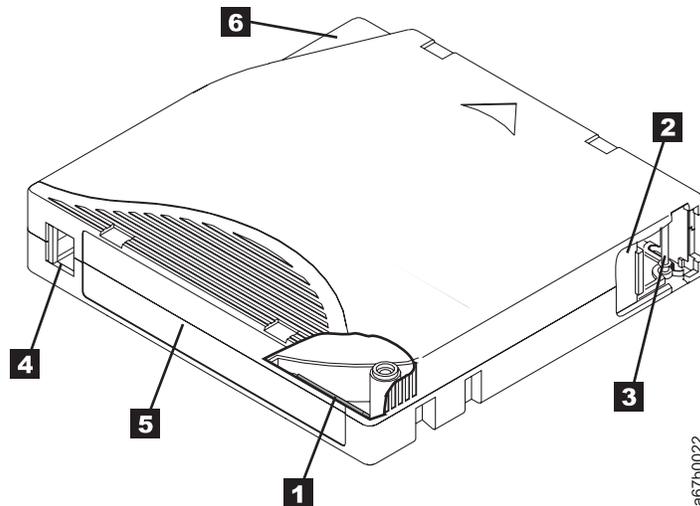


Figure 35. The IBM System Storage LTO Data Cartridge

All generations of the IBM LTO Ultrium Data Cartridge include a Linear Tape-Open Cartridge Memory (LTO-CM) chip (**1** in Figure 35), 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, 4, and 5 of the LTO Ultrium data cartridge has a nominal cartridge life of 20,000 load and unload cycles; Generations 1 and 2 of the LTO Ultrium data cartridge have a nominal cartridge life of 10,000 load and unload cycles.

Ultrium cleaning cartridge

This section gives information about the appearance and usage of the IBM TotalStorage LTO Ultrium Cleaning Cartridge.

To maintain the operating efficiency of the drive, IBM supplies a cleaning cartridge with the first frame of each media type. Thus if the TS3500 Tape Library contains frames with both LTO Ultrium and 3592 tape drives, IBM supplies one LTO Ultrium cleaning cartridge and one 3592 cleaning cartridge regardless of how many frames of each type are in the library. 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 TotalStorage LTO Ultrium Cleaning Cartridge (known as the universal cleaning cartridge) and the LTO Ultrium Cleaning Cartridge are compatible with all Ultrium tape drives. To enable your Ultrium 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 System Storage TS3500 Tape Library 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 System Storage TS3500 Tape Library with ALMS Operator Guide*). You can load multiple cleaning cartridges and store them in any cartridge storage slot except the slot that is reserved for the diagnostic cartridge (see the section about inaccessible storage slots in the *IBM System Storage TS3500 Tape Library 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.

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 System Storage TS3500 Tape Library 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

Ultrium diagnostic cartridge

This section gives information about the appearance and usage of the Ultrium diagnostic cartridge.

The Ultrium diagnostic cartridge is a cartridge with known good media that is reserved for diagnostic purposes only. One cartridge slot is reserved in the first Ultrium frame for the Ultrium diagnostic cartridge. The slot is located at Column 1, Row 1. The volume serial (VOLSER) number for a diagnostic cartridge is represented as D6 IxxLy, where xx equals alphanumeric characters and y equals the generation of the cartridge type. Table 52 shows the compatibility between each generation of diagnostic cartridge and LTO Ultrium tape drive. The characters of the VOLSER are white on a black background. During service calls, your IBM Service Representative will use the cartridge to ensure that the tape drives run correctly and to specification.

Table 52. LTO Ultrium diagnostic cartridge and tape drive compatibility

Cartridge generation (y)	LTO Ultrium tape drives				
	Ultrium 5	Ultrium 4	Ultrium 3	Ultrium 2	Ultrium 1
4	Yes	Yes	No	No	No
3	No	Yes	Yes	No	No
2	No	No	Yes	Yes	No
1	No	No	No	Yes	Yes

If your library is installed with a second accessor, service bay A (the HA1 frame) contains only gripper test slots for diagnostic cartridges. Service bay B contains gripper test slots for diagnostic cartridges, and also contains unusable storage slots. The storage slots in service bay B are not usable if the frame is configured as a service bay. Never insert any type of cartridge into service bays. Each service bay contains gripper test slots for three Ultrium diagnostic cartridges and three 3592 diagnostic cartridges.

Because internal diagnostics for the LTO Ultrium tape drive will 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.

Ultrium bar code label

This section describes the appearance and specifications of the Ultrium bar code label.

Each Ultrium 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 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, T, U, or V. L identifies the cartridge as an LTO cartridge. 1 indicates that the cartridge is the first generation of its type; 2, 3, 4, or 5 indicates that the cartridge is the second, third, fourth, or fifth 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.

Figure 36 on page 149 shows a sample bar code label for the LTO Ultrium 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, LT, LU, or LV
- Label and printing to be non-glossy
- Nominal narrow line or space width of 0.423 mm (0.017 in.)
- Wide to narrow ratio of 2.75:1
- Minimum bar length of 11.1 mm (0.44 in.)

To determine the complete specifications of the bar code and the bar code label, visit the Web at <http://www.ibm.com/support>. Select System Storage from the Choose support type dropdown menu and press the blue arrow icon. Then, select Tape Systems from the Product Family dropdown menu and select 3580 Tape Drive from the Product dropdown menu. Then select Go. Next, under Other resources, select LTO Ultrium media. Scroll to the bottom of the Linear Tape-Open data cartridges page and select LTO label specifications under Learn more. 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.

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 System Storage TS3500 Tape Library 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 may 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 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 System Storage TS3500 Tape Library with ALMS Operator Guide*.

To order bar code labels, see “Ordering bar code labels for Ultrium cartridges” on page 167.

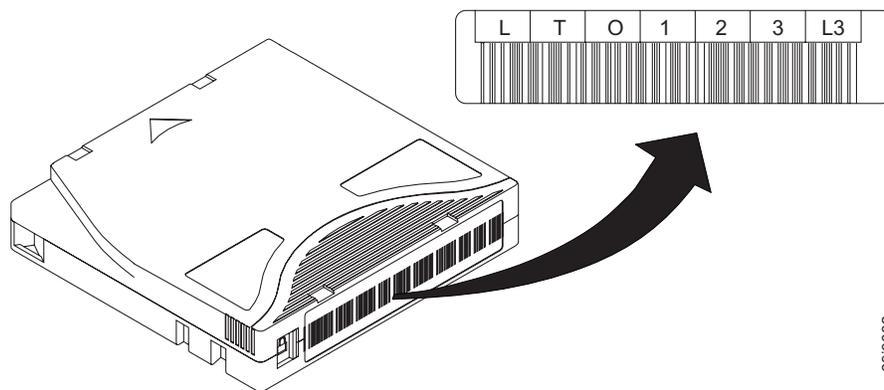


Figure 36. Sample bar code label on the LTO Ultrium 2 Tape Cartridge. The volume serial number (LTO123) and bar code are printed on the label.

Guidelines for using Ultrium bar code labels

Apply the following guidelines whenever you use Ultrium 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 may interfere with the ability of the bar code reader to read the bar code.

Setting the write-protect switch on an Ultrium tape cartridge

This section gives instructions for setting the write-protect switch on an Ultrium tape cartridge.

The position of the write-protect switch on an Ultrium tape cartridge (see **1** in Figure 37) 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.

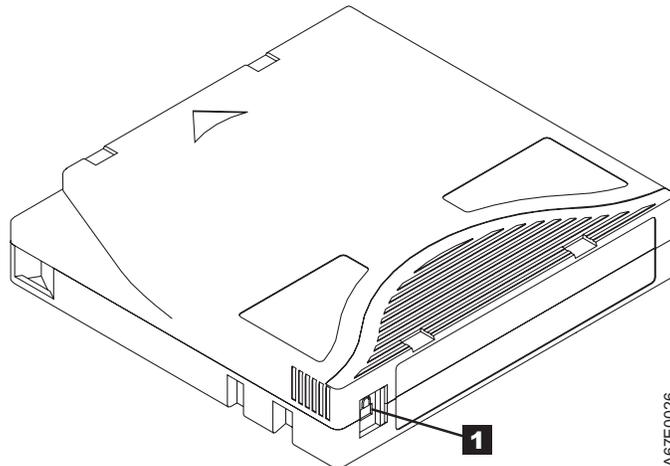


Figure 37. Setting the write-protect switch on an Ultrium tape cartridge

Handling Ultrium tape cartridges

This section introduces ways to handle Ultrium tape cartridges to avoid damage to the cartridge case and the tape.



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.

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

Provide training for using Ultrium tape cartridges

This topic presents the following guidelines for providing training for people using Ultrium 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 Ultrium tape cartridges

Adhere to the following guidelines when packaging or shipping Ultrium 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. Ultrium Turtle Cases (by Perm-A-Store) have been tested and found to be satisfactory (see Figure 38). They are available at <http://www.turtlecase.com>.



Figure 38. 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 the following:
 - 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 39 on page 154).



Figure 39. Double-boxing tape cartridges for shipping

Provide proper acclimation and environmental conditions for Ultrium 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 100 oersteds (for example, terminals, motors, video equipment, X-ray equipment, or fields that exist near high-current cables or power supplies). Such exposure can cause the loss of recorded data or make the blank cartridge unusable.
- Maintain the proper conditions for storing and shipping the cartridges.

Perform a thorough inspection of Ultrium tape cartridges

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 40 on page 155. If there are gaps in the seam, the leader pin may be dislodged and may need to be repositioned.)

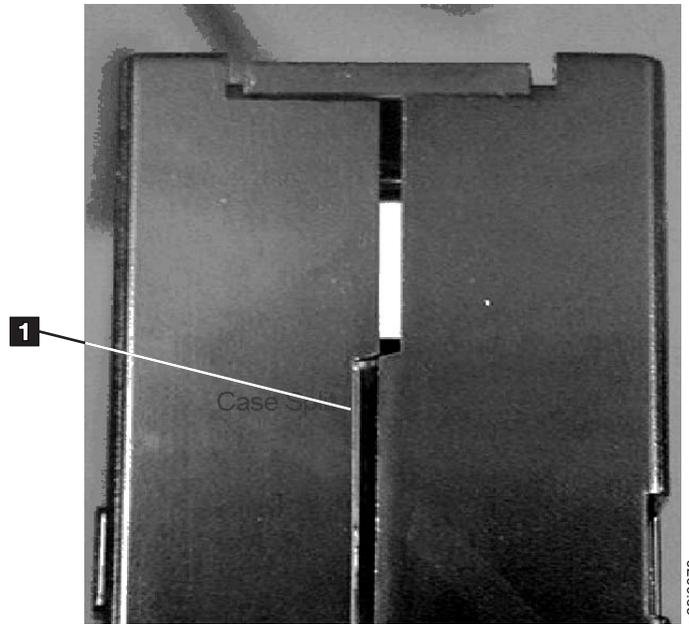


Figure 40. Gap in cartridge seam

Handle the Ultrium tape cartridge carefully

This list offers guidelines for handling Ultrium tape cartridges.

- Do not drop the Ultrium 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 Ultrium tape cartridges

This topic provides examples of problems with Ultrium tape cartridges and steps to resolve them.

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 Ultrium cartridge

This topics in this section provide procedures to use when you move a leader pin into its proper position in an Ultrium tape cartridge, or when you reattach the pin if it has separated from the tape.

If the leader pin in your Ultrium 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.



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 Ultrium cartridge

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)

To reposition the leader pin, perform the following steps.

A leader pin that is improperly positioned inside an Ultrium tape cartridge can interfere with the operation of the drive. Figure 41 shows a leader pin in the incorrect **1** and correct **2** positions.

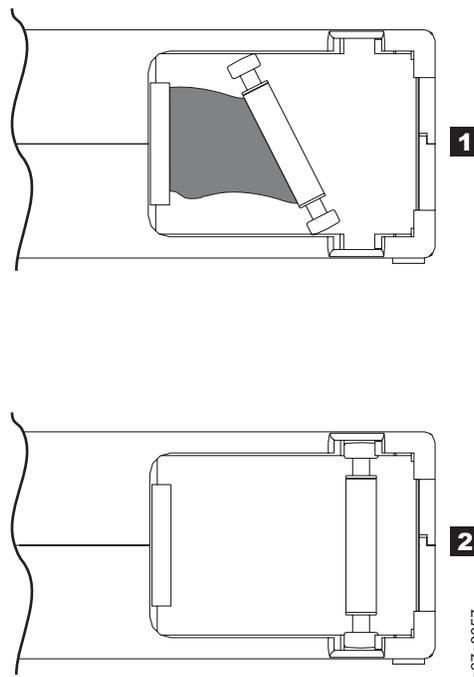


Figure 41. Leader pin in the incorrect and correct positions in an Ultrium tape cartridge. The cartridge door is open and the leader pin is visible inside the cartridge.

1. Slide open the cartridge door (**1** in Figure 42) 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.

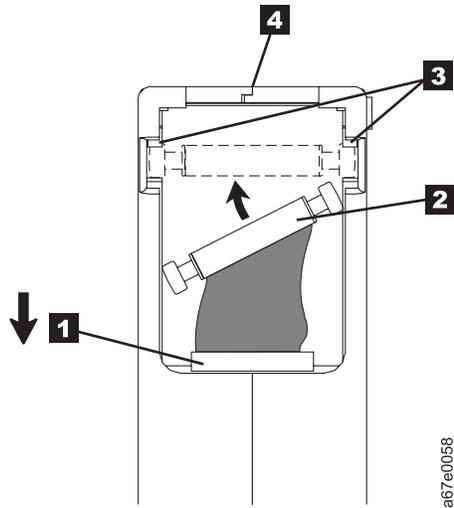


Figure 42. Placing the dislodged leader pin into the correct position. The cartridge door is open to show the leader pin.

5. To rewind the tape, insert the cartridge manual rewind tool (**1** in Figure 43) into the cartridge's hub (**2**) and turn it clockwise until the tape becomes taut.

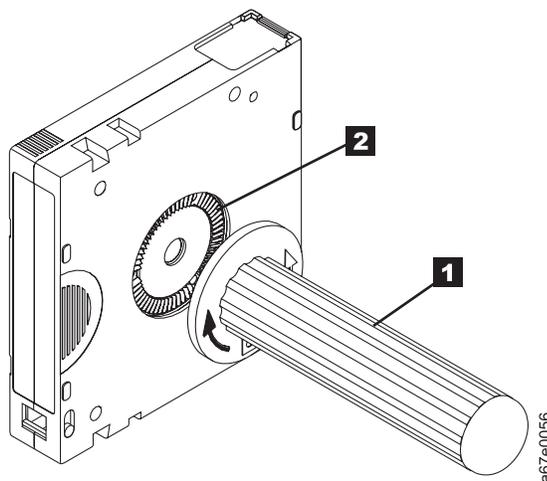


Figure 43. Rewinding the tape into the cartridge

6. Remove the rewind tool.

Reattaching a leader pin in an Ultrium cartridge

The first meter of tape in a Ultrium 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 44). A plastic brace that holds the cartridge door open.
- **Cartridge manual rewind tool** (see **2** in Figure 44). 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 44). 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.

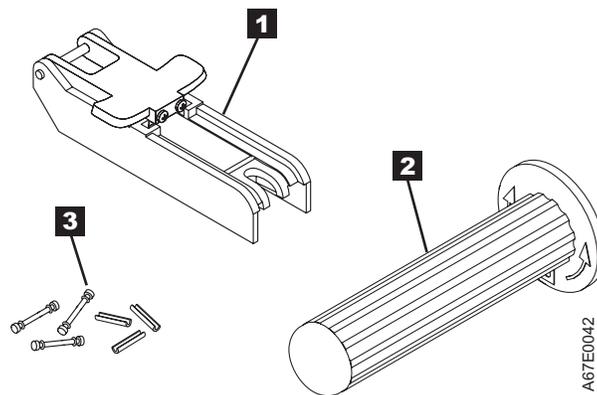


Figure 44. Leader Pin Reattachment Kit

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 45 on page 160) 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**.

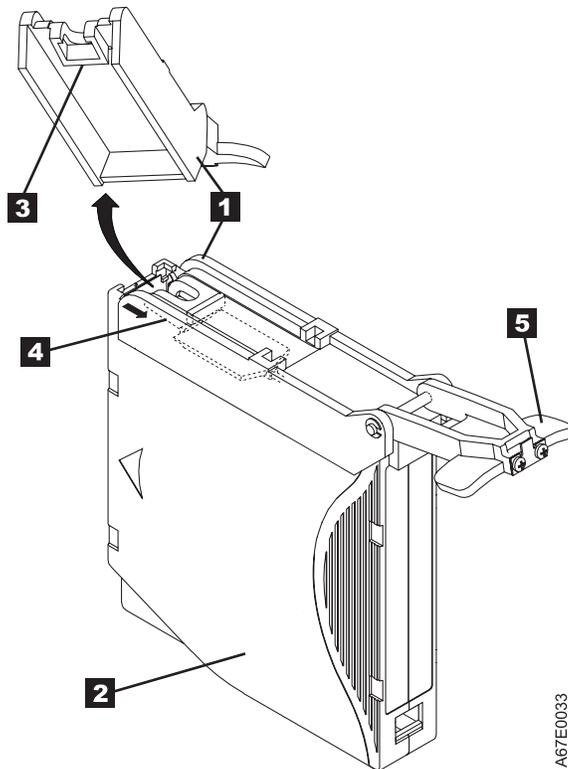


Figure 45. Attaching the leader pin attach tool to an Ultrium tape cartridge. To hold the cartridge door open, hook the tool into the door and pull the tool back.

2. To find the end of the tape inside the cartridge, attach the cartridge manual rewind tool (**1** in Figure 46 on page 161) 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.

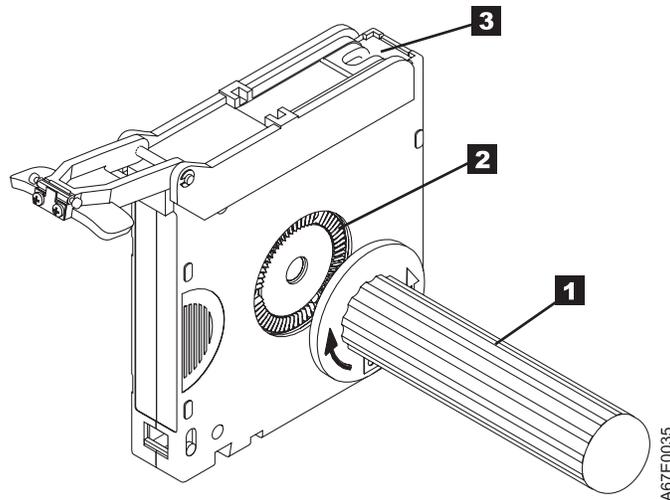


Figure 46. Winding the tape out of the Ultrium tape cartridge. Turn the cartridge manual rewind tool clockwise to see the end of the tape, then turn it counterclockwise to bring the tape to the cartridge door.

5. On the leader pin (**1** in Figure 47), 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.

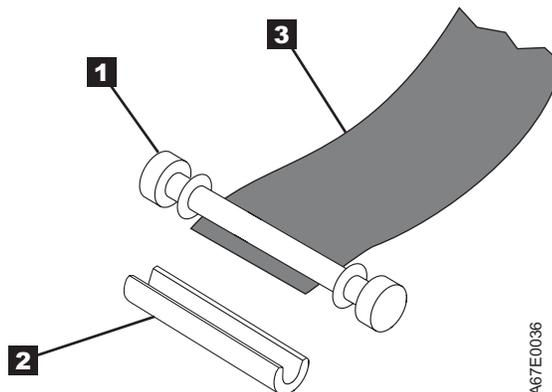


Figure 47. Removing the C-clip from the leader pin. Use your fingers to push the C-clip from the leader pin.

7. Position the tape in the alignment groove of the leader pin attach tool (see **1** in Figure 48 on page 162).
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 the following step use care when folding the tape over the pin.
11. Fold the tape over the leader pin and hold it with your fingers (see Figure 48 on page 162).

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.

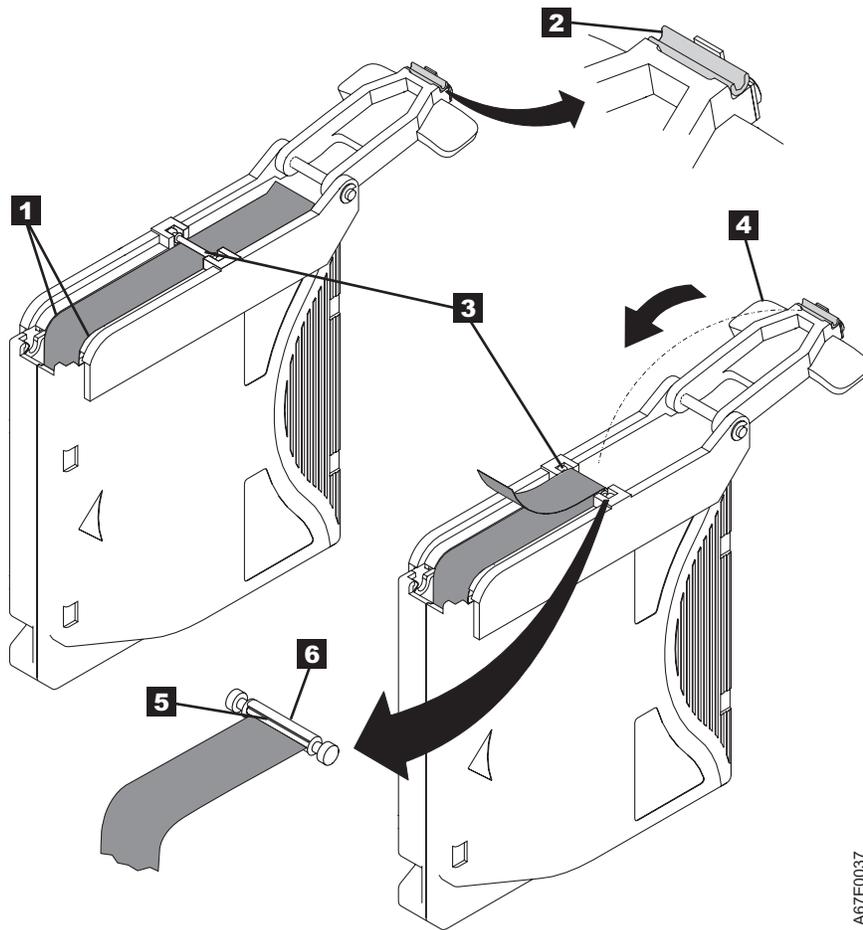


Figure 48. Attaching the leader pin to the tape

12. 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.
13. Swing the pivot arm open and trim the excess tape **5** so that it is flush with the reattached leader pin **6**.
14. Use your fingers to remove the leader pin from the cavity **3** in the leader pin attach tool.
15. 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.
16. Remove the rewind tool.
17. Remove the leader pin attach tool by lifting its end up and away from the cartridge.

Environmental and shipping specifications for Ultrium cartridges

This topic provides the operating, storage, and shipping specifications for Ultrium tape cartridges.

Before you use an Ultrium 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 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 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 53 gives the environment for operating, storing, and shipping LTO Ultrium tape cartridges.

Table 53. Environment for operating, storing, and shipping the LTO Ultrium 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.			
Notes:				
1. Operational storage equals less than 6 months.				
2. Archival storage equals greater than 6 months.				

Disposing of Ultrium tape cartridges

This section describes how to dispose of Ultrium tape cartridges according to federal and other regulations.

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

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

If a tape cartridge must be disposed of in a secure manner, you can erase the data on the cartridge by using a high-energy ac degausser (use a minimum of 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 Ultrium cartridges and media supplies

This section tells how to order additional Ultrium tape cartridges and other related media supplies.

You can use one of the following methods to order the cartridges and media supplies shown in Table 54:

- 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 54. Ordering Ultrium cartridges and media supplies

Supply Item	Method of Ordering	Feature Codes for RFID Labels
IBM System Storage 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 ¹ labels, also specify the feature code provided.	FC 1421
IBM System Storage LTO Ultrium 1500 GB Data Cartridge Order VOLSER labels separately.	Specify Machine Type 3589 Model 015.	N/A
IBM System Storage 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 System Storage LTO Ultrium 1500 GB WORM Data Cartridge Order VOLSER labels separately.	Specify Machine Type 3589 Model 035.	N/A
IBM TotalStorage 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 TotalStorage LTO Ultrium 800 GB WORM Data Cartridge Order VOLSER labels separately.	Specify Machine Type 3589 Model 033.	N/A
IBM TotalStorage 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

Table 54. Ordering Ultrium cartridges and media supplies (continued)

Supply Item	Method of Ordering	Feature Codes for RFID Labels
IBM TotalStorage LTO Ultrium 800 GB Data Cartridge Order VOLSER labels separately.	Specify Machine Type 3589 Model 011.	N/A
IBM TotalStorage 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 TotalStorage LTO Ultrium 400 GB WORM Data Cartridge Order VOLSER labels separately.	Specify Machine Type 3589 Model 029.	N/A
IBM TotalStorage 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 TotalStorage LTO Ultrium 400 GB Data Cartridge Order VOLSER labels separately.	Specify Machine Type 3589 Model 009.	N/A
IBM TotalStorage 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 TotalStorage LTO Ultrium 200 GB Data Cartridge Order VOLSER labels separately.	Specify Machine Type 3589 Model 007.	N/A
IBM TotalStorage 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 TotalStorage 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
Note: N/A = Not applicable		

Ordering bar code labels for Ultrium cartridges

This section provides a list of authorized suppliers of bar code labels for Ultrium cartridges.

Bar code labels with volume serial (VOLSER) numbers are required for Ultrium 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 IBM System Storage 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 which allow end users to print labels on their own printing equipment.

Table 55. 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 section introduces information about the 3592 tape drive media.

In addition to automating the storage and movement of IBM LTO Ultrium Tape Cartridges, the TS3500 Tape Library does the same for IBM TotalStorage 3592 Enterprise Tape Cartridges.

Overview of 3592 media

This section describes the tape cartridges that are used by 3592 tape drives in the TS3500 Tape Library.

The 3592 tape drive uses nine different data cartridge types and a cleaning cartridge. Characteristics of these cartridges are summarized in Table 56 on page 170.

Figure 49 shows the IBM TotalStorage 3592 Enterprise Tape Cartridge.

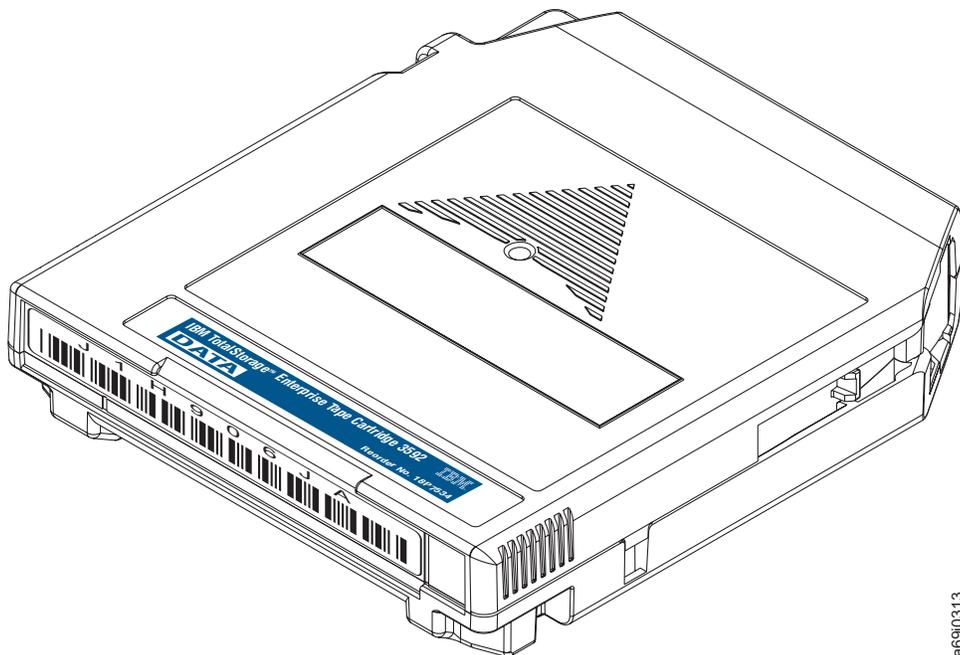


Figure 49. Components of the IBM TotalStorage 3592 Enterprise Tape Cartridge

Cartridges can be distinguished by the text on the product label, as well as by the color of the cartridge case. Table 56 on page 170 gives the differences of the 3592 Tape Cartridges.

Table 56. Types of IBM 3592 TotalStorage Enterprise Tape Cartridges

Text on product label and type of media ¹	Native capacity				Case color	Label, door, and write-protect switch color	Part number
	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	300 GB (J1A format)	Black	Dark blue	18P7534
		500 GB (465.66 GiB) E05 format					
		300 GB (279.39 GiB) J1A format	300 GB (279.39 GiB) J1A format				
Extended data, JB	1 600 GB (1490.12 GiB) E07 format	1 000 GB (931.32 GiB)	700 GB (651.93 GiB)	Not supported	Black	Dark green	23R9830
	1 000 GB (931.32 GiB) E06 format						
Advanced data, JC	4 TB (3.64 TiB)	Not supported	Not supported	Not supported	Black	Dark purple	46X7452
Economy, JJ	Not supported	128 GB (119.21 GiB) E06 format	100 GB (93.13 GiB) E05 format	60 GB (58.88 GiB) J1A format	Black	Light blue	24R0316
		100 GB (93.13 GiB) E05 format					
		60 GB (58.88 GiB) J1A format	60 GB (58.88 GiB) J1A format				
Advanced economy, JK	500 GB (465.66 GiB)	Not supported	Not supported	Not supported	Black	Light purple	46X7453
WORM, JW	Not supported	640 GB (596.04 GiB) E06 format	500 GB (465.66 GiB) E05 format	300 GB (279.39 GiB) J1A format	Platinum (silvery gray)	Dark blue	18P7538
		500 GB (465.66 GiB) E05 format					
		300 GB (279.39 GiB) J1A format	300 GB (279.39 GiB) J1A format				
Extended WORM, JX	1 600 GB (1490.12 GiB) E07 format	1 000 GB (931.32 GiB)	700 GB (651.93 GiB)	Not supported	Platinum (silvery gray)	Dark green	23R9831
	1 000 GB (931.32 GiB) E06 format						
Advanced WORM, JY	4 TB (3.64 TiB)	Not supported	Not supported	Not supported	Platinum (silvery gray)	Dark purple	46X7454

Table 56. Types of IBM 3592 TotalStorage Enterprise Tape Cartridges (continued)

Economy WORM, JR	Not supported	128 GB (119.21 GiB) E06 format	100 GB (93.13 GiB) E05 format	60 GB (J1A format)	Platinum (silvery gray)	Light blue	24R0317
		100 GB (93.13 GiB) E05 format					
		60 GB (58.88 GiB) J1A format	60 GB (58.88 GiB) J1A format				
Cleaning, CLNxxxJA ²	N/A ³	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. Where xxx equals three numerals.
3. N/A = Not applicable

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 xxxJA where a space occurs after CE and xxx equals three numerals.

The 3592 tape drive does not support Ultrium formats.

Firmware for each type of 3592 Tape Drive (TS1140, TS1130, TS1120, and J1A) will not work in any other 3592 Tape Drive.

You can update firmware for the 3592 tape drive without scheduling downtime. This enhancement is called a *nondisruptive drive firmware update*. It is available through the IBM System Storage 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 System Storage TS3500 Tape Library with ALMS Operator Guide*.

WORM functionality for 3592 tape drives and media

All 3592 tape drives with the appropriate microcode version installed are capable of reading and writing WORM cartridges. The The TS1120 and later tape drives support WORM behaviors and format attributes. These tape drives support the following four 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 and later tape drives

JY (advanced)

Supported by the TS1140 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 servo manufacturer's word 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 already written on the tape. The microcode keeps track of the last appendable point on the tape by means of an overwrite-protection pointer 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, and 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 System Storage 3592 Tape Drive SCSI Reference*.

The 3592 tape drives allow append operations to data already on WORM cartridges, and allow overwrite of file marks and other non-data attributes to provide application transparency. However, they do not allow data overwrite under any circumstances. Once full of data, WORM cartridges may not 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, and JC 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 or JK 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 System Storage 3592 Tape Drive SCSI Reference*.

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 System Storage 3592 Tape Drive SCSI Reference*.

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 is for a JY cartridge in E07 density is 4 TB (3.64 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 either of the short length (economy) cartridge types (JJ or JK), or on the WORM cartridges (JW, JX, JY, and JR). Capacity scaling is only offered on the JA, JB, and JC 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 TotalStorage 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 writes or reads 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 media” on page 169 for these details.

TS1120 and newer tape drives that are encryption-enabled perform encryption after compression.

Figure 50 on page 175 shows the IBM TotalStorage 3592 Enterprise Tape Cartridge and its components.

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		

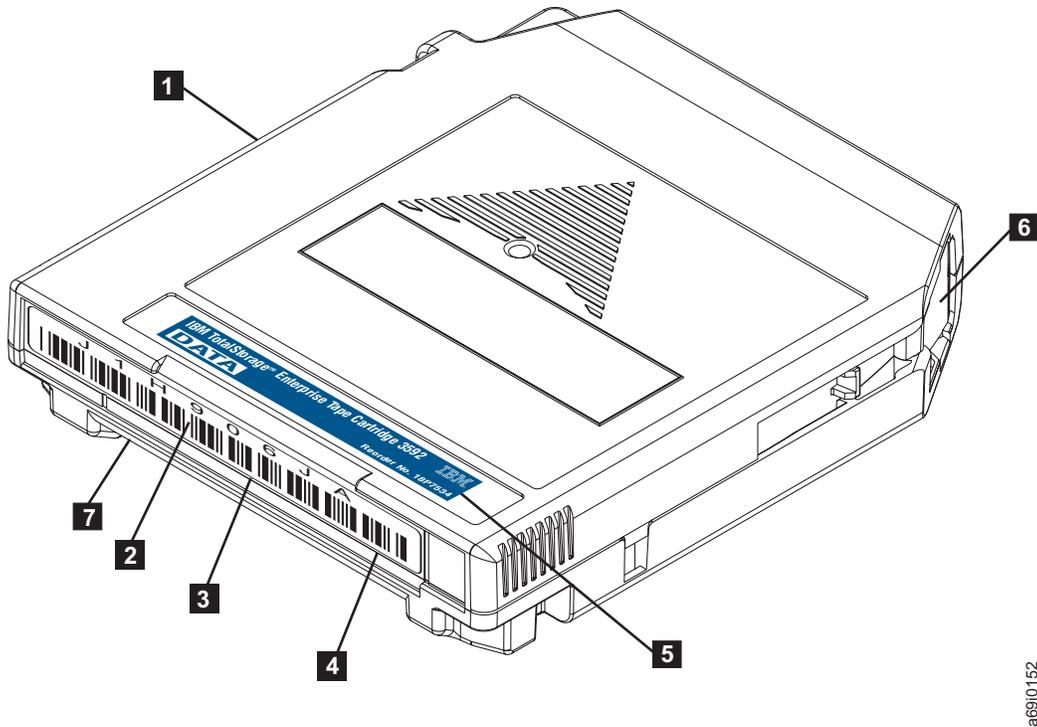


Figure 50. Components of the IBM TotalStorage 3592 Enterprise Tape Cartridge

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 50) 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 in.) over the length of the label and have no folds, missing pieces, tears, or any extraneous markings. Failure to follow these placement requirements will result in degraded readability.

The IBM product label **5** specifies the type of cartridge: data, Economy, WORM, Economy WORM, or cleaning.

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

This section gives information about the appearance and usage of the IBM TotalStorage 3592 Enterprise 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 TotalStorage 3592 Enterprise Cleaning Cartridge with the first 3592 tape drive in the library. This cleaning cartridge may be used in all 3592 tape drives.



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 51 on page 178) 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 69. Also refer to the sections about cleaning drives, enabling or disabling automatic cleaning, and enabling automatic eject of expired cleaning cartridges in the *IBM System Storage TS3500 Tape Library 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 System Storage TS3500 Tape Library with ALMS Operator Guide*.

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 51) before you load the cartridge.

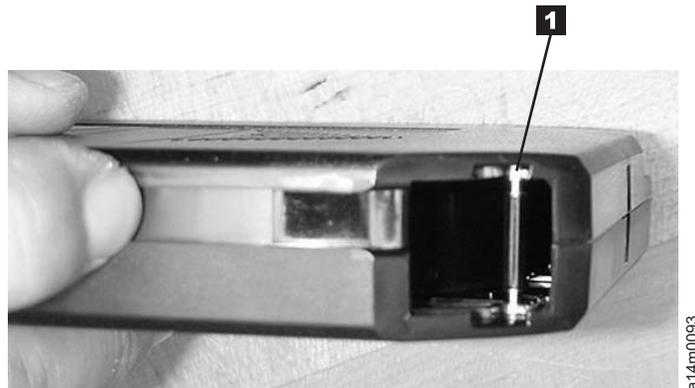


Figure 51. Leader pin in proper position in the 3592 cleaning cartridge (the cartridge door is manually retracted)

While the cleaning is in process, the 8-character message display on the drive shows the message, CLEAN*.

The IBM TotalStorage 3592 Enterprise 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 52). 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 53 on page 179) is also light gray.

- 1** Non-moveable light gray block
- 2** Sample label for cleaning cartridge



Figure 52. Characteristics that identify the 3592 cleaning cartridge



Figure 53. Door of the 3592 cleaning cartridge

Before a drive can be cleaned, you must ensure that an IBM TotalStorage 3592 Enterprise Cleaning Cartridge is loaded in the library (to determine whether one or more cleaning cartridges are loaded, see the section about removing or loading a cleaning cartridge in the *IBM System Storage TS3500 Tape Library with ALMS Operator Guide*). You can load multiple cleaning cartridges and store them in any cartridge storage slot except the slot that is reserved for the diagnostic cartridge (see the section about inaccessible storage slots in the *IBM System Storage TS3500 Tape Library with ALMS Operator Guide*).

3592 diagnostic cartridge

This section gives 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 CE xxxJJ (for J1A, TS1120, and TS1130 tape drives) or CE xxxJK (for TS1140 tape drives), where a space occurs after CE and xxx equals three numerals. 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.

3592 bar code label

This section describes the appearance and specifications of the 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 data (JC), economy (JJ), advanced economy (JK), economy WORM (JR), WORM (JW), extended WORM (JX), advanced WORM (JY), cleaning, or diagnostic cartridge. Figure 54 on page 181 shows a sample bar code label for the IBM TotalStorage 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, JJ, JK, JW, JX, JY, or JR
- 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 54 on page 181). 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 System Storage TS3500 Tape Library 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 System Storage TS3500 Tape Library with ALMS Operator Guide*.

To order bar code labels, see “Ordering 3592 bar code labels” on page 194.

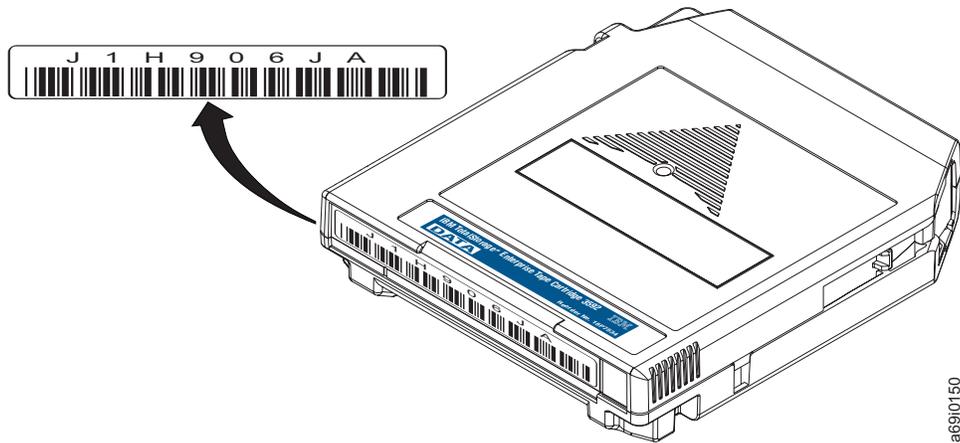


Figure 54. Sample bar code label on the IBM TotalStorage 3592 Enterprise Tape Cartridge. The volume serial number (J1H906JA) and bar code are printed on the label.

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 machine readable labels on other surfaces of the cartridge. They may interfere with the ability of the bar code reader to read the bar code.
- 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

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:

- Barcode Compatibility Mode must be enabled on the TS3500 Tape Library operator panel.
- 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 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 181.

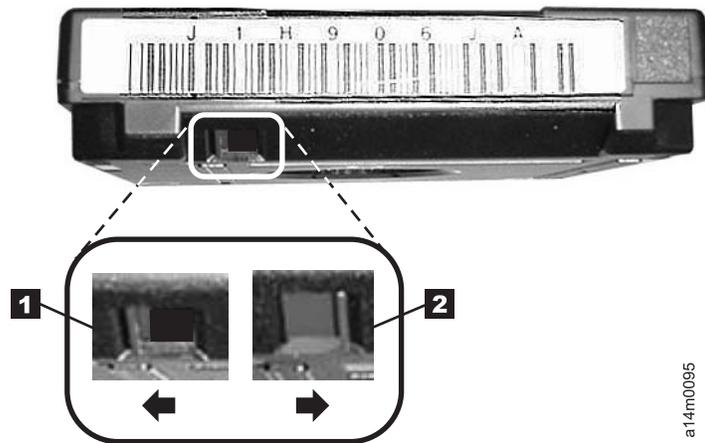
Note that the bar code scanner only reads the VOLSER. If a single character media type identifier is applied, it is ignored by the library. Also, it is difficult to read the label of a cartridge mounted in the drive. Slower operation and repeated read attempts may be observed. This is normal for these labels.

Setting the write-protect switch on a 3592 Cartridge

This section gives instructions for setting the write-protect switch on a 3592 Tape Cartridge.

The position of the write-protect switch on the 3592 Tape Cartridge (see Figure 55) determines whether 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.



a14m0095

Figure 55. Setting the write-protect switch on the 3592 Tape Cartridge

Handling 3592 tape cartridges

This section introduces ways to handle 3592 tape cartridges to avoid damage to the cartridge case and the tape.



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.

Incorrect handling or an inhospitable environment can damage the IBM TotalStorage 3592 Enterprise Tape Cartridge or its magnetic tape. To avoid damage to your tape cartridges and to ensure the continued high reliability of your TS3500 Tape Library, use the following guidelines:

Provide training for using 3592 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 3592 tape cartridges

- When you ship a cartridge, ship it in its original or better packaging.
- Use only shipping container 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 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 the following:
 - Place the cartridge in polyethylene plastic wrap or bags to protect it from dust, moisture, and other contaminants.
 - Pack the cartridge snugly; do not allow it to move around.
 - Double-box the cartridge (place it inside a box, then place that box inside the shipping box) and add padding between the two boxes.

Provide proper acclimation and environmental conditions for 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 100 Oersteds (for example, terminals, motors, video equipment, X-ray equipment, or fields that exist near high-current cables or power supplies). Such exposure can cause the loss of recorded data or make the blank cartridge unusable.
- Maintain the 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 areas provided on 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

- 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

This section gives the procedure to use when you move a leader pin into its proper position in a 3592 tape cartridge.



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

If the leader pin in your 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 56 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)

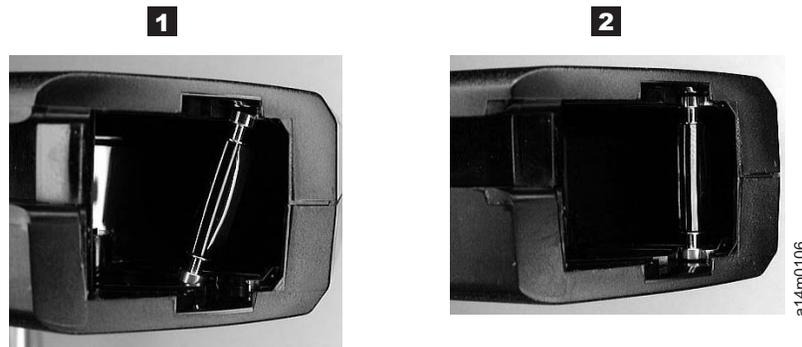


Figure 56. Leader pin in the incorrect and correct positions in a 3592 tape cartridge. The cartridge door is open and the leader pin is visible inside the cartridge.

To reposition the leader pin, perform the following steps.

1. Slide open the cartridge door (see **1** in Figure 57 on page 187) 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.

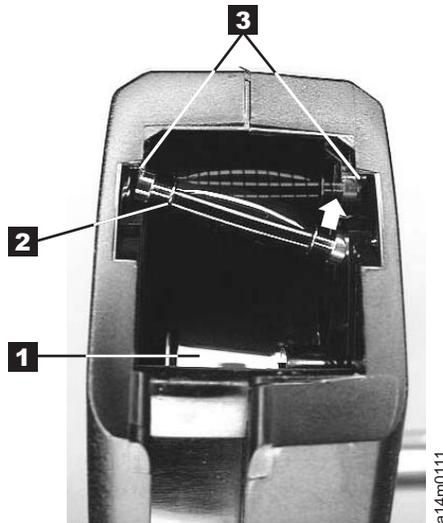


Figure 57. Placing the dislodged leader pin into the correct position.. The cartridge door is open, showing the leader pin out of position

5. To rewind the tape, insert the cartridge manual rewind tool (see **1** in Figure 58) into the cartridge's hub **2** and turn it clockwise until the tape becomes taut.

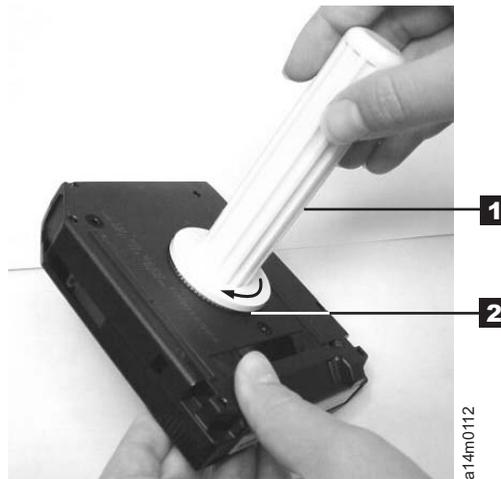


Figure 58. Rewinding the tape into the cartridge

6. Remove the rewind tool by pulling it away from the cartridge.

Environmental and shipping specifications for 3592 cartridges

This section gives a table of the 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 57 lists the environmental conditions for operating, storing, and shipping IBM TotalStorage 3592 Enterprise Tape Cartridges.

Table 57. Environment for operating, storing, and shipping the IBM TotalStorage 3592 Enterprise 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.		
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

This section describes how to 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 TotalStorage 3592 Enterprise 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

This section describes how to maintain 3592 Tape Cartridges and the 3584 Tape Library to ensure proper operation.

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 3584 Tape Library helps to keep IBM magnetic tape cartridge systems operating in a reliable and efficient manner.

Ordering 3592 media supplies

This section gives an overview of the methods for ordering 3592 tape cartridges and other related media supplies.

You can order media supplies in two ways. 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 TotalStorage 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 58 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 58 shows a few examples of ordering options for each cartridge type. Note that additional feature codes are required to completely specify all desired characteristics of the cartridges. Orders may be placed by calling 1-800-IBM-CALL (1-800-426-2255).

Table 58. 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 Data cartridges, labeled and initialized
520	JC/9035	5221	5231	N/A	4 TB (3.64 TiB)	20-pack 3592 Advanced Data cartridges, labeled, not initialized

Table 58. 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 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
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

Table 58. 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			
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
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 Table 56 on page 170.
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 59 on page 193 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 59 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 59. Ordering 3592 media supplies by using part numbers

Supply Item ¹	Capacity ²	Part Number
IBM TotalStorage 3592 Enterprise Tape Cartridge - Data (JA)	E06 format: 640 GB (596.04 GiB) E05 format: 500 GB (465.66 GiB) J1A format: 300 GB (279.39 GiB)	18P7534
IBM TotalStorage 3592 Enterprise Tape Cartridge - Extended Data (JB)	E07 format: 1 600 GB (1490.12 GiB) E06 format: 1 000 GB (931.32 GiB) E05 format: 700 GB (651.93 GiB)	23R9830
IBM TotalStorage 3592 Enterprise Tape Cartridge - Advanced Data (JC)	E07 format: 4 TB (3.64 TiB)	46X7452
IBM TotalStorage 3592 Enterprise Tape Cartridge - Economy (JJ)	E06 format: 128 GB (119.21 GiB) E05 format: 100 GB (93.13 GiB) J1A format: 60 GB (58.88 GiB)	24R0316
IBM TotalStorage 3592 Enterprise Tape Cartridge - Advanced Economy (JK)	E07 format: 500 GB (465.66 GiB)	46X7453
IBM TotalStorage 3592 Enterprise Tape Cartridge - Economy WORM (JR)	E06 format: 128 GB (119.21 GiB) E05 format: 100 GB (93.13 GiB) J1A format: 60 GB (58.88 GiB)	24R0317
IBM TotalStorage 3592 Enterprise Tape Cartridge - 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 TotalStorage 3592 Enterprise Tape Cartridge - 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 TotalStorage 3592 Enterprise Tape Cartridge - Advanced WORM (JY)	E07 format: 4 TB (3.64 TiB)	46X7454
IBM TotalStorage 3592 Enterprise Tape Cartridge - 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 56 on page 170 for more detailed information.

Ordering supplies for repairs

We recommend 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

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 System Storage TS3500 Tape Library 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 end users to print labels on their own printing equipment.

Table 60. 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 System Storage TS3500 Tape Library 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 System Storage TS3500 Tape Library 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 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 tape drive and the TS1140 tape drive 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 the following cables:

- TS1140 and Ultrium 5 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 61.

Table 61. 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 62 on page 198 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 62. 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 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 205).

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 System Storage TS3500 Tape Library 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 63 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 63, the values for Port 2 do not apply to tape drives that have a single port.

Table 63. 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 63. 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 System Storage TS3500 Tape Library 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 64 on page 201.

Table 64. Valid Loop IDs and their associated AL_PAs for Ultrium tape drives and 3592 tape drives in the IBM System Storage TS3500 Tape Library

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 64. Valid Loop IDs and their associated AL_PAs for Ultrium tape drives and 3592 tape drives in the IBM System Storage TS3500 Tape Library (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

This section defines 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 TotalStorage LTO Ultrium Tape Drive SCSI Reference* or *IBM System Storage 3592 Tape Drive SCSI Reference*. For information about the SCSI commands for the library, see the *IBM System Storage TS3500 Tape Library 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 System Storage TS3500 Tape Library 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/1to/>.

Under IBM System Storage TS3500 Tape 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 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 65. 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 66. 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 67. 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

This topic describes tape encryption in the TS3500 Tape Library.

Data is one of the most highly valued resources in a competitive business environment. Protecting that data, controlling access to it, and verifying its authenticity while maintaining its availability are priorities in our security-conscious world. Data encryption is a tool that answers many of these needs.

The IBM System Storage TS1120 (3592 Model E05) and newer 3592 tape drives are capable of encrypting data as it is written to any size IBM TotalStorage Enterprise Tape Cartridge 3592, including WORM cartridges. The IBM System Storage TS1040 LTO Ultrium 4 and newer Ultrium tape drives are also capable of encrypting data as it is written to any LTO 4 or newer data cartridge. Encryption is performed at full line speed in the tape drive after compression. (Compression is more efficiently done before encryption.) This new capability adds a strong measure of security to stored data without the processing overhead and performance degradation associated with encryption performed on the server or the expense of a dedicated appliance.

The following three major elements comprise the tape drive encryption solution:

The encryption-enabled tape drive

The TS1130, LTO Ultrium 4, and newer tape drives are *encryption-capable*. All TS1120 Model E05 Tape Drives with Feature Code 5592 or 9592 are *encryption capable*. This means that they are functionally capable of performing hardware encryption, but this capability has not yet been activated. In order 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 System Storage TS3500 Tape Library with ALMS Operator Guide* for information about how to enable encryption.

Note: FC 1604, Transparent LTO Encryption, is required in order to use system-managed or library-managed encryption on LTO Ultrium 4 and LTO Ultrium 5 tape drives. It is not required for application-managed encryption. Refer to the sections on each method of encryption for more information.

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, are capable of performing key management. For environments without such applications or those where application agnostic encryption is desired, IBM provides a key manager (such as the IBM Encryption Key Manager component for the Java platform or the Tivoli Key Lifecycle Manager) to perform all necessary key management tasks. “Managing encryption” on page 212 provides more information.

Encryption policy

This is the method 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” for more information.

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 and not 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 via support line contract.

Managing encryption

This topic introduces the key manager and the 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 that are used to encrypt information being written to, and decrypt information being read from, tape media (tape and cartridge formats). IBM currently supports the IBM Encryption Key Manager component for the Java platform or the 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, and is designed to be a shared resource deployed in several locations within an Enterprise. It is capable of serving numerous IBM encrypting tape drives, regardless of where those drives reside (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 keystore to hold the certificates and keys (or pointers to the certificates and keys) required for all encryption tasks. Refer to the appropriate key manager documentation for detailed information about the key manager and the keystores it supports.

There are three methods of encryption management to choose from. These methods differ in where the encryption policy engine resides and where key management is performed for your encryption solution, and how the key manager is connected to the drive. Your operating environment determines which is the best for you. Key management and the encryption policy engine may be located in any one of the following three environmental layers.

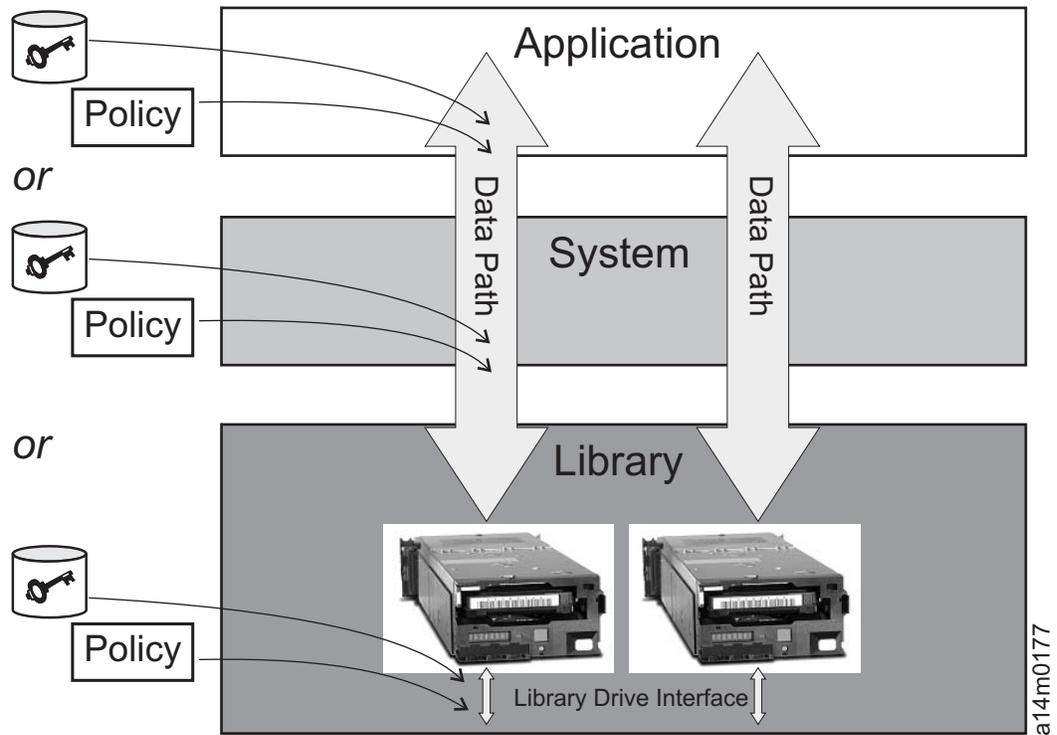


Figure 59. Three possible locations for encryption policy engine and key management.

Application Layer

Initiates data transfer for tape storage, for example TSM.

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 IBM System Storage TS3500 Tape Library, which contains an internal interface to each tape drive within it.

Planning for application-managed encryption

This topic explains application-managed encryption (AME).

This method is best where operating environments run an application already capable of generating and managing encryption policies and keys, such as Tivoli Storage Manager (TSM). Policies specifying 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 written and encrypted using the application-managed encryption method can only be read by the same software application that wrote them.

A key manager is not required by, or used by, application-managed tape encryption.

Application-managed tape encryption on TS1120, LTO Ultrium 4, and newer 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, see your Tivoli Storage Manager documentation or visit <http://publib.boulder.ibm.com/infocenter/tivihelp/v1r1/index.jsp>.

Planning for system-managed encryption

This topic explains system-managed encryption (SME).

This method is best for encryption on TS1120, LTO Ultrium 4, and newer tape drives in System z operating environments.

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 may 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* and the *IBM System Storage TS3500 Tape Library with ALMS Operator Guide*.

System z

Encryption policies specifying 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®) may also be used. Key generation and management is performed by the key manager 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 Virtualization Engine 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 System Storage TS1130 and TS1120 Tape Drives (3592)*.

Planning for library-managed encryption

This topic explains library-managed encryption (LME).

This method is best for TS1120, LTO Ultrium 4, and newer tape drives in an open-attached TS3500 Tape Library. Barcode 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 is performed by the key manager. Policy control and keys pass through the library-to-drive interface, therefore encryption is transparent 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 written on the tape volume by the application. Refer to the appropriate section of the *IBM System Storage TS3500 Tape Library with ALMS Operator Guide* for more information.

Notes:

- If you use library-managed encryption and IBM tape and changer drivers running 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*, available on the Web: <http://www-01.ibm.com/support/docview.wss?rs=577&tuid=ssg1S7002972> .
- When using LME, an additional Ethernet cable should be attached, preferably to a different network switch. This is for redundancy and better backup job reliability.
- When using LME with Ultrium 5 tape drives, the Tivoli Key Lifecycle Manager (TKLM) 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 may 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.

In order to perform encryption the following is required:

- Encryption-capable tape drive(s) (TS1120, LTO Ultrium 4, or newer tape drives)
- 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 68 presents an overview of these rules.

Table 68. Tape drive configuration for encryption

Drive types	Library setup (for libraries with ALMS)
<p>LTO Tape Drives</p> <p>Note: Feature code 1604 is required to enable encryption on LTO Ultrium 4 and newer tape drives if using LME or SME.</p>	<ul style="list-style-type: none"> • Encryption can be enabled with a mix of both encryption-capable (LTO Ultrium 4 and newer) drives and drives that are not encryption capable (LTO Ultrium 2 and Ultrium 3). • Any LTO Ultrium 4 and newer 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 tape drives, the Tivoli Key Lifecycle Manger (TKLM) is required as the key manager.
<p>3592 Tape Drives</p>	<ul style="list-style-type: none"> • 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.
<p>Mixed (LTO and 3592) Drives</p>	<ul style="list-style-type: none"> • 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 68 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 System Storage TS3500 Tape Library with ALMS Operator Guide*.

Appendix A. Accessibility

Accessibility features for the *IBM System Storage TS3500 Tape Library Introduction and Planning Guide*

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 System Storage TS3500 Tape Library 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 System Storage TS3500 Tape Library 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.

Appendix B. Notices

Notices

The information provided by this media supports the products and services described with consideration for the conditions described herein.

IBM may not offer the products, services, or features discussed in this document in other countries. Consult your local IBM representative for information on the products and services currently available in your area. Any reference to an IBM product, program, or service is not intended to state or imply that only that IBM product, program, or service may be used. Any functionally equivalent product, program, or service that does not infringe any IBM intellectual property right may be used instead. However, it is the user's responsibility to evaluate and verify the operation of any non-IBM product, program, or service.

IBM may have patents or pending patent applications covering subject matter described in this document. The furnishing of this document does not give you any license to these patents. You can send license inquiries to:

*IBM Director of Licensing
IBM Corporation
North Castle Drive
Armonk, NY 10504-1785
U.S.A.*

The following paragraph does not apply to the United Kingdom or any other country where such provisions are inconsistent with local law:

INTERNATIONAL BUSINESS MACHINES CORPORATION PROVIDES THIS PUBLICATION "AS IS" WITHOUT WARRANTY OF ANY KIND, EITHER EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF NON-INFRINGEMENT, MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. Some states do not allow disclaimer of express or implied warranties in certain transactions, therefore, this statement may not apply to you.

This information could include technical inaccuracies or typographical errors. Changes are periodically made to the information herein; these changes will be incorporated in new editions of the publication. IBM may make improvements and/or changes in the product(s) and/or the program(s) described in this publication at any time without notice.

Any references in this information to non-IBM Web sites are provided for convenience only and do not in any manner serve as an endorsement of those Web sites. The materials at those Web sites are not part of the materials for this IBM product and use of those Web sites is at your own risk.

IBM may use or distribute any of the information you supply in any way it believes appropriate without incurring any obligation to you.

Any performance data contained herein was determined in a controlled environment. Therefore, the results obtained in other operating environments may vary significantly. Some measurements may have been made on development-level

systems and there is no guarantee that these measurements will be the same on generally available systems. Furthermore, some measurement may have been estimated through extrapolation. Actual results may vary. Users of this document should verify the applicable data for their specific environment.

Information concerning non-IBM products was obtained from the suppliers of those products, their published announcements or other publicly available sources. IBM has not tested those products and cannot confirm the accuracy of performance, compatibility or any other claims related to non-IBM products. Questions on the capabilities of non-IBM products should be addressed to the suppliers of those products.

All statements regarding IBM's future direction or intent are subject to change or withdrawal without notice, and represent goals and objectives only.

This information is for planning purposes only. The information herein is subject to change before the products described become available.

This information contains examples of data and reports used in daily business operations. To illustrate them as completely as possible, the examples include the names of individuals, companies, brands, and products. All of these names are fictitious and any similarity to the names and addresses used by an actual business enterprise is entirely coincidental.

Trademarks

The following terms are trademarks of the International Business Machines Corporation in the United States, other countries, or both.

- AIX
- Enterprise Storage Server
- ESCON
- FICON
- i5/OS
- iSeries
- IBM
- pSeries
- S/390
- System Storage
- TotalStorage
- z/OS
- zSeries

IBM, the IBM logo, and [ibm.com](http://www.ibm.com) are trademarks or registered trademarks of International Business Machines Corporation in the United States, other countries, or both. If these and other IBM trademarked terms are marked on their first occurrence in this information with a trademark symbol ((R) or (TM)), these symbols indicate U.S. registered or common law trademarks owned by IBM at the time this information was published. Such trademarks may also be registered or common law trademarks in other countries. A current list of IBM trademarks is available on the Web at "Copyright and trademark information" at <http://www.ibm.com/legal/copytrade.shtml>.

Adobe, the Adobe logo, PostScript, and the PostScript logo are either registered trademarks or trademarks of Adobe Systems Incorporated in the United States, and/or other countries.

Java and all Java-based trademarks are trademarks of Sun Microsystems, Inc. in the United States, other countries, or both.

Microsoft, Windows, and Windows NT are trademarks of Microsoft Corporation in the United States, other countries, or both.

Intel, Intel logo, Intel Inside, Intel Inside logo, Intel Centrino, Intel Centrino logo, Celeron, Intel Xeon, Intel SpeedStep, Itanium, and Pentium are trademarks or registered trademarks of Intel Corporation or its subsidiaries in the United States and other countries.

UNIX is a registered trademark of The Open Group in the United States and other countries.

Linux is a registered trademark of Linus Torvalds in the United States, other countries, or both.

Other company, product, and service names may be trademarks or service marks of others.

Electronic emission notices

This section contains the electronic emission notices or statements for the United States and other countries.

Federal Communications Commission statement

This explains the Federal Communications Commission's (FCC) statement.

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, might cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference, in which case the user will be required to correct the interference at his own expense.

Properly shielded and grounded cables and connectors must be used in order to meet FCC emission limits. IBM is not responsible for any radio or television interference caused by using other than recommended cables and connectors, or by unauthorized changes or modifications to this equipment. Unauthorized changes or modifications could void the user's authority to operate the equipment.

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

Industry Canada compliance statement

This Class A digital apparatus complies with Canadian ICES-003.

Cet appareil numérique de la classe A est conform à la norme NMB-003 du Canada.

European Union Electromagnetic Compatibility Directive

This product is in conformity with the protection requirements of European Union (EU) Council Directive 2004/108/EC on the approximation of the laws of the Member States relating to electromagnetic compatibility. IBM cannot accept responsibility for any failure to satisfy the protection requirements resulting from a non-recommended modification of the product, including the fitting of non-IBM option cards.

Attention: This is an EN 55022 Class A product. In a domestic environment this product might cause radio interference in which case the user might be required to take adequate measures.

Responsible Manufacturer:

International Business Machines Corp.
New Orchard Road
Armonk, New York 10504
914-499-1900

European community contact:

IBM Deutschland GmbH
IBM Technical Regulations, Department M456
IBM-Allee 1, 71139 Ehningen, Germany

Australia and New Zealand Class A Statement:

Attention: This is a Class A product. In a domestic environment this product might cause radio interference in which case the user might be required to take adequate measures.

Germany Electromagnetic compatibility directive: Deutschsprachiger EU Hinweis: Hinweis für Geräte der Klasse A EU-Richtlinie zur Elektromagnetischen Verträglichkeit

Dieses Produkt entspricht den Schutzanforderungen der EU-Richtlinie 2004/108/EG zur Angleichung der Rechtsvorschriften über die elektromagnetische Verträglichkeit in den EU-Mitgliedsstaaten und hält die Grenzwerte der EN 55022 Klasse A ein.

Um dieses sicherzustellen, sind die Geräte wie in den Handbüchern beschrieben zu installieren und zu betreiben. Des Weiteren dürfen auch nur von der IBM empfohlene Kabel angeschlossen werden. IBM übernimmt keine Verantwortung für die Einhaltung der Schutzanforderungen, wenn das Produkt ohne Zustimmung der IBM verändert bzw. wenn Erweiterungskomponenten von Fremdherstellern ohne Empfehlung der IBM gesteckt/eingebaut werden.

EN 55022 Klasse A Geräte müssen mit folgendem Warnhinweis versehen werden:

"Warnung: Dieses ist eine Einrichtung der Klasse A. Diese Einrichtung kann im Wohnbereich Funk-Störungen verursachen; in diesem Fall kann vom Betreiber verlangt werden, angemessene Maßnahmen zu ergreifen und dafür aufzukommen."

Deutschland: Einhaltung des Gesetzes über die elektromagnetische Verträglichkeit von Geräten

Dieses Produkt entspricht dem "Gesetz über die elektromagnetische Verträglichkeit von Geräten (EMVG)." Dies ist die Umsetzung der EU-Richtlinie 2004/108/EG in der Bundesrepublik Deutschland.

Zulassungsbescheinigung laut dem Deutschen Gesetz über die elektromagnetische Verträglichkeit von Geräten (EMVG) (bzw. der EMC EG Richtlinie 2004/108/EG) für Geräte der Klasse A

Dieses Gerät ist berechtigt, in Übereinstimmung mit dem Deutschen EMVG das EG-Konformitätszeichen - CE - zu führen.

Verantwortlich für die Einhaltung der EMV Vorschriften ist der Hersteller:

International Business Machines Corp.
New Orchard Road
Armonk, New York 10504
Tel: 914-499-1900

Der verantwortliche Ansprechpartner des Herstellers in der EU ist:

IBM Deutschland GmbH
Technical Regulations, Abteilung M456
IBM-Allee 1, 71139 Ehningen, Germany

Generelle Informationen:

Das Gerät erfüllt die Schutzanforderungen nach EN 55024 und EN 55022 Klasse A.

People's Republic of China Class A Electronic Emission statement

中华人民共和国“A类”警告声明

声明

此为A级产品，在生活环境中，该产品可能会造成无线电干扰。在这种情况下，可能需要用户对其干扰采取切实可行的措施。

Taiwan Class A compliance statement

警告使用者：
這是甲類的資訊產品，在居住的環境中使用時，可能會造成射頻干擾，在這種情況下，使用者會被要求採取某些適當的對策。

talenti

Taiwan contact information

This topic contains the product service contact information for Taiwan.

IBM Taiwan Product Service Contact Information:
IBM Taiwan Corporation
3F, No 7, Song Ren Rd., Taipei Taiwan
Tel: 0800-016-888

台灣IBM 產品服務聯絡方式：
台灣國際商業機器股份有限公司
台北市松仁路7號3樓
電話：0800-016-888

f2c00790

Japan Voluntary Control Council for Interference (VCCI) Class A Statement

この装置は、クラス A 情報技術装置です。この装置を家庭環境で使用する
と電波妨害を引き起こすことがあります。この場合には使用者が適切な対策
を講ずるよう要求されることがあります。 VCCI-A

Japan Electronics and Information Technology Industries Association (JEITA) Statement (less than or equal to 20 A per phase)

高調波ガイドライン適合品

jeita1

Korean Communications Commission (KCC) Class A Statement

이 기기는 업무용(A급)으로 전자파적합기기로서 판매자 또는 사용자는 이 점을 주의하시기
바라며, 가정외의 지역에서 사용하는 것을 목
적으로 합니다.

Russia Electromagnetic Interference (EMI) Class A Statement

ВНИМАНИЕ! Настоящее изделие относится к классу А.
В жилых помещениях оно может создавать
радиопомехи, для снижения которых необходимы
дополнительные меры

rusemi

Glossary

This glossary defines the special terms, abbreviations, and acronyms used in this publication and other related publications. If you do not find the term you are looking for, see the *IBM Glossary of Computing Terms* at the following Web site: www.ibm.com/ibm/terminology.

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. The Enhanced Frame Control Assembly of the 3584 Tape Library offers a 2N power design with no single point of failure or single point of repair.

3584 Tape Library. See *IBM System Storage TS3500 Tape Library*.

3588 Tape Drive. See *IBM System Storage 3588 Tape Drive Model F3A* or *IBM System Storage TS1030 Tape Drive Model F3B*. Also known as the *Ultrium 3 Tape Drive*.

3592 Tape Controller Model J70. See *IBM TotalStorage 3592 Tape Controller Model J70*.

3592 Tape Drive. See the following entries: *IBM TotalStorage 3592 Tape Drive Model J1A*; *IBM System Storage TS1120 Tape Drive*; *IBM System Storage TS1130 Tape Drive*; *IBM System Storage TS1140 Tape Drive*.

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 Tape Library, 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 Tape Library for normal operation.

Activity screen. The primary screen on the touchscreen of the TS3500 Tape Library. 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 System Storage 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 Tape Library, the sum of their average throughput of uninterrupted data.

AIX. See *Advanced Interactive eXecutive*.

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 TS3500 Tape 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 IBM System Storage Tape Library Specialist web interface.

automatic inventory. A survey of the location of cartridges in the TS3500 Tape Library. The library performs the survey at power-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 TS3500 Tape 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 (also known as Models L22, L23, L32, L52, or L53). 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 by using a modem.

capacity. See *media capacity*.

Capacity Expansion Feature. Applicable only to the base frame (Models L22, L23, L32, L52, or L53) 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. Applicable only to base frame Models L22, L23, L52, and L53, 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 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 TS3500 Tape Library.

CETool. 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 the Call Home program for the TS3500 Tape Library, collect library and drive logs, backup 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.

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. (1) To decipher data. (2) In Cryptographic Support, to convert ciphertext into plaintext. See also *encrypt*.

dc. Direct current.

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

degausser. A device that makes magnetic tape nonmagnetic.

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

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

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 the following entries: *IBM TotalStorage LTO Ultrium 1 Tape Drive*; *IBM TotalStorage LTO Ultrium 2 Tape Drive*; *IBM TotalStorage LTO Ultrium 3 Tape Drive*; *IBM TotalStorage LTO Ultrium 4 Tape Drive*; *IBM System Storage LTO Ultrium 5 Tape Drive*; *IBM System Storage 3588 Tape Drive Model F3A*; *IBM System Storage TS1030 Tape Drive Model F3B*; *IBM TotalStorage 3592 Tape Drive Model J1A*; *IBM System Storage TS1120 Tape Drive*; *IBM System Storage TS1130 Tape Drive*; *IBM System Storage TS1140 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 which 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.

e-mail. 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 Java 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.

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 baseband 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 may be added to the base frame of the TS3500 Tape Library. Also known as the Model D22, D23, D32, D52, D53, S24, or S54, the expansion frame includes a rail assembly for the cartridge accessor and up to 12 tape drives.

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 Ultrium 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).

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.

frame. (1) In Fibre Channel technology, a unit of transmission that includes delimiters, control characters, information, and checking characters. (2) See *library frame*.

frame control assembly (FCA). The power structure for Models L22, D22, L32, D32, L52, and D52. 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 TS3500 Tape Library. 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.

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 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 Ultrium 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

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*.

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 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 S24 and S54, a feature that adds licensed capacity to the library.

High density frame. An expansion frame that contains HD slots.

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 3584 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 System Storage 3588 Tape Drive Model F3A. A data-storage device that controls the movement of the magnetic tape in an IBM LTO Ultrium Tape Cartridge. The drive houses the mechanism (drive head) that reads and writes data to the tape. Its native data capacity is 400[®] GB (372.53 GiB) per cartridge; with 2:1 compression, its capacity is up to 800 GB (745.05 GiB). The Model F3A drive provides 2 Gbps Fibre Channel connectivity. Also known as the Ultrium 3 Tape Drive.

IBM System Storage 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 System Storage TS1030 Tape Drive Model F3B. A data-storage device that controls the movement of the magnetic tape in an IBM LTO Ultrium Tape Cartridge. The drive houses the mechanism (drive head) that reads and writes data to the tape. Its native data capacity is 400 GB (372.53 GiB) per cartridge; with 2:1 compression, its capacity is up to 800 GB (745.05 GiB). The Model F3B drive provides 4 Gbps Fibre Channel connectivity. Also known as the Ultrium 3 Tape Drive.

IBM System Storage TS1040 Tape Drive Model F4A. A data-storage device that controls the movement of the magnetic tape in an IBM LTO Ultrium Tape Cartridge. The drive houses the mechanism (drive head) that reads and writes data to the tape. Its native data capacity is 800 GB (745.05 GiB) per cartridge; with 2:1 compression, its capacity is up to 1.6 TB (1.46 TiB). The Model F4A drive provides 4 Gbps Fibre Channel connectivity. Also known as the Ultrium 4 Tape Drive.

IBM System Storage TS1050 Tape Drive Model F5A. A data-storage device that controls the movement of the magnetic tape in an IBM LTO Ultrium Tape Cartridge. The drive houses the mechanism (drive head) that reads and writes data to the tape. Its native data capacity is 800 GB (745.05 GiB) per cartridge; with 2:1 compression, its capacity is up to 1.6 TB (1.46 TiB). The dual-port drive provides 8 Gbps Fibre Channel connectivity. Also known as the Ultrium 5 Tape Drive.

IBM System Storage TS1120 Tape Drive. A high-performance, high-capacity streaming cartridge tape product designed for efficient back-up for mid-range and high-end computing systems. The drive houses the mechanism (drive head) that reads and writes data to the tape. When the media is formatted for a J1A format, the drive's native data capacity is 300

GB (279.39 GiB) and its data rate is 40 MB/s; with 3:1 compression, its capacity is 900 GB (838.19 GiB). When the media is formatted for a E05 format, the drive's native data capacity is 500 GB (465.66 GiB) and its data rate is 100 MB/s; with 3:1 compression, its capacity is 1.5 TB (1.36 TiB). Also known as the 3592 Tape Drive Model E05.

IBM System Storage TS1130 Tape Drive. A high-performance, high-capacity streaming cartridge tape product designed for efficient backup for mid-range and high-end computing systems. The drive houses the mechanism (drive head) that reads and writes data to the tape. The drive's native data capacity is 1 000 GB (931.32 GiB) and its data rate is 160 MB/s. All TS1130 Tape Drives are encryption capable. Also known as the 3592 Tape Drive Model E06 or EU6.

IBM System Storage TS1140 Tape Drive. A high-performance, high-capacity streaming cartridge tape product designed for efficient backup for mid-range and high-end computing systems. The drive houses the mechanism (drive head) that reads and writes data to the tape. The drive's native data capacity is 3 500 GB (3259.63 GiB) and its data rate is 250 MB/s. All TS1140 Tape Drives are encryption capable. Also known as the 3592 Tape Drive Model E07.

IBM System Storage TS3500 Tape Library. Formerly known as the IBM TotalStorage 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, machine type 3584, can include up to 16 frames and 192 drives, and any combination of Ultrium tape drives in Ultrium frames, and 3592 tape drives in 3592 frames.

IBM TotalStorage 3592 Tape Drive Model J1A. Located within the TS3500 Tape Library, high-performance, high-capacity streaming cartridge tape product designed for efficient back-up for mid-range and high-end computing systems. The drive houses the mechanism (drive head) that reads and writes data to the tape. Its native data capacity is 300 GB (279.39 GiB). Its native data rate is 40 MB/s.

IBM TotalStorage 3592 Tape Controller Model J70. Located in the Tape Frame Model F05, a device that links the IBM eServer™ zSeries server (mainframe host), the L05 Library Manager, and the 3592 tape drives in the TS3500 Tape Library.

IBM TotalStorage LTO Ultrium 1, 2, 3, 4, and 5 Tape Drives. Located within the TS3500 Tape Library, a data-storage device that controls the movement of the magnetic tape in an IBM LTO Ultrium Tape Cartridge. The drive houses the mechanism (drive head) that reads and writes data to the tape. Native data capacities are:

- Ultrium 1: native data capacity is 100 GB (93.13 GiB) per cartridge; with 2:1 compression, its capacity is up

to 200 GB (186.26 GiB). The drive is also known as the IBM Ultrium Internal Tape Drive.

- Ultrium 2: native data capacity is 200 GB (186.26 GiB) per cartridge; with 2:1 compression, its capacity is up to 400 GB (372.53 GiB).
- Ultrium 3: native data capacity is 400 GB (372.53 GiB) per cartridge; with 2:1 compression, its capacity is up to 800 GB (745.05 GiB).
- Ultrium 4: native data capacity is 800 GB (745.05 GiB) per cartridge; with 2:1 compression, its capacity is up to 1.6 TB (1.46 TiB).
- Ultrium 5: native data capacity is 800 GB (745.05 GiB) per cartridge; with 2:1 compression, its capacity is up to 1.6 TB (1.46 TiB).

IBM TotalStorage Productivity Center (TPC). See *Tivoli Storage Productivity Center (TSPC)*.

ID. Identifier.

IEE. See *import/export element*.

IEEA. See *import/export element address*.

IEEE. Institute of Electrical and Electronics Engineers.

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. 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.

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.

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 Model L22, L23, L52, and L53 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 Ultrium Tape Cartridges.

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. 1000 Btu's.

KiloVolt. 1000 volts.

KiloWatt. 1000 watts.

kVA. KiloVolt.

kW. KiloWatt.

L

label. See *bar code label* or *radio frequency identification label*.

label area. On the LTO Ultrium 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*.

leader pin. On the LTO Ultrium 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 takeup 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 frame (Models L22, L23, L32, L52, or L53) and expansion frame (Models D22, D23, D32, D52, D53, S24, or S54).

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.

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 Accellis format focuses on fast access; the Ultrium format focuses on high capacity. The Ultrium format is the preferred format when capacity (rather than fast access) is the key storage consideration. An Ultrium cartridge has a compressed data capacity of up to 800 GB (at 2:1 compression) and a native data capacity of up to 400 GB. The Ultrium format is designed with a four-generation road map that provides for up to 1.6 TB per cartridge (2:1 compression) in Generation 4 and a compressed transfer rate of up to 320 MB per second.

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.

logical library. A set of cartridge storage slots and tape drives that are defined as a library by an operator. The operator identifies the slots and drives to the library by their location or count. The ability of the TS3500 Tape Library 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 Ultrium tape drive 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 Ultrium Data Cartridge, an embedded electronics and interface module that can store and retrieve a cartridge's historical usage and other information.

LTO-CM. See *LTO cartridge memory*.

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 a MIB. The TS3500 Tape Library can use the MIB to interpret problem alerts that are transmitted by SNMP traps.

manual cleaning. A method by which an operator selects a menu option from the touchscreen of the TS3500 Tape Library or IBM System Storage 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*.

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 Ultrium 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 (1 represents the Ultrium 1 tape cartridge, 2 represents the Ultrium 2 tape cartridge, 3 represents the Ultrium 3 tape cartridge, T represents the Ultrium 3 WORM tape cartridge, 4 represents the Ultrium 4 tape cartridge, U represents the Ultrium 4 WORM tape cartridge, 5 represents the Ultrium 5 tape cartridge, and V represents the Ultrium 5 WORM tape cartridge).

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 master 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 Ultrium Tape Cartridges and 3592 Tape Cartridge, tape that uses very small, pure metal particles (rather than oxide coatings) in the magnetic layer.

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

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 Ultrium tape cartridges and 3592 tape cartridges in the TS3500 Tape Library. A library can consist of frames that house all LTO Ultrium 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.

Model J1A. See *IBM TotalStorage 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 Ultrium 3 and newer 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 tape library. The unit's LCD touchscreen provides information about the operation of the TS3500 Tape Library, and one or two I/O stations for inserting and removing cartridges.

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 e-mail, the web, intranets, or CD-ROM), and can be viewed with the Acrobat Reader, which is software from Adobe Systems that can be downloaded at no cost from the Adobe Systems home page.

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 line 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*.

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 (RFID) 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 that is 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-enabled 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 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*.

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 encryption-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.

SC1. Model SC1. See *Shuttle connection*.

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 System Storage 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. Both Netscape Navigator and Internet Explorer support SSL, and 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 pSeries, IBM iSeries, 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 desired service.

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) parallel 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.

speed matching. The ability of the Ultrium 2, 3592 J1A, and newer 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 and Ultrium tape drives that 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 end 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 nonoperational and being kept 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. See the following entries: *IBM TotalStorage LTO Ultrium 1 Tape Drive*; *IBM TotalStorage LTO Ultrium 2 Tape Drive*, *IBM System Storage 3588 Tape Drive Model F3A*, *IBM System Storage TS1030 Tape Drive Model F3B*; *IBM System Storage LTO Ultrium 4 Tape Drive*; *IBM System Storage LTO Ultrium 5 Tape Drive*; *IBM TotalStorage 3592 Tape Drive Model J1A*; *IBM System Storage TS1120 Tape Drive*; *IBM System Storage TS1130 Tape Drive*; *IBM System Storage TS1140 Tape Drive*.

Tape Frame. See *IBM 3953 Tape Frame Model F05*.

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). A software solution that manages storage infrastructures in Open Systems environments.

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

Total Productivity Center (TPC). See *Tivoli Storage Productivity Center*.

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 Total 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.

TS1120 Tape Drive. See *IBM System Storage TS1120 Tape Drive*.

TS1130 Tape Drive. See *IBM System Storage TS1130 Tape Drive*.

TS1140 Tape Drive. See *IBM System Storage TS1140 Tape Drive*.

TSM. See *Tivoli Storage Manager*.

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*.

Ultrium Tape Drive. See *IBM TotalStorage LTO Ultrium 1 Tape Drive, IBM TotalStorage LTO Ultrium 2 Tape Drive, IBM System Storage 3588 Tape Drive Model F3A, IBM System Storage TS1030 Tape Drive Model F3B, IBM System Storage LTO Ultrium 4 Tape Drive, and IBM System Storage LTO Ultrium 5 Tape Drive*.

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 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.

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 Ultrium 3, 4, and 5 and 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 the LTO Ultrium Tape Cartridge or 3592 Tape Cartridge, a switch that prevents accidental erasure of data. Pictures of a locked and unlocked padlock appear on the switch. When you slide the switch to the locked padlock, data cannot be written to the tape. When you slide the switch to the unlocked padlock, data can be written to the tape.

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.

Index

Special characters

.csv
See comma-separated value (.csv) format

Numerics

3588 Tape Drives, description 17, 18
3592 Model J1A Tape Drive, description 17
3592 Tape Cartridges, description 25, 169
3592 tape drives, description 17
3953 F05 frame, overview 32
3953 L05 library manager, overview 32

A

ac power cords, dual 50, 51
accessibility 219
accessor
description of cartridge 13
description of dual 7
accessor controller 13
acclimating the cartridge
3592 Tape Cartridges 184, 188
LTO Ultrium tape cartridges 154, 163
acoustical specifications
for Models L22, D22, L52, and D52 114
for Models L23, D23, L53, and D53 114
for Models L32 and D32 114
for tape library 113
adapters, for Fibre Channel interface 203
address
arbitrated loop physical address (AL_PA) 199
Loop ID for Fibre Channel drives 199
World Wide Node Name 202
World Wide Port Name 202
addressing, hard and soft 200
Advanced Library Management System (ALMS)
description 45
encryption 215
Entry ALMS 45, 132
Full ALMS 45, 132
Intermediate ALMS 45, 132
AL_PA
See Arbitrated Loop Physical Address (AL_PA)
ALMS
See also Advanced Library Management System (ALMS)
Tape System Reporter 57
arbitrated loop connection 197
Arbitrated Loop Physical Address (AL_PA) 199

attaching leader pin to Ultrium tape, procedure 157, 159
attaching library to servers 26, 30, 204
attaching library to System z server 32
audit logging 71
SNMP audit logging 71
automatic cleaning 43, 69
average block locate time 81
average rewind time 80

B

backhitchless backspace, in 3592 tape drives 22
bar code label
description and specifications
3592 tape cartridges 179, 181
LTO Ultrium tape cartridges 167
LTO Ultrium Tape Cartridges 148, 149
location
3592 tape cartridges 174
LTO Ultrium Tape Cartridges 148
ordering
3592 tape cartridges 194
LTO Ultrium tape cartridges 167
silos compatibility 179
Silo labels on 3592 tape cartridges 181
suppliers
3592 tape cartridges 194
3592 Tape Cartridges xx
LTO Ultrium tape cartridges 167
LTO Ultrium Tape Cartridges xx
bar code, description and specifications
3592 tape cartridges 180
LTO Ultrium Tape Cartridges 148
base frame, description 3
Base Numbering xxi
binary xxi
bridges, in Fibre Channel network 31
bulk rekey 215
burst data rate 79, 80

C

cables
Fibre Channel 196
power, routing through top of library 109
routing Fibre Channel through top of frame 106
running between frames 112
SCSI 31
Call Home
Heartbeat 59
Problem 59
Test 59
Call Home feature 58, 59
capacity
compressed
3592 tape cartridges 174
3592 Tape Cartridges 25, 169
LTO Ultrium Tape Cartridges 25, 143
Models L22, D22, L23, D23, and S24 207
Models L32 and D32 208
Models L52, D52, L53, D53, and S54 209
native
3592 tape cartridges 174
3592 Tape Cartridges 17, 18, 25, 169
LTO Ultrium Tape Cartridges 17, 25, 143
transparently adding or removing 45, 47
Capacity Expansion feature, for Model L32 54
Capacity On Demand
High Density 55
Models L22, L23, L52, and L53 55
Models S24 and S54 55
capacity scaling, for 3592 data cartridges 22, 172
capacity-based LEOT reporting, in 3592 tape drives 22
cartridge accessor 13
cartridge accessor controller 13
cartridge assignment policy 48
cartridge cache
in HD frames 9
cartridge door, location
3592 tape cartridges 174
LTO Ultrium Tape Cartridges 143
cartridge gripper 13
cartridge memory
for 3592 Tape Cartridges 176
for LTO Ultrium Tape Cartridges 144
cartridge move time 84
HD frame 87
cartridge storage slots, description 13
CETool interface 68
channel calibration
3592 tape drives 22
LTO Ultrium tape drives 19
CIDR 76, 78
classless-interdomain routing (CIDR) 76, 78
cleaning a drive 69
cleaning cartridge
description
3592 Cleaning Cartridge 26, 171, 177
LTO Ultrium Cleaning Cartridges 26, 145
ordering
3592 Cleaning Cartridge 189

- cleaning cartridge (*continued*)
 - ordering (*continued*)
 - LTO Ultrium Cleaning Cartridges 165
 - clearance specifications 101
 - Model S24
 - Model S54 101
 - comma-separated value (.csv) format 57
 - Command Line Interface
 - TS3500 Tape Library 57
 - Common Information Model (CIM)
 - Agent 72
 - compatible tape cartridges
 - 3592 tape drives 24
 - 3592 Tape Drives 25
 - LTO Ultrium tape drives 19, 37
 - LTO Ultrium Tape Drives 25
 - components in tape library 12
 - compressed capacity
 - 3592 tape cartridges 174
 - 3592 Tape Cartridges 25, 169
 - LTO Ultrium Tape Cartridges 25, 143
 - compressed data transfer rate 79
 - configurations
 - sample 41
 - with ALMS 45
 - configuring storage capacity without disruption 47
 - connections, Fibre Channel 31
 - connectors
 - for Fibre Channel interface 31, 203
 - for SCSI interface 31
 - control path
 - additional, role in reducing library failure 40, 44
 - using for control path failover 45
 - control path failover
 - description 51
 - use with multiple control paths 45
 - controller, accessor 13
 - cooling specifications 115
 - Models L22, D22, L32, D32, L52, and D52 115
 - Models L23, D23, L53, and D53 116
 - current, inrush and leakage 117
 - customer circuit breakers
 - for Models L23, D23, L53, and D53 128
 - customer engineer (CE) cartridge
 - 3592 tape cartridge 179
 - 3592 Tape Cartridge 171
 - LTO Ultrium Tape Cartridge 141
- D**
- data buffer with read ahead feature, in 3592 tape drives 23
 - data capacity
 - 3592 Tape Cartridges 17, 18
 - LTO Ultrium Tape Cartridges 17
 - data cartridge
 - description
 - 3592 tape cartridges 174
 - 3592 Tape Cartridges 169
 - LTO Ultrium Tape Cartridges 143
 - load and unload cycles
 - 3592 tape cartridges 175
 - data cartridge (*continued*)
 - load and unload cycles (*continued*)
 - LTO Ultrium Tape Cartridges 144
 - ordering
 - 3592 tape cartridges 189
 - LTO Ultrium Tape Cartridges 165
 - data compression, in 3592 tape drives 23
 - data gathering, description 56
 - data path failover, description 51
 - data storage xxi
 - data transfer rate
 - 3592 Tape Drives 17, 18, 80
 - LTO Ultrium Tape Drives 17, 79
 - degaussing tape cartridges
 - 3592 Tape Cartridges 189
 - LTO Ultrium Tape Cartridges 155, 164
 - delivery route, of tape library 99
 - depth
 - of HA1 frame 95
 - of Model S24 96
 - of Model S54 97
 - of Models L22 and D22 90
 - of Models L23 and D23 91
 - of Models L32 and D32 92
 - of Models L52 and D52 93
 - of Models L53 and D23 94
 - description of tape library 1
 - device drivers, supported 28
 - diagnostic cartridge
 - 3592 rape Cartridge 179
 - 3592 Tape Cartridge 171
 - LTO Ultrium Tape Cartridge 141, 147
 - diagnostic reporting 70
 - dimensions
 - for HA1 frame 95
 - for Model S24 96
 - for Model S54 97
 - for Models L22 and D22 90
 - for Models L23 and D23 91
 - for Models L32 and D32 92
 - for Models L52 and D52 93
 - for Models L53 and D53 94
 - disposing of a tape cartridge
 - 3592 tape cartridges 189
 - LTO Ultrium tape cartridges 164
 - documentation, viewing latest 28
 - door
 - front 13
 - safety switch 13
 - downloading logs in .csv format 57
 - drive error log 58
 - drive firmware, updating 18
 - drive mechanical and electrical reliability, in 3592 tape drives 23
 - drive performance specifications 79
 - drive statistics log 56
 - dual ac line cords, use of 50, 51
 - dual accessors 7
 - dual-gripper transport mechanism 13
 - dynamic partitioning 45, 46
- E**
- Economy cartridge 169
 - Economy WORM cartridge 169
- EEDK**
- See externally encrypted data key
- EKM**
- See Encryption Key Manager
- elements in the library 130
 - enabling
 - ALMS 45
 - virtual I/O slots 47
 - encryption
 - description 20, 23
 - key management 211
 - key stores 212
 - keys 212
 - overview 211
 - planning 213, 215
 - library configuration 215
 - policy configuration 211
 - system-managed 214
 - tape drive
 - encryption 215
 - Encryption Key Manager
 - description 212
 - with secure socket layer 74
 - encryption-capable tape drive 211
 - encryption-enabled tape drive 211
 - enhanced format for recording
 - error-correction codes, in 3592 tape drives 23
 - enhanced frame control assembly
 - description 51
 - location 13
 - environmental specifications
 - for library 113
 - for media
 - 3592 Tape Cartridges 188
 - LTO Ultrium tape cartridges 163
 - erasing, LTO Ultrium Tape Cartridges 164
 - error reporting
 - SNMP messaging 70
 - TapeAlert flags 70
 - through remote support (Call Home) 58, 59
 - ESCON interface 32
 - expansion frames, description 3
 - export performance
 - with virtual I/O slots 86
- F**
- failover, description 51
 - feature codes
 - of elements in library 129, 131
 - fibers, optical in Fibre Channel 197
 - Fibre Channel cables, routing through top of frame 106
 - Fibre Channel drive
 - 1 Gbps, 2 Gbps, 4 Gbps, and 8 Gbps interfaces 196
 - adapters 203
 - addressing 199
 - cables 196
 - compatibility with Multi-Path Architecture 40
 - connections 31
 - connectors 203
 - port 195

- Fibre Channel drive *(continued)*
 - setting Loop ID 200
 - topologies, supported 197
 - use of SCSI protocol 195
 - use with bridge 31
 - use with hub 31, 199
 - use with repeaters 31
 - use with switch 31
 - zoning 198, 203
- Fibre Channel interface 30
- FICON interface 32
- fire suppression
 - for HA1 frame (service bay A) 110
 - for Models L22, D22, L23, and D23 110
 - for Models L32 and D32 109
 - for Models L52, D52, L53, and D53 110
 - general provisions 109
- firmware, updating library and drive 18
- flexible drive assignment 46
- floor requirements for library 98
- frame
 - combining in library 34
 - description 3, 4
 - in Fibre Channel topology 197
 - maximum quantity in library 1, 3
 - mixing drive types in 34
- frame control assembly
 - description 50
- frames
 - power requirements 117
- front door 13
- Full Capacity feature for Models L22, L23, L52, and L53 55

G

- G xxi
- generation of Ultrium cartridge, determining 19
- Gi xxi

H

- HA1 frame
 - clearance specifications 101
 - depth 95
 - description 7, 8
 - fire suppression 110
 - height 95
 - weight 95
 - width 95
- handling cartridges
 - 3592 tape cartridges 184
 - LTO Ultrium Tape Cartridges 155
- hard addressing 200
- HD frame
 - constant force spring 9
 - description 9
 - Model S24 9
 - Model S54 9
 - performance 87
 - shuffle operation 9
 - tier 9

- HD slot
 - description 9
- Heartbeat Call Home 59
- Heartbeat Call Home capability 58
- height
 - of HA1 frame 95
 - of Model S24 96
 - of Model S54 97
 - of Models L22 and D22 90
 - of Models L23 and D23 91
 - of Models L32 and D32 92
 - of Models L52 and D52 93
 - of Models L53 and D53 94
 - of tape library 89
- high availability (HA1) frame, description 7, 8
- high density
 - shuttle connections 15
- high resolution tape directory, in 3592 Tape Drives 22
- High Voltage Differential (HVD) SCSI interface 30, 31
- high-density frame
 - description 9
- host
 - sharing, library 40, 41
 - supported 26
- hub, in Fibre Channel network 31
- HVD
 - See High Voltage Differential (HVD) SCSI interface

I

- IBM i
 - control paths 44
- IBM System Storage TS3000 System Console 32, 60, 63, 67, 68
- IDs
 - AL_PA 199
 - Loop 199
 - World Wide Node Name 202
 - World Wide Port Name 202
- import performance
 - with virtual I/O slots 86
- import/export performance
 - with virtual I/O slots 86
- input/output (I/O) station
 - description 13
 - expanded 53
 - quantity of I/O slots per frame 53
- inrush current 117
- Insert notification setting, description 49
- insertion guide, on LTO Ultrium Tape Cartridges 143, 144
- inspecting
 - 3592 Tape Cartridges 185
 - LTO Ultrium tape cartridges 154
- interfaces, supported 30, 32
- Intermediate Capacity feature for Models L22, L23, L52, and L53 55
- inventory
 - time 84
- inventory with audit
 - time 84
- IPv4 addresses
 - format 76

- IPv4 addresses *(continued)*
 - subnet mask 76, 78
- IPv6 addresses 76
 - format 76
 - prefix 76, 78
- iSeries server
 - conditions for Fibre Channel attachment 204
 - effects of ALMS on 205

J

- JA cartridge type 169
- JB cartridge type 169
- JC cartridge type 169
- jewel case 153
- JJ cartridge type 169
- JK cartridge type 169
- JR cartridge type 169
- JW cartridge type 169
- JX cartridge type 169
- JY cartridge type 169

K

- K xxi
- key management
 - methods 212
- key manager
 - IBM Encryption Key Manager 212
 - Tivoli Key Lifecycle Manager 212
- keyboards
 - accessibility features 219
- Ki xxi

L

- label
 - for 3592 tape cartridges 175
 - for LTO Ultrium Tape Cartridges 144
- label area
 - on 3592 tape cartridges 174, 175
 - on LTO Ultrium Tape Cartridges 143, 144
- laser safety and compliance notice xiv
- LC duplex fiber optics cables 196
- leader pin
 - in 3592 Tape Cartridges 177
 - in LTO Ultrium Tape Cartridges 144
 - reattaching to Ultrium tape 159
- leader pin reattachment kit
 - ordering
 - for 3592 tape cartridges 193
 - for LTO Ultrium Tape Cartridges 165
 - using
 - for 3592 tape cartridges 185
 - for LTO Ultrium Tape Cartridges 159
- leakage current 117
- length of tape library 89
- library
 - error log 58
 - firmware, updating 18
 - frames, description 3, 13
 - library placement 89

- library statistics log 56
- line cords, dual ac 50, 51
- Linear Tape-Open (LTO) Cartridge Memory (CM) 144
- link speed, supported 196
- link, in Fibre Channel network 197
- Load balancing
 - in HD frames 9
- load balancing, description 51
- load time 79
- logical library
 - changing quantity of storage slots 47
 - control path in 40
 - creating and using multiple for sharing 43
 - description 43
 - effects of manually inserted new media 49
 - maximum quantity in library 41, 43
 - mixing drives types in 35, 44
 - sharing 41, 43
- logical unit number (LUN), description 43, 202
- logs, downloading in .csv format 57
- loop connection, in Fibre Channel interface 197
- Loop ID, assignment 199
- Low Voltage Differential (LVD) SCSI interface 30, 31
- low-power mode 19
- LTO Ultrium Tape Cartridges, description 25, 141
- LUN
 - See logical unit number (LUN)
- LVD
 - See Low Voltage Differential (LVD) SCSI interface

M

- M xxi
- Machine Reported Product Data (MRPD) log 59
- mainframe
 - connection of TS3500 Tape Library to 1
- Management Information Base 70
- manual cleaning 69
- manually inserting cartridges, role of insert notification setting 49
- maximum quantity of logical libraries per frame 43
- maximum rewind time 80
- media
 - mixing in drives and frames 25
 - ordering
 - 3592 tape cartridges 189
 - LTO Ultrium Tape Cartridges 165
 - using
 - with 3592 Tape Drives 169
 - with LTO Ultrium tape drives 37
 - with LTO Ultrium Tape Drives 141
- media reuse, in 3592 tape drives 21
- media-type identifier for Ultrium cartridges 148

- messages
 - remote support (Call Home) 58, 59
 - SNMP traps 70
- metric xxi
- Mi xxi
- MIB
 - See Management Information Base (MIB)
- mixed drive types, protection against non-support 40
- mixing
 - drive types in frames 34
 - media in drives 37
- Model HA1
 - dimensions 95
- Model L22, Intermediate, Full, and On Demand features 55
- Model L23, Intermediate, Full, and On Demand features 55
- Model L32, Capacity Expansion feature 54
- Model L52, Intermediate, Full, and On Demand features 55
- Model L53, Intermediate, Full, and On Demand features 55
- Model S24
 - capacity 207
 - clearance specifications 101
 - depth 96
 - height 96
 - High Density Capacity on Demand 55
 - high density technology 9
 - Model S54
 - clearance specifications 101
 - weight 96
 - width 96
- Model S54
 - capacity 209
 - depth 97
 - height 97
 - High Density Capacity on Demand 55
 - high density technology 9
 - weight 97
 - width 97
- Models L22 and D22
 - acoustical specifications 114
 - capacity 207
 - clearance specifications 101
 - depth 90
 - fire suppression 110
 - height 90
 - power cords 124
 - weight 90
 - width 90
- Models L23 and D23
 - acoustical specifications 114
 - capacity 207
 - clearance specifications 101
 - customer circuit breakers 128
 - depth 91
 - fire suppression 110
 - height 91
 - power cords 125
 - power cords to adjacent frames 127
 - weight 91

- Models L23 and D23 (*continued*)
 - width 91
- Models L32 and D32
 - acoustical specifications 114
 - capacity 208
 - clearance specifications 101
 - depth 92
 - fire suppression 109
 - height 92
 - power cords 121
 - weight 92
 - width 92
- Models L52 and D52
 - acoustical specifications 114
 - capacity 209
 - clearance specifications 101
 - depth 93
 - fire suppression 110
 - height 93
 - power cords 124
 - weight 93
 - width 93
- Models L53 and D53
 - acoustical specifications 114
 - capacity 209
 - clearance specifications 101
 - customer circuit breakers 128
 - depth 94
 - fire suppression 110
 - height 94
 - power cords 125
 - power cords to adjacent frames 127
 - weight 94
 - width 94
- modem, role in remote support 58, 59
- mount history log 56
- mount performance 84
- move restraints, for tape library 100
- move time 84
 - HD frame 87
- MRPD log
 - See Machine Reported Product Data (MRPD) log
- mtlib program, using 28
- Multi-Path Architecture 40
- multiple control paths
 - for control path failover 45
 - for IBM i, System i, iSeries, and AS/400 attachment 44
- multiple subsystem and automation support, in 3592 tape drives 23

N

- native capacity
 - 3592 tape cartridges 174
 - 3592 Tape Cartridges 25
 - LTO Ultrium Tape Cartridges 25, 143
- native data transfer rate 79, 80
- node, in network 197
- nominal unload time 79
- nondestructive drive firmware update 18, 171

O

- offboard data string searching, in 3592 tape drives 23
- on-the-fly adaptive equalization, in 3592 tape drives 22
- operating systems, supported 26
- operator clearance specifications 101
- operator panel 13
- operator panel controller 13
- ordering tape cartridges and supplies
 - 3592 tape cartridges
 - by 3599 tape media method 190
 - by part number 192
 - LTO Ultrium Tape Cartridges 165

P

- partitioning capability of SAN-ready Multi-Path Architecture 40
- partitioning, dynamic 46
- patch panel 13, 197
- performance
 - drive 79
 - library 83
 - shuttle complex 88
- persistent binding 203
- pipes, running between frames 112
- planning considerations
 - encryption 215
 - application-managed 213
 - library-managed 215
- point-to-point connection 197
- port statistics log 56
- port, Fibre Channel 195, 197
- position-based LEOT reporting, in 3592 tape drives 22
- power cables, routing through top of library on solid floor 109
- power cord
 - dual ac 50, 51
 - specifications
 - for Models L22, D22, L52, and D52 124
 - for Models L23, D23, L53, and D53 125
 - for Models L32 and D32 121
 - to adjacent frame models L23, D23, L53, and D53 127
- power distribution unit 51
- power management, in Ultrium tape drives 19
- power receptacles, for Models L23, D23, L53, and D53 127
- power requirements
 - frames 117
 - LAN switch in remote support 120
 - modem in remote support 120
 - monitor in remote support 120
 - remote support facility 120
 - remote support switch 120
 - TS3000 System Console 120
- power specifications
 - Models L22, D22, L32, D32, L52, and D52 115
 - Models L23, D23, L53, and D53 115, 116

- power structure
 - enhanced frame control assembly 50, 51
 - frame control assembly 50
 - power distribution unit 51
- preferred zone for accessor, setting 8
- prefix (IPv6) 76, 78
- Problem Call Home 59
- Problem Call Home capability 58
- problems, resolving
 - through remote support (Call Home) 58, 59
 - through SNMP messaging 70
 - through TapeAlert flags 70
- product label, on 3592 tape cartridges 174, 175

R

- rail system 13
- range of cartridges, assigning to logical library 48
- recording method
 - of 3592 tape drives 174
 - of Ultrium Tape Drives 143
- recursive accumulating backhitchless flush, in 3592 tape drives 22
- rekey 215
- relative humidity specification
 - for media
 - 3592 Tape Cartridges 188
 - LTO Ultrium Tape Cartridges 163
 - for tape library 113
- remote support
 - security 63, 67, 68
 - through a modem 58
 - through a system console 58, 60
 - through Heartbeat Call Home 58
 - through Problem Call Home 58
 - through Test Call Home 58
 - through TS3000 System Console 60
 - remote support security 63, 67, 68
- repeaters, in Fibre Channel network 31
- restrictions on iSeries (AS/400) support 204
- rewind time
 - average 80
 - maximum 80

S

- safety switch, door 13
- SAN
 - See* Storage Area Network (SAN), sharing on
- SAN Fibre Channel Switch 198
- SARS
 - See* Statistical Analysis and Reporting System (SARS)
- SC duplex fiber optics cables 196
- scalability of tape library 3
- SCSI
 - See* small computer systems interface (SCSI)
- secure socket layer (SSL) 74

- security
 - remote support through TS3000 System Console 63, 67, 68
 - SNMP audit logging 71
- security, controlling data 100, 164, 189
- segmentation, for 3592 data cartridges 172
- serial number, cartridge
 - for 3592 tape cartridges 179
 - for LTO Ultrium Tape Cartridges 148
- servers, supported 26
- service alert, from remote support (Call Home) 58, 59
- service bays
 - clearance specifications 101
 - description 7
 - service clearance specifications 101
- setting write-protect switch
 - on 3592 Data Cartridges 183
 - on LTO Ultrium Data Cartridges 151
- settings, calibration for 3592 tape drives 22
- sharing
 - drive, restrictions 205
 - library by multiple hosts 40, 41
- shuffle
 - in HD frame 9
- shuttle complex
 - clearance specifications 105
 - dimensions 105
 - logical configuration 15
 - performance considerations 88
 - physical configuration 15
 - structure of 15
- SI xxi
- Simple Network Management Protocol (SNMP) 70, 71
- small computer systems interface (SCSI)
 - bus length between terminator 31
 - cables 31
 - connectors 31
 - High Voltage Differential (HVD) signaling 30, 31
 - IDs, binding to drives 203
 - Low Voltage Differential (LVD) signaling 30, 31
 - Ultra 160 support 31
- SMI-S
 - See* Storage Management Initiative - Specification
- SNMP
 - See also* Simple Network Management Protocol (SNMP)
 - audit logging 71
- soft addressing 200
- specifications
 - for bar code and bar code label 3592 tape cartridges 180
 - LTO Ultrium Tape Cartridges 148
 - for media
 - 3592 Tape Cartridges 188
 - LTO Ultrium tape cartridges 163
 - for tape library
 - acoustical 113, 114
 - clearances, for operator and service 101
 - cooling 115

- specifications (*continued*)
 - fire-suppression provisions 109
 - power 115
 - relative humidity 113
 - routing power cables 109
 - temperature 113
 - wet bulb temperature 113
- physical
 - for HA1 frame 95
 - for Model S24 96
 - for Model S54 97
 - for Models L22, D22, and D22 90
 - for Models L23 and D23 91
 - for Models L32 and D32 92
 - for Models L52 and D52 93
 - for Models L53 and D53 94
- power and cooling
 - Models L22, D22, L32, D32, L52, and D52 115
 - Models L23, D23, L53, and D53 116
- speed matching
 - in 3592 tape drives 21
 - in LTO Ultrium tape drives 19
- speed, link 196
- SSL 74
 - encryption key manager communication 74
 - Web communication 74
- stacking tape cartridges
 - 3592 tape cartridges 185
 - LTO Ultrium Tape Cartridges 155
- standard features and feature codes of the library 129
- Statistical Analysis and Reporting System (SARS) 20
- Storage Area Network (SAN), sharing on 205
- storage capacity, transparently adding or removing 45, 47
- Storage Management Initiative - Specification (SMI-S) 72
- storage slot pooling 46
- storage slots, changing quantity in logical library 47
- subnet mask (IPv4) 76, 78
- supplies, ordering
 - 3592 tape cartridges 189
 - LTO Ultrium Tape Cartridges 165
- supported Fibre Channel topologies 197
- switch, in network 31, 198
- system console, role in providing remote support 58, 60
- System i server
 - effects of ALMS on 205
- System i, iSeries, AS/400
 - control paths 44
- System z server, attaching to library 32
- system-managed encryption 214

T

- Ti xxi
- tape cartridge
 - bar code label for 3592 tape cartridges description 179

- tape cartridge (*continued*)
 - bar code label for 3592 tape cartridges (*continued*)
 - guidelines for using 181
 - ordering 179
 - specifications 175, 180
 - bar code label for 3592 Tape Cartridges
 - placement 180
 - bar code label for LTO Ultrium tape cartridges
 - ordering 167
 - bar code label for LTO Ultrium Tape Cartridges
 - description 148
 - guidelines for using 149
 - placement 148
 - specifications 148
 - bar code, description and specifications
 - 3592 tape cartridges 180
 - LTO Ultrium Data Cartridges 148
 - capacity
 - 3592 data cartridges 174
 - 3592 Data Cartridges 25, 169
 - LTO Ultrium Data Cartridges 25, 143
 - cartridge door
 - 3592 data cartridges 175
 - LTO Ultrium Data Cartridges 144
 - cartridge life
 - 3592 data cartridges 175
 - LTO Ultrium Data Cartridges 144
 - cleaning cartridge
 - 3592 Tape Cartridge 169, 177
 - LTO Ultrium Tape Cartridges 141, 145
 - compatible cartridges
 - with 3592 tape drives 37
 - with 3592 Tape Drives 25, 169
 - with LTO Ultrium tape drives 37
 - with LTO Ultrium Tape Drives 25, 141
 - customer engineer (CE) cartridge
 - 3592 tape cartridge 179
 - 3592 Tape Cartridge 171
 - LTO Ultrium Tape Cartridge 141
 - data cartridge
 - 3592 data cartridges 174
 - 3592 Data Cartridges 169
 - LTO Ultrium Data Cartridges 143
 - data security
 - for 3592 tape cartridges 189
 - for LTO Ultrium tape cartridges 164
 - degaussing
 - 3592 Tape Cartridges 189
 - LTO Ultrium Tape Cartridges 155, 164
 - diagnostic cartridge
 - 3592 tape Cartridge 179
 - 3592 Tape Cartridge 171
 - LTO Ultrium Tape Cartridge 141, 147
 - dimension of LTO Ultrium Data Cartridges 143

- tape cartridge (*continued*)
 - disposal of
 - 3592 tape cartridges 189
 - LTO Ultrium tape cartridges 164
 - Economy 169
 - Economy WORM 169
 - handling
 - 3592 tape cartridges 184
 - LTO Ultrium Tape Cartridges 155
 - inserting data and scratch cartridges into library
 - manually 49
 - insertion guide on LTO Ultrium Data Cartridges 144
 - inspecting
 - 3592 Tape Cartridges 185
 - LTO Ultrium tape cartridges 154
 - labels
 - for 3592 tape cartridges 175
 - for LTO Ultrium Tape Cartridges 144
 - leader pin
 - description 144
 - location in 3592 tape cartridges 185
 - location in 3592 Tape Cartridges 177
 - location in LTO Ultrium Tape Cartridges 144
 - reattaching to Ultrium Tape Cartridge 159
 - repositioning in a 3592 tape cartridge 185
 - repositioning in an Ultrium tape cartridge 157
 - Linear Tape-Open cartridge memory (LTO-CM) 144
 - load and unload cycles
 - 3592 data cartridges 175
 - LTO Ultrium Data Cartridges 144
 - mixing in drives 37, 53
 - move time 84
 - move time in HD frame 87
 - ordering
 - 3592 tape cartridges 189, 194
 - LTO Ultrium Tape Cartridges 165
 - product label, 3592 tape cartridges 175
 - Silo-style bar code label for 3592 tape cartridges
 - guidelines for using 181
 - specifications for media
 - 3592 Tape Cartridges 188
 - LTO Ultrium tape cartridges 163
 - stacking
 - 3592 tape cartridges 185
 - LTO Ultrium Tape Cartridges 155
 - statistics log 56
 - tips for handling
 - 3592 tape cartridges 184, 185
 - LTO Ultrium Tape Cartridges 152, 155
 - training for handling
 - 3592 Tape Cartridges 184
 - LTO Ultrium Tape Cartridges 152
 - types of
 - 3592 Tape Cartridges 169

- tape cartridge (*continued*)
 - types of (*continued*)
 - Ultra Tape Cartridges 141
 - unassigned, reassigning 49
 - WORM
 - 3592 Tape Cartridge 170, 171
 - LTO Ultrium Tape Cartridge 141
 - write-protect switch
 - 3592 data cartridges 175
 - 3592 Data Cartridges 183
 - LTO Ultrium Data Cartridges 144, 151
- tape drive
 - 1 Gbps drive 17
 - 2 Gbps drive 17, 18
 - 3592 Tape Drives, description 13
 - 4 Gbps drive 17
 - 8 Gbps drive 17
 - backhitchless backspace in 3592 tape drives 22
 - capacity scaling in 3592 tape drives 22
 - capacity-based LEOT reporting in 3592 tape drives 22
 - channel calibration in 3592 tape drives 22
 - cleaning 69
 - compatible cartridges and format
 - with 3592 Tape Drives 25, 169
 - with LTO Ultrium tape drives 19, 37
 - with LTO Ultrium Tape Drives 25, 141
 - data buffer with read ahead feature in 3592 tape drives 23
 - data compression in 3592 tape drives 23
 - data transfer rate 79, 80
 - description
 - 3592 tape drives 17, 20
 - LTO Ultrium tape drives 17
 - LTO Ultrium Tape Drives 18
 - device drivers, supported 28
 - drive mechanical and electrical
 - reliability in 3592 tape drives 23
 - encryption 20, 23
 - enhanced format for recording
 - error-correction codes in 3592 tape drives 23
 - firmware, updating 18
 - high resolution tape directory in 3592 tape drives 22
 - identifying WORM-capable Ultrium drive 18, 141
 - LTO Ultrium Tape Drives,
 - description 13
 - maximum quantity
 - 3592 tape drives 17
 - LTO Ultrium tape drives 17
 - per frame 17
 - maximum quantity in library 1
 - media reuse in 3592 tape drives 21
 - mixing in a logical library 35
 - multiple subsystem and automation support in 3592 tape drives 23
 - offboard data string searching in 3592 tape drives 23
- tape drive (*continued*)
 - on-the-fly adaptive equalization, in 3592 tape drives 22
 - performance 79
 - position-based LEOT reporting in 3592 tape drives 22
 - recursive accumulating backhitchless flush in 3592 tape drives 22
 - speed matching
 - in 3592 Tape Drives 21
 - in LTO Ultrium tape drives 19
 - type of interface attachment 30
 - using a repaired Ultrium cartridge 157
 - WORM support
 - for 3592 tape drives 22
 - for 3592 Tape Drives 171
 - for LTO Ultrium Tape Drives 18, 141
 - tape encryption, description 20, 23
 - Tape Library Specialist web interface, description 56
 - Tape System Reporter 57
 - TapeAlert support 70
 - temperature specification
 - for media
 - 3592 Tape Cartridges 188
 - LTO Ultrium Tape Cartridges 163
 - for tape library 113
 - Test Call Home 59
 - Test Call Home capability 58
 - tier
 - in HD frame 9
 - Tivoli Storage Productivity Center (TSPC) 72
 - topologies, supported
 - description 197
 - two-node direct connection 199
 - two-node switched fabric 198
 - TPC
 - See* TotalStorage Productivity Center (TPC)
 - Trademarks 222
 - traps, SNMP 70
 - TS1120 Tape Drive, description 17
 - TS1130 Tape Drive, description 17
 - TS1140 Tape Drive, description 17
 - TS3000 System Console (TSSC)
 - role in providing remote support 32, 60
 - security when providing remote support 63, 67, 68
 - TS3500 Command Line Interface 57
 - TS3500 Tape Library
 - Command Line Interface 57
 - TS3500 Tape Library, description 1
 - TS7700 backend switches 13
 - TS7700 Virtualization Engine
 - integrated library manager 32
 - TSSC
 - See* TS3000 System Console (TSSC)
 - Turtlecase 153
 - two-node direct connection
 - topology 197, 199
 - two-node switched fabric loop
 - topology 197, 198
 - types of Ultrium Tape Cartridges 141

U

- Ultra 160 SCSI interface support 31
- Ultrium Tape Cartridges, description 25, 141
- Ultrium tape drives, description 17
- Ultrium Tape Drives, description 18
- unassigned cartridges, reassigning 49
- units *xxi*
- universal cleaning cartridge, ordering for LTO Ultrium Drives 165
- unload time 79, 80
- updating library and drive firmware 18

V

- virtual I/O slots
 - import/export performance 86
- virtual I/O slots, enabling or disabling 45, 47
- VOLSER
 - See* volume serial (VOLSER) number
- voltage, ac 117
- volume serial (VOLSER) number
 - description
 - 3592 tape cartridges 179
 - LTO Ultrium Tape Cartridges 148
 - determining generation of Ultrium cartridge 19
 - determining type of 3592 cartridge 179
 - location
 - 3592 tape cartridges 174
 - LTO Ultrium Tape Cartridges 148

W

- web interface, description 56
- Web-Based Enterprise Management (WBEM) protocol 72
- weight
 - of HA1 frame 95
 - of Model S24 96
 - of Model S54 97
 - of Models L22 and D22 90
 - of Models L23 and D23 91
 - of Models L32 and D32 92
 - of Models L52 and D52 93
 - of Models L53 and D53 94
- wet bulb temperature specification
 - for media
 - 3592 Tape Cartridges 188
 - LTO Ultrium Tape Cartridges 163
 - for tape library 113
- width
 - of HA1 frame 95
 - of Model S24 96
 - of Model S54 97
 - of Models L22 and D22 90
 - of Models L23 and D23 91
 - of Models L32 and D32 92
 - of Models L52 and D52 93
 - of Models L53 and D53 94
- wiring, running between frames 112
- World Wide Node Name,
 - description 202
- World Wide Port Name, description 202

WORM

See write once read many (WORM)

write once read many (WORM)

cartridge

for 3592 Tape Drives 169

for Ultrium 3, 4 and 5 tape
drives 141

for 3592 tape drives 22

functionality

for 3592 Tape Drives 171

for Ultrium 3, 4, and 5 tape
drives 141

identifying an Ultrium WORM tape

drive 18, 141

write-protect switch

location

3592 tape cartridges 174, 175

LTO Ultrium Tape Cartridges 143

setting

3592 Tape Cartridges 183

LTO Ultrium Tape Cartridges 151

Z

zone, setting, viewing, or changing

preferred accessor 7

zoning 198, 203, 205

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

IBM System Storage TS3500 Tape Library with ALMS
Introduction and Planning Guide

Publication No. GA32-0593-06

We appreciate your comments about this publication. Please comment on specific errors or omissions, accuracy, organization, subject matter, or completeness of this book. The comments you send should pertain to only the information in this manual or product and the way in which the information is presented.

For technical questions and information about products and prices, please contact your IBM branch office, your IBM business partner, or your authorized remarketer.

When you send comments to IBM, you grant IBM a nonexclusive right to use or distribute your comments in any way it believes appropriate without incurring any obligation to you. IBM or any other organizations will only use the personal information that you supply to contact you about the issues that you state on this form.

Comments:

Thank you for your support.

Send your comments to the address on the reverse side of this form.

If you would like a response from IBM, please fill in the following information:

Name

Address

Company or Organization

Phone No.

Email address



Fold and Tape

Please do not staple

Fold and Tape



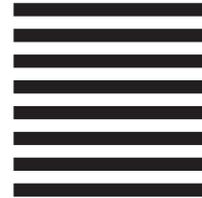
NO POSTAGE
NECESSARY
IF MAILED IN THE
UNITED STATES

BUSINESS REPLY MAIL

FIRST-CLASS MAIL PERMIT NO. 40 ARMONK, NEW YORK

POSTAGE WILL BE PAID BY ADDRESSEE

International Business Machines Corporation
Information Development
Building 9032-2, Department GZW
9000 South Rita Road
Tucson, Arizona U.S.A. 85744-0002



Fold and Tape

Please do not staple

Fold and Tape



Printed in USA

GA32-0593-06



Spine information:



IBM System Storage TS3500 Tape
Library with ALMS

Introduction and Planning Guide