IBM System Storage TS3310 Tape Library

SCSI Reference

GA32-0476-00

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Note
Before using this information and the product it supports, read the information in "Notices" on page 77.

First Edition (October 2005)

This is the first edition of the *IBM System Storage TS3310 Tape Library*.

Read This First

This is the first edition of the *IBM System Storage TS3310 Tape Library* (October 2005).

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Contents

Tables

Preface

This manual contains information about how to use and program the IBM System Storage TS3310 Tape Library. It is intended for those who use the Small Computer System Interface (SCSI) to communicate with the library. The book contains the following chapters:

Chapter 1, "Introduction," on page 1 provides general information about the library and its components.

Chapter 2, "General SCSI Information," on page 3 provides an overview of SCSI bus operations, messages, and commands.

Chapter 3, "Using the SCSI Commands," on page 11 provides detailed information about the SCSI library commands.

Related Publications

Refer to the following publications for additional information about the library. To ensure that you have the latest publications, visit the web at:

http://www.ibm.com/storage/lto

3576 Tape Library Publications

- *IBM System Storage TS3310 Tape Library Setup and Operator Guide*, GA32-0477
- *IBM System Storage TS3310 Tape Library Maintenance Information*, GA32-0478

Other IBM Publications and Sources

- For a list of compatible software, operating systems, and servers, visit the web at **http://www.ibm.com/storage/lto**.
- **http://www.ibm.com/storage/lto** (for bar code and bar code label specifications for LTO Ultrium Tape Cartridges)
- *IBM Translated Safety Notices*, 95P0851
- *IBM Ultrium Device Drivers Installation and User's Guide*, GA32-0430
- *IBM Ultrium Device Drivers Programming Reference*, GC35-0483

Related Information

For additional related information, see:

- *Fibre Channel Arbitrated Loop (FC-AL-2)*, published by the American National Standards Institute (ANSI) as NCITS 332:1999.
- *Fibre Channel Tape and Tape Medium Changers (FC-TAPE)*, published by the American National Standards Institute. Final draft available as T11/99-069v4 on the web at `http://www.t11.org`; actual document available from ANSI as NCITS TR-24:1999.
- *Fibre Channel Protocol for SCSI*, Second Version (FCP-2), published by the American National Standards Institute and available on the web at `http://www.t10.org`.

- *SCSI Parallel Interface-3 (SPI-3)*, published by InterNational Committee on Information Technology Standards (INCITS) and available on the web at `http://www.t10.org`.
- *SCSI-3 Stream Commands (SSC)*, published by the American National Standards Institute and available on the web at `http://www.t10.org`.
- *SCSI Stream Commands-2 (SSC-2)*, published by the American National Standards Institute and available on the web at `http://www.t10.org`.
- *SCSI Primary Commands-2 (SPC-2)*, published by the American National Standards Institute and available on the web at `http://www.t10.org`.
- *SCSI Primary Commands-3 (SPC-3)*, published by the American National Standards Institute and available on the web at `http://www.t10.org`.

Portions of this manual were adapted from documentation provided by the InterNational Committee on Information Technology Standards (INCITS).

Chapter 1. Introduction

The IBM System Storage TS3310 Tape Library is the newest member of the IBM TotalStorage family of tape solutions and consists of the IBM System Storage TS3310 Tape Library Model L5B and the IBM System Storage TS3310 Tape Library Model E9U.

This library offers high performance, capacity, and technology designed for reliability and the heavy demands of tape storage. The library is highly modular with scalability varying from the base library 5U control module to additional expansion units of 9U height each. This automated tape library incorporates high-performance IBM LTO Ultrium 3 Tape Drives for the midrange to enterprise open systems environment. Tape cartridge physical capacity has doubled to 400 GB native capacity (800 GB with 2:1 compression) with the IBM TotalStorage LTO Ultrium 400 GB Data Cartridge (for use only with Ultrium 3 format Tape Drives), and drive performance has more than doubled to 80 MB/second native data transfer rate with the IBM TotalStorage LTO Ultrium 3 Tape Drives compared to IBM LTO Ultrium 2 Tape Drives. IBM LTO Ultrium 3 tape drives can read and write original LTO Ultrium 2 data cartridges and read LTO Ultrium 1 data cartridges.

The IBM System Storage TS3310 Tape Library Model L5B is the 5U base library unit which contains the library control module, fixed tape cartridge storage with 30 slots, I/O station with 6 slots, touch screen display, cartridge handling robotics, and up to 2 LTO Ultrium 3 tape drives.

The IBM System Storage TS3310 Tape Library Model E9U is an optional 9U expansion module that can be stacked on top of or below a base TS3310 L5B Tape Library. Each E9U expansion module can accommodate up to 4 LTO Ultrium 3 Tape Drives and up to 92 tape cartridge slots, and 0-12 configurable I/O station slots. In this initial release of this model, one of these TS3310 E9U Tape Libraries can be stacked under a TS3310 Model L5B Tape Library forming an integrated 14U tape library (5U base library and one 9U expansion module).

Chapter 2. General SCSI Information

Media Changer Commands and Parameters

The commands supported by the Media Changer device are shown in the following table.

Table 1. Media Changer Device Supported Commands

Command	Code
INITIALIZE ELEMENT STATUS	07h
INITIALIZE ELEMENT STATUS WITH RANGE	E7h
INQUIRY	12h
LOG SENSE	4Dh
MODE SELECT (6)	15h
MODE SENSE (6)	1Ah
MOVE MEDIUM	A5h
PERSISTENT RESERVE IN	5Eh
PERSISTENT RESERVE OUT	5Fh
POSITION TO ELEMENT	2Bh
PREVENT ALLOW MEDIUM REMOVAL	1Eh
READ BUFFER	3Ch
READ ELEMENT STATUS	B8h
RELEASE ELEMENT (6)	17h
REQUEST SENSE	03h
RESERVE ELEMENT (6)	16h
SEND DIAGNOSTIC	1Dh
TEST UNIT READY	00h
WRITE BUFFER	3Bh

The supported parameters are summarized in Table 4.

Table 2. Media Changer Device Supported Parameters

Command	Page	Code
Inquiry	Supported VPD Pages	00h
Inquiry	Unit Serial Number Page	80h
Inquiry	Device Identification Page	83h
Inquiry	Firmware Revision Page	C0h
Inquiry	Vendor Specific Command	D0h
Inquiry	Implemented SCSI-2 Command Page	E0h
Inquiry	Implemented Vendor Specific Command	E1h
Log Sense	Supported Log Pages	00h
Log Sense	TapeAlert page	2Eh
Mode Sense	Informational Exceptions Control Page	1Ch
Mode Sense	Element Address Assignment Page	1Dh
Mode Sense	Transport Geometry Parameters Page	1Eh
Mode Sense	Device Capabilities Page	1Fh
Mode Sense	Return all pages	3Fh

The Media Changer will not support any diagnostic parameters.

General Command Support Behavior

Element Addressing

The starting addresses of the four element types are:

- 0001h: Medium Transport
- 0010h: Import/Export
- 0100h: Data Transfer
- 1000h: Storage

Command Status

Individual command status responses are not documented, as they all follow the same general format as described here. After processing any command, the library returns status from among the following:

- **Good** - The library returns a Good status (00h) when it is able to process the command without errors.
- **Busy** - The library returns Busy status (08h) when a motion command is still being processed, or the library is generally not able to process additional commands at that time.

- **Reservation Conflict** - The library returns a Reservation Conflict (18h) whenever an initiator attempts to access a logical unit that has been reserved by another initiator, except for the following commands:
  - INQUIRY
  - LOG SENSE
  - PREVENT/ALLOW MEDIUM REMOVAL
  - REQUEST SENSE
- **Check Condition** - The library returns the Check Condition status (02h) when the following general situations occur (all generate sense data):
  - The library is Not Ready (sense key 02h).
  - The library has encountered a Hardware Error (sense key 04h).
  - A parameter in the CDB is invalid or there is an invalid field in a parameter list, resulting in an Illegal Request (sense key 05h).
  - A Unit Attention condition is pending (sense key 06h).
  - A command has been aborted (sense key 0Bh).

A complete list of all possible sense data and their causes is located in Table 56 on page 69. This status information will not be separated by individual commands.

Status values of Condition Met, Intermediate Condition Met, and Queue Full are not currently used. The Initiator should issue a Request Sense command to determine the precise cause of the Check Condition status and clear it.

Response data, however, will be documented as applicable for each command, and included as part of the command section.

Unit Attentions

Unit Attentions will be queued by the library as necessary to report all events and conditions. They are presented in the order of their occurrence (first in, first out). Unit attentions are generated for the following conditions:

- A power on or a reset (external or internal) occurred.
- A library door closed, or a transition from not ready to ready occurred.
- A mailbox closed.
- A firmware update completed.
- A persistent reservation has been preempted or released, or a registration has been preempted.
- Mode parameters have changed.

Resets

Either a Power On Reset or a SCSI Reset resets the library. When reset, the library does the following:

- Returns to Bus Free
- All non-persistent reservations are cleared.

Common CDB Fields

Each Command Descriptor Block contains a Logical Unit Number (LUN) field as well as a Control byte field. The LUN field is bits 5-7 of byte 1 and is there only for legacy compatibility. Logical Unit selection should be accomplished via the Identify message.

The Control byte is shown in Table 3. It is always the last byte of a CDB, regardless of the size of the CDB.

Table 3. Control byte

Bit / Byte	7	6	5	4	3	2	1	0
last	Vendor Specific		Reserved			NACA	Flag	Link

Vendor Specific - This field is used to provide additional data or control for a command. Specific uses are described within the applicable commands.

Normal Auto Contingent Allegiance (NACA) - If this field is set to 0, the initiator should issue a REQUEST SENSE command immediately following receipt of a Check Condition. If this field is set to 1, ACA support will be provided.

Flag - This field is not supported and must be set to 0.

Link - This field is not supported and must be set to 0.

Reserved Fields

Reserved fields are not checked, and no error will be sent if they contain non-zero values.

Online/Offline Operation

Each Media Changer device can be placed in either an online or offline mode. The purpose of these modes is to configure whether the Media Changer is being controlled by a SCSI initiator or by the operator panel. When the Media Changer is online, a SCSI initiator is controlling it and all SCSI commands are supported. When the Media Changer is offline, the operator panel is controlling it, and the only allowed SCSI commands are INQUIRY and REQUEST SENSE. All other commands will respond with a check condition, along with an ASC/ASCQ of 04/8D (unit offline).

6 The READ ELEMENT STATUS command is allowed with DVCID=1, VOLTAG=0
6 while the library is offline or the main door is open.

Supported Interfaces

SCSI Parallel and Fibre Channel interface types are supported as described below.

SCSI Parallel Interface Support

The library supports parity checking on the SCSI Parallel interface. It will attempt to retry when parity errors are detected, but if unsuccessful will attempt to respond with a Check Condition indicating in which phase the parity error was detected.

If permitted by the initiator, the library will also support disconnects for commands that take a lengthy time to process, such as MOVE MEDIUM. Disconnect privilege is granted by the initiator via the Identify message.

Supported Messages

The SCSI message system (Message In/Message Out) allows communication between an initiator and a target for the purpose of physical path management. The supported messages are shown in Table 4 on page 7. The direction is relative

to the initiator.

Table 4. Supported SCSI messages

Description	Code	Direction
COMMAND COMPLETE	00h	In
EXTENDED MESSAGE	01h	Out
SAVE DATA POINTERS	02h	In
RESTORE POINTERS	03h	In
DISCONNECT	04h	In
INITIATOR DETECTED ERROR	05h	Out
ABORT	06h	Out
MESSAGE REJECT	07h	Both
NO-OP	08h	Out
MESSAGE PARITY ERROR	09h	Out
BUS DEVICE RESET	0Ch	Out
IDENTIFY	80h-FFh	Both

COMMAND COMPLETE (00h) - This message is sent from the target to an initiator to indicate that the execution of a command completed and valid status has been sent to the initiator.

EXTENDED MESSAGE (01h) – This message is sent from an initiator to the target to attempt to negotiate synchronous or wide data transfers. The library supports both.

SAVE DATA POINTERS (02h) - This message is issued before every disconnect message following a Data In or Data Out phase. The message is not sent when disconnecting after a Command Descriptor Block (CDB) that did not transfer data.

RESTORE POINTERS (03h) - This message is sent from the target to direct the initiator to continue sending data.

DISCONNECT (04h) - This message is sent by the target to inform an initiator that the present data transfer will be suspended. The target will reselect the initiator at a later time to continue the current operation.

INITIATOR DETECTED ERROR (05h) - This message is sent from an initiator to inform the target that an error occurred. This allows the target to retry the operation.

ABORT (06h) - This message is sent from the initiator to the target to clear the current or pending operation. The target goes directly to the BUS FREE phase after successful receipt of this message.

MESSAGE REJECT (07h) - This message is sent from the initiator or target to indicate that the last message received was inappropriate or not implemented.

NO-OP (08h) - This message is sent from the initiator to inform the target that no message is valid in response to the target request for a message.

MESSAGE PARITY ERROR (09h) - This message is sent from the initiator to the target to indicate that one or more bytes in the last message received contained a parity error.

BUS DEVICE RESET (0Ch) - This message is sent from an initiator to clear all commands, data, and status at the target. When the target recognizes this message, it aborts the command currently being executed and proceeds to the BUS FREE state.

IDENTIFY (80h - FFh) - These messages are sent either by the initiator or by the target to establish (or re-establish) the logical connection path (nexus) between an initiator and target for a particular logical unit.

Fibre Channel Interface Support

The library Fibre Channel ports can be N_Ports for point-to-point topologies or NL_Ports for arbitrated loop topologies. Only Class 3 service is supported. Private arbitrated loops are supported if the library is not attached to a Fibre Channel fabric, and public arbitrated loops are supported if the library is attached to a Fibre Channel fabric.

Logical Libraries

The underlying physical library is not exposed externally to applications. Rather, logical representations of Media Changer devices are created, and these are presented instead. Through this method the physical library can be partitioned and concurrently shared in a heterogeneous environment. Storage and Data Transfer elements cannot be shared across logical libraries; they can only be assigned to one logical library at a time. The Medium Transport element (the robotic mechanism) is shared across all logical libraries, and as a result there may be some delays encountered as each logical library waits its turn for this shared resource.

Import/Export elements can also be shared across logical libraries. This is further discussed in Mailbox Behavior. All other aspects of the logical Media Changer devices are identical to an independent physical Media Changer.

Mailbox Behavior

There are three characteristics affecting Import/Export elements that warrant explanation.

First, these elements are contained in removable magazines. When the magazines are removed, the elements are still counted in the number of Import/Export elements and will have element descriptors returned for them in response to a READ ELEMENT STATUS command. Their element status will indicate that they are not accessible, and will also report an exception with an ASC/ASCQ of 3B/12.

Secondly, some IBM libraries are configured with multiple physical mailboxes, each containing their own set of magazines. Whenever a mailbox is opened, the status for the elements it contains will indicate that they are not accessible until the mailbox is closed again.

And finally, the mailbox magazine(s) can be assigned to and shared by different logical libraries. The Import/Export elements they contain are then used on a “first come, first served” basis. When shared Import/Export elements are in use by one logical library, element status for those elements will indicate that they are empty,

but not accessible for all other logical libraries that share them. The presence of media and associated volume tag information will only be available to the logical library using the elements at that time. When media is removed from the shared elements, they become available for use by the next logical library requesting them, and their element status indicates that they are accessible.

These three characteristics require applications to process the complete element status returned in the element descriptors (including accessibility and exception conditions) to achieve optimum usage of the Import/Export elements. Reliance on only full or empty element status may result in failed operations (e.g., an Export). This might be due to not locating a usable Import/Export element when several may actually be available, if the search had only taken into account full status rather than accessibility.

Autocleaning

IBM libraries support a user-configurable option to have the library automatically clean drives when requested by the drives (refer to the specific IBM library documentation for details). This process involves the library loading a special cleaning cartridge into the requesting drive, allowing the drive to perform the cleaning operation, and then the library unloading the cartridge and returning it to storage.

If this option is enabled and configured, the library maintains a pool of storage slots that contain the cleaning cartridges. These slots and cartridges are not associated with or counted towards any logical library, and as such are not reported to any application.

The library typically checks for cleaning requests from drives after unloading data cartridges. If a cleaning request is found, the library will select a cleaning cartridge from the pool and perform the clean. While the cleaning operation is in progress, the logical library containing the drive being cleaned will continue to accept and perform SCSI commands. If a Move Medium command is received with the drive as a destination, and it is still being cleaned, the command will be queued until the cleaning operation completes. Cleaning operations vary by drive and conditions, but can take up to a few minutes to complete.

Element status for the Data Transfer element being cleaned will not reflect the presence of the cleaning cartridge. It will continue to report that it is empty and accessible.

Removed Drives

Depending on how the library is configured, occasionally Data Transfer elements will be reported where no drive is physically present at the time. This could be due to a drive that has been removed for service, or simply a placeholder for the addition of a future drive. These empty “drive bays” will be counted and reported via Mode Sense and Read Element Status commands. Status for such elements will indicate that they are not accessible, and will report an ASC/ASCQ of 83/04. These elements could appear in between Data Transfer elements that are present, creating “gaps” among the physical drives. This should not be considered an error.

Chapter 3. Using the SCSI Commands

This chapter describes the following SCSI commands:

INITIALIZE ELEMENT STATUS (07h)

The library will determine status (full or empty) for all elements, as well as barcode label information (volume tags) for the media. Barcode labels will be scanned unless otherwise directed (and the library supports a non-barcode option). The library may not fully execute this command if the Automatic Inventory option is enabled, and element status is already known.

Results of the status initialization will be buffered by the library for retrieval via the READ ELEMENT STATUS command. Element status and barcode label information is retained by the library across power cycles.

Usage

This command can be used to gather status for all the elements, and should be issued whenever the library indicates that element status may have changed, such as after a power cycle or door opening and closing. It should then be followed by a READ ELEMENT STATUS command to retrieve the status.

CDB Format

The INITIALIZE ELEMENT STATUS CDB format in shown in Table 5.

Table 5. INITIALIZE ELEMENT STATUS CBD

Bits / Bytes	7	6	5	4	3	2	1	0
0	Op Code (07h)							
1	Logical Unit Number			Reserved				
2	Reserved							
3	Reserved							
4	Reserved							
5	NBL	Control						

Parameters

NBL (No Barcode Label)

A value of 0 indicates that the specified elements will be checked for all relevant status, including bar code labels. A value of 1 indicates that elements will be checked for media presence only (no bar code labels). The NBL bit is not supported on libraries that have a barcode scanner.

INITIALIZE ELEMENT STATUS WITH RANGE (E7h)

The library will examine the range of elements requested and determine their status relative to media presence (full or empty). Barcode labels will be scanned unless otherwise directed (and the library supports a non-barcode option). The library will always fully execute this command regardless of the Automatic Inventory setting.

Results of the status initialization will be buffered by the library for retrieval via the READ ELEMENT STATUS command. Element status and barcode label information is retained by the library across power cycles.

Usage

This command can be issued to gather status for some or all of the elements, and can be used in conjunction with host application error handling if the normal element status maintained by the library returns an unexpected result. It should then be followed by a READ ELEMENT STATUS command to retrieve the status.

CDB Format

The INITIALIZE ELEMENT STATUS WITH RANGE CDB format is shown in Table 6.

Table 6. Initialize Element Status With Range CDB

Bits / Bytes	7	6	5	4	3	2	1	0
0	Op Code (E7h)							
1	Logical Unit Number			Reserved				Range
2 : 3	MSB Starting Element Address LSB							
4	Reserved							
5	Reserved							
6 : 7	MSB Number of Elements LSB							
8	Reserved							
9	NBL	Control						

Parameters

Range A value of 0 indicates that all element addresses will be checked and that the Starting Element Address and Number of Elements fields will be ignored. A value of 1 indicates that the series of elements beginning at the specified Starting Element Address for the specified Number of Elements will be checked.

Starting Element Address

The Starting Element Address specifies the beginning address of the range to check. It must be a valid address for an element that exists within the library; no adjustment will be made to convert to a next higher valid address. This field is ignored if the Range field is 0.

Number of Elements

This field specifies the number of elements to check. Gaps in element types and addresses are automatically handled until a quantity of physical elements equal to this number has been checked. If this field is 0, the range checked will start with the Starting Element Address and continue through all remaining elements. This field is ignored if the Range field is 0.

NBL (No Barcode Label)

A value of 0 indicates that the specified elements will be checked for all relevant status, including bar code labels. A value of 1 indicates that elements will be checked for media presence only (no bar code labels). The NBL bit is not supported on libraries that have a barcode scanner.

INQUIRY (12h)

In response to this command the library returns static data that describes various subsystem parameters. If an INQUIRY command is received from an initiator with a pending unit attention condition, the library will perform the INQUIRY command and will not clear the unit attention condition. An INQUIRY command will respond with a Check Condition status only when it cannot return the requested Inquiry data.

Usage

This command would normally only be issued once for each logical unit as desired by the initiator to facilitate the initialization process.

CDB Format

The INQUIRY CDB format is shown in Table 7.

Table 7. Inquiry CDB

Bits / Bytes	7	6	5	4	3	2	1	0
0	Op Code (12h)							
1	Logical Unit Number			Reserved			CMDDT	EVPD
2	Page Code							
3	Reserved							
4	Allocation Length							
5	Control							

Parameters

Command Support Data (CMDDT)
This field is not supported and must be set to 0.

Enable Vital Product Data (EVPD)
An EVPD value of 1 indicates that the vital product data specified by the Page Code should be returned. A value of 0 indicates that standard inquiry data should be returned.

Page Code
This field specifies which vital product data page to return if the EVPD bit is set to 1. If the EVPD bit is set to 0, the Page Code must be 00h. The library supports the following page codes:

00h Supported Vital Product Data pages

80h Unit Serial Number page

83h Device Identification page

C0h Firmware Revision page

D0h Vendor Specific page

E0h Implemented SCSI–2 Command page

E1h Implemented vendor Specific Command page

FFh Vendor Use Only

Allocation Length

The Allocation Length field specifies the maximum number of bytes that the initiator allocated for returned inquiry data. An Allocation Length of 0 indicates that no inquiry data is to be transferred (this condition is not considered an error).

The library terminates the data transfer when it has transferred the lesser of either the number of bytes specified by the Allocation Length field or all of the available inquiry data. The lengths for inquiry data returned are:

3Ah (58 bytes)
(depending on device type) for the Standard Inquiry data

0Ch (12 bytes)
for the Supported Vita Product Data page (00h)

14h (20 bytes)
for the Unit Serial Number page (80h)

30h (48 bytes)
for the Device Identification page (83h)

1Ah (26 bytes)
for the Firmware Revision page (C0h)

8 **87h (135 bytes)**
for the Vendor Specific Command Support page (D0h)

6 **16h (22 bytes)**
6 for the Implemented SCSI–2 Command page (E0h)

05h (5 bytes)
for the Vendor Specific commands page (E1h)

Response

The standard INQUIRY response returns information as shown in Table 8.

Table 8. IBM standard inquiry data format

Bits / Bytes	7	6	5	4	3	2	1	0
0	Peripheral Qualifier			Peripheral Device Type				
1	RMB	Reserved						
2	Version							
3	AERC	Obsolete	NormACA	HiSup	Response Data Format			
4	Additional Length							
5	SCCS	Reserved						
6	BQue	EncServ	BarC	MultiP	MChngr	Obsolete	Obsolete	Addr16
7	RelAdr	Obsolete	Wbus16	Sync	Linked	Obsolete	CmdQue	SftRe
8 : 15	MSB Vendor Identification LSB							
16 : 31	MSB Product Identification LSB							

Table 8. IBM standard inquiry data format (continued)

Bits / Bytes	7	6	5	4	3	2	1	0
32	MSB							
:	Firmware Revision Level							
35								LSB
36	MSB							
:	Plant of Manufacture							
37								LSB
38	MSB							
:	Serial Number							
49								LSB
50	MSB							
:	'0' (in ASCII)							
51								LSB
52								
:	Reserved							
57								

Peripheral Qualifier
A return value of 0 indicates that the library is a single LUN device. If a LUN other than 0 was specified, this field returns 011b, which indicates that only LUN 0 is supported.

Peripheral Device Type
The value returned by this field is set to 01000b, indicating a Medium Changer Device. Any LUN other than 0 returns 11111b, which indicates that the device is unknown.

RMB (Removable Medium Bit)
This field returns 1, indicating media is removable.

Version
This field returns 03h, indicating compliance with the SCSI-3 standard.

AERC (Asynchronous Event Reporting Capability)
Returned as 0, indicating AERC is not supported.

NormACA (Normal ACA Supported)
This field returns a 0, indicating the NACA bit in the Control byte of a CDB is not supported.

HiSup (Hierarchical Support)
This field returns a 1, indicating that the hierarchical addressing model is used to assign LUNs, and that the REPORT LUNs command is supported.

Response Data Format
Returned as 0010b, indicating response data is in standard SCSI format.

Additional Length
This field returns 35h, indicating 53 additional bytes of data are available.

SCCS (SCC Supported)
This field returns a 0.

BQue (Basic Queuing)
Returned as 0, indicating basic queuing is not supported.

EncServ (Enclosure Services)
Returned as 0, indicating an enclosure services component is not included.

BarC (Bar Code)
This field returns a 1, indicating a bar code scanner is installed (also returned in byte 55 below).

MultiP (Multi Port)
Returned as 0, indicating that this is not a multi-port device.

MChngr (Media Changer)
This field returns a 0, indicating it is not an attached Media Changer device.

7 **Wide SCSI Addr16 (Address 16)**
7 Returned as 1, indicating a 16-bit wide SCSI addresses are supported
7 (applies to parallel SCSI only).

Relative RelAdr (Address)
Returned as 0, indicating relative addressing is not supported.

Wbus16 (Wide Bus 16)
Returned as 1, indicating 16 bit transfers are supported (applies to parallel SCSI only).

Sync (Synchronous Transfer)
Returned as 1, indicating synchronous transfers are supported (applies to parallel SCSI only).

Linked (Linked Commands)
Returned as 0, indicating linked commands are not supported.

CmdQue (Command Queuing)
For Fibre Channel, this is returned as 1, indicating command queuing is supported. For SCSI, this is returned as 0, indicating no command queuing is supported.

SftRe (Soft Reset)
Returned as 0, indicating a soft reset is not supported.

Vendor Identification
Returned as "IBM ", space filled to eight bytes.

Product Identification
Returned as "3576-MTL ". It is space filled to 16 bytes.

Firmware Revision Level
Returned as the ASCII representation of the revision level, such as "100A" or "203A".

Plant of Manufacture
Returned as the ASCII representation of the manufacturing facility.

Serial Number
Returned as serial number of device, right justified with leading zeros (in ASCII).

Supported Vital Product Data Page

Table 9 shows the format of the Supported Vital Product Data page.

Table 9. Supported vital product data page

Bits / Bytes	7	6	5	4	3	2	1	0
0	Peripheral Qualifier			Peripheral Device Type				
1	Page Code (00h)							
2	Reserved							
3	Page Length							
4	First Page Code Supported							
5	Second Page Code Supported							
6	Third Page Code Supported							
7	Fourth Page Code Supported							
8	Fifth Page Code Supported							
8	Sixth Page Code Supported							
10	Seventh Page Code Supported							
11	Eighth Page Code Supported							

Peripheral Qualifier
A return value of 0 indicates that the library is a single LUN device. If a LUN other than 0 was specified, this field returns 011b, which indicates that only LUN 0 is supported.

Peripheral Device Type
The value returned by this field is set to 01000b, indicating a Medium Changer Device. Any LUN other than 0 returns 11111b, which indicates that the device is unknown.

Page Code
Returned as 00h, indicating this page.

Page Length
Returned as 08h, indicating the remaining number of bytes in this page following this field.

First Page Code Supported
Returned as 00h, indicating support for the Supported Vital Product Data Page.

Second Page Code Supported
Returned as 80h, indicating support for the Unit Serial Number Page.

Third Page Code Supported
Returned as 83h, indicating support for the Device Identification Page.

Fourth Page Code Supported
Returned as C0h, indicating support for the Firmware Revision page.

Fifth Page Code Supported
Returned as D0h, indicating support for the Vendor Specific Command page.

Sixth Page Code Supported
Returned as E0h, indicating support for the Implemented SCSI-2 Command page.

Seventh Page Code Supported
Returned as E1h, indicating support for the Implemented Vendor Specific Command page.

Eighth Page Code Supported
Returned as FFh. Vendor use only.

Unit Serial Number Page (80h)

Table 10 shows the format of the Unit Serial Number page.

Table 10. Unit Serial Number page

Bits / Bytes	7	6	5	4	3	2	1	0
0	Peripheral Qualifier			Peripheral Device Type				
1	Page Code (80h)							
2	Reserved							
3	Page Length							
4 : 15	MSB Serial Number LSB							
16 : 19	MSB Unique Logical Library Identifier LSB							

Peripheral Qualifier
A return value of 0 indicates that the library is a single LUN device. If a LUN other than 0 was specified, this field returns 011b, which indicates that only LUN 0 is supported.

Peripheral Device Type
The value returned by this field is set to 01000b, indicating a Medium Changer Device. Any LUN other than 0 returns 11111b, which indicates that the device is unknown.

Page Code
Returned as 80h, indicating this page.

Page Length
Returned as 10h, indicating the remaining number of bytes following this field.

Serial Number
The value returned for this field is the serial number for the system, right justified with leading zeros.

Unique Logical Library Identifier
Such as the ASCII representation of the logical library name, for example _LL3.

Device Identification Page (83h)

Table 11 on page 21 shows the format of the Device Identification Page.

Table 11. Device Identification Page

Bytes \ Bits	7	6	5	4	3	2	1	0
0	Peripheral Qualifier			Peripheral Device Type				
1	Page Code (83h)							
2	Reserved							
3	Page Length (*n*-3)							
	Identification Descriptors							
4	First Identification Descriptor							
:								
N	Last Identification Descriptor							

Peripheral Qualifier
A return value of 0 indicates that the library is a single LUN device. If a LUN other than 0 was specified, this field returns 011b, which indicates that only LUN 0 is supported.

Peripheral Device Type
The value returned by this field is set to 01000b, indicating a Medium Changer Device. Any LUN other than 0 returns 11111b, which indicates that the device is unknown.

Page Code
Returned as 83h, indicating this page.

Page Length
Returns the remaining number of bytes following this field.

Identification Descriptors

shows the general format of an identification descriptor.

Table 12. General identification Descriptor

Bytes \ Bits	7	6	5	4	3	2	1	0
0	Reserved				Code Set			
1	Reserved		Association		Identifier Type			
2	Reserved							
3	Identifier Length (*n*-3)							
4 : *N*	Identifier							

Code Set
This field returns the following values:

- 1h – the Identifier field contains binary values
- 2h – the Identifier field contains ASCII characters

Association
This field returns the following values:

- 0h – the Identifier field is associated with the address physical or logical device

- 1h – the Identifier field is associated with the port that received the request

Identifier Type
This field returns the following values:

- 1h – The identifier is a concatenation of the Vendor Identification field from the Standard inquiry Data and the Serial Number field (without the vendor ID prefix) from the Unit Serial Number page.
- 3h – The identifier is an IEEE Registered format Name_Identifier (Worldwide Name).
- 4h – The identifier is a port number. In this case, the Code Set and Association fields will both be set to 1.

Identifier Length
This is the length of the Identifier field, and will vary by identifier type.

Identifier
This is the identifier as described by the Code Set, Association, and Identifier Type fields.

Media Changer Identification Descriptor

Media Changer logical units will only report a single identifier as shown in Table 13. They will report the same identifier on either SCSI or Fibre Channel.

Table 13. Media Changer Identification Descriptor

Bits / Bytes	7	6	5	4	3	2	1	0
0	Reserved				Code Set = 2h			
1	Reserved		Association - 0h		Identifier Type = 1h			
2	Reserved							
3	Identifier Length - 28h (40)							
4 : 11	MSB Vendor ID LSB							
12 : 27	MSB Device Type and Model Number LSB							
28 : 39	MSB Serial Number LSB							
40 : 43	MSB Unique Logical Library Identifier LSB							

Vendor ID
Returned as ""IBM "

Device Type and Model Number
Returned as "3576-MTL ".

Serial Number
Returned as serial number of the device, right justified with leading zeros.

Unique Logical Library Identifier
Such as the ASCII representation of the logical library name, for example, _LL3.

Firmware Revision Page (C0h)

Table 14 shows the format of the Firmware Revision page.

Table 14. Firmware Revision page

Bits / Bytes	7	6	5	4	3	2	1	0
0	Peripheral Qualifier			Peripheral Device Type				
1	Page Code (C0h)							
2	Reserved							
3	Page Length							
4 : 25	MSB Revision LSB							

Peripheral Qualifier
A return value of 0 indicates that the library is a single LUN device. If a LUN other than 0 was specified, this field returns 011b, which indicates that only LUN 0 is supported.

Peripheral Device Type
The value returned by this field is set to 01000b, indicating a Medium Changer Device. Any LUN other than 0 returns 11111b, which indicates that the device is unknown.

Page Code
Returned as C0h, indicating this page.

Page Length
Returned as 16h, indicating the remaining number of bytes following this field.

Revision
Returned as the ASCII representation (22 bytes) of the firmware revision level in the form Firmware Revision = *xxxx*, where *xxxx* is the same value as reported in the Firmware Revision Level field of the Standard Inquiry response.

Implemented SCSI-2 Command Page (E0h)

Table 15 shows the format of the Implemented SCSI-2 Command Page.

Table 15. Implemented SCSI-2 Command page (E0h)

Bits / Bytes	7	6	5	4	3	2	1	0
0	Peripheral Qualifier			Peripheral Device Type				
1	Page Code (E0h)							
2	Reserved							
3	Page Length							
4	TEST UNIT READY							
5	REQUEST SENSE							
6	INITIALIZE ELEMENT STATUS							
7	INQUIRY							
8	MODE SELECT							
9	RESERVE							
10	RELEASE							
11	MODE SENSE							
12	SEND DIAGNOSTIC							
13	PREVENT/ALLOW MEDIUM REMOVAL							
14	POSITION TO ELEMENT							
15	WRITE BUFFER							
16	READ BUFFER							
17	LOG SENSE							
18	PERSISTENT RESERVE IN							
19	PERSISTENT RESERVE OUT							
20	MOVE MEDIUM							
21	READ ELEMENT STATUS							

Peripheral Qualifier

A return value of 0 indicates that the library is a single LUN device. If a LUN other than 0 was specified, this field returns 011b, which indicates that only LUN 0 is supported.

Peripheral Device Type

The value returned by this field is set to 01000b, indicating a Medium Changer Device. Any LUN other than 0 returns 11111b, which indicates that the device is unknown.

Page Code

Returned as E0h, indicating this page.

Page Length

Returned as 12h, indicating the remaining number of bytes following this field.

Implemented SCSI-2 Commands

Byte 4 through byte 21 list the implemented SCSI-2 commands for the library. Refer to Table 1 on page 3 for the command code associated with each command.

Implemented Vendor Specific Command Page (E1h)

Table 16 shows the format of the Implemented Vendor Specific Command Page.

Table 16. Implemented Vendor Specific Command page (E1h)

Bits / Bytes	7	6	5	4	3	2	1	0
0	Peripheral Qualifier			Peripheral Device Type				
1	Page Code (E1h)							
2	Reserved							
3	Page Length							
4	Initialize Element Status with Range							

Peripheral Qualifier

A return value of 0 indicates that the library is a single LUN device. If a LUN other than 0 was specified, this field returns 011b, which indicates that only LUN 0 is supported.

Peripheral Device Type

The value returned by this field is set to 01000b, indicating a Medium Changer Device. Any LUN other than 0 returns 11111b, which indicates that the device is unknown.

Page Code

Returned as E1h, indicating this page.

Page Length

Returned as 01h, indicating the remaining number of bytes following this field.

Implemented Vendor Specific Commands

Byte 4 lists the implemented vendor specific command for the library. Refer to Table 1 on page 3 for the command code associated with each command.

LOG SENSE (4Dh)

The library returns information for the requested log page. The only supported log page is the Tape Alert page, with a limited set of flags. The library will return the current values of the flags on request, and then clear them.

Usage

This command can be used to monitor conditions of the library.

CDB Format

The LOG SENSE CDB format is shown in the following table.

Table 17. LOG SENSE CDB format

Bits / Bytes	7	6	5	4	3	2	1	0
0	Op Code (4Dh)							
1	Logical Unit Number			Reserved			PPC	SP
2	PC		Page Code					
3	Reserved							
4	Reserved							
5 6	Parameter Pointer							
7 8	Allocation Length							
9	Control							

Parameters

PPC (Parameter Pointer Control)

Must be set to 0. The library will return log parameters starting with the parameter code specified in the Parameter Pointer field, and return up to the number of bytes specified in the Allocation Length field. Log parameters are returned in ascending order according to their parameter code. A PPC bit of 0 and a Parameter Pointer field of 0 will cause all available log parameters for the requested page code to be returned, subject to the Allocation Length.

SP (Save Parameters)

Must be set to 0. The library does not support the saving of log parameters.

PC (Page Control)

Must be set to 01b. The library only returns cumulative values for any log parameter rather than threshold or default values.

Page Code

The Page Code field identifies which log page is being requested by the initiator.

Table 18. Page Code field

Page Code	Page Name	Page Description
00h	Supported Log Pages	Returns list of supported log pages
2Eh	Tape Alert Log	Returns the 64 tape alert flags

Parameter Pointer

This field specifies which log parameter to begin with for the requested log page. A PPC bit of 0 and a Parameter Pointer field of 0 will cause all available log parameters for the requested page code to be returned, subject to the Allocation Length. More detailed definition of this field is contained within the specific log page descriptions.

Allocation Length

The Allocation Length field is used to determine the maximum amount of data to return. The transfer completes after either all the data has been transferred or an amount equal to the Allocation Length has been sent. Specify FFFFh to include all available data.

Response

The response to a LOG SENSE command returns the log page specified in the Page Code field of the CDB. The log page format is described in "Log Page Format." The valid Page Code fields are listed in Table 19. The various log parameters are described within their respective pages, along with their Parameter Codes. The Log Parameter format is described in "Log Parameter Format."

Log Page Format

The following table shows the Log Page format. The first four bytes are the Parameter List Header, followed by the list of log parameters.

Table 19. Log Page format

Bytes \ Bits	7	6	5	4	3	2	1	0
0	Reserved		Page Code					
1	Reserved							
2	Page Length (n-3)							
3								
4	Log Parameter (First)							
x+3	(Length x)							
	.							
	.							
	.							
n-y+1	Log Parameter (Last)							
n	(Length y)							

Parameters

Page Code

This field identifies which log page is being transferred.

Page Length
This field indicates the total number of bytes available to return for this page, beginning with the first log parameter. The value set for this field depends on the value specified for the Page Code.

Log Parameters
These are dependent upon the log page. The various parameters as well as their format for the supported pages are listed below.

Table 20. Log Parameter Format

Bits / Bytes	7	6	5	4	3	2	1	0
0 1	Parameter Code							
2	DU	DS	TSD	ETC	TMC		LBIN	LP
3	Parameter Length (n-3)							
4 n	Parameter Value							

Parameter Code
This field identifies which log parameter was transferred. The valid values for this field depend on the log page.

DU (Disable Update)
Will be set to 0. The library will always update values reflected by the log parameters.

DS (Disable Save)
Will be set to 1. The library does not support saving of log parameters.

TSD (Target Save Disable)
Will be set to 0. The library provides a self-defined method for saving log parameters.

ETC (Enable Threshold Comparison)
Will be set to 0. No comparison to threshold values is made.

TMC (Threshold Met Criteria)
Will be set to 0. Comparison to threshold values is not supported.

LBIN (List Parameter Binary)
This field is only valid if LP is set to 1. When LBIN is set to 0, the list parameter is ASCII. When LBIN is set to 1, the list parameter is a binary value.

LP (List Parameter)
This field will be set to 0 for data counters and set to 1 for list parameters.

Parameter Length
This field indicates the number of bytes that follow this field, which is the size of the parameter value.

Parameter Value
This field contains the actual parameter data, which can be either a data counter or a list parameter (ASCII string or binary value).

Supported Log Page (00h)

This page returns a list of all log pages supported by the library.

Table 21. Supported Log Page (00h)

Bits / Bytes	7	6	5	4	3	2	1	0
0	Reserved		Page Code (00h)					
1	Reserved							
2 3	Page Length (0002h)							
4	Supported Log Page (00h)							
5	Tape Alert Log Page (2Eh)							

Parameters

Page Code

The returned value is 00h, indicating this page.

Page Length

The returned value is 0002h.

The page codes for all the supported pages (including this one) follow the page length field.

Tape Alert Log Page (2Eh)

The Tape Alert log page follows the standard log page format. Each Tape Alert is returned as an individual log parameter, with its state reflected in bit zero of the one-byte Parameter Value field of the log parameter. When this bit is set to one, the alert is active.

When requesting the Tape Alert log page, the Parameter Pointer determines from what point in the Tape Alert table the alerts are returned. The value zero specifies that all tape alerts should be returned. If the Parameter Pointer is set from 1 to 64, all tape alerts from that point to the end of the list are returned. The various log parameters are listed in the following table.

Table 22. Tape Alert Log Page Parameters

Log Param	Param Code	DU	DS	TSD	ETC	TMC	LBIN	LP	Param Length
Tape Alert Flag 1	0001h	0	1	0	0	0	0	0	1
Tape Alert Flag 2	0002h	0	1	0	0	0	0	0	1
...		0	1	0	0	0	0	0	1
Tape Alert Flag 63	003Fh	0	1	0	0	0	0	0	1
Tape Alert Flag 64	0040h	0	1	0	0	0	0	0	1

The severity of the flags has the following meaning:

- Critical (C)
- Warning (W)
- Informational (I)

The set of flags that are supported is as follows:

Flag 2: Library Hardware B(W)
This flag is set for any unrecoverable mechanical error.

Flag 4: Library Hardware D (C)
This flag is set when the internal Power-On-Self-Tests (POST) fail or when a mechanical error occurs that requires a power cycle to recover, and is not internally cleared until the device is powered off.

Flag 13: Library Pick Retry (W)
This flag is set when a high retry count threshold is passed when performing an operation to pick a cartridge from a slot before the operation succeeds. It is internally cleared when another pick operation is attempted.

Flag 14: Library Place Retry (W)
This flag is set when a high retry count threshold is passed when performing an operation to place a cartridge back into a slot before the operation succeeds. It is internally cleared when another place operation is attempted.

Flag 15: Library Load Retry (W)
This flag is set when a high retry count threshold is passed when performing an operation to load a cartridge into a drive before the operation succeeds. It is internally cleared when another load operation is attempted. Note that if the load actually fails due to a media or drive problem, the appropriate TapeAlert flags should be set by the drive.

Flag 16: Library Door (C)
This flag is set when media move operations cannot be performed because a door is open, and is internally cleared when the door is closed.

Flag 23: Library Scan Retry (W)
This flag is set when a high retry count threshold is passed when performing an operation to scan the barcode on a cartridge before the operation succeeds. It is internally cleared when another barcode scanning operation is attempted.

MODE SELECT 6 (15h)

The library does not support any changeable parameters, and this command is supported for compatibility only.

Usage

A MODE SENSE command with the PC field set to 1h and the Page Code field set to 3Fh can be issued before the MODE SELECT command is issued to determine which mode parameters are supported, which mode parameters are changeable, and the supported length of each page. Since the library does not support any changeable parameters, use of MODE SELECT provides limited value. A list of the available mode pages can be found in the Mode Sense Specifications.

CDB Format

The six-byte MODE SELECT CDB format is shown in Table 23.

Table 23. MODE SELECT CDB

Bits / Bytes	7	6	5	4	3	2	1	0
0	Op Code (15h)							
1	Logical Unit Number			PF	Reserved			SP
2	Reserved							
3	Reserved							
4	Parameter List Length							
5	Control							

PF (Page Format)

This bit indicates that the data sent by the initiator after the MODE SELECT header and block descriptors complies with the definition of pages in the SCSI standard. The value must be set to 1.

SP (Save Parameters)

Savable pages are not supported and this field must be set to 0.

Parameter List Length

This field specifies the number of bytes that will be transferred for the MODE SELECT parameter list, and should be equal to the length of a single Parameter List Header plus the lengths of all pages to be transferred. A length of zero indicates that no data is transferred. This is not considered to be an error.

Mode Parameter Header

Following the MODE SELECT CDB, a single Mode Parameter Header should be sent as shown in Table 24 on page 32. None of the fields are actually used however; and, should all be set to zero.

MODE SELECT 6 (15h)

Table 24. Mode Select (6) Parameter Header

Bits / Bytes	7	6	5	4	3	2	1	0
0	Reserved							
1	Reserved							
2	Reserved							
3	Reserved							

MODE SENSE 6 (1Ah)

The library will return the current settings for the supported mode pages.

Usage

This command can be used to determine certain operational settings governing the behavior of the library. For example, the number of elements and their assigned addresses can be obtained through use of MODE SENSE, which allows an application to adapt to a library configuration instead of using fixed values. Use of MODE SENSE to obtain these parameters during initialization is highly recommended to facilitate the most flexibility in supporting the library.

CDB Format

Table 25. MODE SENSE CDB format

Bits / Bytes	7	6	5	4	3	2	1	0
0	Op Code (1Ah)							
1	Logical Unit Number			Rsvd	DBD	Reserved		
2	PC		Page Code					
3	Reserved							
4	Allocation Length							
5	Control							

Parameters

DBD (Disable Block Descriptor)

A value of 0 or 1 is supported, although block descriptors are not returned.

PC (Page Control)

This field indicates the type of mode page parameter values to return as shown in the following table.

Table 26. Page Control (PC) field

Page Control		Description
0	0	Report current values defined by: • The values set by the last successful MODE SELECT command. • The default values if no saved values exist.
0	1	Report changeable values.
1	0	Report default values.
1	1	Report saved values (default values if no pages are previously saved).

Page Code

The Page Code field determines which pages should be reported. See Table 28 on page 34.

Allocation Length

This field specifies the number of bytes that the host allocated for returned

MODE SENSE data. A length of 0 means that the library will return no MODE SENSE data. This is not considered to be an error.

Response

The six-byte MODE SENSE response consists of a single four-byte Mode Parameter Header, followed by zero or more mode pages. Each page is individually described in "Mode Pages."

Mode Parameter Header

The following table lists the format of the Mode Parameter Header for the six-byte MODE SENSE command.

Table 27. Mode Parameter Header format for MODE SENSE (6)

Bits / Bytes	7	6	5	4	3	2	1	0
0	Mode Data Length							
1	Reserved							
2	Reserved							
3	Reserved							

Mode Data Length

This specifies the length in bytes that is available to be transferred as part of the response. The Mode Data Length does not include itself but does include the remaining 3 bytes of the parameter header, as well as the overall total number of bytes being sent for all requested pages.

The following table lists the mode pages supported by the library.

Table 28. Supported Mode Pages

Page Code	Page Name	Page Description
1Ch	Informational Exceptions Control	Provides information regarding SCSI tape alert processing within the library.
1Dh	Element Address Assignment	Provides information regarding SCSI element address assignments and respective element ranges.
1Eh	Transport Geometry Parameters	Provides information regarding the Media Changer's capabilities.
1Fh	Device Capabilities	Provides information regarding cartridge movement possibilities within the library.
3Fh	All Mode Pages	Returns all mode pages.

Informational Exceptions Control Page (1Ch)

The Informational Exceptions Control mode page describes the capabilities of the library for reporting exception conditions. It was previously known as the Tape Alert mode page when exception conditions were limited to only Tape Alert flags.

The main purpose of this page is to indicate that the library can report exception conditions by being polled. The exception conditions primarily involve the Tape Alert flags, but may include additional conditions as well, as defined by the Sense

Data.

Table 29. Informational Exceptions Control Page (1Ch)

Bit / Byte	7	6	5	4	3	2	1	0
0	PS	Rsvd	Page Code (1Ch)					
1	Parameter List Length = 0Ah							
2	Perf	Rsvd	EBF	EWasc	Dexcpt	Test	Rsvd	LogErr
3	Reserved				MRIE			
4 7	Interval Timer							
8 11	Report Count							

PS (Parameters Savable)
This page is not savable, and this field is set to zero.

Page Code
This field identifies the Informational Exceptions Control mode page and returns 1Ch.

Parameter List Length
This field is set to 0Ah (10).

LogErr (Log Errors)
This field is set to 0 to indicate that logging of informational exception conditions is vendor specific (unique to the library in this case).

Test This field is set to 0 to indicate that test failure indications will not be generated.

Dexcpt (Disable Exception Control)
This field is set to 1, indicating that the initiator must poll the LOG SENSE Tape Alert page.

EWasc (Enable Warning)
This field is set to 0, indicating that reporting of warnings is disabled.

EBF (Enable Background Function)
This field is set to 0 indicating that background functions are not enabled.

Perf (Performance)
This field is set to 0 to indicate that informational exception operations that are the cause of delays are acceptable.

MRIE (Method of Reporting Informational Exceptions)
This field is set to 0h to indicate that exception conditions or warnings will not be reported, and that the initiator must poll.

Interval Timer
This field is set to 0000 0000h to indicate that the interval is vendor specific. The library does not support a timer interval.

Report Count
This field is set to 0000 0000h to indicate that there is no limit on the number of exception conditions reported.

Element Address Assignment Page (1Dh)

The Element Address Assignment mode page returns the first element address and the element quantity for each element type. The quantity is based on the number of elements configured in the library, some of which may be temporarily removed (like a storage magazine or drive). Elements that are temporarily removed will not change the overall number of elements for that element type. The format of the page is shown in the table below. Initiators should always retrieve this page and use these values when communicating element-based commands with the library. The addresses and quantities of elements should never be assumed or hard-coded by the initiator, as they are subject to change.

Table 30. Element Address Assignment Page (1Dh)

Bit / Byte	7	6	5	4	3	2	1	0
0	PS	Rsvd	Page Code (1Dh)					
1	Parameter List Length = 12h							
2 3	First Medium Transport Element Address (0001h)							
4 5	Number of Medium Transport Elements							
6 7	First Storage Element Address (1000h)							
8 9	Number of Storage Elements							
10 11	First Import/Export Element Address (0010h)							
12 13	Number of Import/Export Elements							
14 15	First Data Transfer Element Address (0100h)							
16 17	Number of Data Transfer Elements							
18 19	Reserved							

PS (Parameters Savable)

This page is not savable, and this field is set to zero.

Page Code

This field identifies the Element Address Assignment mode page and returns 1Dh.

Parameter List Length

This field is set to 12h (18).

First Medium Transport Element Address

This returns 0001h, which is the address of the first medium transport element (accessor).

Number of Medium Transport Elements
This field returns 0001h.

First Storage Element Address
This field returns 1000h, which is the address of the first storage element.

Number of Storage Elements
This field varies, depending on the configuration of the subsystem.

First Import/Export Element Address
This field returns 0010h, which is the address of the first Import/ Export element.

Number of Import/Export Elements
This field varies, depending on the configuration of the subsystem. If no Import/Export elements are installed, this field returns zero.

First Data Transfer Element Address
This field returns 0100h, which is the address of the first data transfer element (drive).

Number of Data Transfer Elements
This field varies, depending on the configuration of the subsystem.

Transport Geometry Parameters Page (1Eh)

The Transport Geometry Parameters page describes whether a medium transport element is a member of a set of elements that share a common robotics subsystem, and whether it is capable of handling double-sided media. This library currently contains a single medium transport element, so all are the first element in a set of one.

Table 31. Transport Geometry Parameters Page (1Eh)

Bit / Byte	7	6	5	4	3	2	1	0
0	PS	Rsvd	Page Code (1Eh)					
1	Parameter List Length = 02h							
2	Reserved							Rotate
3	Member Number In Transport Element Set							

PS (Parameters Savable)
This page is not savable, and this field is set to zero.

Page Code
This field identifies the Transport Geometry Parameters mode page and returns 1Eh.

Parameter List Length
This field is set to 02h, since only a single medium transport is reported.

Rotate This field returns 0, since double-sided media is not supported.

Member Number In Medium Transport Element Set
This field returns 0, since the library has a single medium transport.

Device Capabilities Page (1Fh)

The Device Capabilities page defines the rules governing cartridge movement within the library. It describes from which element type to the next a cartridge can be moved, directly defining which element types can be used as either source or target elements. The library does not allow the medium transport element

(accessor) to be a target, and only as a source on a limited basis.

Table 32. Device Capabilities Page (1Fh)

Bit / Byte	7	6	5	4	3	2	1	0
0	PS	Rsvd	Page Code (1Fh)					
1	Parameter List Length = 0Eh							
2	Reserved				DT 1	I/E 1	ST 1	MT 0
3	Reserved							
4	Reserved				MT to DT 0	MT to I/E 1	MT to ST 1	MT to MT 0
5	Reserved				ST to DT 1	ST to I/E 1	ST to ST 1	ST to MT 0
6	Reserved				I/E to DT 1	I/E to I/E 1	I/E to ST 1	I/E to MT 0
7	Reserved				DT to DT 1	DT to I/E 1	Dt to ST 1	DT to MT 0
8 15	Reserved							

PS (Parameters Savable)
This page is not savable, and this field is set to zero.

Page Code
This field identifies the Device Capabilities mode page and returns 1Fh.

Parameter List Length
This field is set to 0Eh (14).

DT (Data Transfer)
This field is set to 1 to indicate that the data transfer elements (drives) can store cartridges.

I/E (Import/Export)
This field is set to 1 to indicate that the Import/Export elements can store cartridges.

ST (Storage)
This field is set to 1 to indicate that the storage elements can store cartridges.

MT (Medium Transport)
This field is set to 0 to indicate that the accessor cannot store cartridges.

The remaining element type to element type fields describe the allowable source to target transitions. A zero is returned for any transition involving the Medium Transport (MT) except for when the MT is a source and the destination is either I/O or Storage. A one is returned for all other transitions.

All Mode Pages (3Fh)

When this page is requested, all supported mode pages are returned in ascending order.

MOVE MEDIUM (A5h)

The library will attempt to physically move a cartridge from the requested source element to the requested destination. The library will make reasonable attempts to retry this operation within the scope of its capabilities, but if unsuccessful, will try to return the cartridge to its source element. If the source element was a drive, the library will attempt to leave the cartridge in either a storage or I/O element if the configuration supports it (not partitioned in the case of the I/O), otherwise it may remain in the picker.

When the source and destination addresses are the same, the library will still do a full Get and Put, even if it is a drive (data transfer element).

The library will check that the source element is occupied and that the destination element is empty. It will also check for media compatibility between the source and destination elements. Failures in either of these will result in a Check Condition.

Usage

Storage, data transfer, and import/export elements can be used as valid source or destination elements. The medium transport element (picker) cannot be a destination element. It can be a source element to recover stranded media.

This is the primary command for the library, and should be used to accomplish any media movement within the system. If the library indicates a failure due to element status problems (source empty, destination full, media incompatible, etc.), element status should be re-initialized and re-synchronized. This would apply to both hardware errors and illegal requests.

CDB Format

Note: The TS3310 Tape Library will respond with a Good status whenever a received MOVE MEDIUM command exactly matches the saved last successful MOVE MEDIUM command and the current status of the source element is empty or inaccessible.

The MOVE MEDIUM CDB format is shown in Table 33 on page 40.

MOVE MEDIUM (A5h)

Table 33. MOVE MEDIUM CDB

Bits / Bytes	7	6	5	4	3	2	1	0
0	Op Code (A5h)							
1	Logical Unit Number			Reserved				
2 : 3	MSB Medium Transport Element Address LSB							
4 : 5	MSB Source Element Address LSB							
6 : 7	MSB Destination Element Address LSB							
8 : 9	Reserved							
10	Reserved							Invert
11	Control							

Parameters

Medium Transport Element Address
This field contains the address of the Medium Transport element to use for the move. A value of 0001h is the address for all Medium Transport elements, but a value of 0000h is also supported to select the default Medium Transport element.

Source Element Address
This field specifies the element address from where the cartridge is retrieved.

Destination Element Address
This field specifies the element address for where the cartridge is to be placed.

Invert
This field must be set to 0 since the library does not support double-sided media.

PERSISTENT RESERVE IN (5Eh)

The library returns information about persistent reservation and reservation keys that are currently active.

Usage

This command is used in conjunction with PERSISTENT RESERVE OUT to manage persistent reservations. It can be used to retrieive a list of the current reservations and the registered reservation keys. The PERSISTENT RESERVE IN and PERSISTENT RESERVE OUT commands should not be used with the RESERVE ELEMENT (6) and RELEASE ELEMENT (6) commands.

CDB Format

The PERSISTENT RESERVE IN command in CBD format is shown in Table 34.

Table 34. PERSISTENT RESERVE IN CDB

Bits / Bytes	7	6	5	4	3	2	1	0
0	Op Code (5Eh)							
1	Logical Unit Number			Service Action				
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7-8	Allocation Length							
9	Control							

Parameters

Service Action

This field specifies the type of request being made as follows:

- 0h – Read all registered reservation keys
- 1h – Read all current persistent reservations

Allocation Length

This field specifies the byte length allowed for returning the requested data. The number of bytes returned is the lesser of the available data to return, or the allocation length.

Response

Persistent Reserve in Response

Two types of responses are available, depending on the requested service action.

Read Keys Response: The response for Read Keys service action is shown in Table 35:

Table 35. Read Keys Response

Bits / Bytes	7	6	5	4	3	2	1	0
0	Generation							
:								
3								
4	Additional Length (n-7)							
:								
7								
Reservation Key List								
8	First Reservation Key							
:								
15								
...								
n-7	Last Reservation Key							
n								

Generation
This field is a 32-bit counter that is incremented every time a PERSISTENT RESERVE OUT command requests a Register, a Register and Ignore Existing Key, a Clear, a Preempt, or a Preempt and Abort service action. This counter is not maintained across power cycles.

Additional Length
This field indicates the length in bytes of the Reservation Key list.

Reservation Key List
This is a list of all the 8-byte reservation keys that have been registered through the PERSISTENT RESERVE OUT command.

Read Reservations Response: The response to Read Reservations action is shown in Table 36:

Table 36. Read Reservations Response

Bits / Bytes	7	6	5	4	3	2	1	0
0	Generation							
:								
3								
4	Additional Length (0010h)							
:								
7								
Reservation Descriptor								
8	Reservation Key							
:								
15								
16 : 19	Scope-specific Address							
20	Reserved							
21	Scope				Type			
22	Obsolete							
23								

Parameters

Generation
This field is a 32-bit counter that is incremented every time a PERSISTENT RESERVE OUT command requests a Register, a Register and Ignore Existing Key, a Clear, a Preempt, or a Preempt and Abort service action. This counter is not maintained across power cycles.

Additional Length
This field indicates the length in bytes of the Reservation Descriptor, and returns 0010h (16).

Since element reservations are not supported, a single reservation descriptor is returned per logical unit

Reservation Key
This is the 8-byte reservation key that was registered through the PERSISTENT RESERVE OUT command.

Scope-specific Address
Element reservations are not supported and this field returns 0000h.

Scope This field returns a 0h, indicating a logical unit scope. Element scope is not supported.

Type This field returns the type of reservation as follows:

- 3h – Exclusive Access – The initiator holding the persistent reservation has exclusive read and write access. Requests from any other initiators to transfer data to or from the logical unit will result in a Reservation Conflict.
- 6h – Exclusive Access, Registrants Only – Any currently registered initiator has exclusive data transfer access. Requests from unregistered initiators to transfer data to or from the logical unit will result in a Reservation Conflict.

PERSISTENT RESERVE OUT (5Fh)

The library will perform service actions relative to persistent reservations as requested. This includes creating and clearing reservations.

Usage

This command is used in conjunction with PERSISTENT RESERVE IN to manage persistent reservations. It can be used to request exclusive access to the device. The PERSISTENT RESERVE IN and PERSISTENT RESERVE OUT commands should not be used with the RESERVE ELEMENT (6) and RELEASE ELEMENT (6) commands.

CDB Format

The PERSISTENT RESERVE OUT CBD format is shown in Table 37.

Table 37. PERSISTENT RESERVE OUT CDB

Bits / Bytes	7	6	5	4	3	2	1	0
0	Op Code (5Fh)							
1	Logical Unit Number			Service Action				
2	Scope				Type			
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7-8	Parameter List Length (18h)							
9	Control							

Parameters

Service Action

This field specifies what reservation action to take as follows:

- 00h Register – Register a reservation key without making a reservation.
- 01h Reserve – Create a persistent reservation of the specified scope and type.
- 02h Release – Releases the selected reservation for the requesting initiator.
- 03h Clear – Clears all reservations keys and all persistent reservations.
- 04h Preempt – Preempt reservations keys from another initiator.
- 05h Preempt and Abort – Preempt reservations from another initiator and abort all tasks for all initiators with the specified reservation key.
- 06h Register and Ignore Existing Key – Register a new reservation key and discard the existing reservation key.

Scope Only logical unit scope is supported, and this field must be set to 0h.

Type This field specifies the type of reservation as follows:

- 3h Eclusive Access – The initiator holding the persistent reservation has exclusive read and write access. Requests from any other initiators to transfer data to or from the logical unit will result in a Reservation Conflict.
- 6h Exclusive Access, Registrants Only – Any currently registered initiator has exclusive data transfer access. Requests from unregistered initiators to transfer data to or from the logical unit will result in a Reservation Conflict.

Parameter List Length

This field returns 18h (24) to indicate the length of the PERSISTENT RESERVE OUT parameter list, which is shown in Table 38.

Table 38. PERSISTENT RESERVE OUT parameter list

Bits / Bytes	7	6	5	4	3	2	1	0
0	Reservation Key							
:								
7								
8	Service Action Reservation Key							
:								
15								
16	Scope-specific Address							
:								
19								
20	Reserved							APTPL
21	Reserved							
22	Obsolete							
23								

Reservation Key

This is an 8-byte reservation key that identifies the initiator.

Service Action Reservation Key

This field applies to the following service actions only, as follows:

- Register – This is a new reservation key to register.
- Register and Ignore Existing Key – This is the new reservation key to register.
- Preempt – This is the reservation key of the persistent reservation to preempt.
- Preempt and Abort – This is the reservation key of the persistent reservation to preempt.

Scope-specific Address

Element reservations are not supported, and this field must be 0000h.

Activate Persist Through Power Loss (APTPL)

Persistent reservations are not supported across cycles, so this field must be 0.

POSITION TO ELEMENT (2Bh)

The library will move the picker in front of the specified element.

Usage

This command can be used to pre-position the robotics to an element to enhance performance, or it can be used as a general-purpose way to relocate the robotics without involving media movement. This might be useful for diagnostic or demonstration purposes.

Parameters

The POSITION TO ELEMENT CDB format is shown in Table 39.

Table 39. POSITION TO ELEMENT CDB

Bits / Bytes	7	6	5	4	3	2	1	0
0	Op Code (2Bh)							
1	Logical Unit Number			Reserved				
2 : 3	MSB Medium Transport Element Address LSB							
4 : 5	MSB Destination Element Address LSB							
6 : 7	Reserved							
8	Reserved							Invert
9	Control							

Medium Transport Element Address
This field contains the address of the Medium Transport element to position. A value of 0001h is the address of the Medium Transport element, but a value of 0000h is also supported (which selects the default Medium Transport element).

Destination Element Address
This field contains the element address of the target to position to. It can be a storage, data transfer, or import/export element.

Invert This field must be set to 0.

PREVENT/ALLOW MEDIUM REMOVAL (1Eh)

The library will prohibit movement of media to an Import/Export element when media removal has been prevented. MOVE MEDIUM commands requesting such a move will be rejected with a Check Condition indicating Medium Removal Prevented. This command does not control locking or unlocking of a mailbox. The library automatically locks mailboxes during robotic access, and unlocks them afterwards.

While media removal is prevented, importing of media can still occur. The medium removal setting does not persist across power cycles of the library.

Any initiator issuing this command to allow medium removal (Prevent set to 00b) will allow medium removal for all initiators. This is done to maintain compatibility with certain bridged environment behavior (e.g., Fibre Channel to Parallel SCSI).

Usage

In conjunction with keyed access to the physical library doors, this command can be used to secure the library against unauthorized removal of media.

CDB Format

Table 40 shows The PREVENT/ALLOW MEDIUM REMOVAL CDB format.

Table 40. PREVENT/ALLOW MEDIUM REMOVAL CDB

Bits / Bytes	7	6	5	4	3	2	1	0
0	Op Code (1Eh)							
1	Logical Unit Number			Reserved				
2	Reserved							
3	Reserved							
4	Reserved							Prevent
5	Control							

Parameters

Prevent

This field controls medium removal as follows:

00b Allow medium removal

01b Prohibit medium removal

10b Not supported

11b Not supported

READ BUFFER (3Ch)

The library will return a requested buffer of data. The Media Changer logical unit supports the echo buffer mode only.

Usage

This command can be used primarily for enhanced domain validation. The initiator can use Descriptor mode first to determine the size of the data available to read, followed by Data mode to then read it. Depending on the size of the requested buffer, it can also be retrieved in blocks, utilizing offsets into the buffer.

CDB Format

The READ BUFFER CDB format is shown in Table 41.

Table 41. READ BUFFER CDB

Bits / Bytes	7	6	5	4	3	2	1	0
0	Op Code (3Ch)							
1	Logical Unit Number			Reserved		Mode		
2	Buffer ID							
3 : 5	MSB Buffer Offset LSB							
6 : 8	MSB Allocation Length LSB							
9	Control							

Parameters

The function of this command and the meaning of fields within the command descriptor block depend on the contents of the mode field.

Mode The supported modes are:

- Ah - Echo Buffer
- Bh - Echo Buffer Descriptor

Echo Buffer Mode

In Echo Buffer Mode, data is transferred to the initiator from the echo buffer. The echo buffer will transfer the same data that was received from the last WRITE BUFFER command sent with Echo Buffer Mode. If the allocation length is insufficient to accommodate the number of bytes of data as received in the prior echo buffer mode WRITE BUFFER command, the returned data will be truncated. This is not considered an error. If a prior echo buffer mode WRITE BUFFER command was not successfully completed, the echo buffer mode READ BUFFER will return a Check Condition, with a Sense Key of Illegal Request and additional sense code of Command Sequence Error. The data may be read from the echo buffer multiple times.

Echo Buffer Descriptor Mode
In Echo Buffer Descriptor Mode, a maximum of four bytes of READ BUFFER descriptor information is returned for the echo buffer. The Buffer Offset field is reserved in this mode. The allocation length should be set to at least four for this mode.

Buffer ID
This field specifies which buffer the request is for. The IDs are the same for both the READ BUFFER and WRITE BUFFER commands.

Descriptor Mode can be used to determine the size or capacity of a given
6 buffer. No Buffer IDs are supported at this time.

Buffer Offset
This field contains the byte offset within the specified buffer from which data shall be transferred. The initiator should conform to the offset boundary requirements returned in the READ BUFFER descriptor described in "Read Buffer Response. "

Allocation Length
In Data Mode, this field should be set to accommodate the amount of data being requested for return. In Descriptor Mode, this field should be set to at least four.

Response

Read Buffer Response

In Data Mode, the requested buffer is returned per the buffer offset and allocation length.

In Descriptor Mode, a buffer descriptor is returned as shown in the following table:

Table 42. Read Buffer Response

Bits / Bytes	7	6	5	4	3	2	1	0
0	Offset Boundary							
1 : 3	Buffer Capacity							

Offset Boundary
This field returns the boundary alignment (byte boundary) within the selected buffer for subsequent READ BUFFER commands. The value contained in this field is interpreted as a power of two.

Therefore, the value contained in the Buffer Offset field of subsequent READ BUFFER commands should be a multiple of $2^{\text{offset boundary}}$ as shown in the following table.

Table 43. Offset Boundary

Offset Boundary	$2^{\text{offset boundary}}$	Buffer Offsets
0h	$2^0 = 1$	Byte boundaries
1h	$2^1 = 2$	Even-byte boundaries
2h	$2^2 = 4$	Four-byte boundaries

Table 43. Offset Boundary (continued)

Offset Boundary	$2^{\text{offset boundary}}$	Buffer Offsets
3h	$2^3 = 8$	Eight-byte boundaries
4h	$2^4 = 16$	16-byte boundaries
...	...	Etc.
FFh	Not applicable	0 is the only supported buffer offset.

Buffer Capacity

This field returns the size of the requested buffer in bytes.

The Return Buffer stops being filled when the number of allocation length bytes has been transferred or when all the available data from the buffer has been transferred, whichever amount is less. This holds true for either mode.

READ ELEMENT STATUS (B8h)

The library returns current status and information regarding the requested elements. The data is primarily derived from having done an Inventory operation (using INITIALIZE ELEMENT STATUS or INITIALIZE ELEMENT STATUS WITH RANGE), but in the case of data transfer elements is also augmented by communication with the drives. Element status remains valid as long as the subsystem integrity has not been breached, such as by opening a door or through a power cycle.

Element status will be reported for all elements, including those represented by only a placeholder, as in the case of uninstalled drives or magazines that physically have a place reserved in the configuration. As such, it is important to process the fields governing accessibility and exception conditions.

Usage

This command should be issued whenever new element status information is needed, or the library has indicated that status may have changed. If the status information is suspect, an INITIALIZE ELEMENT STATUS WITH RANGE command should be issued to refresh it.

CDB Format

The Read Element Status CDB format is shown in Table 44.

Table 44. Read Element Status CDB

Bits / Bytes	7	6	5	4	3	2	1	0
0	Op Code (B8h)							
1	Logical Unit Number			VolTag	Element Type Code			
2 : 3	MSB Starting Element Address LSB							
4 : 5	MSB Number of Elements LSB							
6	Reserved						CurData	DVCID
7 : 9	MSB Allocation Length LSB							
10	Reserved							
11	Control							

Parameters

VolTag (Volume Tag)

This field indicates whether the volume tag (bar code label) information should be returned. A value of 1 will return the labels, a value of 0 will not.

Element Type Code

This field specifies the element types selected for the returned information, as shown in Table 45.

Table 45. Element Type Code

Code	Selected Element Type
0000b (0)	All element types reported
0001b (1)	Medium Transport Element (Accessor)
0010b (2)	Storage Element
0011b (3)	Import/Export Element
0100b (4)	Data Transfer Element (drives)

Starting Element Address

This field specifies the minimum element address to report. Only elements with an element type code specified by the Element Type Code field, and with an address greater than or equal to the starting element address will be reported. The starting element address must be a valid element address, but not have to be within the range specified by the Element Type Code field.

Number of Elements

This field specifies the maximum number of element descriptors to return. Only those descriptors that can be completely transferred within the allotted allocation length will be returned.

CurData (Current Data)

This field is ignored (although the library will not cause device motion to report element status).

DVCID (Device ID)

This field indicates whether device identifiers (inquiry page information or serial numbers) are returned for the specified range. Identifiers are returned if this field is set to 1. They are not returned if this field is set to 0. Only data transfer elements can return device identifiers.

Allocation Length

This field specifies the byte length allowed for returned element descriptors. Only complete element descriptors are returned. The library returns element descriptors until one of the following conditions are met:

- All available element descriptors have been returned.
- The number of element descriptors specified in the Number of Elements field have been returned.
- The number of bytes specified in the Allocation Length field have been returned.
- There is less allocation length space available than is required by the next complete element descriptor.

Response

Read Element Status Response

Element status data consists of an eight-byte header, followed by one or more element status pages (per element type). Each element status page consists of a header, followed by one or more element descriptor blocks. A complete response then looks like:

```
Element Status Header
  Element Status Page Header (first element type)
    Element Descriptor
    ...(more descriptors)...
    Element Descriptor
  ...(more status pages)...
  Element Status Page Header (next element type)
    Element Descriptor
    ...
    Element Descriptor
```

There are only up to four Element Status Pages, one for each element type.

Element Status Header: One header is returned for each READ ELEMENT STATUS command. The format is shown in Table 46.

Table 46. Element Status header

Bits / Bytes	7	6	5	4	3	2	1	0
0	MSB							
:	First Element Address Reported							
1								LSB
2	MSB							
:	Number of Elements Available							
3								LSB
4	Reserved							
5	MSB							
:	Byte Count of Report Available							
7								LSB

First Element Address Reported
This field indicates the lowest element address found that meets the CDB request.

Number of Elements Reported
This field indicates the number of elements found that meet the CDB request.

Byte Count of Report Available
This field indicates the number of available element status bytes that meet the CDB requirements. The value does not include the eight -byte element status header, and is not adjusted to match the value specified in the Allocation Length field of the CDB. This facilitates first issuing a READ ELEMENT STATUS command with an allocation length of eight bytes in order to determine the allocation length required to transfer all the element status data specified by the command.

Element Status Page: Each element status page consists of an eight -byte header, followed by one or more element descriptor blocks. One Element Status Page header is returned for each grouping of element descriptor blocks, by element type. The format of the Element Status Page header is shown in Table 47 on page 55.

Table 47. Element Status Page format

Bytes \ Bits	7	6	5	4	3	2	1	0
0	Element Type Code							
1	PVolTag	AVolTag	Reserved					
2	MSB							
:	Element Descriptor Length							
3								LSB
4	Reserved							
5	MSB							
:	Byte Count of Descriptor Data Available							
7								LSB

Element Type Code
This field indicates the specific element type being returned by the element descriptor.

PVolTag (Primary Volume Tag)
A value of one indicates that the primary volume tag field (barcode label) is present in each of the element descriptor blocks that follow. A value of zero indicates that they are not present.

AVolTag (Alternate Volume Tag)
Alternate Volume Tags are not supported. The returned value for this field is 0, and the alternate volume tag fields are omitted from the element descriptors.

Element Descriptor Length
This field indicates the number of bytes contained in a single element descriptor. Refer to the individual element descriptor descriptions for each element type for their respective possible lengths.

Byte Count of Descriptor Data Available
This field indicates the number of element descriptor data bytes available for the elements of this element type that meet the CDB requirements. This value represents the Element Descriptor Length field multiplied by the number of element descriptors for this element type. This value does not include the 8-byte Element Status Page header, nor is it adjusted to match the allocation length.

Element Descriptors

The following sections contain the field definitions for the following element descriptors:

- Medium transport element: accessor
- Storage elements: storage cells
- Import/Export elements: each I/O station cell
- Data transfer elements: each tape drive

Each element descriptor includes the element address, status flags, source storage element address, and barcode label. Some descriptors also contain extended status information. Additional sense code and qualifier information depends on the element type.

Primary Volume Tag Field

Volume tags (returned in the Primary Volume Tag field) are basically barcode labels on the media. The library supports labels from 5 to 16 characters in length. The Primary Volume Tag field contains 32 bytes of label data (space filled to 32 bytes), followed by two reserved bytes, then two bytes of volume sequence number. The library returns zeros for the last four bytes of Primary Volume Tag data.

If the user has configured the library to support media identification, media identifiers will be reported as found on the barcode labels as part of the volume tag. If this feature is not enabled, any media identifiers found will not be reported.

Medium Transport Element Descriptor

Table 48 shows the Medium Transport Element Descriptor format.

Table 48. Medium Transport Element Descriptor format

Bits / Bytes	7	6	5	4	3	2	1	0
0 : 1	MSB Element Address LSB							
2	Reserved					Except	Reserved	Full
3	Reserved							
4	Additional Sense Code							
5	Additional Sense Code Qualifier							
6 : 8	Reserved							
9	SValid	Invert	Reserved					
10 : 11	MSB Source Storage Element Address LSB							
12 : 47	Primary Volume Tag Information (Field omitted if PVolTag = 0; remaining fields move up)							
48 : 51	Reserved							

Element Address
This field contains the element address of the accessor.

Except This field is set to 1 if the element is in an abnormal state. Additional information will be available in the Additional Sense Code and Additional Sense Code Qualifier fields. This field is set to 0 if the element is in a normal state.

Full This field is set to 0 if the element does not contain media. It is set to 1 if it does. Since the medium transport element cannot be a destination element,

this field should normally return 0. There may be error situations where media is left in the picker, which would be indicated by this field. In the case of dual pickers, differentiation of state will be provided through the Additional Sense Code and Additional Sense Code Qualifier fields when exception conditions are present (such as stranded media).

Additional Sense Code
If the element is in an abnormal state (no error or exception associated with it), this field will be set to a value as described in Table 56 on page 69.

Additional Sense Code Qualifiers
If the element is in an abnormal state, this field will be set to a value as described in Table 56 on page 69.

SValid (Source Valid)
This field is set to 1 if the Source Storage Element Address field is valid, otherwise it is set to 0.

Invert This field is set to 0. The library does not support inverting media.

Source Storage Element Address
If the Source Valid field is set to 1, this field will contain the element address of the last storage element the media was in. Since the medium transport element cannot be a destination element, this would be an abnormal condition.

PVolTag (Primary Volume Tag)

This field will normally return spaces if the primary volume tag is requested, since the medium transport element cannot be a destination element. In certain error situations, a volume tag will be returned to indicate which cartridge may be stranded within the picker.

Storage Element Descriptor

Table 49 shows the format of the Storage Element Descriptor.

Table 49. Storage Element Descriptor format

Bits / Bytes	7	6	5	4	3	2	1	0
0 : 1	MSB Element Address LSB							
2	Reserved				Access	Except	Reserved	Full
3	Reserved							
4	Additional Sense Code							
5	Additional Sense Code Qualifier							
6 : 8	Reserved							
9	SValid	Invert	Reserved					
10 : 11	MSB Source Storage Element Address LSB							
12 : 47	Primary Volume Tag Information (Field omitted if PVolTag = 0; remaining fields move up)							
48 : 51	Reserved							

Element Address
This field contains the element address of the storage element.

Access
This field is set to 1 if access by a medium transport element is allowed. It is set to 0 if access is denied.

Except This field is set to 1 if the element is in an abnormal state. Additional information may be available in the Additional Sense Code and Additional Sense Code Qualifier fields. If this field is 1, the primary volume tag information could be invalid. This field is set to 0 if the element is in a normal state.

Full This field is set to 0 if the element does not contain media. It is set to 1 if it does.

Additional Sense Code (ASC)
If the element is in an abnormal state, this field will be set to a value as described in Table 56 on page 69.

Additional Sense Code Qualifier (ASCQ)
If the element is in an abnormal state, this field will be set to a value as described in Table 56 on page 69.

SValid (Source Valid)
This field is set to 1 if the Source Storage Element Address field is valid, otherwise it is set to 0.

Invert This field is set to 0. The library does not support inverting media.

Source Storage Element Address
If the Source Valid field is set to 1, this field will contain the element address of the last storage element the media was moved from. It may be the same as this element.

Primary Volume Tag Information

If requested, this field contains the volume tag (bar code label) information for media residing in this element address. Five to sixteen character barcode labels are supported.

Import/Export Element Descriptor

Table 50 shows the format of the Import/Export Element Descriptor.

Table 50. Import/Export Element Descriptor

Bytes \ Bits	7	6	5	4	3	2	1	0
0 : 1	MSB Element Address LSB							
2	Reserved		InEnab	ExEnab	Access	Except	Imp/Exp	Full
3	Reserved							
4	Additional Sense Code							
5	Additional Sense Code Qualifier							
6 : 8	Reserved							
9	SValid	Invert	Reserved					
10 : 11	MSB Source Storage Element Address LSB							
12 : 47	Primary Volume Tag Information (Field omitted if PVolTag = 0; remaining fields move up)							
48 : 51	Reserved							

Element Address
This field contains the element address of the import/export element.

InEnab (Import Enable)
A value of one indicates that the element supports movement of media into the scope of the Media Changer device. A value of zero indicates that this element does not support import actions. The library returns a value of one for all import/export elements.

ExEnab (Export Enable)
A value of one indicates that the element supports movement of media out of the scope of the Media Changer device. A value of zero indicates that this element does not support export actions. The library returns a value of one for all import/export elements.

Access
This field is set to 1 if access by a medium transport element is allowed. It is set to 0 if access is denied.

Imp/Exp (Import/Export)
A value of one indicates that media present in the element was placed there by an operator. A value of zero indicates that media present in the element was placed there by a medium transport element.

Full This field is set to 0 if the element does not contain media. It is set to 1 if it does.

Additional Sense Code
If the element is in an abnormal state, this field will be set to a value as described in Table 56 on page 69.

Additional Sense Code Qualifier
If the element is in an abnormal state, this field will be set to a value as described in Table 56 on page 69.

Svalid (Source Valid)
This field is set to 1 if the Source Storage Element Address field is valid, otherwise it is set to 0.

Invert This field is set to 0. The library does not support inverting media.

Source Storage Element Address
If the Source Valid field is set to 1, this field will contain the element address of the last storage element the media was moved from. It may be the same as this element.

Primary Volume Tag
If requested, this field contains the volume tag (bar code label) information for media residing in this element address. Five to sixteen character barcode labels are supported.

Data Transfer Element Descriptor Page

Table 51 shows the format of the Data Transfer Element Descriptor page.

Table 51. Data Transfer Element Descriptor page format

Bytes \ Bits	7	6	5	4	3	2	1	0
0 : 1	MSB Element Address LSB							
2	Reserved				Access	Except	Reserved	Full
3	Reserved							
4	Additional Sense Code							
5	Additional Sense Code Qualifier							
6	NotBus	Reserved	IDValid	LUValid	Reserved	Logical Unit Number		
7	SCSI Bus Address							
8	Reserved							
9	SValid	Invert	Reserved					
10 : 11	MSB Source Storage Element Address LSB							
12 : 47	Primary Volume Tag Information (Field omitted if PVolTag = 0; remaining fields move up)							
48	Reserved				Code Set			
49	Reserved				Identifier Type			
50	Reserved							
51	Identifier Length = *x*; where *x* is 0h to 40h (valid identifier data)							
52 : 115	Device Identifier Field omitted if DVCID=0; remaining fileds move up (Always padded to 64 byte length if DVCID=1)							

Element Address
This field contains the element address of the storage element.

Access
This field is set to 1 if access by a medium transport element is allowed. It is set to 0 if access is denied. When set to 1, it implies that cartridges are unloaded and accessible if present. When set to 0, it implies that cartridges are not unloaded if present.

Except This field is set to 1 if the element is in an abnormal state. Additional information may be available in the Additional Sense Code and Additional Sense Code Qualifier fields. If this field is 1, the primary volume tag information could be invalid. This field is set to 0 if the element is in a normal state.

Full This field is set to 0 if the element does not contain media. It is set to 1 if it does.

Additional Sense Code (ASC)
If the element is in an abnormal state, this field will be set to a value as described in "Additional Sense Codes and Qualifiers."

Additional Sense Code Qualifier (ASCQ)
If the element is in an abnormal state, this field will be set to a value as described in "Additional Sense Codes and Qualifiers."

NotBus
This field is not supported and is set to 0.

IDValid
A value of one indicates that the SCSI Bus Address field is valid. A value of zero indicates that it is not.

LUValid
This field is not supported and is set to 0.

Logical Unit Number
This field is not supported and is set to 0.

SCSI Bus Address
When the IDValid field is set to one, this field contains the tape drive SCSI address. This is only applicable to SCSI tape drives, and does not apply to Fibre Channel tape drives.

Svalid (Source Valid)
This field is set to 1 if the Source Storage Element Address field is valid, otherwise it is set to 0.

Invert This field is set to 0. The library does not support inverting media.

Source Element Address
If the Source Valid field is set to 1, this field will contain the element address of the last storage element the media was moved from.

Primary Volume Tag Information
If requested, this field contains the volume tag (bar code label) information for media residing in this element address. Five to sixteen character barcode labels are supported.

Code Set
This field is set to:

- 0h – RESERVED.
- 1h – The device identifier field contains binary values.
- 2h – The device identifier field contains ASCII values.

Identifier Type
This field is set to:

- 0h – The Device Identifier, if the Identifier Length is set, lists the vendor specific device serial number only.
- 1h – The Device Identifier lists the eight-byte Vendor ID, followed by vendor specific unique identifier information.
- 2h – The Device Identifier contains a Canonical form of IEEE Extended Unique Identifier, 64- bit (EUI-64). In this case, the Identifier Length field is set to 8.
- 3h – The Device Identifier contains an FC-PH Name_identifier.

Identifier Length
This field contains the length in bytes of valid Device Identifier information. If no device identifier is available, or the DVCID bit in the

CDB is zero, the Identifier Length field is 0h and the Code Set and Identifier Type fields are also 0h. If the DCVID bit is set, the Identifier Length may be set between 0 and 64 (40h) bytes, depending on the associated drive type..

Device Identifier

This field provides up to 64 bytes of device identifier information for the device associated with the data transfer element. The format is Identifier Type 1, which is equivalent to the drive's Inquiry page 83h. The Identifier Length specifies the length of valid device identifier information. If the DVCID bit in the CDB is zero, this field is omitted. The Device Identifier field is padded with ASCII character 20h (space) to fill the complete 64 bytes. If the DVCID bit is set and the Identifier Length is 0, this field will still be 64 bytes long.

RELEASE ELEMENT 6 (17h)

The library releases any outstanding reservation that had previously been made by the same initiator via the RESERVE command. Only whole logical unit reservations are allowed; individual element reservations are not supported.

Usage

This command should be used to release the library from any reservations previously made.

CDB Format

8 The RELEASE ELEMENT 6 CDB format is shown in Table 52.

Table 52. RELEASE ELEMENT 6 CDB

Bits / Bytes	7	6	5	4	3	2	1	0
0	Op Code (17h)							
1	Logical Unit Number			3rdPty	Third Party Device ID			Element
2	Reservation ID							
3 : 4	Reserved							
5	Control							

Parameters

3rdPty
This field is not supported, and the value must be set to 0.

Third Party Device ID
This field is not supported, and the value must be set to 0.

Element
This field is not supported, and the value must be set to 0.

Reservation ID
This field is not supported, and the value must be set to 0.

REQUEST SENSE (03h)

The library returns eighteen bytes of sense data to the requesting initiator. The data is preserved until either the REQUEST SENSE command or any other command is received. The library can queue multiple Unit Attentions for processing.

Usage

This command should be issued whenever the initiator receives a CHECK CONDITION from the library. It should continue to be issued until all check conditions have been cleared.

CDB Format

The REQUEST SENSE CDB format in shown in Table 53.

Table 53. REQUEST SENSE CDB

Bits / Bytes	7	6	5	4	3	2	1	0
0	Op Code (03h)							
1	Logical Unit Number			Reserved				
2	Reserved							
3	Reserved							
4	Allocation Length							
5	Control							

Parameters

Allocation Length

This field specifies the number of sense bytes requested by the initiator.

Response

Request Sense Response

The sense data format is shown in Table 54 on page 67.

Table 54. Sense Information Format

Bits / Bytes	7	6	5	4	3	2	1	0
0	Valid	Response Code (70h)						
1	Reserved							
2	Reserved				Sense Key			
3 : 6	MSB Information LSB							
7	Additional Sense Length (OAh)							
8 : 11	MSB Command Specific Information (0000 0000h) LSB							
12	Additional Sense Code (ASC)							
13	Additional Sense Qualifier (ASCQ)							
14	Field Replaceable Unit Code							
15	SKSV	C/D	Reserved	Reserved	BPV	Bit Pointer		
16 : 17	MSB Field Pointer LSB							

Valid The Valid field is set to 0 if the Information field is not valid. It is set to 1 if the Information field contains valid additional data as described below.

Response Code

The Response Code field is set to 70h to indicate that the library returns current errors.

Sense Key

The Sense Key values are shown in Table 55.

Table 55. Sense Keys

Sense Key	Description
0h	No Sense. No specific sense key information to report.
2h	Not Ready. The library is not ready to perform motion commands.
4h	Hardware Error. A hardware error was detected and operator intervention may be required.
5h	Illegal Request. The CDB or supplied parameter data contains an unsupported or illegal parameter.
6h	Unit Attention. The library operating status changed. Additional processing may be required.
Bh	Aborted Command . The library aborted the command.

Information

This field returns additional information for certain ASC/ASCQs where a specific device must be identified and the sense data is associated with a Unit Attention condition instead of a specific command. These are described as follows:

- If the ASC/ASCQ is related to Import/Export stations, then byte 6 indicates which I/O station it pertains to (1 to 4).
- If the ASC/ASCQ is related to a specific Data Transfer Element, then bytes 5 and 6 contain the element address of that element.
- If the ASC/ASCQ is related to Towers, then byte 6 indicates which Tower it pertains to (1 to n).

Additional Sense Length
This field specifies the number of additional sense bytes that follow this field, and returns 0Ah (10).

Command Specific Information
This field is not supported and returns 0000 0000h.

Additional Sense Code (ASC)
This field denotes a specific error condition. Additional information is provided in the Additional Sense Code Qualifier (ASCQ) field. Table 56 on page 69 lists all the codes.

Additional Sense Code Qualifier (ASCQ)
This field provides additional information for the ASC. Refer to Table 56 on page 69 for more information.

Field Replaceable Unit Code
This field is not used and returns zero.

SKSV (Sense Key Specific Value)
This field returns a value of 1 if bytes 15-17 contain valid data for a Sense Key of Illegal Request (05h). Otherwise this field returns 0.

C/D (Command/Data)
A value of 1 indicates that the illegal parameter was detected in the CDB. It returns 0 if the illegal parameter was detected in the data parameters. This field only applies if SKSV is 1.

BPV (Bit Pointer Valid)
A value of 0 indicates that the Bit Pointer field is not valid. A value of 1 indicates that the Bit Pointer field is valid. This field only applies if SKSV is 1.

Bit Pointer
This field indicates which bit of the byte designated by the field pointer is in error. For a multi-bit field, it points to the most significant bit of the field. This field only applies if SKSV is 1.

Field Pointer
This field indicates which byte of the CDB or Parameter List (starting with byte zero) was in error. For a multi-byte field, the Field Pointer points to the most significant byte. This field only applies if SKSV is 1.

Returned Error Codes
Table 56 on page 69 lists the Additional Sense Codes (ASC) and Additional Sense Code Qualifiers (ASCQ) associated with particular Sense Keys.

Additional Sense Codes and Qualifiers (ASC/ASCQ)

Table 56 on page 69 lists the Additional Sense Codes (ASC) and Additional Sense Code Qualifiers (ASCQ) associated with the reported Sense Keys. A sense key of 00h (no sense) has no ASC/ASCQ associated with it. A few ASC/ASCQs can be associated with more than one sense key.

Table 56. Additional Sense Codes and Qualifiers

ASC	ASCQ	Sense Key	Description
00h	00h	00h	No Additional Sense Code.
04h	00h	02h	The library is not ready due to an unknown cause.
	01h		The library is becoming ready.
	03h		The library is not ready and a manual intervention is required.
	83h		The library is not ready due to aisle power being disabled.
	8Dh		The library is not ready because it is offline.
08h	01h	0Bh	LU Communication - Timeout
	80h		SCSI failure
	82h		SCSI command execution or queuing failure
	83h		SCSI command failed
	84h		SCSI time-out
	85h		SCSI autosense failed
	86h		SCSI aborted
	87h		SCSI abort failed
	88h		SCSI status failed
	B0h		FC data underrun
	B1h		FC DMA error
	B2h		FC reset
	B3h		FC data overrun
	B4h		FC queue full
	B5h		Port unavailable
	B6h		Port logged out
	B7h		Port configuration changed
15h	01h	04h	A mechanical positioning error occurred.
1Ah	00h	05h	Parameter list length error
1Bh	00h	0Bh	Synchronous data transfer error
20h	00h	05h	Illegal opcode in CDB.
21h	01h		Invalid element address in CDB.
24h	00h		Invalid field in CDB.
25h	00h		Illegal LUN.
26h	00h		Invalid field in Parameter List.
	04h		Invalid release of persistent reservation

Table 56. Additional Sense Codes and Qualifiers (continued)

	28h	00h	06h	Not Ready to Ready change, door(s) opened and closed.
		01h		I/O station opened and closed.
	29h	00h		Power on, SCSI bus reset, or Bus device reset occurred.
		01h		Power on occurred
		04h		Internal reset occurred
	2Ah	01h		Mode parameters have been changed.
		03h		Reservations preempted
		04h		Reservations released
		05h		Registrations preempted
	2Ch	00h	05h	Command sequence error
	30h	00h		Incompatible media installed.
	39h	00h		Saving parameters not supported
	3Bh	0Dh	04h, 05h	The destination element is full.
		0Eh		The source element is empty.
		12h	05h	Media magazine not installed.
		A0h		Media type does not match destination media type
6	3Eh	00h	02h	Logical Unit has not self-configured yet
8	3Fh	01h	06h	New firmware loaded
		0Fh	04h	Echo buffer overwritten
	40h	80h	04h	Component failure.
	43h	00h	0Bh	Message error
	44h	00h	04h, 0Bh	Firmware detected an internal logic failure.
	45h	00h	0Bh	Select or reselected failure
	47h	00h	0Bh	SCSI parity error
	48h	00h	0Bh	Initiator detected error message received
	49h	00h	0Bh	Invalid message error
	4Ah	00h	0Bh	Command phase error
	4Bh	00h	0Bh	Data phase error
	4Eh	00h	0Bh	Overlapped commands attempted
	53h	00h	04h	A drive did not load or unload a tape.
8		01h	04h,05h	A drive did not unload a cartridge.
8		02h	05h	Medium removal prevented.
		81h		I/O Station door is open.
		82h	04h	Cannot lock the I/O Station.
		83h		Cannot unlock the I/O Station.

Table 56. Additional Sense Codes and Qualifiers (continued)

83h	00h	04h	Label too short or too long.
	02h	05h	Barcode label questionable
	03h		Cell status and bar code label questionable.
	04h		Data transfer element not installed.
	05h		Data transfer element is varied off and not accessible for library operations.
	06h		Element is contained within an offline tower or I/O Station and is not accessible for library operations.

RESERVE ELEMENT 6 (16h)

The library reserves the entire library for the initiator making the request. Only whole logical unit reservations are allowed; individual element reservations are not supported. The reservation remains in effect until either the initiator that made the reservation sends a RELEASE command, or a reset or powercycle of the library occurs.

Usage

This command should be used to reserve the library for extended operations, such as issuing a SEND VOLUME TAG followed by a REQUEST VOLUME ELEMENT ADDRESS sequence. Initiators issuing a RESERVE should follow it with a RELEASE when the extended operation sequence is complete.

CDB Format

Table 57. RESERVE ELEMENT 6 CDB

Bits / Bytes	7	6	5	4	3	2	1	0
0	Op Code (16h)							
1	Logical Unit Number			3rdPrty	Third Party Device ID			Element
2	Reservation Identification							
3 : 4	MSB Reserved LSB							
5	Control							

Parameters

3rdPrty
This field is not supported, and must be set to 0.

Third Party Device ID
This field is not supported, and must be set to 0.

Element
This field is not supported, and must be set to 0.

Reservation ID
This field is not supported, and must be set to 0.

SEND DIAGNOSTIC (1Dh)

If the Self Test option is requested, the library executes a pre-defined diagnostic.

Usage

This command can be used to verify the operational status of the library and its components.

CDB Format

The SEND DIAGNOSTIC CDB format is shown Table 58.

Table 58. Send Diagnostic CDB

Bits / Bytes	7	6	5	4	3	2	1	0
0	Op Code (1Dh)							
1	Logical Unit Number			PF	Reserved	Self Test	DevOfl	UnitOfl
2	Reserved							
3	MSB							
:	Parameter List Length							
4								LSB
5	Control							

Parameters

PF (Page Format)
Diagnostic pages are not supported and this field should be set to 0.

SelfTest
When set to 1 the library will perform a predefined self-test. The SEND DIAGNOSTIC command will not return until this completes, and command completion status will indicate the results of this test. When set to 0, the self-test is not performed.The Self Test performs the following tests:

DevOfl (Device Offline)
This field is not supported and should be set to 0.

UnitOfl (Unit Offline)
This field is not supported and should be set to 0.

Parameter List Length
This field is not supported and should be set to 0.

TEST UNIT READY (00h)

The library returns status based on its current mode and state. These are defined in Table 59.

Table 59. Mode State Responses

Mode	State	Status
Online	Ready	Good
Online	Not Ready	Check Condition
Offline	Ready	Check Condition
Offline	Not Ready	Check Condition

It will also return any pending Unit Attentions regardless of the current mode and state, to convey changes within the subsystem, such as I/O station accesses, door openings, etc. The various types of Unit Attention conditions are listed in the Request Sense command section in Table 56 on page 69.

Usage

The TEST UNIT READY command allows the initiator to verify that the library is ready to accept commands or perform motion tasks. It is a suitable command for general polling to monitor the library, and receive information via Unit Attentions on any changes within the library.

CDB Format

The TEST UNIT READY CDB format is shown in Table 60.

Table 60. TEST UNIT READY CDB

Bits / Bytes	7	6	5	4	3	2	1	0
0	Op Code (00h)							
1	Logical Unit Number			Reserved				
2	Reserved							
3	Reserved							
4	Reserved							
5	Control							

WRITE BUFFER (3Bh)

The library will receive a requested buffer of data and write it to the appropriate internal storage.

Usage

This command can be used primarily to perform enhanced domain validation (using the echo buffer mode). The initiator can either transfer the data with a single WRITE BUFFER command, or it can also transfer it in blocks utilizing offsets into the buffer.

CDB Format

The WRITE BUFFER CDB format is shown in Table 61.

Table 61. WRITE BUFFER CDB

Bits / Bytes	7	6	5	4	3	2	1	0
0	Op Code (3Bh)							
1	Logical Unit Number			Reserved		Mode		
2	Buffer ID							
3 : 5	MSB … Buffer Offset … LSB							
6 : 8	MSB … Parameter List Length … LSB							
9	Control							

Mode The supported mode is:

- Ah - Echo Buffer

Echo Buffer Mode

In this mode, the amount of data specified by the Parameter List Length is transferred from the initiator to the Echo Buffer. The Buffer ID and Buffer Offset fields are ignored in this mode.

Buffer ID

This field specifies which buffer the request is for. The IDs are the same for both the READ BUFFER and WRITE BUFFER commands.

Buffer Offset

This field indicates the starting location (byte offset) within the specified buffer to write data. The initiator should conform to the offset boundary requirements returned in the READ BUFFER descriptor that is described in the Read Buffer Response.

Parameter List Length

If applicable, this field should be set to indicate the amount of data being written.

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Glossary

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

Numbers

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

IBM TotalStorage 3576 Tape Library. A device that can be attached to a supported server and used to write data to and from magnetic tape. With its robotics, the tape library can process up to 72 tape cartridges each with a capacity of 200 GB and at a data transfer rate of 35 MB per second.

A

A. Ampere.

ac. Alternating current.

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

alternating current (ac). An electric current that reverses its direction at regularly recurring intervals.

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

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

arbitrated loop. See *Fibre Channel arbitrated loop (FC-AL)*.

automatic cleaning. Represented as Auto Clean on the library's operator panel, a function that lets you specify that the library automatically clean the tape drive head with a cleaning cartridge.

B

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

bar code label. A specially coded label that can be affixed to a tape cartridge and which enables a device to identify the cartridge and its volume serial number. 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. In the tape library, a device specialized for scanning and reading bar codes and converting them into either the ASCII or EBCDIC digital character code.

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

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

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 fundamental data unit.

C

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

cartridge. See *tape cartridge*.

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

caster. A wheel mounted in a swivel frame and used for supporting the tape library.

CD. Compact disc.

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

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

cm. Centimeter.

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

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

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

current. The quantity of charge per unit time, measured in Amperes (Amps, A).

D

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

dc. Direct current.

default setting. The value that is assumed when none is explicitly specified.

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.

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

differential . See *High Voltage Differential (HVD)*.

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

disable. To make nonfunctional.

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

drive. See *IBM Ultrium 1 Tape Drive* or *IBM TotalStorage LTO Ultrium 2 Tape Drive*.

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

E

eject. To remove or force out from within.

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

e-mail. See *electronic mail*.

enable. To make functional.

erase. To remove recorded matter from a magnetic tape.

Ethernet. Local area network (LAN) technology that transmits information between computers at speeds of 10 and 100 million bits per second (Mbps).

export. To remove media from the library using the I/O station.

F

failover. The routing of all transactions to a second device when the first device fails.

Fibre Channel. An optics cable utilizing filaments to transmit data.

Fibre Channel arbitrated loop (FC-AL). In this topology, two or more Fibre Channel end points are interconnected through a looped interface. Information is routed through the loop to its destination.

Fibre Channel topologies. Shared loop host and storage controllers.

fiducial. Reference points (such as bar code labels on the library's columns and magazines) that guide the cartridge handling device to the cartridge's location.

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 (servers).

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

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.

G

GB. gigabyte.

GBIC. Gigabit interface converter.

Gbit. gigabit

gigabit (Gbit). 1 000 000 000 bits.

gigabyte (GB). 1 000 000 000 bytes.

gigabit interface converter (GBIC). Converts copper interface to optic interface.

H

head. See *drive head*.

hertz (Hz). A unit of frequency equal to one cycle per second.

High Voltage Differential (HVD). A logic signaling system that enables data communication between a supported server and another device, such as the 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*.

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

HVD. High voltage differential.

Hz. Hertz.

I

IBM TotalStorage LTO Ultrium 2 Tape Drive. A data-storage device that controls the movement of the magnetic tape IBM LTO Ultrium Tape Cartridges. The drive houses the mechanism (drive head) that reads and writes data to the tape. Its native data capacity is 200 GB per cartridge; with 2:1 compression, its capacity is up to 400 GB.

IBM Ultrium 1 Tape Drive. A data-storage device that controls the movement of the magnetic tape in IBM LTO Ultrium Tape Cartridges. The drive houses the mechanism (drive head) that reads and writes data to the tape. Its native data capacity is 100 GB per cartridge; with 2:1 compression, its capacity is up to 200 GB. The drive is also known as the IBM Ultrium Internal Tape Drive.

ID. Identifier.

import. To insert media into the library using the I/O station.

independent software vendor (ISV). A company that makes and sells software products that run on one or more computer hardware or operating system platforms.

insert. Pertaining to the tape library, to place a tape cartridge into a cartridge storage slot in the library.

install. To set up for use or service. 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.

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

inventory. A survey of tape cartridges in the library.

ISV. See *independent software vendor*.

K

kg. Kilogram.

kilogram (kg). One thousand grams (approximately 2.2 pounds).

L

LAN. Local area network.

label. See *bar code label*.

LCD. See *liquid crystal display*.

Linear Tape-Open (LTO). A type of tape storage technology developed by the IBM Corporation, Hewlett-Packard, and Seagate. LTO technology is an "open format" technology, which means that its users will have multiple sources of product and media. The "open" nature of LTO technology enables compatibility between different vendors' offerings by ensuring that vendors comply with verification standards. The LTO technology is implemented in two formats: the Accelis format focuses on fast access; the Ultrium format focuses on high capacity. The Ultrium format is the preferred format when capacity (rather than fast access) is the key storage consideration. An Ultrium cartridge has a compressed data capacity of up to 200 GB (at 2:1 compression) and a native data capacity of up to 100 GB. The Ultrium format is designed with a 4-generation road map that provides for up to 1.6 TB per cartridge (at 2:1 compression) in Generation 4, with compressed transfer rate of up to 320 MB per second.

liquid crystal display (LCD). A low-power display technology used in computers and other I/O devices.

load. Pertaining to the tape library and following the insertion of a tape cartridge into a cartridge storage slot, the act (performed by the picker) 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.

Local area network (LAN). A computer network that spans a relatively small area. Most LANs are confined to a single building or group of buildings.

Low Voltage Differential (LVD). A low-noise, low-power, and low-amplitude electrical signaling system that enables data communication between a supported server and another device such as the tape library. LVD signaling uses two wires to drive one signal over copper wire. The use of wire pairs reduces electrical noise and cross talk. This method of data transmission requires a cable that is no longer than 25 meters (82 ft.).

LTO. Linear Tape-Open.

LVD. Low-voltage differential.

M

m. Meter.

MB. Megabyte.

media. The plural of *medium*.

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

megabyte (MB). 1 000 000 bytes.

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

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

Model L18. One of three versions of the tape library. The Model L18 has a storage capacity of 18 cartridges. Contrast with *Model L36, and Model L72*.

Model L36. One of three versions of the tape library. The Model L36 has a storage capacity of 36 cartridges. Contrast with *Model L18, and Model L72*.

Model L72. One of three versions of the tape library. The Model L72 has a storage capacity of 72 cartridges. Contrast with *Model L18, and Model L36*.

N

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

NVRAM. Non-Volatile Random Access Memory

Non-Volatile Random Access Memory. A type of memory that retains its contents when power is turned off.

O

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

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

operator panel. Located on the front door of the tape library, the functional unit that contains buttons to control the tape library, and an LCD display that provides information about the operation of the library.

P

PDF. Portable Document Format.

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

picker. An electromechanical device located on the picker assembly that moves cartridges between the cartridge storage slots, tape drives, or I/O station.

picker assembly. The mechanism in the Tape Library that moves cartridges between the storage slots, tape drives, and the I/O station. The assembly includes the rotary axis motor, sensors, picker, and bar code reader.

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.

POST. Power-On Self Test.

PostScript. A standard specified by Adobe Systems, Incorporated, that defines how text and graphics are presented on printers and display devices.

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

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

Power-On Self Test (POST). A series of diagnostic tests that are run automatically by a device when the power to that device is turned on.

push buttons. Located below the operator panel of the tape library, 4 buttons that, when pressed, let you interact with the menus on the operator panel.

put. Pertaining to the tape library, to place, by means of a robotic device, a tape cartridge into a storage slot or drive.

R

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

rackmount kit. A packaged collection of articles used to install the rack-mounted version of the tape library.

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

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 Management Unit (RMU). Device that allows user access to the library using a web browser.

remove. Pertaining to the tape library, to take a tape cartridge from a cartridge storage slot.

RMU. Remote management unit.

robotics. The picker and any associated mechanisms that move a tape cartridge within the tape library.

S

SAN. Storage area network

SCSI. Small computer systems interface.

SCSI-2. Small computer systems interface-2.

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 bus cable. See *SCSI bus*.

SCSI cable. See *SCSI bus*.

SCSI commands. An operation performed by a target (tape drive) for an initiator (host). The command is initiated by the operator from the host console.

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 host adapter card. The logic card that connects a host (server) to the SCSI bus cable. Synonymous with *SCSI controller*.

SCSI ID. The hexadecimal representation of the unique address (0-F) which a user assigns to the tape library and which is used in SCSI protocols to identify or select the drive. The user normally assigns and sets the SCSI ID when installing the drive.

seat, seated. (1) To fit to. (2) To ensure that one object is fitted to another object.

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 pSeries, iSeries, HP, and Sun are servers. Synonymous with *host*.

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

Simple Network Management Protocol (SNMP). An agreed-upon format for managing complex networks. SNMP works by sending messages, called protocol data units (PDUs), to different parts of a network. SNMP-compliant devices, called agents, store data about themselves in Management Information Bases (MIBs) and return this data to the SNMP requesters.

sled. Pertaining to a tape library, the enclosure that contains the tape drive.

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 provide for faster data transmission rates than standard serial and parallel ports (up to 160 MB 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.

Small Computer Systems Interface-2 (SCSI-2). See *Small Computer Systems Interface (SCSI)*.

SNMP. Simple Network Management Protocol.

Storage Area Network (SAN). High-speed, open-standard scalable network of storage devices and servers providing accelerated data access.

storage slot. See *cartridge storage slot*.

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 *IBM Ultrium Tape Drive*.

TB. Terabyte.

teach. A process where the bar code reader reads the fiducial labels to identify the types of storage and tape drives installed in the library.

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.

terabyte (TB). 1 000 000 000 000 bytes.

transfer rate. See *data transfer rate*.

trap. An unprogrammed conditional jump to a specified address that is automatically activated by hardware.

U

Ultra SCSI. See *Small Computer Systems Interface (SCSI)*.

Ultra2 SCSI. See *Small Computer Systems Interface (SCSI)*.

Ultrium Tape Drive. See *IBM Ultrium 1 Tape Drive* or *IBM TotalStorage LTO Ultrium 2 Tape Drive*.

unload. Pertaining to the tape library, the act (performed by the tape drive) of rewinding the tape into the cartridge and ejecting it from the drive and the act (performed by the picker) of transferring the cartridge to a cartridge storage slot.

V

V dc. Volts of direct current.

VOLSER. Volume serial number.

volume serial number (VOLSER). A number that a computer assigns to a tape cartridge when it prepares (initializes) the cartridge for use.

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.

voltage. The electric potential or potential difference expressed in volts.

W

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

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

write protected. A tape volume is write protected if some logical or physical mechanism causes the device processing the tape volume to prevent the program from writing on the volume.

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

Index

Special characters

Numerics

A

B

C

E

H

I

L

M

N

P

R

S

T

U

V

W

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SCSI Reference

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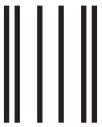

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