SL500
Modular Library System

Bridged Interface Reference Manual

ORACLE

SL500 Modular Library System Bridged Interface Reference Manual

E21065-02

Table of Contents

List of Tables

Preface

Documentation Accessibility

Our goal is to make Oracle products, services, and supporting documentation accessible to all users, including users that are disabled. To that end, our documentation includes features that make information available to users of assistive technology. This documentation is available in HTML format, and contains markup to facilitate access by the disabled community. Accessibility standards will continue to evolve over time, and Oracle is actively engaged with other market-leading technology vendors to address technical obstacles so that our documentation can be accessible to all of our customers. For more information, visit the Oracle Accessibility

Program Web site at http://www.oracle.com/accessibility/.

Accessibility of Code Examples in Documentation

Screen readers may not always correctly read the code examples in this document. The conventions for writing code require that closing braces should appear on an otherwise empty line; however, some screen readers may not always read a line of text that consists solely of a bracket or brace.

Accessibility of Links to External Web Sites in Documentation

This documentation may contain links to Web sites of other companies or organizations that Oracle does not own or control. Oracle neither evaluates nor makes any representations regarding the accessibility of these Web sites.

Deaf/Hard of Hearing Access to Oracle Support Services

To reach Oracle Support Services, use a telecommunications relay service (TRS) to call Oracle Support at 1.800.223.1711. An Oracle Support Services engineer will handle technical issues and provide customer support according to the Oracle service request process.

Information about TRS is available at

http://www.fcc.gov/cgb/consumerfacts/trs.html, and a list of phone numbers is available at http://www.fcc.gov/cgb/dro/trsphonebk.html.

Related Documentation

The following list contains the names and order numbers of publications that provide additional information about `the product`.

The documentation is available online at:

http://docs.sun.com/app/docs/prod`/filename`

and/or

http://docs.sfbay.sun.com/app/docs/prod`/filename`

Function	Title	Part Number
	Hardware Publications	
Installation	xxyyzz Installation Manual	
Hardware	xxyyzz Service Manual	
Safety	Regulatory and Safety Compliance Guides	820-5506-xx 816-7190-12
	Software Publications	
Administrator	aabbcc Administrator Guide	
User	aabbcc User's Guide	

Documentation, Support, and Training

Function	URL
Web Site	http://www.oracle.com/index.html
Documentation	
Customer:	http://docs.sun.com
Employee:	http://docs.sfbay.sun.com/
Partner:	https://spe.sun.com/spx/control/Login
Downloads	
Customer:	http://www.sun.com/download/index.jsp
Employee:	https://dlrequest-zn-dlapps1.sfbay.sun.com/usr/login
Support	http://www.sun.com/support/
Training	http://www.oracle.com/global/us/education/sun_select_country.html
Online Account	https://reg.sun.com/register

1

General Information

This manual describes the SCSI Media Changer (SMC) Command set for Oracle's StorageTek SL500 Modular Library System with a Bridged Interface for Serial Attached SCSI (SAS) and Fibre Channel devices.

A "Bridged" SL500 library uses designated Hewlett-Packard (HP) **LTO-5 or LTO-6 tape drives** as the interface to the library or partition. The tape drive determines the destination for commands based on the Logical Unit Number (LUN) that is sent with the command:

* LUN 0: SCSI Stream Commands processed by the **tape drive**.

* LUN 1: SCSI Media Changer commands that are passed to the **library**.

The library uses one of the following tape drives as the Bridged SCSI interface:

* Fibre Channel (FC) HP LTO-5

* Fibre Channel (FC) HP LTO-6

* Serial Attached SCSI (SAS) HP LTO-5

* Serial Attached SCSI (SAS) HP LTO-6

Serial Attached SCSI

Serial Attached SCSI is a computer bus that moves data to and from devices; for example, tape drives. The SAS interface is a point-to-point serial protocol that uses the standard SCSI command set.

The T10 technical committee of the International Committee for Information Technology Standards (INCITS) develops and maintains the SAS protocol.

Overview

* Serial connection.

* Multiple Initiator Support.

* Gigabit per second data transfer rates.

* Scalable for media rates, distance, media, and protocols.

Components

A typical Serial Attached SCSI system consists of the following basic components:

1. **Initiators:** A device that originates requests for processing by a target.

2. **Targets:** A device (SL500 library tape drives) containing logical units and target ports that receives requests for processing and sends responses to an initiator. The target device for this document is an LTO5 tape drive.

3. **Expanders:** Devices that provide large storage environments the ability to connect multiple targets and initiators through a switched device for scalability and redundancy. SAS benefits include improved performance, simplified cabling with the mini SAS connectors (iPass), and lower power requirements.

The Fibre Channel Standard

The SL500's implementation of Fibre Channel conforms to the American National Standards Institute (ANSI), National Committee for Information Technology Standards (NCITS) formerly X3.

Overview

- Serial connection: Copper (electrical) or Fiber (optical) transmissions

- Multiple Initiator Support

- Information transparent

- 100 MB/s data transfer rates (and higher)

- Scalable for media rates, distance, media, and protocols

Implementation

Library:

- Arbitrated loop

- FCP (SCSI-3) command set for medium changer devices

- Class 3 level of service

- Private Loop operation

- Public Loop operation

- Direct fabric attach operation

- Hard-assigned port addresses (AL-PA)

- Basic and extended link services

- Connections to an external hub (or switch)

- Data transfer rates of 100 MB/s

- Standard approved length shortwave fibre optic cables

- Multimode laser operating at 780 nanometers (shortwave) non–OFC

Hub:

- Multiple ports

- Standard approved length fibre optic and copper cables

- Multimode laser operating at 780 nanometers (shortwave) non–OFC

- Single mode laser operating at 1300 nanometers (longwave)

- Cascading hub attachments

- Gigabit Interface Converter (GBIC) connections in the hub

Switch:

- Attachment to FL_Ports is supported.

2

Host Application Best Practices

This chapter outlines the major differences between the SL500 and a Bridged SL500 library. These details are important to Host Applications that will run on a Bridged SL500 library.

Running on Both Fibre Channel or SAS Ports

Oracle recommends that Host Application treat the second bridged SL500 drive port as a fail over port. The library may report a CHECK CONDITION to a command received on one port, when the other port is already busy with a library command. When a host application receives either of the following new CHECK CONDITIONs, it should reissue the command:

- Not Ready, Logical Unit Offline (02/04/12h)

- Aborted Command, Logical Unit Communication Failure (0Bh/08/00)

Library Partitioning Differences

The steps required to partition a library are for the most part the same on a Bridged SL500 library. The major differences are:

1. The operator must plan ahead and make sure that there is at least 1 HP LTO-5 or LTO-6 tape drive in each partition.

2. If more than one HP LTO-5 or LTO-6 tape drive resides in a partition, then the operator can select the tape drive that will be used for bridging. The SLC shows a bridge symbol on tape drives that are capable of bridging.

3. Host Access Control is not applicable to a bridged SL500 library

   - On a non-Bridged SL500 library, the operator assigned host definitions to each partition. The definition consisted of the Host ID (Host World Wide Port Name) and a Logical Unit Number.

   - On a Bridged SL500 library, all hosts that send commands to the bridged drive on LUN 0 may also send commands to the library or partition on LUN 1. Commands are processed by the partition in which the bridged drive resides.

Selecting the Bridged Drive

When there is more than one HP LTO-5 or HP LTO-6 tape drive in a non-partitioned library or a library partition, it is up to the operator to select the drive that will be used for bridging. The operator will use SLC to select the drive.

> **Note –** It is not currently possible to select the bridge drive when no partitions are defined on a partitioning licensed library.

Logical Unit Number Addressing

- LUN 0 is used to communicate with the HP LTO-5 or HP LTO-6 drive.

- LUN 1 is used to communicate with the SL500 library.

SCSI Command Differences

The following list highlights the SCSI Media Changer command differences when running on a Bridged SL500 library instead of a non-bridged SL500 library:

Last CDB Byte

The last CDB Byte – Vendor Unique Bits – are no longer treated as reserved bits for most commands.

Inquiry Command

- The Standard Inquiry page is 74 bytes instead of 36 bytes long, when the allocation length is greater than 36. The extended length page includes Inquiry Version Descriptors.

- The Supported Inquiry page returns the following pages:

  - Supported Page (00h)

  - Serial Number Page (80h)

  - Device ID Page (83h)

  - SCSI Port Page (88h)

- The Inquiry Device ID Page (83h) format has changed.

- The Inquiry SCSI Ports Page (88h) is supported.

Mode Select 6 and Mode Select 10 Commands

The following pages are new:

- The Fibre Channel Disconnect/Reconnect page (02h)

- The SAS Disconnect/Reconnect page (02h)

- The SAS Port Control Page (19h)

- The SAS Phy Control and Discover Mode Subpage (19h/01h)

Mode Sense 6 and Mode Sense 10 Commands

The following pages are new:

- The Fibre Channel Disconnect/Reconnect page (02h)

- The SAS Disconnect/Reconnect page (02h)

- The SAS Port Control Page (19h)

- The SAS Phy Control and Discover Mode Subpage (19h/01h)

- The SAS Shared Control Mode Subpage (19h/02h)

- Control Mode Subpage (19h/03h)

Persistent Reserve In Command

- The Read Full Status (03h) Service Action is supported.

- The CRH bit in the Report Capabilities page is set to 1, indicating that the library supports the exceptions to the SPC-2 RESERVE and RELEASE commands as described in SPC-3.   A non-bridged library library returns a value of 0.

Persistent Reserve Out Command

- The Exclusive Access, All Registrants Type (8h) is supported.

- The Register and Move (07h) Service Action is supported.

- A Test Unit Ready Command returns GOOD status when there is a Persistent Reservation in effect by a different host with an Exclusive Access Reservation or when there is Persistent Reservation in effect and the requesting host is not registered. The non-bridged SL500 would have reported a RESERVATION CONFLICT in this case.

- A Reserve 6, Reserve 10, Release 6, or Release 10 command received by the same host that holds a Persistent Reservation will result in GOOD status. A non-bridged SL500 library would return a RESERVATION CONFLICT in this case.

- A Reserve 6, Reserve 10, Release 6, or Release 10 command received by any registered host when there is an All Registrants Reservation or a Registrants Only Reservation will result in GOOD status. A non-bridged SL500 library would return a RESERVATION CONFLICT in this case.

Prevent/Allow Media Removal

- The library maintains 1 Prevent bit for each initiator. If any initiator has prevented media removal, then the CAP or CAPs will be locked.

- The non-bridged SL500 library allowed media removal, if any host issued an Allow Media Removal command.

Reserve 6 and Release 6 Commands

- Element Reservations are not supported on a bridged SL500 library.

Reserve 10 and Release 10 Commands

- Customers should not use 3rd party reservations. These are legacy SPC-2 commands. Persistent Reservations should instead be implemented.

Write Buffer Command

- Expect that a Library firmware download will take up to 30 minutes on a bridged SL500 library.

3

Operation and Configuration Details

This chapter provides details for operation and configuration that are important while writing host applications.

Multiple Initiator Support

The library architecture supports multiple initiators with the following details:

- Unit - Reserve and Release commands are supported. Persistent Reserve commands are also supported. Host software applications should perform reservations whenever possible.

- If an initiator modifies a mode page, all other initiators will then receive a unit attention indicating the mode parameters have changed.

- The library maintains separate prevent or allow medium removal status for each initiator. If any host/initiator has issued a prevent command, then no access to the Cartridge Access Port (CAP) door will be allowed.

Host Timeout Characteristics

Host timeout values for SCSI commands may require adjustment based on the configuration of the library.

Fast Load

The library architecture provides for optional fast load operations. The following applies only if the fast load option is disabled:

- The library's robot will mount a tape to a drive and wait at the drive location until the tape is fully loaded before beginning another task.

- A SCSI move command may require additional time to complete. The host software must adjust SCSI time-out values to allow for the tape drive load time in addition to the robotics motion time.

Device Reservations

The SL500 tape library support both the Reserve/Release management method and also the Persistent Reservations management method.

- TABLE 3-1 outlines the reservation restrictions placed on commands for the Reserve/Release method, defined in the ANSI SCSI-3 Primary Commands (SPC-2) standard.

- TABLE 3-2 defines the reservation restrictions placed on commands for the Persistent Reservations method, defined in the ANSI SCSI-3 Primary Commands (SPC-3) Standard.

Conflict	Command will not be performed and the library will terminate the command with Reservation Conflict status.
Allowed	Command will be allowed to execute to normal completion.

TABLE 3-1 Reserve/Release Management Method

Command	Action when Reserved by a different Initiator
Initialize Element (07h)	Conflict
Initialize Element with Range (37h/E7h)	Conflict
Inquiry (12h)	Allowed
Log Sense (4Dh)	Allowed
Mode Select (15h/55h)	Conflict
Mode Sense (1Ah/5Ah)	Conflict
Move Medium (A5h)	Conflict
Persistent Reserve In (5Eh)	Conflict
Persistent Reserve Out (5Fh)	Conflict
Position to Element (2Bh)	Conflict
Prevent/Allow Removal (1Eh)	Prevent = 0, allowed Prevent = 1, conflict
Read Element Status (B8h)	Conflict
Release Unit (17h/57h)	Allowed, the reservation is not released.
Report LUNS (A0h)	Allowed
Report Target Port Groups (A3h)	Allowed
Request Sense (03h)	Allowed
Request Volume Element Address (B5h)	Conflict
Reserve Unit (16h/56h)	Conflict
Send Diagnostic (1Dh)	Conflict
Send Volume Tag (B6h)	Conflict
Test Unit Ready (00h)	Conflict
Write Buffer (3Bh)	Conflict

TABLE 3-2 Persistent Reservation Management Method

Command	Library is Reserved by a different Initiator with a Persistent Reservation		
		Registered Initiators	
	Non-Registered Initiators	Exclusive Access Reservation	ALL Registrants or Exclusive Access Registrants Only
Initialize Element Status (07h)	Conflict	Conflict	Allowed
Initialize Element Status w/Range (37h/E7h)	Conflict	Conflict	Allowed
Inquiry (12h)	Allowed	Allowed	Allowed
Log Sense (4Dh)	Allowed	Allowed	Allowed
Mode Select (15h/55h)	Conflict	Conflict	Allowed
Mode Sense (1Ah/5Ah)	Conflict	Conflict	Allowed
Move Medium (A5h)	Conflict	Conflict	Allowed
Persistent Reserve In (5Eh)	Allowed	Allowed	Allowed

Persistent Reserve Out (5Fh)
  SA=Register
  SA=Reserve
  SA=Release
  SA=Clear
  SA=Preempt
  SA=Preempt/Abort
  SA=Register and Ignore
  SA=Register and Move
	
	Allowed
	Conflict
	Conflict
	Conflict
	Conflict
	Conflict
	Allowed
	Conflict
		
		Allowed
		Conflict
		Allowed[1]
		Allowed
		Allowed
		Allowed
		Allowed
		Conflict
			
			Allowed
			Conflict
			Allowed[1]
			Allowed
			Allowed
			Allowed
			Allowed
			Conflict

Position to Element (2Bh)	Conflict	Conflict	Allowed

Prevent/Allow Media Removal (1Eh)
  Prevent = 0
  Prevent = 1
	
	Allowed
	Conflict
		
		Allowed
		Conflict
			
			Allowed
			Allowed

Read Element Status (B8h)	Conflict	Conflict	Allowed
Release (17h/57h)	Conflict	Conflict	Allowed
Report LUNs (A0h)	Allowed	Allowed	Allowed
Report Target Port Groups (A3h)	Allowed	Allowed	Allowed
Request Sense (03h)	Allowed	Allowed	Allowed
Request Volume Element Address (B5h)	Conflict	Conflict	Allowed
Reserve (16h/56h)	Conflict	Conflict	Allowed
Send Diagnostics (1Dh)	Conflict	Conflict	Allowed
Send Volume Tag (B6h)	Conflict	Conflict	Allowed
Test Unit Ready (00h)	Allowed	Allowed	Allowed
Write Buffer (3Bh)	Conflict	Conflict	Allowed
Note –[1] The reservation is not released.			

4

Command Set

This chapter lists and describes the small computer system interface (SCSI) command set for serial attached SCSI (SAS) and Fibre Channel (FC) interfaces to the SL500 Modular Library System.

TABLE 4-5 contains a list of the commands, command codes, and page numbers that contain a description of the command.

Note – This manual does not describe the commands for tape drives. Refer to the tape drive documentation for information about SCSI commands for a tape drive.

Implementation Requirements

The structure for all command descriptor blocks is:

The first byte contains a:

- Group Code that provides 8 groups of commands
- Command Code that provides 32 command codes for each group

The second byte in all command descriptor blocks:

- Starts the command parameters

Additional bytes:

- Contains command parameters

Last byte in all command descriptor blocks:

- Control byte

Note – The library is SCSI-3 compliant.

- For some commands,
  a list of parameters accompanies the request during Data Out.

- For all commands,
  if there is an invalid parameter in the command descriptor block, then the device terminates the command without altering the medium.

Command Descriptor Block

Initiators use three types of CDBs to communicate commands to the targets:

- 6–Byte commands (TABLE 4-1)
- 10–Byte commands (TABLE 4-2)
- 12–Byte commands (TABLE 4-3)

The first byte in the command descriptor block contains an operation code.

TABLE 4-1 6-Byte Command Descriptor Block

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Group Code			Command Code				
1	Reserved			Command Parameters				
2 to 4	(MSB)　　　　　　　　　Command Parameters　　　　　　　　　(LSB)							
5	Control Byte							

TABLE 4-2 10-Byte Command Descriptor Block

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Operation Code							
1	Reserved			Command Parameters				
2 to 8	(MSB)　　　　　　　　　Command Parameters　　　　　　　　　(LSB)							
9	Control Byte							

TABLE 4-3 12-byte Command Descriptor Block

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Operation Code							
1	Reserved			Command Parameters				
2 to 9	(MSB)　　　　　　　　　Command Parameters　　　　　　　　　(LSB)							
10	Reserved							
11	Control Byte							

Control Byte

The control byte is the last byte of every Command Descriptor Block and has the following structure:

TABLE 4-4 Control Byte

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
5, 9, or 11	Vendor Specific		Reserved			NACA (0)	Flag (0)	Link (0)

- **Vendor Specific**
  Provides additional information about the device or for a command.

- **NACA**
  The normal auto contingent allegiance bit controls the rules for handling an auto contingent condition caused by a command. This bit is set to 0 to indicate that if a contingent allegiance condition occurs, the command will return a check condition.

- **Flag (not supported)**
  This bit causes an interrupt in the initiator allowing a device to respond with intermediate status. This bit is not supported and should be 0.

- **Link (not supported)**
  Allows devices that support command linking to continue the I/O process. This bit is not supported and should be 0.

List of Supported Commands

TABLE 4-5 Supported Commands

Command and Page Number	Hex Code
Initialize Element Status on page 32	07
Initialize Element Status With Range on page 33	37/E7
Inquiry on page 34	12
Log Sense on page 46	4D
Mode Select (6) on page 52	15
Mode Select (10) on page 71	55
Mode Sense (6) on page 91	1A
Mode Sense (10) on page 120	5A
Move Medium on page 160	A5
Persistent Reserve In on page 162	5E
Persistent Reserve Out on page 172	5F
Position to Element on page 176	2B
Prevent/Allow Medium Removal on page 177	1E
Read Element Status on page 178	B8
Release (6) on page 204	17
Release (10) on page 205	57
Report LUNS on page 206	A0
Report Target Port Groups on page 208	A3
Request Sense on page 212	03
Request Volume Element Address on page 224	B5
Reserve (6) on page 227	16
Reserve (10) on page 228	56
Send Diagnostic on page 230	1D
Send Volume Tag on page 232	B6
Test Unit Ready on page 234	00
Write Buffer on page 235	3B

SCSI Command Status

Good

Good status (00h) indicates that the device successfully completed the command.

Check Condition

Check Condition status (02h) occurs when any error, unit exception, or abnormal condition generates sense data. The initiator should issue a Request Sense command following a Check Condition status to determine the nature of the error.

Check Condition status occurs when one of the following conditions exist:

- Issuing an invalid command or parameter

- Issuing a command to a device that is not ready

- Detecting a hardware error

- Sensing an illegal request

- Detecting SCSI protocol errors

Busy

Busy status (08h) occurs when the target is unable to accept a command from an otherwise acceptable initiator. The normal initiator recovery from a Busy status is to reissue the command.

Reservation Conflict

The library returns Reservation Conflict status (18h) whenever a SCSI initiator attempts to access a logical unit or element that is reserved by another initiator.

Initialize Element Status

The host uses the Initialize Element Status command (07h) to request an inventory of the cartridge tapes held in the library. The library accepts this command for compatibility, but does not perform any action.

At power-on the library performs an audit of and maintains the inventory during operations. The library also performs an audit after someone has opened and closed the front door.

An initiator can obtain inventory information for the library by using the Read Element Status command.

TABLE 4-6 Initialize Element Status Command

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Operation Code (07h)							
1	Ignored			Reserved (00h)				
2	Reserved (00h)							
3	Reserved (00h)							
4	Reserved (00h)							
5	Control Byte (00h)							

Initialize Element Status With Range

The Initialize Element Status With Range command (37h and E7h) is a request from the host to perform an inventory of a portion of the cartridge tapes within the library. The library accepts this command for compatibility, but does not perform any action.

When the library powers-on it performs an audit of and maintains the inventory during operations. The library also performs an audit after someone has opened and closed the front door.

An initiator can obtain inventory information for the library by using the Read Element Status command.

TABLE 4-7 Initialize Element Status With Range Command

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Operation Code (37h/E7h)							
1	Ignored			Reserved (00h)			Fast	Range
2 to 3	(MSB) Element Address (LSB)							
4 to 5	(MSB) Reserved (00h) (LSB)							
6 to 7	(MSB) Number of Elements (LSB)							
8	Reserved (00h)							
9	Control Byte (00h)							

Initialize Element Status with Range Definitions:

Fast	Ignore this field.
Range	Ignore this field.
Element Address	Ignore this field.
Number of Elements	Ignore this field.

Inquiry

The Inquiry command (12h) requests that the library send to the initiator information regarding the library's parameters.

TABLE 4-8   Inquiry Command

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Operation Code (12h)							
1	Ignored			Reserved (00h)			CmdDt (0)	EVPD
2	Page Code							
3 to 4	MSB Allocation Length LSB							
5	Control Byte (00h)							

Inquiry Command Definitions:

CmdDt	Command support data is not supported (0).
EVPD	The enable vital product data bit indicates the type of inquiry data the initiator is requesting. Supported values are: 0 = Request for standard inquiry data 1 = Request for vital support product data page
Page Code	If the EVPD value is 0, this field is set to 00h. If the EVPD value is 1, this field must be: 00h = Supported vital product pages 80h = Unit serial number page 83h = Device identification page 88h = SCSI ports page C8h = Vendor Specific Device Capabilities page
Allocation Length	The allocation length field specifies the number of bytes the initiator has allocated for data returned from the Inquiry command. A value of 0 indicates that no inquiry data is to be transferred. This condition is *not* considered an error.

The library transfers either the number of bytes specified by the Allocation Length field or all of the available inquiry data, whichever is less.

- The data length for the standard inquiry data the library returns is 4Ah (72d) bytes.

- The data length for the supported pages (00h) is 08h (8d) bytes for a bridged HP LTO-5 drive and 9h (9d) bytes for a bridged HP LTO-6 drive.

- The data length for the unit serial number page (80h) is 10h (16d) bytes.

- The data length for the device identification page (83h) is 40h (64d) bytes.

- The data length for the SCSI ports page (88h) is 1Ch (28d) or 34h (52d) bytes.

- The data length for the vendor specific device capabilities page (C8h) is 8h (8d) bytes.

Note – The Inquiry command returns check condition status only when the requested data cannot be returned. This command will not clear any pending unit attention conditions.

Standard Inquiry Data

For the Inquiry command, the library returns 4Ah (74d) bytes of data in this format.

TABLE 4-9 Standard Inquiry Data

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Peripheral Qualifier			Peripheral Device Type				
1	RMB (1)	Reserved (0)						
2	Version (05h)							
3	Reserved (0)		Norm ACA (0)	HiSup (1)	Response Data Format (2)			
4	Additional Length							
5	SCCS (0)	ACC (0)	TPGS (1)		3PC (0)	Reserved (1)		Protect (0)
6	BQue (0)	EncServ (0)	VS (0)	MultiP (1)	MChngr (0)	Reserved (1)		ADDR16[a] (0)
7	Rsvd (0)	Rsvd (0)	WBUS16[a] (0)	SYNC[a] (0)	LINKED (0)	Rsvd (0)	CmdQue	VS (0)
8 to 15	(MSB) Vendor Identification (LSB)							
16 to 31	(MSB) Product Identification (LSB)							
32 to 35	(MSB) Product Revision Level (LSB)							
36 to 57	(MSB) Reserved (00h) (LSB)							
58 to 59	(MSB) Version Descriptor 1 (LSB)							
	...							
72 to 73	(MSB) Version Descriptor 8 (LSB)							

Note – [a] The meaning of these fields are specific to the SCSI Parallel Interface (SPI-5). For protocols other than the SCSI Parallel Interface, these fields are reserved.

Standard Inquiry Data Definitions:

Peripheral Qualifier	The library returns a value of:
	000b= Indicates the specified peripheral device type is currently connected to this logical unit.
	011b = If the command is sent to an unsupported logical unit.
	Note: (b = binary notation)
Peripheral Device Type	The library returns a value of:
	8h = Indicates that the library is a medium changer device.
	1Fh = If the command is sent to an unsupported logical unit.
RMB	Removable Medium;
	The library returns a value of: 1 indicating the medium is removable.
Version	The library returns a value of 5h, which indicates compliance to SCSI-3
NormACA	The Normal Auto Contingent Allegiance (NACA) bit controls the rules for handling an auto contingent condition caused by a command.
	The library returns a value of 0, indicating it does not support setting the NACA bit to one in the control byte of a CDB.
HiSup	The library returns a value of 1, indicating the library uses the hierarchical addressing model to identify logical units.
Response Data Format	A value of 2 indicates the data found is in accordance with the SCSI-3 specification.
Additional Length	1Fh = The library has 31 additional bytes of Standard Inquiry Data available to the initiator.
	45h = The library has 69 additional bytes of Standard Inquiry Data available to the initiator. This value is returned if the Allocation Length in the CDB is 36 bytes or larger.
SCCS	The library returns a value of 0, indicating the library does not contain an embedded storage array controller component.
ACC	The library returns a value of 0, indicating it does not contain an access control coordinator that may be addressed through this logical unit.
TPGS	The library returns a value of 01b, which indicates that implicit asymmetric logical unit access is supported.
	The library is capable of changing target port asymmetric access states without a Set Target Port Groups command.
	The Report Target Port Groups command is supported and the Set Target Port Groups command is not supported.
3PC	The library returns a value of:
	0 = indicating third-party commands are not supported.
Protect	The library returns a value of:
	0 = indicating that it does not support protection information.
BQUE	The library returns a value of:
	0 = indicating basic queuing is not supported.
VS	Vendor Specific bit is set to:
	0 = indicating there is no vendor-specific information with this command.

MultiP	Multiple Ports 01b = Indicates there are multiple target ports.
MChngr	The library is not embedded in or attached to a medium transport element and returns a value of 0.
ADDR16[a]	The library returns a value of 0.
WBUS16[a]	The library returns a value of 0.
SYNC[a]	The library returns a value of 0.
LINKED	The library returns a value of: 0 = LINKED command bit, indicating linked commands are not supported.
CmdQue	• 0 = The library does not support command queuing. • 1 = The library supports command queuing (for example, the library is bridged, and the HP LTO-5 or LTO-6 tape drive supports command queuing).
Vendor Identification	Contains the ASCII character sequence "STK" followed by blanks. If the specified logical unit is not supported, this field contains all blanks.
Product Identification	Contains the ASCII character sequence "SL500" followed by blanks.
Product Revision Level	Contains an ASCII character sequence that represents the product revision.
Version Descriptors	The bridged drive returns up to eight Version Descriptors that are used to identify up to eight standards to which the drive conforms.

Error Conditions:

The library returns Check Condition status for the Inquiry command only when a severe error occurs. To recover from a Check Condition status report on the Inquiry command, verify that the Inquiry CDB is OK, and retry the Inquiry command.

Supported Pages

The library returns 8h (8d) bytes (HP LTO-5 bridged drive) or 9h (9d) bytes (HP LTO-6 bridged drive) of supported page data in this format.

TABLE 4-10 Supported Pages

Byte	Bit							
	7	6	5	4	3	2	1	0
0	Peripheral Qualifier			Peripheral Device Type				
1	Page Code (00h)							
2	Reserved (00h)							
3	Additional Page Length							
4	Supported Page (00h)							
5	Serial Number Page (80h)							
6	Device Identification Page (83h)							
7	SCSI Ports Page (88h)							
8	Vendor Specific Device Capabilities Page (C8h) (HP LTO-6 Bridged Drive only)							

Inqury: Supported Pages Definitions:

Peripheral Qualifier	The library returns a value of:
	000b = indicates the specified peripheral device type is currently connected to this logical unit.
	011b = If the command is sent to an unsupported logical unit.
	Note: (b = binary notation).
Peripheral Device Type	The library returns a value of:
	8h = Indicates that the library is a medium changer device.
	1Fh = If the command is sent to an unsupported logical unit.
Page Code	Identifies the page as the supported pages (00h).
Additional Page Length	Indicates the remaining bytes in the data:
	04h = HP LTO-5 Bridged Drive
	05h = HP LTO-6 Bridged Drive
Supported Page	00h = Indicates the first vital page is page 0 (current page)
	80h = Unit Serial Number Page
	83h = Device Identification Page
	88h = SCSI Ports Page
	C8h = Vendor Specific Device Capabilities Page

Unit Serial Number Page

The library returns 10h (16d) bytes of unit serial number page data in this format.

TABLE 4-11 Unit Serial Number Page

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Peripheral Qualifier			Peripheral Device Type				
1	Page Code (80h)							
2	Reserved (00h)							
3	Additional Page Length (0Ch)							
4 to 15	(MSB) Unit Serial Number (LSB)							

Unit Serial Number Page Definitions:

Peripheral Qualifier	The library returns a value of:
	000b = Indicates the specified peripheral device type is currently connected to this logical unit.
	011b = If the command is sent to an unsupported logical unit. (b = binary notation).
Peripheral Device Type	The library returns a value of:
	8h = Indicates that the library is a medium changer device.
	011b = If the command is sent to an unsupported logical unit.
Page Code	This field is set to:
	80h = Identifying the page as the unit serial number page.
Additional Page Length	This field is set to:
	0Ch = The number of bytes in the product serial number.
Unit Serial Number	This field contains a unique 12-character ASCII identifier for the library.
	For example: 522**XX**0000121 Where: XX indicates the library partition number. For non-partitioned libraries, XX is 00.

Device Identification Page

The library returns 40h (64d) bytes of device identification page data:

TABLE 4-12 Device Identification Page Data

Byte	\multicolumn{8}{c}{Bit}							
	7	6	5	4	3	2	1	0
0	Peripheral Qualifier			Peripheral Device Type				
1	Page Code (83h)							
2	Reserved (00h)							
3	Additional Page Length (3Ch)							
T10 Vendor Identifier								
4	Protocol Identifier (0)				Code Set (2)			
5	PIV (0)	Rsvd	Association (0)		Identifier Type (1)			
6	Reserved (00h)							
7	Identifier Length (24h)							
8 to 15	(MSB)			Vendor Identification				(LSB)
16 to 31	(MSB)			Product Identification				(LSB)
32 to 43	(MSB)			Unit Serial Number				(LSB)
Logical Unit NAA Identifier								
44	Protocol Identifier (0h)				Code Set (1)			
45	PIV (0)	Rsvd	Association (0)		Identifier Type (3)			
46	Reserved (00h)							
47	Identifier Length (08h)							
48 to 55	(MSB)			NAA Identifier				(LSB)
Relative Target Port Identifier								
56	Protocol Identifier (0h or 6h)				Code Set (1)			
57	PIV (1)	Rsvd	Association (1)		Identifier Type (4)			
58	Reserved (00h)							
59	Identifier Length (04h)							
60 to 63	(MSB)			Relative Target Port Identifier				(LSB)

Device Identification Page Definitions:

Peripheral Qualifier	The library returns a value of: • 000b= Indicating the specified peripheral device type is currently connected to this logical unit. • 011b = If the command is sent to an unsupported logical unit. (b = binary notation)
Peripheral Device Type	The library returns a value of: • 8h = Indicates that the library is a medium changer device. • 1Fh = If the command is sent to an unsupported logical unit.
Additional Page Length	A value of: 3Ch = indicates there are 60d (decimal) additional bytes of Device ID Inquiry Data available to the initiator.
Protocol Identifier	• 0h = Fibre Channel • 6h = Serial Attached SCSI
Code Set	1h = The identifier field contains binary values 2h = The identifier field contains ASCII printable characters
Identifier Type	1h = The identifier field contains T10 Vendor ID data 3h = The identifier field contains a 64-bit IEEE Registered Address 4h = The identifier field contains the Relative Target Port Identifier
Identifier Length	4h = The identifier length for the Relative Target Port Identifier 8h = The identifier length for the 64-bit IEEE Registered Address 28h = The identifier length for the T10 Vendor ID data
Association	00b = The identifier field is associated with the addressed logical unit. 01b = The identifier field is associated with the target port that received the request.
PIV	0b = The protocol identifier field contents are reserved. 1b = The protocol identifier field is valid.
Vendor Identification	Contains the ASCII character sequence "STK" followed by blanks. If the specified logical unit is not supported, this field contains all blanks.
Product Identification	This field contains the ASCII character sequence "SL500" followed by blanks.
NAA Identifier	This field contains the IEEE Registered name for the library. See TABLE 4-13.
Relative Target Port Identifier	• 1 = Target Port 1 • 2 = Target Port 2
Unit Serial Number	This field contains a unique 12-character ASCII identifier for the library. • For example: 522**XX**0000121 Where: XX indicates the library **partition** number. For non-partitioned libraries, XX is 00.

TABLE 4-13 IEEE Registered Name

63 (MSB)	Bits ...		0 (LSB)
NAA	**IEEE Company ID**	**Vendor Specific Identifier**	
5h	00 10 4f (h)	Different for every library	

SCSI Ports Page

The library returns 1Ch (28d) or 34h (52d) bytes of SCSI Ports data in this format:

TABLE 4-14 SCSI Ports Page Data

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Peripheral Qualifier			Peripheral Device Type				
1	Page Code (88h)							
2	Reserved (00h)							
3	Additional Page Length							
4 to 27	(MSB) SCSI Port Identification Descriptor (LSB)							
28 to 51	(MSB) SCSI Port Identification Descriptor (included if both ports are enabled) (LSB)							

SCSI Ports Page Definitions:

Peripheral Qualifier	The library returns a value of: • 000b = Indicates the specified peripheral device type is currently connected to this logical unit. • 011b = If the command is sent to an unsupported logical unit. (b = binary notation) .
Peripheral Device Type	The library returns a value of: • 8h = Indicates that the library is a medium changer device. • 1Fh = If the command is sent to an unsupported logical unit.
Additional Page Length	The library has: • 18h = 24d additional bytes of SCSI Ports Data available to the initiator. • 30h = 48d additional bytes of SCSI Ports Data available to the initiator. **Note:** This value is returned, if both SCSI ports are enabled.
SCSI Port Identification Descriptor	See TABLE 4-15 for more information.

SCSI Port Identification Descriptor Data

TABLE 4-15 SCSI Port Identification Descriptor Data

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Reserved (00h)							
1	Reserved (00h)							
2 to 3	(MSB)			Relative Port Identifier				(LSB)
4 to 9	(MSB)			Reserved (00h)				(LSB)
10 to 11	(MSB)			Target Port Descriptor Length (0Ch)				(LSB)
12	Protocol Identifier (0h or 6h)				Code Set (1)			
13	PIV (1)	Rsvd	Association (1)		Identifier Type (3)			
14	Reserved (00h)							
15	Identifier Length (8h)							
16 to 23	(MSB)			Port Name Identification				(LSB)

SCSI Port Identification Descriptor Data Definitions:

Relative Port Identifier	1 = Port 1 2 = Port 2
Protocol Identifier	0 = Fibre Channel 6 = Serial Attached SCSI
Code Set	The library returns a value of: 1 = indicates the identifier contains binary values.
Identifier Type	The library returns a value of: 3 = indicates the identifier field contains a 64-bit IEEE formatted address.
Association	The library returns a value of: 1 = indicates the identifier field is associated with the port that received the request.
PIV	The library returns a value of 1= indicates the protocol identifier is valid
Port Name Identification	Contains the 64-bit IEEE formatted address for the Port Name.

Vendor Specific Device Capabilities Page

> **Note –** The Vendor Specific Device Capabilities page is not supported when the bridged drive is an HP LTO-5 drive.

The library returns 8h (8d) bytes of vendor specific device capabilities page data in this format.

TABLE 4-16 Vendor Specific Device Capabilities Page

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Peripheral Qualifier			Peripheral Device Type				
1	Page Code (C8h)							
2	Reserved (00h)							
3	Additional Page Length (04h)							
4	Reserved (00h)							
5	Reserved (00h)							
6	Reserved (00h)							
7	Reserved (00h)							

Vendor Specific Device Capabilities Page Definitions:

Peripheral Qualifier	The library returns a value of:
	000b = Indicates the specified peripheral device type is currently connected to this logical unit.
	011b = Indicates if the command is sent to an unsupported logical unit. (b = binary notation).
Peripheral Device Type	The library returns a value of:
	8h = Indicates that the library is a medium changer device.
	1Fh = Indicates if the command is sent to an unsupported logical unit.
Page Code	This field is set to:
	C8h = Identifies the page as the vendor specific device capabilities page.
Additional Page Length	This field is set to 4h (4d) bytes.

Log Sense

The Log Sense command (4Dh) enables the library to report its error logs and statistics to the initiator.

TABLE 4-17 Log Sense Command

Byte	\multicolumn{8}{c}{Bit}							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	\multicolumn{8}{c}{Operation Code (4Dh)}							
1	\multicolumn{3}{c}{Ignored}			\multicolumn{3}{c}{Reserved (0)}			PPC (0)	SP (0)
2	\multicolumn{2}{c}{PC}		\multicolumn{6}{c}{Page Code}						
3	\multicolumn{8}{c}{Reserved (00h)}							
4	\multicolumn{8}{c}{Reserved (00h)}							
5 to 6	(MSB) \multicolumn{8}{c}{Parameter Pointer} (LSB)							
7 to 8	(MSB) \multicolumn{8}{c}{Allocation Length} (LSB)							
9	\multicolumn{8}{c}{Control Byte (00h)}							

Log Sense Command Definitions:

PPC	Parameter Pointer Control is not supported (0).
SP	Save Parameters feature is not supported (0).
PC	The library accepts values of 0 or 1 in the Page Control field.
Page Code	00h = List Supported pages 07h = List Last *n* Error Events page 2Eh = Informational Exceptions TapeAlert page (0 or 1 in the PC field)
Parameter Pointer	The Parameter Pointer allows an initiator to request data starting at a specific parameter code. This value is set to 00h for page code 0h.
Allocation Length	Specifies the number of bytes the initiator has allocated for data returned from the Log Sense command. A value of 0 is considered an error. The maximum data length for the log sense data that the library can return is 3C4h bytes. The length varies based on the Page Code selected. 00h = List Supported pages—length is 7h 07h = List Last *n* Error Events page—length is 3C4h 2Eh = Informational Exceptions TapeAlert page—length is 144h

Supported Pages Format Page

The Supported Pages Format page lists all the Log Sense page codes supported by the library.

TABLE 4-18 Supported Pages Format Page

Byte	Bit							
	7	6	5	4	3	2	1	0
0	Page Code (00h)							
1	Reserved (00h)							
2 to 3	(MSB) Page Length (03h) (LSB)							
4	Supported Pages Page Code (00h)							
5	Last n Errors Events Page Code (07h)							
6	Informational Exceptions TapeAlert Page Code (2Eh)							

Last *n* Errors Events Page Format

The Last *n* Errors Events Page provides a list of the most recent errors events logged on the library. Each event is an ASCII string that includes a time stamp, a fault symptom code (FSC), and an optional mechanism.

Note – Each error event is 48 bytes long, and can contain up to 20 events.

TABLE 4-19 Last *n* Errors Events Page

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Page Code (07h)							
1	Reserved (00h)							
2 to 3	(MSB) Page Length (*n* - 3) (LSB)							
ASCII String for Event Specified by Parameter Pointer:								
4 to 7	Result Code							
8 to 11	Activity Code							
12 to 15	Request Id							
16 to 19	Op State							
20 to 23	Module							
24 to 27	Row							
28 to 31	Column							
32 to 33	Month							
34 to 35	Day							
36 to -37	Hour							
38 to 39	Minute							
40 to 42	Second							
43 to 51	Pad (ASCII spaces)							
Additional Events (48d bytes per event)								
n to 47 to n	Additional Log Parameters							

Note – Time is specified as universal time.

Informational Exceptions TapeAlert Page

The Informational Exceptions TapeAlert page is read from the library at a minimum of:

- At the beginning of a write/read job occurring on a device inside the library, even if media is not loaded in that device.

- Immediately after a fatal error during a write/read job occurring on a device inside the library.

- At the end of a write/read job occurring on a device inside the library.

Though not mandatory, the host software may also poll the Log Sense page every 60 seconds while the tape library is idle.

Each flag will be cleared to zero in the following circumstances:

- At library power on.

- When the TapeAlert Log page is read.

- On a reset.

TABLE 4-20 lists information about the Informational Exceptions TapeAlert Page format. The TapeAlert page returns A4h bytes in this format.

The *n* represents a TapeAlert flag: currently, all values are set to default. Unsupported flags are also returned as defaults.

TABLE 4-20 Informational Exceptions TapeAlert Page Format

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Page Code (2Eh)							
1	Reserved (00h)							
2 to 3	(MSB) Page Length (5*n*)							(LSB)
TapeAlert Flags: n goes from 1 to 32								
5*n* -1 to 5*n*	Parameter Code (*n*)							
5*n* +1	DU (0)	DS (1)	TSD (0)	ETC (0)	TMC (0)	Rsvd (0)	LBIN (0)	LP (0)
5*n* +2	Parameter Length							
5*n* +3	Value of Flag							Flag

Note – The entire TapeAlert page should be read to obtain all the information.

Informational Exceptions TapeAlert Page Definitions:

Parameter Code	A 2-byte field which represents the TapeAlert Flag number.
DU	Disable Update is always 0, which indicates that the target updates the log parameter value instead of the initiator.
DS	Disable Save is always 1, which indicates saving the log is not supported.
TSD	Target Save Disable is always 0.
ETC	Enable Threshold Comparison is always 0.
TMC	Threshold Met Criteria is always 0.
LBIN	The library returns 0 indicating it is not used.
LP	List Parameter is always 0, which indicates the log parameter is a data counter.
Parameter Length	Parameter Length is always 0x01. All are 1-byte flags.
Flag	A value of 0x01 indicates that the flag the Parameter Code is pointed to is active; all other values are off.

TapeAlert Flags

TABLE 4-21 lists information about the TapeAlert flags. Flags are:

- in sequential order,
- have valid values of 0 (off) or 1 (on)
- reports all 32

Type codes indicate:

- C = Critical
- W = Warning
- I = Informational

TABLE 4-21 TapeAlert Flags

Code	Flag Name	Description	Type
0001h	Library Hardware A	Set when the library cannot communicate with a tape drive. This does *not* cause the library to stop operating.	C
0002h	Library Hardware B	Set when the servo control mechanism breaks lock. The various causes are when the hand positioning on the column fails or when the hand fails.	W
0003h	Library Hardware C	Set when the library has a hardware fault.	C
0004h	Library Hardware D	Set when camera initialization, calibration, or mechanical initialization test fails.	C
0005h	Library Diagnostics Required	Set when the library might have a hardware fault.	W
0006h	Library Interface	Set when a corrupted SCSI command is sent to the library from an initiator. Currently, this flag is set when a parity error is detected on the SCSI bus.	C

TABLE 4-21 TapeAlert Flags (Continued)

Code	Flag Name	Description	Type
0007h	Predictive Failure	Set when a library hardware failure is predicted.	W
0008h	Library Maintenance	Set when preventive maintenance is required.	W
0009h	Library Humidity Limits	Set when general conditions inside the library exceed the humidity specifications.	C
000Ah	Library Temperature Limits	Set when general conditions inside the library exceed the temperature specifications.	C
000Bh	Library Voltage Limits	Set when the voltage supply exceeds specifications.	C
000Ch	Library Stray Tape	Set when a cartridge was left in a drive because of a previous hardware fault.	C
000Dh	Library Pick Retry	Set if the hand requires more than one try to pick a cartridge from a cell or drive.	W
000Eh	Library Place Retry	Set if the hand requires more than one try to place a cartridge into a cell.	W
000Fh	Library Load Retry	Set if the hand requires more than one try to place a cartridge into a drive.	W
0010h	Library Door	Set if the door has been opened, and no library motions are allowed. When the door is closed, the library will IPL.	C
0011h	Library Mail slot	Set when the mail slot (cartridge access port) switch has failed.	C
0012h	Library Magazine	Set when the library needs the magazine.	C
0013h	Library Security	Set when the security was compromised.	W
0014h	Library Security Mode	Set when the security mode was changed.	I
0015h	Library Offline	Set when the library has been placed into maintenance mode from the operator panel or a Web interface.	I
0016h	Library Drive Offline	Set when a drive was taken offline.	I
0017h	Library Scan Retry	Set when more than one attempt is required to read a bar code. The problem is caused when only part of the bar code can be read. The library supports cartridges with no labels.	W
0018h	Library Inventory	Set when the library detected an inconsistency in its inventory.	C
0019h	Library Illegal Operation	Set when an unsupported SCSI command is sent to the library. This is *not* a corrupted command for flag 6.	W
001Bh	Cooling Fan failure	Set when the library cooling fan has failed	W
001Ch	Power Supply	Set when a redundant power supply has failed inside the library. Check the library users manual for instructions on replacing the failed power supply.	W
001Dh	Power Consumption	Set when the library power consumption is outside the specified range.	W
0020h	Unreadable Bar Code Labels	The library was unable to read the bar code on a cartridge.	I

Mode Select (6)

The 6-byte Mode Select command (15h) enables an initiator to specify certain operating parameters for the library. The library uses the saved or default versions of these parameters to configure itself during power-on or after a logical unit reset.

The mode values sent to the library apply to all initiators. If an initiator issues a Mode Select command that changes any parameters, the library generates a Check Condition status to all other initiators with a sense key of Unit Attention and an Additional Sense Code (ASC) and Additional Sense Code Qualifier (ASCQ) of Mode Parameters Changed.

When the library receives a Mode Select (6) command, the library validates all parameters before it performs any changes. If a value is not valid, the library returns the appropriate error message and does not change the parameters.

TABLE 4-22 Mode Select (6) Command

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Operation Code (15h)							
1	Ignored			PF (1)	Reserved (0)			SP
2	Reserved (00h)							
3	Reserved (00h)							
4	Parameter List Length							
5	Control Byte							

Mode Select (6) Command Definitions:

PF	Page Format supports SCSI-3 specification and requires a value of 1.
SP	The library supports the saved page (SP) function. The values are: 0 = Current mode values are changed to the values specified by this command. Saved values are not affected. 1 = Current mode values and saved mode values are changed to the values specified by this command.
Parameter List Length	00h = No data transferred *Note:* A value of 00h is not considered an error. Any other value is considered an error and is not supported. The **Mode Parameter Header** *and* the following pages are transferred: • 14h = Disconnect Reconnect Page are transferred • 0Ch = Logical Unit Page are transferred • 0Ch = Fibre Channel Port Control Page are transferred • 14h = SAS Port Control Page are transferred • 68h = SAS Phy Control and Discover Mode Subpage are transferred • 10h = Informational Exceptions Tape Alert Mode Page are transferred • 18h = Element Address Assignment Page are transferred

Mode Select (6) Data

The initiator must provide mode parameter data in a parameter list including:

- "Mode Select (6) Parameter Header" on page 53
- "Fibre Channel Disconnect/Reconnect Page" on page 54
- "SAS Disconnect/Reconnect Page" on page 56
- "Fibre Channel Logical Unit Page" on page 58
- "SAS Logical Unit Page" on page 58
- "Fibre Channel Port Control Page" on page 59
- "SAS Port Control Page" on page 61
- "SAS Phy Control and Discover Mode Subpage" on page 63
- "Informational Exceptions TapeAlert Page" on page 66 or
- "Element Address Assignment Mode Page" on page 68

If the parameter list length field in the command is 0, then no Mode Select data is required.

Note – Before issuing any Mode Select commands, an initiator should issue a Mode Sense command with the Page Control field set to 01h, and the Page Code field set to 3Fh to determine which pages are supported, which parameters within the pages are changeable, and the supported length of each page.

Mode Select (6) Parameter Header

The library returns a four-byte Mode Select parameter header as follows:

TABLE 4-23 Mode Select Parameter (6) Header

Byte	Bit							
	7	6	5	4	3	2	1	0
0	Reserved (00h)							
1	Reserved (00h)							
2	Reserved (00h)							
3	Reserved (00h)							

Note – The header definitions for the library must all be 00h.

Fibre Channel Disconnect/Reconnect Page

TABLE 4-24 shows the format of the Mode Sense Fibre Channel Disconnect/ Reconnect page.

TABLE 4-24 Fibre Channel Disconnect/reconnect Page

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	PS	SPF	Page Code (02h)					
1	Page length (0Eh)							
2	Buffer Full Ratio							
3	Buffer Empty Ratio							
4 to 5	(MSB)	Bus Inactivity Limit						(LSB)
6 to 7	(MSB)	Disconnect Time Limit						(LSB)
8 to 9	(MSB)	Connect Time Limit						(LSB)
10 to 11	(MSB)	Maximum Burst Size						(LSB)
12	EMPD	FAA	FAB	FAC	Restricted			
13	Reserved							
14 to 15	(MSB)	First Burst Size						(LSB)

Mode Sense: Fibre Channel Disconnect/Reconnect Page Definitions

PS	The parameters Saveable bit is set to 0.
SPF	The library returns a value of 0 = the SubPage Format bit, indicating page_0 format is being used.
Page Code	This field is set to: 02h = identifies the page as the Disconnect/Reconnect page.
Buffer Full Ratio	This field indicates the device server, during read operations, how full the buffer should be prior to requesting an interconnect tenancy.
Buffer Empty Ratio	This field indicates the device server, during write operations, how empty the buffer should be prior to transmitting an FCP_XFER_RDY IU that requests the initiator to send data.
Bus Inactivity Limit	This field indicates the maximum time that the target is permitted to maintain an interconnect tenancy without data or information transfer, measured in transmission word increments. • 0000h indicates that there is no bus inactivity limit.
Disconnect Time Limit	This field indicates the minimum delay between interconnect tenancies measured in increments of 128 transmission words. • 0000h indicates that the disconnect time limit does not apply.
Connect Time Limit	The field indicates the maximum duration of a single interconnect tenancy, measured in increments of 128 transmission words. • 0000h indicates that there is no connect time limit.
Maximum Burst Size	This field indicates the maximum size of FCP_DATA IU that the device server shall transfer to the initiator or request from the initiator. This value is expressed in increments of 512 bytes. • 0000h indicates there is no limit on the amount of data transferred per data transfer operation.
EMPD	The Enable Modify Data Pointers bit indicates whether or not the target may use the random buffer access capability to reorder FCP_DATA IUs for a single SCSI command. • 0 = The target shall generate continuously increasing relative offset values for each FCP_DATA IU for a single SCSI command. • 1 = The target may transfer the FCP_DATA IUs for a single SCSI command in any order.
FAA, FAB, FAC	The fairness access (FA) bits, FAA, FAB, and FAC, indicate whether a target in a loop configuration shall use the access fairness algorithm. A value of 0 indicates that the target does not use fairness, while a value of 1 indicates that the target does use a fairness algorithm. • The **FAA bit** controls arbitration when the target wishes to send one or more FCP_DATA IU frames to an initiator. • The **FAB bit** controls arbitration when the initiator wishes to send one or more FCP_XFER_RDY IU frames to a target. • The **FAC bit** controls arbitration when the target wishes to send an FCP_RSP IU frame to an initiator.
First Burst Size	This field value is expressed in increments of 512. n 0000h indicates that there is no first burst size limit.

SAS Disconnect/Reconnect Page

TABLE 4-25 shows the format of the Mode Sense Serial Attached SCSI Disconnect/
Reconnect page.

TABLE 4-25   SAS Disconnect/Reconnect Page

Byte	Bit							
	7	6	5	4	3	2	1	0
0	PS	SPF	Page Code (02h)					
1	Page Length (0Eh)							
2	Reserved (00h)							
3	Reserved (00h)							
4 to 5	(MSB) Bus Inactivity Time Limit (LSB)							
6	Reserved (00h)							
7	Reserved (00h)							
8 to 9	(MSB) Maximum Connect Time Limit (LSB)							
10 to 11	(MSB) Maximum Burst Size (LSB)							
12	Reserved (00h)							
13	Reserved (00h)							
14 to 15	(MSB) First Burst Size (LSB)							

Mode Sense: SAS Disconnect/Reconnect Page Definitions:

PS	The parameters Saveable bit is set to 0.
SPF	The library returns a value of: 0 = SubPage Format bit, indicating page_0 format is being used.
Page Code	This field is set to: 02h = identifies the page as the Disconnect/Reconnect page.
Bus Inactivity Time Limit	This field contains the maximum time in 100 µs increments that an SSP target port is permitted to maintain a connection without transferring a frame to the SSP initiator port. • 0000h indicates that there is no bus inactivity limit.
Maximum Connect Time Limit	This field contains the maximum duration of a connection in 100 µs increments. • 0000h specifies that there is no maximum connection time limit.
Maximum Burst Size	For read data, this field contains the maximum amount of data in 512-byte increments that is transferred during a connection by an SSP target port per I_T_L_Q nexus without transferring at least one frame for a different I_T_L_Q nexus. For write data, the value shall specify the maximum amount of data that an SSP target port requests via a single XFER_RDY frame. • 0000h in this field specifies that there is no maximum burst size.
First Burst Size	If the ENABLE FIRST BURST bit in the COMMAND frame is set to zero, then the FIRST BURST SIZE field is ignored. If the ENABLE FIRST BURST bit in the COMMAND frame is set to one, then the value in the FIRST BURST SIZE field contains the maximum amount of write data in 512-byte increments that may be sent by the SSP initiator port to the SSP target port without having to receive an XFER_RDY frame from the SSP target port.

Fibre Channel Logical Unit Page

TABLE 4-26 shows the format of the Fibre Channel Logical Unit page.

TABLE 4-26 Fibre Channel Logical Unit Page

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	PS (0)	SPF (0)	Page Code (18h)					
1	Page Length (06h)							
2	Reserved				Protocol Identifier (0)			
3	Reserved							EPDC
4 to 7	(MSB)　　　　　　　　　　　　　Reserved　　　　　　　　　　　　　(LSB)							

Fibre Channel Logical Unit Page Definitions:

PS	The Parameters Saveable bit is set to 0.
SPF	The library returns a value of 0 for the SubPage Format bit, indicating page_0 format is being used.
Protocol Identifier	This field is set to 0h indicating the Fibre Channel protocol.
EPDC	The Enable Precise Delivery Checking bit is defined as follows: 0 = The target shall not use the precise delivery function and shall ignore the contents of the CRN field 1 = The logical unit shall use precise delivery function defined in the FCP-2 standard.

SAS Logical Unit Page

TABLE 4-27 shows the format of the Serial Attached SCSI (SAS) Logical Unit Page.

TABLE 4-27 SAS Logical Unit Page

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	PS (0)	SPF (0)	Page Code (18h)					
1	Page Length (06h)							
2	Reserved			TLR	Protocol Identifier (6h)			
3 to 7	(MSB)　　　　　　　　　　　　　Reserved　　　　　　　　　　　　　(LSB)							

Serial Attached SCSI Logical Unit Page Definitions:

PS	The Parameters Saveable bit is set to 0.
SPF	The library returns a value of; 0 = SubPage Format bit, indicating page_0 format is being used.
Protocol Identifier	The field is set to: 06h indicating Serial Attached SCSI protocol.
TLR	0b = Transport Layer Retries are disabled. 1b = Transport Layer Retries are enabled for Transfer Ready and Data Frames for the logical unit.

Fibre Channel Port Control Page

TABLE 4-28 shows the format of the Fibre Channel Port Control page.

TABLE 4-28 Fibre Channel Port Control Page

Byte	Bit							
	7	6	5	4	3	2	1	0
0	PS (0)	SPF (0)	Page Code (19h)					
1	Page Length (06h)							
2	Reserved				Protocol Identifier (0)			
3	DTFD	PLPB	DDIS	DLM	RHA	ALWI	DTIPE	DTOLI
4	Reserved							
5	Reserved							
6	Reserved					RR_TOV units		
7	Resource Recovery Time Out Value (RR_TOV)							

Fibre Channel Port Control Page Definitions:

PS	The Parameters Saveable bit is set to 0.
SPF	The library returns a value of: 0 = SubPage Format bit, indicating page_0 format is being used.
Protocol Identifier	This field is set to: 0h = Indicates the Fibre Channel protocol.
DTFD	Disabled Target Fabric Discovery. If the library is not attached to an arbitrated loop, it shall ignore the DTFD bit. 0 = The target attached by an arbitrated loop shall discover a fabric loop port if present on the loop and perform the public loop functions defined for targets by FC-FLA. 1 = The target attached by an arbitrated loop shall not recognize the presence of a fabric loop port on the loop.

PLPB	Prevent Loop Port Bypass. If the library is not attached to an arbitrated loop, it shall ignore the PLPB bit.
	0 = The target allows the Loop Port Bypass (LPB) and Loop Port Enable (PBE) primitive sequences to control the port bypass circuit and participation on the loop as specified by FC-AL-2.
	1 = The target attached to an FC-AL-2 loop shall ignore any Loop Port Bypass (LPB) and Loop Port Enable (LPE) primitive sequences.
DDIS	Disable Discovery. If the library is not attached to an arbitrated loop, it shall ignore the DDIS bit.
	0 = The target shall wait to complete target discovery as defined by FC-PLDA, FC-FLA, and FC-TAPE before allowing processing of tasks to resume.
	1 = The target without a valid FLOGI attached to an arbitrated loop shall not require receipt of Address or Port Discovery (ADISC or PDISC ELSs) following loop initialization as described in FC-PLDA and FC-FLA.
DLM	Disable Loop Master. If the library is not attached to an arbitrated loop, it shall ignore the DLM bit.
	0 = The target may participate in loop master arbitration in the normal manner and, if successful, may become loop master during the loop initialization process.
	1 = The target attached to an FC-AL-2 loop shall not participate in loop master arbitration and shall not become loop master. The target shall only repeat LISM frames it receives.
RHA	Require Hard Address. If the library is not attached to an arbitrated loop, it shall ignore the RHA bit.
	0 = The target follows the normal initialization procedure, including the possibility of obtaining a soft address during the loop initialization process.
	1 = The target attached to an arbitrated loop shall only attempt to obtain its hard address. If there is a conflict for the hard address selection during loop initialization or the target does not have a valid hard address available, the target shall enter the nonparticipating state.
ALWI	Allow Login Without Loop Initialization. If the library is not attached to an arbitrated loop, it shall ignore the ALWI bit.
	0 = The target shall perform the normal loop initialization procedure before entering the monitoring mode and accepting a login ELS.
	1 = The target attached to an FC-AL-2 loop shall use the hard address available in the connector or in device address jumpers, enter the monitoring state in participating mode, and accept logins without using the loop initialization procedure (see FC-AL-2).

DTIPE	Disabled Target Initiated Port Enabled. If the library is not attached to an arbitrated loop, it shall ignore the DTIPE bit.
	0 = The target shall enable itself onto the loop in according to the rules specified in FC-AL-2.
	1 = The target attached to an arbitrated loop shall wait for an initiator to send the Loop Port Enable (LPE) primitive sequence before inserting itself into a loop (see FC-AL-2)
DTOLI	Disable Target Originated Loop Initialization. If the library is not attached to an arbitrated loop, it shall ignore the **DTOLI** bit.
	0 = The target attached by an arbitrated loop shall generate LIP(F7,xx) after it enables a port into a loop.
	1 = The target attached by an arbitrated loop shall not generate a LIP following insertion into the loop.
RR_TOV units	Resource Recovery Time Out Value Units will always be 011b = 0.1 second units
RR_TOV	Resource Recovery Time Out Value will always be F0h = 24 seconds

SAS Port Control Page

TABLE 4-29 shows the format of the Serial Attached SCSI (SAS) Port Control page.

TABLE 4-29 SAS Port Control Page

	Bit							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	PS (0)	SPF (0)	Page Code (19h)					
1	Page Length (0Eh)							
2	RSVD	Continue AWT	BAE	LED	Protocol Identifier (6h)			
3	Reserved							
4 to 5	(MSB)	I_T Nexus Loss Time						(LSB)
6 to 7	(MSB)	Initiator Response Timeout						(LSB)
8 to 9	(MSB)	Reject to Open Limit						(LSB)
10 to 15	(MSB)	Reserved (00h)						(LSB)

Serial Attached SCSI Port Control Page Definitions:

PS	The parameters Saveable bit is set to 0.
SPF	The library returns a value of: 0 = SubPage Format bit, indicating page_0 format is being used.
Page Code	This field is set to: 19h = identifies the page as the SAS Port Control mode page.
Protocol Identifier	This field is set to: 06h = indicates the Serial Attached SCSI protocol.
Continue AWT	Continuous Arbitration Wait Time (AWT) 0 = The SAS port shall stop the AWT timer and set the AWT timer to zero when it receives an OPEN_REJECT (RETRY). 1 = The SAS port shall not stop the AWT timer and shall not set the AWT timer to zero when the SAS port receives an OPEN_REJECT (RETRY).
BAE	Broadcast Asynchronous Event (BAE). The device server shall: 0 = Disable origination of Broadcast (Asynchronous Event). 1 = Enable origination of Broadcast (Asynchronous Event).
Ready LED Meaning	The Ready LED Meaning bit specifies the READY LED signal behavior.
I_T Nexus Loss Time	This field contains the minimum time that the SSP Target Port shall retry connection requests to an SSP initiator port that are rejected with responses indicating the SSP initiator port may no longer be present before recognizing an I_T nexus loss: 0000h = Vendor-specific amount of time. 0001h - FFFFh = Time in milliseconds. FFFFh = The SSP target port shall never recognize an I_T nexus loss.
Initiator Response Timeout	This field contains the minimum time in milliseconds that the SSP target port shall wait for the receipt of a frame before aborting the command associated with that frame. 0000h indicates that the SSP target port shall wait forever.
Reject to Open Limit	This field contains the minimum time in 10 microsecond increments that the target port shall wait to establish a connection request with an initiator port on an I_T nexus after receiving an OPEN_REJECT (RETRY), OPEN_REJECT (RESERVED CONTINUE 0), or OPEN_REJECT (RESERVED CONTINUE 1) 0000h indicates that minimum time is vendor specific.

SAS Phy Control and Discover Mode Subpage

TABLE 4-30 shows the format of the Serial Attached SCSI Phy Control and Discover Mode Subpage.

TABLE 4-30 SAS Phy Control and Discover Mode Subpage

Byte	Bit							
	7	6	5	4	3	2	1	0
0	PS (0)	SPF (1)	Page Code (19h)					
1	Subpage Code (01h)							
2 to 3	(MSB)	Page Length (64h)						
								(LSB)
4	Reserved							
5	Reserved				Protocol Identifier (6h)			
6	Generation Code							
7	Number of Phys							
SAS Phy Mode Descriptor List								
8 to 55	(MSB)	First SAS Phy Mode Descriptor						
								(LSB)
56 to 103	(MSB)	Second SAS Phy Mode Descriptor						
								(LSB)

Serial Attached SCSI Phy Control and Discover Mode Subpage Definitions:

PS	The parameters Saveable bit is set to 0.
SPF	The library returns a value of: 1 = SubPage Format bit, indicates this page uses the sub_page mode.
Page Code	19h = Identifies the page as the SAS Port Control mode page.
Sub-Page Code	A value of: 01h = Identifies the sub-page as the SAS Phy Control and Discover Mode Subpage.
Protocol Identifier	06h indicates the Serial Attached SCSI protocol.
Generation Code	This field is a one-byte counter that shall be incremented by one by the device server every time the values in this mode page are changed.
Number of Phy	This field contains the number of phys in the SAS target device and indicates the number of SAS Phy Mode Descriptors in the SAS Phy Mode descriptor list.
SAS Phy Mode Descriptor Data	See TABLE 4-31 for more information.

SAS Phy Mode Descriptor Data

TABLE 4-31 SAS Phy Mode Descriptor Data

Byte	\<span\>Bit\</span\>							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Reserved (00h)							
1	Phy Identifier							
2	Reserved (00h)							
3	Reserved (00h)							
4	RSVD	Attached Device Type		Reserved (0)				
5	Reserved				Negotiated Physical Link Rate			
6	Reserved				Attach SSP Init Port	Attach STP Init Port	Attach SMP Init Port	RSVD
7	Reserved				Attach SSP Tgt Port	Attach STP Tgt Port	Attach SMP Tgt Port	RSVD
8 to 15	(MSB) SAS Address (LSB)							
16 to 23	(MSB) Attached SAS Address (LSB)							
24	Attached Phy Address							
25 to 31	Reserved (00h)							
32	Programmed Minimum Physical Link Rate				Hardware Minimum Physical Link Rate			
33	Programmed Maximum Physical Link Rate				Hardware Maximum Physical Link Rate			
34 to 41	Reserved (00h)							
42 to 43	(MSB) Vendor Specific (LSB)							
44 to 47	Reserved (00h)							

Serial Attached SCSI Phy Mode Descriptor Data Definitions:

PS	The parameters Saveable bit is set to 0.
Phy Identifier	A unique identifier is returned for each Phy.

Attached Device Type	This field indicates the device type attached to this Phy: 000b = No device attached 001b = SAS device 010b = Expander device 011b = Expander device compliant with a previous version of the SAS standard
Negotiated Physical Link Rate	This field indicates the logical link rate being used by the Phy: 0h = UNKNOWN. Phy is enabled. Unknown Physical link rate. 1h = DISABLED. Phy is disabled. 2h = PHY_RESET_PROBLEM 3h = SPINUP_HOLD 4h = PORT_SELECTOR 8h = G1. Physical link rate is 1.5 Gb/s 9h = G2. Physical link rate is 3.0 Gb/s Ah =G3. Physical link rate is 6.0 Gb/s
Attached SSP Initiator Port	This bit indicates the value of the SSP Initiator Port field received in the IDENTIFY address frame during the identification sequence.
Attached STP Initiator Port	This bit indicates the value of the STP Initiator Port field received in the IDENTIFY address frame during the identification sequence.
Attached SMP Initiator Port	This bit indicates the value of the SMP Initiator Port field received in the IDENTIFY address frame during the identification sequence.
Attached SSP Target Port	This bit indicates the value of the SSP Target Port field received in the IDENTIFY address frame during the identification sequence.
Attached STP Target Port	This bit indicates the value of the STP Target Port field received in the IDENTIFY address frame during the identification sequence.
Attached SMP Target Port	This bit indicates the value of the SMP Target Port field received in the IDENTIFY address frame during the identification sequence.
SAS Address	This field indicates the SAS Address of the drive that is the bridged interface for the library or partition.
Attached SAS Address	This field contains the value of the SAS Address field transmitted in the IDENTIFY address frame during the identification sequence.
Attached Phy Address	This field indicates the value of Attached Phy Address field received in the IDENTIFY address frame during the identification sequence.
Programmed Minimum Physical Link Rate	8h = 1.5 Gb/s 9h = 3.0 Gb/s Ah = 6.0 Gb/s
Hardware Minimum Physical Link Rate	8h = 1.5 Gb/s 9h = 3.0 Gb/s Ah = 6.0 Gb/s
Programmed Maximum Physical Link Rate	8h = 1.5 Gb/s 9h = 3.0 Gb/s Ah = 6.0 Gb/s
Hardware Maximum Link Rate	8h = 1.5 Gb/s 9h = 3.0 Gb/s Ah = 6.0 Gb/s

Informational Exceptions TapeAlert Page

TABLE 4-32 defines the Informational Exceptions TapeAlerts.

TABLE 4-32 Informational Exceptions TapeAlerts Page

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	PS (0)	SPF (0)	Page Code (1Ch)					
1	Page Length (0Ah)							
2	Perf (0)	Rsvd (0)	EBF(0)	EWasc	DExcpt (1)	Test	Rsvd (0)	LogErr (0)
3	Reserved (0)				MRIE (3h)			
4 to 7	(MSB)	Interval Timer						(LSB)
8 to 11	(MSB)	Report Counter / Test Flag Number						(LSB)

Informational Exceptions TapeAlerts Page Definitions:

PS	The Parameters Saveable bit is set to 0.
SPF	The library accepts a value of 0 for the SubPage Format bit, indicating page_0 format is being used.
Perf	Performance bit is set to 0, which indicates acceptance of informational exception operations that cause delays.
EBF	Enable Background Functions bit will always be 0.
EWasc	This should be set to 0 for the enable warning bit, indicating warning reporting shall be disabled.
DExcpt	The library accepts a value of 1, which indicates the target Disables All Information Exception operations and *ignores* the MRIE field. In this mode, the software must poll the TapeAlert Log page.
Test	• 0 = The library does not generate false/test informational exceptions. • 1 = The library generates false/test informational exception conditions.
LogErr	The Log Error information exception conditions is set to 0, which indicates this is vendor-specific.
MRIE	Method the library uses to Report Informational Exceptions must be 3h, which indicates that the library reports any informational exception conditions by returning Check Condition status.
Interval Timer	Bytes 4 through 7 must be 00h. The library will only report informational exception condition one time.
Report Counter / Test Flag Number	This is a dual purpose field: • When the Test Flag bit is 0, this field is the report counter. Bytes 8 through 11 must be set to 00h to indicate there is no limit to the number of times the library will report the informational exception condition. This value is returned with Mode Sense. • When the Test bit is 1, this field is the test flag number.

Test Modes

Two test mode options are supported in the current TapeAlert implementation.

Test Mode for All Bits Supported

Using the mode select command to initiate this test will set all of the flags supported by the TapeAlert implementation in the TapeAlert log page. The TapeAlert log sense page then can be read to give the host a snapshot of the supported flags.

The flags will be cleared when the page is read. To do this, set the test mode flag in the TapeAlert mode select page. This indicates that the Report Count/Test Flag Number field is in Test Flag Number mode. Next, set the test flag number to 0x7FFF and issue the Mode Select command. When the command is complete, the TapeAlert log sense page can be read.

Test Mode for Individual Bits

Another test mode allows individual bits to be turned on. This can be useful for the host to debug/test operator interfaces.

Any flag set must be a supported flag. If the flag is not supported, a check condition with an incorrect parameter code is returned. The TapeAlert log sense page then can be read to allow the host to get a log page with the flag of interest set. The flag will be cleared when the page is read.

To test a flag, set the Test Flag in the TapeAlert mode select page. This indicates the Report Count/Test Flag Number field is in Test Flag mode. Set the number of the flag to be tested. Issue the Mode Select command. When the command is complete, the TapeAlert log sense page can be read.

Element Address Assignment Mode Page

This table defines the Element Address Assignment Mode page.

TABLE 4-33 Mode Select (6) Element Address Assignment Mode Page

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

Mode Select (6) Element Address Assignment Mode Page Definitions:

PS	The Parameters Saveable bibit is set to 0.
Page Code	Identifies the Element Address Assignment mode page.
Parameter Length	Indicates the length of the element address assignment parameter list. This field must be 12h, which indicates that there are an additional 12h (18d) bytes of parameter data following this byte.
First Medium Transport Element Address	Identifies the address of the hand in the library. The library has only one hand, so the default value is 0000h.
Number of Medium Transport Elements	Identifies the number of hands in the library. The library has only one hand, so this field must be 0001h (1d).
First Storage Element Address	Identifies the starting address of the cartridge tape storage cells in the library, and the default starting address is 03E8h (1000d).
Number of Storage Elements	Identifies the number of cartridge tape storage cells in the library. This number is based on the configuration of the library and is obtained when the library performs a Mode Sense of mode page 1Dh. The number in the Mode Select command must be the same number returned by the Mode Sense command.
First Import/Export Element Address	Identifies the address of the first Import/Export element. This address is the first CAP element 000Ah (10d) or the first PTP element 0008h(8d).
Number of Import/Export Elements	Identifies the number of Import/Export storage locations. This value is obtained when the library performs a Mode Sense of mode page 1Dh. The number in the Mode Select command must be the same number returned by the Mode Sense command.
First Data Transfer Element Address	Identifies the address of the first tape drive; the default setting address is 1F4h (500d).
Number of Data Transfer Elements	Identifies the total number of tape drives installed in the library. This number varies depending on the configuration. Obtain this value by requesting a Mode Sense of mode page 1Dh. The number in the Mode Select command must be the same number returned by the Mode Sense command.

Element Address Assignments

An initiator can modify the element addresses in the library using a Mode Select command. The four element types are:

- Medium transport (the hand)

  - Storage element (storage cells)

  - Import/export (cartridge access port and Pass-thru Port)

  - Data transfer (tape drives)

Each element type is defined as a range of consecutive elements based on a starting element and a count. The ranges may be configured in any order, but one element type range may not overlap another element type range, and gaps between ranges are allowed.

To change the element address assignments, an initiator should first perform a Mode Sense of mode page 1Dh (Element Address Assignment Page). This provides the count of each element type. The count of each element type cannot be changed and must be used as obtained from the Mode Sense command. Only the starting element number can be modified. The initiator must calculate the starting addresses of each type to ensure no overlaps.

Because the library supports the saved page function, the element address assignments can be saved in non-volatile memory. These values are used to configure the library:

- During power-on
- After a logical unit reset

Mode Select (10)

The 10-byte Mode Select command (55h) enables an initiator to specify certain operating parameters for the library. The library uses the saved or default versions of these parameters to configure itself during power-on or after a logical unit reset.

The mode values sent to the library apply to all initiators. If an initiator issues a Mode Select command that changes any parameters, the library generates a Check Condition status to all other initiators with a sense key of Unit Attention and an Additional Sense Code (ASC) and Additional Sense Code Qualifier (ASCQ) of Mode Parameters Changed.

When the library receives a Mode Select (10) command, the library validates all parameters before it performs any changes. If a value is not valid, the library returns the appropriate error message and does not change the parameters.

TABLE 4-34 Mode Select (10) Command

Byte	\multicolumn{8}{c}{Bit}							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	\multicolumn{8}{c}{Operation Code (55h)}							
1	\multicolumn{3}{c}{Ignored}			PF (1)	\multicolumn{3}{c}{Reserved (0)}			SP
2 to 6	\multicolumn{8}{c}{Reserved (00h)}							
7 to 8	(MSB)	\multicolumn{6}{c}{Parameter List Length}						(LSB)
9	\multicolumn{8}{c}{Reserved}							

Mode Select (10) Command Definitions:

PF	Page Format supports SCSI-3 specification and requires a value of 1.
SP	The library supports the saved page (SP) function. The values are: • 0 = Current mode values are changed to the values specified by this command. Saved values are not affected. • 1 = Current mode values and saved mode values are changed to the values specified by this command.
Parameter List Length	• 00h = No data transferred A value of 00h is not considered an error. Any other value is considered an error and is not supported. • The **Mode Parameter Header** *and* the following pages are transferred: 18h = Disconnect Reconnect Page are transferred 10h = Logical Unit Page are transferred 10h = Fibre Channel Port Control Page are transferred 18h = SAS Port Control Page are transferred 6Ch = SAS Phy Control and Discover Mode Subpage are transferred 14h = Informational Exceptions Tape Alert Mode Page are transferred 1Ch = Element Address Assignment Page are transferred

Mode Select (10) Data

The initiator must provide mode parameter data in a parameter list including:

"Mode Select Parameter Header" on page 72

"Fibre Channel Disconnect/Reconnect Page" on page 73

"SAS Disconnect/Reconnect Page" on page 75

"Fibre Channel Logical Unit Page" on page 77

"SAS Logical Unit Page" on page 77

"Fibre Channel Port Control Page" on page 78

"SAS Port Control Page" on page 81

"SAS Phy Control and Discover Mode Subpage" on page 83

"Informational Exceptions TapeAlert Page" on page 86 or

"Element Address Assignment Mode Page" on page 88

Mode Select (10) Parameter Header

The library returns a 8-byte Mode Select parameter header as follows:

TABLE 4-35 Mode Select Parameter Header

Byte	Bit							
	7	6	5	4	3	2	1	0
0	Reserved (00h)							
1	Reserved (00h)							
2	Reserved (00h)							
3	Reserved (00h)							
4	Reserved (00h)							
5	Reserved (00h)							
6	Reserved (00h)							
7	Reserved (00h)							

Note – The header definitions for the library must be all 00h.

Fibre Channel Disconnect/Reconnect Page

TABLE 4-36 shows the format of the Mode Sense Fibre Channel Disconnect/Reconnect page.

TABLE 4-36 Fibre Channel Disconnect/reconnect Page

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	PS	SPF	Page Code (02h)					
1	Page length (0Eh)							
2	Buffer Full Ratio							
3	Buffer Empty Ratio							
4 to 5	(MSB)	Bus Inactivity Limit						(LSB)
6 to 7	(MSB)	Disconnect Time Limit						(LSB)
8 to 9	(MSB)	Connect Time Limit						(LSB)
10 to 11	(MSB)	Maximum Burst Size						(LSB)
12	EMPD	FAA	FAB	FAC	Restricted			
13	Reserved							
14 to 15	(MSB)	First Burst Size						(LSB)

Mode Sense: Fibre Channel Disconnect/Reconnect Page Definitions

PS	The parameters Saveable bit is set to 0.
SPF	The library returns a value of 0 = the SubPage Format bit, indicating page_0 format is being used.
Page Code	This field is set to: 02h = identifies the page as the Disconnect/Reconnect page.
Buffer Full Ratio	This field indicates the device server, during read operations, how full the buffer should be prior to requesting an interconnect tenancy.
Buffer Empty Ratio	This field indicates the device server, during write operations, how empty the buffer should be prior to transmitting an FCP_XFER_RDY IU that requests the initiator to send data.
Bus Inactivity Limit	This field indicates the maximum time that the target is permitted to maintain an interconnect tenancy without data or information transfer, measured in transmission word increments. 0000h indicates that there is no bus inactivity limit.

Disconnect Time Limit	This field indicates the minimum delay between interconnect tenancies measured in increments of 128 transmission words.
	0000h indicates that the disconnect time limit does not apply.
Connect Time Limit	The field indicates the maximum duration of a single interconnect tenancy, measured in increments of 128 transmission words.
	0000h indicates that there is no connect time limit.
Maximum Burst Size	This field indicates the maximum size of FCP_DATA IU that the device server shall transfer to the initiator or request from the initiator. This value is expressed in increments of 512 bytes.
	0000h indicates there is no limit on the amount of data transferred per data transfer operation.
EMPD	The Enable Modify Data Pointers bit indicates whether or not the target may use the random buffer access capability to reorder FCP_DATA IUs for a single SCSI command.
	0 = The target shall generate continuously increasing relative offset values for each FCP_DATA IU for a single SCSI command.
	1 = The target may transfer the FCP_DATA IUs for a single SCSI command in any order.
FAA, FAB, FAC	The fairness access (FA) bits, FAA, FAB, and FAC, indicate whether a target in a loop configuration shall use the access fairness algorithm. A value of 0 indicates that the target does not use fairness, while a value of 1 indicates that the target does use a fairness algorithm.
	• The **FAA bit** controls arbitration when the target wishes to send one or more FCP_DATA IU frames to an initiator.
	• The **FAB bit** controls arbitration when the initiator wishes to send one or more FCP_XFER_RDY IU frames to a target.
	• The **FAC bit** controls arbitration when the target wishes to send an FCP_RSP IU frame to an initiator.
First Burst Size	This field value is expressed in increments of 512.
	0000h indicates that there is no first burst size limit.

SAS Disconnect/Reconnect Page

TABLE 4-37 shows the format of the Mode Sense Serial Attached SCSI Disconnect/
Reconnect page.

TABLE 4-37   SAS Disconnect/Reconnect Page

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	PS	SPF	Page Code (02h)					
1	Page Length (0Eh)							
2	Reserved (00h)							
3	Reserved (00h)							
4 to 5	(MSB) Bus Inactivity Time Limit (LSB)							
6	Reserved (00h)							
7	Reserved (00h)							
8 to 9	(MSB) Maximum Connect Time Limit (LSB)							
10 to 11	(MSB) Maximum Burst Size (LSB)							
12	Reserved (00h)							
13	Reserved (00h)							
14 to 15	(MSB) First Burst Size (LSB)							

Mode Sense: SAS Disconnect/Reconnect Page Definitions:

PS	The parameters Saveable bit is set to 0.
SPF	The library returns a value of: 0 = SubPage Format bit, indicating page_0 format is being used.
Page Code	This field is set to: 02h = identifies the page as the Disconnect/Reconnect page.
Bus Inactivity Time Limit	This field contains the maximum time in 100 µs increments that an SSP target port is permitted to maintain a connection without transferring a frame to the SSP initiator port. 0000h indicates that there is no bus inactivity limit.
Maximum Connect Time Limit	This field contains the maximum duration of a connection in 100 µs increments. 0000h specifies that there is no maximum connection time limit.
Maximum Burst Size	For read data, this field contains the maximum amount of data in 512-byte increments that is transferred during a connection by an SSP target port per I_T_L_Q nexus without transferring at least one frame for a different I_T_L_Q nexus. For write data, the value shall specify the maximum amount of data that an SSP target port requests via a single XFER_RDY frame. 0000h in this field specifies that there is no maximum burst size.
First Burst Size	If the ENABLE FIRST BURST bit in the COMMAND frame is set to zero, then the FIRST BURST SIZE field is ignored. If the ENABLE FIRST BURST bit in the COMMAND frame is set to one, then the value in the FIRST BURST SIZE field contains the maximum amount of write data in 512-byte increments that may be sent by the SSP initiator port to the SSP target port without having to receive an XFER_RDY frame from the SSP target port.

Fibre Channel Logical Unit Page

TABLE 4-38 shows the format of the Fibre Channel Logical Unit page.

TABLE 4-38 Fibre Channel Logical Unit Page

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	PS (0)	SPF (0)	Page Code (18h)					
1	Page Length (06h)							
2	Reserved				Protocol Identifier (0)			
3	Reserved							EPDC
4 to 7	(MSB) Reserved (LSB)							

Fibre Channel Logical Unit Page Definitions:

PS	The Parameters Saveable bit is set to 0.
SPF	The library returns a value of 0 for the SubPage Format bit, indicating page_0 format is being used.
Protocol Identifier	This field is set to 0h indicating the Fibre Channel protocol.
EPDC	The Enable Precise Delivery Checking bit is defined as follows: 0 = The target shall not use the precise delivery function and shall ignore the contents of the CRN field. 1 = The logical unit shall use precise delivery function defined in the FCP-2 standard.

SAS Logical Unit Page

TABLE 4-39 shows the format of the Serial Attached SCSI (SAS) Logical Unit Page.

TABLE 4-39 SAS Logical Unit Page

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	PS (0)	SPF (0)	Page Code (18h)					
1	Page Length (06h)							
2	Reserved			TLR	Protocol Identifier (6h)			
3 to 7	(MSB) Reserved (LSB)							

Serial Attached SCSI Logical Unit Page Definitions:

PS	The Parameters Saveable bit is set to 0.
SPF	The library returns a value of 0 for the SubPage Format bit, indicating page_0 format is being used.
Protocol Identifier	The field is set to 6h indicating the Serial Attached SCSI (SAS) protocol.
TLR	0b = Transport Layer Retries are disabled. 1b = Transport Layer Retries are enabled for Transfer Ready and Data Frames for the logical unit

Fibre Channel Port Control Page

TABLE 4-40 shows the format of the Fibre Channel Port Control page.

TABLE 4-40 Fibre Channel Port Control Page

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	PS (0)	SPF (0)	Page Code (19h)					
1	Page Length (06h)							
2	Reserved				Protocol Identifier (0)			
3	DTFD	PLPB	DDIS	DLM	RHA	ALWI	DTIPE	DTOLI
4	Reserved							
5	Reserved							
6	Reserved					RR_TOV units		
7	Resource Recovery Time Out Value (RR_TOV)							

Fibre Channel Port Control Page Definitions:

PS	The Parameters Saveable bit is set to 0.
SPF	The library returns a value of: 0 = SubPage Format bit, indicating page_0 format is being used.
Protocol Identifier	This field is set to: 0h = Indicates the Fibre Channel protocol.
DTFD	Disabled Target Fabric Discovery. If the library is not attached to an arbitrated loop, it shall ignore the DTFD bit. 0 = The target attached by an arbitrated loop shall discover a fabric loop port if present on the loop and perform the public loop functions defined for targets by FC-FLA. 1 = The target attached by an arbitrated loop shall not recognize the presence of a fabric loop port on the loop.

PLPB	Prevent Loop Port Bypass. If the library is not attached to an arbitrated loop, it shall ignore the PLPB bit.
	0 = The target allows the Loop Port Bypass (LPB) and Loop Port Enable (PBE) primitive sequences to control the port bypass circuit and participation on the loop as specified by FC-AL-2.
	1 = The target attached to an FC-AL-2 loop shall ignore any Loop Port Bypass (LPB) and Loop Port Enable (LPE) primitive sequences.
DDIS	Disable Discovery. If the library is not attached to an arbitrated loop, it shall ignore the DDIS bit.
	0 = The target shall wait to complete target discovery as defined by FC-PLDA, FC-FLA, and FC-TAPE before allowing processing of tasks to resume.
	1 = The target without a valid FLOGI attached to an arbitrated loop shall not require receipt of Address or Port Discovery (ADISC or PDISC ELSs) following loop initialization as described in FC-PLDA and FC-FLA.
DLM	Disable Loop Master. If the library is not attached to an arbitrated loop, it shall ignore the DLM bit.
	0 = The target may participate in loop master arbitration in the normal manner and, if successful, may become loop master during the loop initialization process.
	1 = The target attached to an FC-AL-2 loop shall not participate in loop master arbitration and shall not become loop master. The target shall only repeat LISM frames it receives.
RHA	Require Hard Address. If the library is not attached to an arbitrated loop, it shall ignore the RHA bit.
	0 = The target follows the normal initialization procedure, including the possibility of obtaining a soft address during the loop initialization process.
	1 = The target attached to an arbitrated loop shall only attempt to obtain its hard address. If there is a conflict for the hard address selection during loop initialization or the target does not have a valid hard address available, the target shall enter the nonparticipating state.
ALWI	Allow Login Without Loop Initialization. If the library is not attached to an arbitrated loop, it shall ignore the ALWI bit.
	0 = The target shall perform the normal loop initialization procedure before entering the monitoring mode and accepting a login ELS.
	1 = The target attached to an FC-AL-2 loop shall use the hard address available in the connector or in device address jumpers, enter the monitoring state in participating mode, and accept logins without using the loop initialization procedure (see FC-AL-2).

DTIPE	Disabled Target Initiated Port Enabled. If the library is not attached to an arbitrated loop, it shall ignore the DTIPE bit.
	0 = The target shall enable itself onto the loop in according to the rules specified in FC-AL-2.
	1 = The target attached to an arbitrated loop shall wait for an initiator to send the Loop Port Enable (LPE) primitive sequence before inserting itself into a loop (see FC-AL-2)
DTOLI	Disable Target Originated Loop Initialization. If the library is not attached to an arbitrated loop, it shall ignore the **DTOLI** bit.
	0 = The target attached by an arbitrated loop shall generate LIP(F7,xx) after it enables a port into a loop.
	1 = The target attached by an arbitrated loop shall not generate a LIP following insertion into the loop.
RR_TOV units	Resource Recovery Time Out Value Units will always be
	011b = 0.1 second units
RR_TOV	Resource Recovery Time Out Value will always be
	F0h = 24 seconds

SAS Port Control Page

TABLE 4-41 shows the format of the Serial Attached SCSI (SAS) Port Control page.

TABLE 4-41 SAS Port Control Page

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	PS (0)	SPF (0)	Page Code (19h)					
1	Page Length (0Eh)							
2	RSVD	Continue AWT	BAE	LED	Protocol Identifier (6h)			
3	Reserved							
4 to 5	(MSB) I_T Nexus Loss Time (LSB)							
6 to 7	(MSB) Initiator Response Timeout (LSB)							
8 to 9	(MSB) Reject to Open Limit (LSB)							
10 to 15	(MSB) Reserved (00h) (LSB)							

Mode Select (6)

Serial Attached SCSI Port Control Page Definitions:

PS	The parameters Saveable bit is set to 0.
SPF	The library returns a value of: 0 = SubPage Format bit, indicating page_0 format is being used.
Page Code	This field is set to: 19h = identifies the page as the SAS Port Control mode page.
Protocol Identifier	This field is set to: 06h = indicates the Serial Attached SCSI protocol.
Continue AWT	Continuous Arbitration Wait Time (AWT) 0 = The SAS port shall stop the AWT timer and set the AWT timer to zero when it receives an OPEN_REJECT (RETRY). 1 = The SAS port shall not stop the AWT timer and shall not set the AWT timer to zero when the SAS port receives an OPEN_REJECT (RETRY).
BAE	Broadcast Asynchronous Event (BAE). The device server shall: 0 = Disable origination of Broadcast (Asynchronous Event). 1 = Enable origination of Broadcast (Asynchronous Event).
Ready LED Meaning	The Ready LED Meaning bit specifies the READY LED signal behavior.
I_T Nexus Loss Time	This field contains the minimum time that the SSP Target Port shall retry connection requests to an SSP initiator port that are rejected with responses indicating the SSP initiator port may no longer be present before recognizing an I_T nexus loss: 0000h = Vendor-specific amount of time. 0001h - FFFFh = Time in milliseconds. FFFFh = The SSP target port shall never recognize an I_T nexus loss.
Initiator Response Timeout	This field contains the minimum time in milliseconds that the SSP target port shall wait for the receipt of a frame before aborting the command associated with that frame. 0000h indicates that the SSP target port shall wait forever.
Reject to Open Limit	This field contains the minimum time in 10 microsecond increments that the target port shall wait to establish a connection request with an initiator port on an I_T nexus after receiving an OPEN_REJECT (RETRY), OPEN_REJECT (RESERVED CONTINUE 0), or OPEN_REJECT (RESERVED CONTINUE 1) 0000h indicates that minimum time is vendor specific.

SAS Phy Control and Discover Mode Subpage

TABLE 4-42 shows the format of the Serial Attached SCSI Phy Control and Discover Mode Subpage.

TABLE 4-42 SAS Phy Control and Discover Mode Subpage

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	PS (0)	SPF (1)	Page Code (19h)					
1	Subpage Code (01h)							
2 to 3	(MSB)	Page Length (64h)						
								(LSB)
4	Reserved							
5	Reserved				Protocol Identifier (6h)			
6	Generation Code							
7	Number of Phys							
SAS Phy Mode Descriptor List								
8 to 55	(MSB)	First SAS Phy Mode Descriptor						
								(LSB)
56 to 103	(MSB)	Second SAS Phy Mode Descriptor						
								(LSB)

SAS Phy Control and Discover Mode Subpage Definitions:

PS	The parameters Saveable bit is set to 0.
SPF	The library returns a value of: 1 = SubPage Format bit, indicates this page uses the sub_page mode.
Page Code	19h, identifies the page as the SAS Port Control mode page.
Sub-Page Code	A value of 01h identifies the sub-page as the SAS Phy Control and Discover Mode Subpage.
Protocol Identifier	06h indicates the Serial Attached SCSI protocol.
Generation Code	This field is a one-byte counter that shall be incremented by one by the device server every time the values in this mode page are changed.
Number of Phy	This field contains the number of phys in the SAS target device and indicates the number of SAS Phy Mode Descriptors in the SAS Phy Mode descriptor list.
SAS Phy Mode Descriptor Data	See TABLE 4-43 for more information.

SAS Phy Mode Descriptor Data

TABLE 4-43 SAS Phy Mode Descriptor Data

Byte	\<td colspan=8 align=center>**Bit**							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Reserved (00h)							
1	Phy Identifier							
2	Reserved (00h)							
3	Reserved (00h)							
4	RSVD	Attached Device Type		Reserved (0)				
5	Reserved				Negotiated Physical Link Rate			
6	Reserved				Attach SSP Init Port	Attach STP Init Port	Attach SMP Init Port	RSVD
7	Reserved				Attach SSP Tgt Port	Attach STP Tgt Port	Attach SMP Tgt Port	RSVD
8 to 15	(MSB) SAS Address (LSB)							
16 to 23	(MSB) Attached SAS Address (LSB)							
24	Attached Phy Address							
25 to 31	Reserved (00h)							
32	Programmed Minimum Physical Link Rate				Hardware Minimum Physical Link Rate			
33	Programmed Maximum Physical Link Rate				Hardware Maximum Physical Link Rate			
34 to 41	Reserved (00h)							
42 to 43	(MSB) Vendor Specific (LSB)							
44 to 47	Reserved (00h)							

Serial Attached SCSI Phy Mode Descriptor Data Definitions:	
PS	The parameters Saveable bit is set to 0.
Phy Identifier	A unique Phy Identifier is returned for each Phy.

Attached Device Type	This field indicates the device type attached to this Phy: 000b = No device attached 001b = SAS device 010b = Expander device 011b = Expander device compliant with a previous version of the SAS standard
Negotiated Physical Link Rate	This field indicates the logical link rate being used by the Phy: 0h = UNKNOWN. Phy is enabled. Unknown Physical Link Rate. 1h = DISABLED. Phy is disabled. 2h = PHY_RESET_PROBLEM 3h = SPINUP_HOLD 4h = PORT_SELECTOR 8h = G1. Physical Link Rate is 1.5 Gb/s 9h = G2. Physical Link Rate is 3.0 Gb/s Ah =G3. Physical Link Rate is 6.0 Gb/s
Attached SSP Initiator Port	This bit indicates the value of the SSP Initiator Port field received in the IDENTIFY address frame during the identification sequence.
Attached STP Initiator Port	This bit indicates the value of the STP Initiator Port field received in the IDENTIFY address frame during the identification sequence.
Attached SMP Initiator Port	This bit indicates the value of the SMP Initiator Port field received in the IDENTIFY address frame during the identification sequence.
Attached SSP Target Port	This bit indicates the value of the SSP Target Port field received in the IDENTIFY address frame during the identification sequence.
Attached STP Target Port	This bit indicates the value of the STP Target Port field received in the IDENTIFY address frame during the identification sequence.
Attached SMP Target Port	This bit indicates the value of the SMP Target Port field received in the IDENTIFY address frame during the identification sequence.
SAS Address	This field indicates the SAS Address of the drive that is the bridged interface for the library or partition.
Attached SAS Address	This field contains the value of the SAS Address field transmitted in the IDENTIFY address frame during the identification sequence.
Attached Phy Address	This field indicates the value of Attached Phy Address field received in the IDENTIFY address frame during the identification sequence.
Programmed Minimum Physical Link Rate	8h = 1.5 Gb/s 9h = 3.0 Gb/s Ah = 6.0 Gb/s
Hardware Minimum Physical Link Rate	8h = 1.5 Gb/s 9h = 3.0 Gb/s Ah = 6.0 Gb/s
Programmed Maximum Physical Link Rate	8h = 1.5 Gb/s 9h = 3.0 Gb/s Ah = 6.0 Gb/s
Hardware Maximum Physical Link Rate	8h = 1.5 Gb/s 9h = 3.0 Gb/s Ah = 6.0 Gb/s

Informational Exceptions TapeAlert Page

TABLE 4-44 defines the Informational Exceptions TapeAlert page.

TABLE 4-44 Informational Exceptions TapeAlert Page

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	PS (0)	SPF (0)	Page Code (1Ch)					
1	Page Length (0Ah)							
2	Perf (0)	Rsvd (0)	EBF (0)	EWasc	DExcpt (1)	Test	Rsvd (0)	LogErr (0)
3	Reserved (0)				MRIE (3h)			
4 to 7	(MSB)	Interval Timer						(LSB)
8 to 11	(MSB)	Report Counter / Test Flag Number						(LSB)

Informational Exceptions TapeAlert Definitions:

PS	The Parameters Saveable bit is set to 0.
SPF	The library accepts a value of 0 for the SubPage Format bit, indicating page_0 format is being used.
Perf	Performance bit is set to 0, which indicates acceptance of informational exception operations that cause delays.
EBF	Enable Background Functions bit will always be 0.
EWasc	This should be set to 0 for the enable warning bit, indicating warning reporting shall be disabled.
DExcpt	The library accepts a value of 1, which indicates the target Disables All Information Exception operations and *ignores* the MRIE field. In this mode, the software must poll the TapeAlert Log page.
Test	0 = The library does not generate false/test informational exceptions. 1 = The library generates false/test informational exception conditions.
LogErr	The Log Error information exception conditions is set to 0, which indicates this is vendor-specific.
MRIE	Method the library uses to Report Informational Exceptions must be 3h, which indicates that the library reports any informational exception conditions by returning Check Condition status.
Interval Timer	Bytes 4 through 7 must be 00h. The library will only report informational exception condition one time.
Report Counter / Test Flag Number	This is a dual purpose field: When the Test Flag bit is 0, this field is the report counter. Bytes 8 through 11 must be set to 00h to indicate there is no limit to the number of times the library will report the informational exception condition. This value is returned with Mode Sense. When the Test bit is 1, this field is the test flag number.

Test Modes

Two test mode options are supported in the current TapeAlert implementation.

Test Mode for All Bits Supported

Using the mode select command to initiate this test will set all of the flags supported by the TapeAlert implementation in the TapeAlert log page. The TapeAlert log sense page then can be read to give the host a snapshot of the supported flags.

The flags will be cleared when the page is read. To do this, set the test mode flag in the TapeAlert mode select page. This indicates that the Report Count/Test Flag Number field is in Test Flag Number mode. Next, set the test flag number to 0x7FFF and issue the Mode Select command. When the command is complete, the TapeAlert log sense page can be read.

Test Mode for Individual Bits

Another test mode allows individual bits to be turned on. This can be useful for the host to debug/test operator interfaces.

Any flag set must be a supported flag. If the flag is not supported, a check condition with an incorrect parameter code is returned. The TapeAlert log sense page then can be read to allow the host to get a log page with the flag of interest set. The flag will be cleared when the page is read.

To test a flag, set the Test Flag in the TapeAlert mode select page. This indicates the Report Count/Test Flag Number field is in Test Flag mode. Set the number of the flag to be tested. Issue the Mode Select command. When the command is complete, the TapeAlert log sense page can be read.

Element Address Assignment Mode Page

TABLE 4-45 defines the Element Address Assignment Mode page.

TABLE 4-45 Mode Select (6) Element Address Assignment Mode Page

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	PS (0)	Rsvd (0)	Page Code (1Dh)					
1	Parameter Length (12h)							
2 to 3	(MSB)	First Medium Transport Element Address						(LSB)
4 to 5	(MSB)	Number of Medium Transport Elements (0001h)						(LSB)
6 to 7	(MSB)	First Storage Element Address						(LSB)
8 to 9	(MSB)	Number of Storage Elements						(LSB)
10 to 11	(MSB)	First Import/Export Element Address						(LSB)
12 to 13	(MSB)	Number of Import/Export Elements						(LSB)
14 to 15	(MSB)	First Data Transfer Element Address						(LSB)
16 to 17	(MSB)	Number of Data Transfer Elements						(LSB)
18	Reserved (00h)							
19	Reserved (00h)							

Mode Select (10) Element Address Assignment Mode Page Definitions:

PS	The Parameters Saveable bit is set to 0.
Page Code	Identifies the Element Address Assignment mode page.
Parameter Length	Indicates the length of the element address assignment parameter list. This field must be 12h, which indicates that there are an additional 12h (18d) bytes of parameter data following this byte.
First Medium Transport Element Address	Identifies the address of the hand in the library. The library has only one hand, so the default value is 0000h.

Number of Medium Transport Elements	Identifies the number of hands in the library. The library has only one hand, so this field must be 0001h (1d).
First Storage Element Address	Identifies the starting address of the cartridge tape storage cells in the library, and the default starting address is 03E8h (1000d).
Number of Storage Elements	Identifies the number of cartridge tape storage cells in the library. This number is based on the configuration of the library and is obtained when the library performs a Mode Sense of mode page 1Dh. The number in the Mode Select command must be the same number returned by the Mode Sense command.
First Import/Export Element Address	Identifies the address of the first Import/Export element. This address is the first CAP element 000Ah (10d) or the first PTP element 0008h(8d).
Number of Import/ Export Elements	Identifies the number of Import/Export storage locations. This value is obtained when the library performs a Mode Sense of mode page 1Dh. The number in the Mode Select command must be the same number returned by the Mode Sense command.
First Data Transfer Element Address	Identifies the address of the first tape drive; the default setting address is 1F4h (500d).
Number of Data Transfer Elements	Identifies the total number of tape drives installed in the library. This number varies depending on the configuration. Obtain this value by requesting a Mode Sense of mode page 1Dh. The number in the Mode Select command must be the same number returned by the Mode Sense command.

Element Address Assignments

An initiator can modify the element addresses in the library using a Mode Select command. The four element types are:

- Medium transport (the hand):

    - Storage element (storage cells)

    - Import/export (cartridge access port and Pass-thru Port)

    - Data transfer (tape drives)

Each element type is defined as a range of consecutive elements based on a starting element and a count. The ranges may be configured in any order, but one element type range may not overlap another element type range, and gaps between ranges are allowed.

To change the element address assignments, an initiator should first perform a Mode Sense of mode page 1Dh (Element Address Assignment Page). This provides the count of each element type. The count of each element type cannot be changed and must be used as obtained from the Mode Sense command. Only the starting element number can be modified. The initiator must calculate the starting addresses of each type to ensure no overlaps.

Because the library supports the saved page function, the element address assignments can be saved in non-volatile memory. These values are used to configure the library:

- During power-on

    - After a logical unit reset

Mode Sense (6)

The 6-byte Mode Sense command (1Ah) enables the library to report its operating mode parameters to the initiator.

- The initiator can request one page or all pages of the mode parameters.

- The initiator can use the Mode Select command to change the values of certain mode parameters.

- Before issuing any Mode Select commands, an initiator should issue a Mode Sense command with the Page Control field set to 01h, and the Page Code field set to 3Fh to determine which:

  - Pages are supported

  - Parameters within the pages are changeable

  - Supported length of each page

TABLE 4-46 Mode Sense Command

Byte	Bit							
	7	6	5	4	3	2	1	0
0	Operation Code (1Ah)							
1	Ignored			Rsvd	DBD	Reserved (0)		
2	Page Control		Page Code					
3	SubPage Code							
4	Allocation Length							
5	Control Byte							

Mode Sense (6) Command Definitions:

DBD	Disable Block Descriptors is ignored.
Page Control	Defines the type of parameters to be returned for the Mode Sense command, values include:
	0h (00b) = Current Values: The library returns the current parameter values, including: Parameters set in the last successful Mode Select command. Default values if saved values are unavailable or invalid. Saved values if a MODE command has not been executed since the last power-on, interface reset, or Task Management Reset.
	1h (01b) = Changeable Values: The library returns the changeable parameter masks. All requested pages are returned Pages indicate which parameters are changeable by the initiator All bits of changeable parameters are set to 1 All bits of parameters that are not changeable are set to 0

Page Control (continued)	**2h (10b)** = Default Values: The library returns the default values. Requested pages are returned with each supported parameter set to its default Parameters not supported by the library are set to 0. Default values for the Element Address Assignment page are based on the configuration of the library.
	3h (11b) = Saved Values: The library returns the saved values. Requested pages are returned with supported parameters set to its saved value. Parameters not supported by the library are set to 0. This option is valid only with mode pages that can be saved.
Page Code	Specifies which pages the library returns, including: 02h = Protocol Specific Disconnect/Reconnect page 18h = Protocol Specific Logical Unit page 19h = Protocol Specific Port Control page 1Ch = Informational Exceptions TapeAlert page 1Dh = Element Address Assignment page 1Eh = Transport Geometry page 1Fh = Device Capabilities page 3Fh = All pages (in the above order)
SubPage Code	The field indicates the Serial Attached SCSI Port Control Subpage, when the protocol is Serial Attached SCSI and the Page Code is set to 19h. 01h = Serial Attached SCSI Phy Control and Discover Mode Subpage 02h = Serial Attached SCSI Shared Port Control Mode Subpage 03h = Serial Attached SCSI Enhanced Phy Control Mode Subpage
Allocation Length	Specifies the length of the parameter list the library returns. The maximum length is 68h (104d) bytes. The length varies based on the Page Code and Sub-Page Code selected: 8 bytes for the parameter list header (always present) 16 additional bytes for the Fibre Channel Disconnect/Reconnect page 16 additional bytes for the SAS Disconnect/Reconnect page 8 additional bytes for the Fibre Channel Logical Unit Control page 8 additional bytes for the SAS Logical Unit Control page 8 additional bytes for the Fibre Channel Port Control page 16 additional bytes for the SAS Port Control page 104 additional bytes for the SAS Phy Control and Discover Mode Subpage 16 additional bytes for the SAS Shared Port Control Mode Subpage 48 additional bytes for the SAS Enhanced Phy Control Mode Subpage 12 additional bytes for the Informational Exceptions TapeAlert page 20 additional bytes for the Element Address Assignment page 4 additional bytes for the Transport Geometry page 20 additional bytes for the Device Capabilities page The library transfers the number of bytes specified by the Allocation Length or the available Mode Sense data, whichever is less.

Mode Sense (6) Data

The library returns the following mode sense data:

• A four-byte Mode Parameter Header followed by

• One mode page or all mode pages in the order specified in the Page Code list.

Mode pages available include:

"Fibre Channel Disconnect/Reconnect Page"

"SAS Disconnect/Reconnect Page"

"Fibre Channel Logical Unit Page"

"SAS Logical Unit Page"

"Fibre Channel Port Control Page"

"SAS Port Control Page"

"SAS Port Control Page"

"SAS Phy Control and Discover Mode Subpage"

"SAS Shared Control Mode Subpage"

"SAS Enhanced Phy Control Subpage"

"Informational Exceptions TapeAlert Control Page"

"Element Address Assignment Page Definition"

"Transport Geometry Mode Page Definition"

"Device Capabilities Page Definition"

The data can be truncated to the length specified in the allocation length field.

Mode Sense (6) Parameter Header Definition

TABLE 4-47 shows the Mode Sense Parameter Header page.

TABLE 4-47 Mode Sense (6) Parameter Header

Byte	Bit							
	7	6	5	4	3	2	1	0
0	Mode Data Length							
1	Reserved							
2	Reserved							
3	Block Descriptor Length (00h)							

Mode Sense (6) Parameter Header Page Definitions:

Mode Data Length	This field indicates the number of bytes of parameter information available to be transferred to the initiator, regardless of the allocation length. This field excludes the Mode Data Length byte but includes three additional Mode Parameter Header bytes and any mode pages that follow.
Block Descriptor Length	The library does not support block descriptors (00h).

Fibre Channel Disconnect/Reconnect Page

TABLE 4-48 shows the format of the Mode Sense Fibre Channel Disconnect/Reconnect page.

TABLE 4-48 Fibre Channel Disconnect/reconnect Page

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	PS	SPF	Page Code (02h)					
1	Page length (0Eh)							
2	Buffer Full Ratio							
3	Buffer Empty Ratio							
4 to 5	(MSB)			Bus Inactivity Time Limit				(LSB)
6 to 7	(MSB)			Disconnect Time Limit				(LSB)
8 to 9	(MSB)			Connect Time Limit				(LSB)
10 to 11	(MSB)			Maximum Burst Size				(LSB)
12	EMPD	FAA	FAB	FAC	Restricted			
13	Reserved							
14 to 15	(MSB)			First Burst Size				(LSB)

Mode Sense: Fibre Channel Disconnect/Reconnect Page Definitions

PS	The parameters Saveable bit is set to 0.
SPF	The library returns a value of 0 = the SubPage Format bit, indicating page_0 format is being used.
Page Code	This field is set to: 02h = identifies the page as the Disconnect/Reconnect page.
Buffer Full Ratio	This field indicates the device server, during read operations, how full the buffer should be prior to requesting an interconnect tenancy.
Buffer Empty Ratio	This field indicates the device server, during write operations, how empty the buffer should be prior to transmitting an FCP_XFER_RDY IU that requests the initiator to send data.
Bus Inactivity Time Limit	This field indicates the maximum time that the target is permitted to maintain an interconnect tenancy without data or information transfer, measured in transmission word increments. 0000h indicates that there is no bus inactivity limit.

Disconnect Time Limit	This field indicates the minimum delay between interconnect tenancies measured in increments of 128 transmission words.
	0000h indicates that the disconnect time limit does not apply.
Connect Time Limit	The field indicates the maximum duration of a single interconnect tenancy, measured in increments of 128 transmission words.
	0000h indicates that there is no connect time limit.
Maximum Burst Size	This field indicates the maximum size of FCP_DATA IU that the device server shall transfer to the initiator or request from the initiator. This value is expressed in increments of 512 bytes.
	0000h indicates there is no limit on the amount of data transferred per data transfer operation.
EMPD	The Enable Modify Data Pointers bit indicates whether or not the target may use the random buffer access capability to reorder FCP_DATA IUs for a single SCSI command.
	• 0 = The target shall generate continuously increasing relative offset values for each FCP_DATA IU for a single SCSI command.
	• 1 = The target may transfer the FCP_DATA IUs for a single SCSI command in any order.
FAA, FAB, FAC	The fairness access (FA) bits, FAA, FAB, and FAC, indicate whether a target in a loop configuration shall use the access fairness algorithm. A value of 0 indicates that the target does not use fairness, while a value of 1 indicates that the target does use a fairness algorithm.
	• The **FAA bit** controls arbitration when the target wishes to send one or more FCP_DATA IU frames to an initiator.
	• The **FAB bit** controls arbitration when the initiator wishes to send one or more FCP_XFER_RDY IU frames to a target.
	• The **FAC bit** controls arbitration when the target wishes to send an FCP_RSP IU frame to an initiator.
First Burst Size	This field value is expressed in increments of 512.
	0000h indicates that there is no first burst size limit.

SAS Disconnect/Reconnect Page

TABLE 4-49 shows the format of the Mode Sense SAS Disconnect/Reconnect page.

TABLE 4-49 SAS Disconnect/Reconnect Page

Byte	| 7	6	5	Bit 4	3	2	1	0
0	PS	SPF	|	|	Page Code (02h)			
1	Page Length (0Eh)							
2	Reserved (00h)							
3	Reserved (00h)							
4 to 5	(MSB) Bus Inactivity Time Limit (LSB)							
6	Reserved (00h)							
7	Reserved (00h)							
8 to 9	(MSB) Maximum Connect Time Limit (LSB)							
10 to 11	(MSB) Maximum Burst Size (LSB)							
12	Reserved (00h)							
13	Reserved (00h)							
14 to 15	(MSB) First Burst Size (LSB)							

Mode Sense: SAS Disconnect/Reconnect Page Definitions:

PS	The parameters Saveable bit is set to 0.
SPF	The library returns a value of: 0 = SubPage Format bit, indicating page_0 format is being used.
Page Code	This field is set to: 02h = identifies the page as the Disconnect/Reconnect page.
Bus Inactivity Time Limit	This field contains the maximum time in 100 µs increments that an SSP target port is permitted to maintain a connection without transferring a frame to the SSP initiator port. • 0000h indicates that there is no bus inactivity limit.
Maximum Connect Time Limit	This field contains the maximum duration of a connection in 100 µs increments. • 0000h specifies that there is no maximum connection time limit.
Maximum Burst Size	For read data, this field contains the maximum amount of data in 512-byte increments that is transferred during a connection by an SSP target port per I_T_L_Q nexus without transferring at least one frame for a different I_T_L_Q nexus. For write data, the value shall specify the maximum amount of data that an SSP target port requests via a single XFER_RDY frame. 0000h in this field specifies that there is no maximum burst size.
First Burst Size	If the ENABLE FIRST BURST bit in the COMMAND frame is set to zero, then the FIRST BURST SIZE field is ignored. If the ENABLE FIRST BURST bit in the COMMAND frame is set to one, then the value in the FIRST BURST SIZE field contains the maximum amount of write data in 512-byte increments that may be sent by the SSP initiator port to the SSP target port without having to receive an XFER_RDY frame from the SSP target port.

Fibre Channel Logical Unit Page

TABLE 4-50 shows the format of the Fibre Channel Logical Unit page.

TABLE 4-50 Fibre Channel Logical Unit Page

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	PS (0)	SPF (0)	Page Code (18h)					
1	Page Length (06h)							
2	Reserved				Protocol Identifier (0)			
3	Reserved							EPDC (0)
4 to 7	(MSB) Reserved (LSB)							

Fibre Channel Logical Unit Page Definitions:

PS	The Parameters Saveable bit is set to 0.
SPF	The library returns a value of 0 for the SubPage Format bit, indicating page_0 format is being used.
Protocol Identifier	This field is set to 0h indicating the Fibre Channel protocol.
EPDC	Enable Precise Delivery Checking bit is set to 0 (not supported)

SAS Logical Unit Page

TABLE 4-51 shows the format of the SAS Logical Unit Page.

TABLE 4-51 SAS Logical Unit Page

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	PS (0)	SPF (0)	Page Code (18h)					
1	Page Length (06h)							
2	Reserved			TLR	Protocol Identifier (6h)			
3 to 7	(MSB) Reserved (LSB)							

Serial Attached SCSI Logical Unit Page Definitions:

PS	The Parameters Saveable bit is set to 0.
SPF	The library returns a value of 0 for the SubPage Format bit, indicating page_0 format is being used.
Protocol Identifier	The field is set to 06h indicating Serial Attached SCSI protocol.
TLR	• 0b = Transport Layer Retries are disabled. • 1b = Transport Layer Retries are enabled for Transfer Ready and Data Frames for the logical unit.

Fibre Channel Port Control Page

TABLE 4-52 shows the format of the Fibre Channel Port Control page.

TABLE 4-52 Fibre Channel Port Control Page

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	PS (0)	SPF (0)	Page Code (19h)					
1	Page Length (06h)							
2	Reserved				Protocol Identifier (0)			
3	DTFD	PLPB	DDIS	DLM	RHA	ALWI	DTIPE	DTOLI
4	Reserved							
5	Reserved							
6	Reserved					RR_TOV units		
7	Resource Recovery Time Out Value (RR_TOV)							

Fibre Channel Port Control Page Definitions:

PS	The Parameters Saveable bit is set to 0.
SPF	The library returns a value of:
	0 = SubPage Format bit, indicating page_0 format is being used.
Protocol Identifier	This field is set to:
	0h = Indicates the Fibre Channel protocol.
DTFD	Disabled Target Fabric Discovery. If the library is not attached to an arbitrated loop, it shall ignore the DTFD bit.
	0 = The target attached by an arbitrated loop shall discover a fabric loop port if present on the loop and perform the public loop functions defined for targets by FC-FLA.
	1 = The target attached by an arbitrated loop shall not recognize the presence of a fabric loop port on the loop.
PLPB	Prevent Loop Port Bypass. If the library is not attached to an arbitrated loop, it shall ignore the PLPB bit.
	0 = The target allows the Loop Port Bypass (LPB) and Loop Port Enable (PBE) primitive sequences to control the port bypass circuit and participation on the loop as specified by FC-AL-2.
	1 = The target attached to an FC-AL-2 loop shall ignore any Loop Port Bypass (LPB) and Loop Port Enable (LPE) primitive sequences.
DDIS	Disable Discovery. If the library is not attached to an arbitrated loop, it shall ignore the DDIS bit.
	0 = The target shall wait to complete target discovery as defined by FC-PLDA, FC-FLA, and FC-TAPE before allowing processing of tasks to resume.
	1 = The target without a valid FLOGI attached to an arbitrated loop shall not require receipt of Address or Port Discovery (ADISC or PDISC ELSs) following loop initialization as described in FC-PLDA and FC-FLA.
DLM	Disable Loop Master. If the library is not attached to an arbitrated loop, it shall ignore the DLM bit.
	0 = The target may participate in loop master arbitration in the normal manner and, if successful, may become loop master during the loop initialization process.
	1 = The target attached to an FC-AL-2 loop shall not participate in loop master arbitration and shall not become loop master. The target shall only repeat LISM frames it receives.

RHA	Require Hard Address. If the library is not attached to an arbitrated loop, it shall ignore the RHA bit.
	0 = The target follows the normal initialization procedure, including the possibility of obtaining a soft address during the loop initialization process.
	1 = The target attached to an arbitrated loop shall only attempt to obtain its hard address. If there is a conflict for the hard address selection during loop initialization or the target does not have a valid hard address available, the target shall enter the nonparticipating state.
ALWI	Allow Login Without Loop Initialization. If the library is not attached to an arbitrated loop, it shall ignore the ALWI bit.
	0 = The target shall perform the normal loop initialization procedure before entering the monitoring mode and accepting a login ELS.
	1 = The target attached to an FC-AL-2 loop shall use the hard address available in the connector or in device address jumpers, enter the monitoring state in participating mode, and accept logins without using the loop initialization procedure (see FC-AL-2).
DTIPE	Disabled Target Initiated Port Enabled. If the library is not attached to an arbitrated loop, it shall ignore the DTIPE bit.
	0 = The target shall enable itself onto the loop in according to the rules specified in FC-AL-2.
	1 = The target attached to an arbitrated loop shall wait for an initiator to send the Loop Port Enable (LPE) primitive sequence before inserting itself into a loop (see FC-AL-2)
DTOLI	Disable Target Originated Loop Initialization. If the library is not attached to an arbitrated loop, it shall ignore the **DTOLI** bit.
	0 = The target attached by an arbitrated loop shall generate LIP(F7,xx) after it enables a port into a loop.
	1 = The target attached by an arbitrated loop shall not generate a LIP following insertion into the loop.
RR_TOV units	Resource Recovery Time Out Value Units will always be
	011b = 0.1 second units
RR_TOV	Resource Recovery Time Out Value will always be
	F0h = 24 seconds

SAS Port Control Page

TABLE 4-53 shows the format of the SAS Port Control page.

TABLE 4-53 SAS Port Control Page

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	PS (0)	SPF (0)	Page Code (19h)					
1	Page Length (0Eh)							
2	RSVD	Continue AWT	BAE	LED	Protocol Identifier (6h)			
3	Reserved							
4 to 5	(MSB) I_T Nexus Loss Time (LSB)							
6 to 7	(MSB) Initiator Response Timeout (LSB)							
8 to 9	(MSB) Reject to Open Limit (LSB)							
10 to 15	(MSB) Reserved (00h) (LSB)							

SAS Port Control Page Definitions:

PS	The parameters Saveable bit is set to 0.
SPF	The library returns a value of: 0 = SubPage Format bit, indicating page_0 format is being used.
Page Code	This field is set to: 19h = identifies the page as the SAS Port Control mode page.
Protocol Identifier	This field is set to 06h = indicates the Serial Attached SCSI (SAS) protocol.
Continuous AWT	0 = The SAS port shall stop the Arbitration Wait Time timer and set the Arbitration Wait Time timer to zero when it receives an OPEN_REJECT (RETRY). 1 = The SAS port shall not stop the Arbitration Wait Time timer and shall not set the Arbitration Wait Time timer to zero when the SAS port receives an OPEN_REJECT (RETRY).
Broadcast Asynchronous Event	The device server shall: 0 = Disable origination of Broadcast (Asynchronous Event). 1 =Enable origination of Broadcast (Asynchronous Event).

Ready LED Meaning	The Ready LED Meaning bit specifies the READY LED signal behavior.
I_T Nexus Loss Time	This field contains the minimum time that the SSP Target Port shall retry connection requests to an SSP initiator port that are rejected with responses indicating the SSP initiator port may no longer be present before recognizing an I_T nexus loss: 0000h = Vendor-specific amount of time. 0001h - FFFFh = Time in milliseconds. FFFFh = The SSP target port shall never recognize an I_T nexus loss.
Initiator Response Timeout	This field contains the minimum time in milliseconds that the SSP target port shall wait for the receipt of a frame before aborting the command associated with that frame. 0000h indicates that the SSP target port shall wait forever.
Reject to Open Limit	This field contains the minimum time in 10 microsecond increments that the target port shall wait to establish a connection request with an initiator port on an I_T nexus after receiving an OPEN_REJECT (RETRY), OPEN_REJECT (RESERVED CONTINUE 0), or OPEN_REJECT (RESERVED CONTINUE 1) 0000h indicates that minimum time is vendor specific.

SAS Phy Control and Discover Mode Subpage

TABLE 4-54 shows the format of the Serial Attached SCSI Phy Control and Discover Mode Subpage.

TABLE 4-54 SAS Phy Control and Discover Mode Subpage

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	PS (0)	SPF (1)	Page Code (19h)					
1	Subpage Code (01h)							
2 to 3	(MSB)	Page Length (64h)						
								(LSB)
4	Reserved							
5	Reserved				Protocol Identifier (6h)			
6	Generation Code							
7	Number of Phys							
SAS Phy Mode Descriptor List								
8 to 55	(MSB)	First SAS Phy Mode Descriptor						
								(LSB)
56 to 103	(MSB)	Second SAS Phy Mode Descriptor						
								(LSB)

Serial Attached SCSI Phy Control and Discover Mode Subpage Definitions:	
PS	The parameters Saveable bit is set to 0.
SPF	The library returns a value of: 1 = SubPage Format bit, indicates this page uses the sub_page mode.
Page Code	19h, identifies the page as the SAS Port Control mode page.
Sub-Page Code	A value of 01h identifies the sub-page as the SAS Phy Control and Discover Mode Subpage.
Protocol Identifier	06h indicates the Serial Attached SCSI protocol.
Generation Code	This field is a one-byte counter that shall be incremented by one by the device server every time the values in this mode page are changed.
Number of Phys	This field contains the number of phys in the SAS target device and indicates the number of SAS Phy Mode Descriptors in the SAS Phy Mode descriptor list.
SAS Phy Mode Descriptor Data	See TABLE 4-55 for more information.

SAS Phy Mode Descriptor Data

TABLE 4-55 SAS Phy Mode Descriptor Data

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Reserved (00h)							
1	Phy Identifier							
2	Reserved (00h)							
3	Reserved (00h)							
4	RSVD	Attached Device Type		Reserved (0)				
5	Reserved				Negotiated Physical Link Rate			
6	Reserved				Attach SSP Init Port	Attach STP Init Port	Attach SMP Init Port	RSVD
7	Reserved				Attach SSP Tgt Port	Attach STP Tgt Port	Attach SMP Tgt Port	RSVD
8 to 15	(MSB) SAS Address (LSB)							
16 to 23	(MSB) Attached SAS Address (LSB)							
24	Attached Phy Address							
25 to 31	Reserved (00h)							
32	Programmed Minimum Physical Link Rate				Hardware Minimum Physical Link Rate			
33	Programmed Maximum Physical Link Rate				Hardware Maximum Physical Link Rate			
34 to 41	Reserved (00h)							
42 to 43	(MSB) Vendor Specific (LSB)							
44 to 47	Reserved (00h)							

Serial Attached SCSI Phy Mode Descriptor Data Definitions:

PS	The parameters Saveable bit is set to 0.
Phy Identifier	A unique Phy Identifier is returned for each Phy.
Attached Device Type	This field indicates the device type attached to this Phy: 000b = No device attached 001b = SAS device 010b = Expander device 011b = Expander device compliant with a previous version of the SAS standard

Negotiated Physical Link Rate	This field indicates the logical link rate being used by the Phy: 0h = UNKNOWN. Phy is enabled. Unknown Physical Link Rate. 1h = DISABLED. Phy is disabled. 2h = PHY_RESET_PROBLEM 3h = SPINUP_HOLD 4h = PORT_SELECTOR 8h = G1. Physical Link Rate is 1.5 Gb/s 9h = G2. Physical Link Rate is 3.0 Gb/s Ah =G3. Physical Link Rate is 6.0 Gb/s
Attached SSP Initiator Port	This bit indicates the value of the SSP Initiator Port field received in the IDENTIFY address frame during the identification sequence.
Attached STP Initiator Port	This bit indicates the value of the STP Initiator Port field received in the IDENTIFY address frame during the identification sequence.
Attached SMP Initiator Port	This bit indicates the value of the SMP Initiator Port field received in the IDENTIFY address frame during the identification sequence.
Attached SSP Target Port	This bit indicates the value of the SSP Target Port field received in the IDENTIFY address frame during the identification sequence.
Attached STP Target Port	This bit indicates the value of the STP Target Port field received in the IDENTIFY address frame during the identification sequence.
Attached SMP Target Port	This bit indicates the value of the SMP Target Port field received in the IDENTIFY address frame during the identification sequence.
SAS Address	This field indicates the SAS Address of the drive that is the bridged interface for the library or partition.
Attached SAS Address	This field contains the value of the SAS Address field transmitted in the IDENTIFY address frame during the identification sequence.
Attached Phy Address	This field indicates the value of Attached Phy Address field received in the IDENTIFY address frame during the identification sequence.
Programmed Minimum Physical Link Rate	8h = 1.5 Gb/s 9h = 3.0 Gb/s Ah = 6.0Gb/s
Hardware Minimum Physical Link Rate	8h = 1.5 Gb/s 9h = 3.0 Gb/s Ah = 6.0 Gb/s
Programmed Maximum Physical Link Rate	8h = 1.5 Gb/s 9h = 3.0 Gb/s Ah = 6.0 Gb/s
Hardware Maximum Physical Link Rate	8h = 1.5 Gb/s 9h = 3.0 Gb/s Ah = 6.0 Gb/s

SAS Shared Control Mode Subpage

TABLE 4-56 shows the format of the SAS Shared Control Mode Subpage.

TABLE 4-56 SAS Shared Control Mode Subpage

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	PS (0)	SPF (1)	Page Code (19h)					
1	Sub-Page Code (02h)							
2 to 3	MSB		Page Length (0Ch)					LSB
4	Reserved (00h)							
5	Reserved				Protocol Identifier (6h)			
6 to 7	MSB		Power Loss Timeout					LSB
8 to 15	Reserved (00h)							

Serial Attached SCSI Shared Port Control Mode Subpage Definitions:

PS	The parameters Saveable bit is set to 0.
SPF	The library returns a value of 1 for the SubPage Format bit, indicating this page uses the sub_page mode page format.
Page Code	19h identifies the page as the SAS Port Control mode page.
Sub-Page Code	02h identifies the sub-page as the SAS Shared Port Control Mode Subpage.
Protocol Identifier	06h indicaties the Serial Attached SCSI protocol.
Power Loss Timeout	This field contains the maximum time, in one millisecond increments, that a target port shall respond to connection requests with OPEN_REJECT (RETRY) after receiving NOTIFY (POWER LOSSEXPECTED).
	0000h indicates that maximum time is vendor-specific.

SAS Enhanced Phy Control Subpage

TABLE 4-57 shows the format of the Serial Attached SCSI Enhanced Phy Control Mode Subpage.

TABLE 4-57 SAS Enhanced Phy Control Mode Subpage

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	PS (0)	SPF (1)	Page Code (19h)					
1	Sub-Page Code (03h)							
2 to 3	MSB	Page Length (2Ch)						LSB
4	Reserved							
5	Reserved				Protocol Identifier (6h)			
6	Generation Code							
7	Number of Phys							
Enhanced Phy Control Mode Descriptor List								
8 to 27	MSB First Enhanced Phy Control Mode Descriptor LSB							
28 to 47	MSB Second Enhanced Phy Control Mode Descriptor LSB							

SAS Enhanced Phy Control Mode Subpage Definitions:

PS	The parameters Saveable bit is set to 0.
SPF	The library returns a value of 1 for the SubPage Format bit, indicating this page uses the sub_page mode page format.
Page Code	19h identifies the page as the SAS Port Control mode page.
Sub-Page Code	03h identifies the sub-page as the SAS Enhanced Phy Control Mode Subpage.
Protocol Identifier	06h indicaties the Serial Attached SCSI protocol.
Generation Code	This field is a one-byte counter that shall be incremented by one by the device server every time the values in this mode page are changed.
Number of Phys	This field contains the number of phys in the SAS target device and indicates the number of Enhanced Phy Control Mode Descriptors in the Enhanced Phy Control Mode descriptor list.
SAS Phy Mode Descriptors	See TABLE 4-58 for more information.

Enhanced Phy Control Mode Descriptor Data

TABLE 4-58 Enhanced Phy Control Mode Descriptor Data

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Reserved (00h)							
1	Phy Identifier							
2 to 3	(MSB)	Descriptor Length (10h)						(LSB)
4 to 7	(MSB)	Programmed Phy Capabilities						(LSB)
8 to 11	(MSB)	Current Phy Capabilities						(LSB)
12 to 15	(MSB)	Attached Phy Capabilities						(LSB)
16	Reserved (00h)							
17	Reserved (00h)							
18	Reserved			Neg. SSC	Negotiated Physical Link Rate			
19	Reserved							Hdware Muxing Support

Enhanced Phy Control Mode Descriptor Data Definitions:

Phy Identifier	A unique Phy Identifier is returned for each Phy.
Descriptor Length	The library returns a value of 10h (16d) bytes.
Programmed Phy Capabilities	This field indicates the SNW-3 (Speed Negotiation Window) Phy capabilities bits that are going to be transmitted in the next link reset sequence containing SNW-3 as defined in TABLE 4-59.
Current Phy Capabilities	This field indicates the outgoing SNW-3 Phy capabilities bits transmitted in the last link reset sequence as defined in TABLE 4-59. If the last link reset sequence did not include SNW-3, then the Current Phy Capablilities field shall be set to 00000000h.
Attached Phy Capabilities	This field indicates the incoming SNW-3 Phy capabilities bits received in the last SNW-3 as defined in TABLE 4-59. If the last link reset sequence did not include SNW-3, then the Attached Phy Capablilities field shall be set to 00000000h.
Negotiated SSC	The Negotiated SSC bit is only valid when the Negotiated Physical Link Rate is great than or equal to 8h. When valid: 0 = SSC is enabled 1 = SSC is disabled.
Hardware Muxing Supported	0 = The Phy does not support multiplexing. 1 = The Phy supports multiplexing.

Phy Capabilities Data

TABLE 4-59 Phy Capabilities Data

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Start (1B)	TX SSC Type	Reserved		Requested Logical Link Rate			
Supported Settings								
1	G1 Without SSC	G1 With SSC	G2 Without SSC	G2 With SSC	G3 Without SSC	G3 With SSC	Reserved	
2	Reserved (00h)							
3	Reserved							Parity

Phy Capabilities Data Definitions:

TX SSC Type	0 = Indicates that the phy's transmitter uses down-spreading SSC when SSC is enabled (for example, the phy is a SAS phy), or that the phy does not support SSC. 1 = Indicates that the phy's transmitter uses center-spreading SSC when SSC is enabled (for example, the phy is an expander phy).
Requested Logical Link Rate	This field indicates if the Phy device supports multiplexing and, if so, the logical link rate that the Phy device is requesting.
G1 Without SSC	The Phy: 0 = Does not support G1 – 1.5 Gbps without SSC. 1 = Supports G1 – 1.5 Gbps without SSC.
G1 With SSC	The Phy: 0 = Does not support G1 – 1.5 Gbps with SSC. 1 = Supports G1 – 1.5 Gbps with SSC.
G2 Without SSC	The Phy: 0 = Does not support G2 – 3 Gbps without SSC. 1 = Supports G2 – 3 Gbps without SSC.
G2 With SSC	The Phy: 0 = Does not support G2 – 3 Gbps with SSC. 1 = Supports G2 – 3 Gbps with SSC.
G3 Without SSC	The Phy: 0 = Does not support G3 – 6 Gbps without SSC. 1 = Supports G3 – 6 Gbps without SSC.
G3 With SSC	The Phy: 0 = Does not support G3 – 6 Gbps with SSC. 1 = Supports G3 – 6 Gbps with SSC.

Parity	The Parity bit shall be set to one or zero such that the total number of SNW-3 Phy device capabilities bits that are set to one is even, including the Start bit and the Parity bit.

Informational Exceptions TapeAlert Control Page

TABLE 4-60 shows the format of the Mode Sense (6) Informational Exceptions TapeAlert Control page.

TABLE 4-60 Informational Exceptions TapeAlert Control Page

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	PS (0)	SPF (0)	Page Code (1Ch)					
1	Page Length (0Ah)							
2	Perf (0)	Rsvd (0)	EBF (0)	EWasc (0)	DExcpt (1)	Test	Rsvd (0)	LogErr (0)
3	Reserved (0h)				MRIE (3h)			
4 to 7	(MSB) Interval Timer (LSB)							
8 to 11	(MSB) Report Count (LSB)							

Informational Exceptions TapeAlert Page Definitions:

PS	The Parameters Saveable bit is set to 0.
SPF	The library returns a value of: 0 = SubPage Format bit, indicating page_0 format is being used
Perf	The performance bit is 0 = Indicates acceptance of informational exception operations that cause delays.
EBF	Enable Background Functions bit will always be 0.
EWasc	Enable Warning bit will always be 0.
DExcpt	The exception bit is 1, which indicates that the library disables all information exception operations ignoring the MRIE field. In this mode the software must poll the TapeAlert Log page
Test	The test operations bit is 0, which requests that the library not generate any false/test informational exception conditions.
LogErr	The log information exception conditions bit is 0, which indicates that logging of informational exception conditions is vendor-specific.
MRIE	This field indicates the method the tape library uses to report informational exception conditions. The field is set to 3h but is ignored because the DExcpt bit is on.

Interval Timer	Bytes 4 through 7 are set to 00h, which indicates that the library will only report the informational exception condition one time.
Report Count	Bytes 8 through 11 are set to the current report counter value.

Element Address Assignment Page Definition

TABLE 4-61 defines the Element Address Assignment page of the Mode Sense (6) command.

TABLE 4-61 Mode Sense (6) Element Address Assignment Page

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	PS (1)	Rsvd (0)	Page Code (1Dh)					
1	Parameter Length (12h)							
2 to 3	(MSB) First Medium Transport Element Address (LSB)							
4 to 5	(MSB) Number of Medium Transport Elements (LSB)							
6 to 7	(MSB) First Storage Element Address (LSB)							
8 to 9	(MSB) Number of Storage Elements (LSB)							
10 to 11	(MSB) First Import/Export Element Address (LSB)							
12 to 13	(MSB) Number Import/Export Elements (LSB)							
14 to 15	(MSB) First Data Transfer Element Address (LSB)							
16 to 17	(MSB) Number Data Transfer Elements (LSB)							
18 to 19	(MSB) Reserved (00h) (LSB)							

Mode Sense (6) Element Address Assignment Page Definitions:

PS	The Parameters Saveable bit specifies that the library can save this page to non-volatile memory and returns a value of 1.
Page Code	Identifies the Element Address Assignment mode page and returns a value of 1Dh.
Parameter Length	12h = Indicates the amount of element address data following this byte.
First Medium Transport Element Address	Identifies the address of the robot and returns a value of 0h.
Number of Medium Transport Elements	0001h = Identifies the number of hands within the library
First Storage Element Address	03E8h = Identifies the starting address of the cartridge tape storage cells. (The default starting address)
Number of Storage Elements	Identifies the number of cartridge tape storage cells within the library. The total number of cartridge tape storage cells depends on how the library is configured.
First Import / Export Element Address	000Ah = Identifies the address of the first Import/Export element. (The default starting address)
Number of Import / Export Elements	Identifies the total number of import/export cells.
First Data Transfer Element Address	1F4h = Identifies the address of the first tape transport installed (The default address)
Number of Data Transfer Elements	Identifies the number of tape drives in the library, and the library returns the configured count.

Transport Geometry Mode Page Definition

This table defines the Mode Sense Transport Geometry Mode page.

TABLE 0-1 Transport Geometry Mode Page

Byte	Bit							
	7	6	5	4	3	2	1	0
0	PS (0)	Rsvd	Page Code (1Eh)					
1	Parameter Length (02h)							
2	Reserved (0)							Rotate (0)
3	Member Number in Transport Element Set (00h)							

Transport Geometry Mode Page Definitions:

PS	The Parameters Saveable bit is set to 0.
Page Code	This field identifies the Transport Geometry mode page; the library returns a value of 1Eh.

Parameter Length	This field indicates the number of additional types of transport geometry descriptor data to follow the header. Each descriptor has two bytes of information. The library has one transport mechanism and returns a value of 02h.
Rotate	This field identifies the ability of the transport mechanism to handle two-sided media. The library does not use multiple-sided media and returns a value of 0.
Member Number in Transport Element Set	This field identifies the specific transport element in the system to which this descriptor is applied. The library has one transport element and returns a value of 00h.

Device Capabilities Page Definition

TABLE 4-62 defines the Device Capabilities page of the Mode Sense command.

TABLE 4-62 Device Capabilities Page

Byte	Bit							
	7	6	5	4	3	2	1	0
0	PS (0)	Rsvd (0)	Page Code (1Fh)					
1	Parameter Length (12h)							
2	Reserved (0h)				StorDT[1] (1)	StorI/E[2] (1)	StorST[3] (1)	StorMT[4] (0)
3	Reserved (0h)							
4	Reserved (0h)				MT->DT (0)	MT->I/E (0)	MT->ST (0)	MT->MT (0)
5	Reserved (0h)				ST->DT (1)	ST->I/E (1)	ST->ST (1)	ST->MT (0)
6	Reserved (0h)				I/E->DT (1)	I/E->I/E (1)	I/E->ST (1)	I/E->MT (0)
7	Reserved (0h)				DT->DT (1)	DT->I/E (1)	DT->ST (1)	DT->MT (0)
8 to 11	Reserved (00h)							
12	Reserved (0h)				MT<>DT (0)	MT<>I/E (0)	MT<>ST (0)	MT<>MT (0)
13	Reserved (0h)				ST<>DT (0)	ST<>I/E (0)	ST<>ST (0)	ST<>MT (0)
14	Reserved (0h)				I/E<>DT (0)	I/E<>I/E (0)	I/E<>ST (0)	I/E<>MT (0)

Mode Select (6)

TABLE 4-62 Device Capabilities Page

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
15	Reserved (0h)				DT->DT (0)	DT<>I/E (0)	DT<>ST (0)	DT<>MT (0)
16 to 19	Reserved (00h)							

Notes:
DT - Data Transfer Element (tape drive)
I/E = Import/Export Element (cartridge access port cell and the PTP cells)
ST = Storage Element (cartridge tape storage cell)
MT= Medium Transport (hand)

Device Capabilities Page Definitions:

PS	The Parameters Saveable bit is set to 0.
Page Code	This field identifies the Device Capabilities mode page and always contains a value of 1Fh.
Parameter Length	This field indicates the amount of device capabilities data following this byte. The library returns a value of 12h (18d).
StorDT	This field identifies the ability of a tape drive to perform the function of element storage. The library returns a value of 1.
StorI/E	This field identifies the ability of a CAP cell to perform the function of element storage. The library returns a value of 1.
StorST	This field identifies the ability of the cartridge tape storage cells to perform the function of element storage. The library returns a value of 1.
StorMT	This field identifies the ability of the hand to perform the function of element storage. The hand cannot be used as the source or destination of a move. The library returns a value of 0.
MT -> DT	This field identifies the support for the Move Medium command, where the source is the hand, and the destination is a tape drive. The library returns a value of 0.
MT -> I/E	This field identifies the support for the Move Medium command, where the source is the hand, and the destination is a CAP cell. The library returns a value of 0.
MT -> ST	This field identifies the support for the Move Medium command, where the source is the hand, and the destination is a cartridge tape storage cell. The library returns a value of 0.
MT -> MT	This field identifies the support for the Move Medium command, where both the source and the destination is the hand. The library returns a value of 0.

Device Capabilities Page Definitions:

ST -> DT	This field identifies the support for the Move Medium command, where the source is a cartridge tape storage cell, and the destination is a tape drive. The library returns a value of 1.
ST -> I/E	This field identifies the support for the Move Medium command, where the source is a cartridge tape storage cell, and the destination is a CAP cell. The library returns a value of 1.
ST -> ST	This field identifies the support for the Move Medium command, where the source is a cartridge tape storage cell, and the destination is a cartridge tape storage cell. The library returns a value of 1.
ST -> MT	This field identifies the support for the Move Medium command, where the source is a cartridge tape storage cell, and the destination is the hand. The library returns a value of 0.
I/E -> DT	This field identifies the support for the Move Medium command, where the source is a CAP cell, and the destination is a tape drive. The library returns a value of 1.
I/E-> I/E	This field identifies the support for the Move Medium command, where both the source, and the destination is a CAP cell. The library returns a value of 1.
I/E -> ST	This field identifies the support for the Move Medium command, where the source is a CAP cell, and the destination is a cartridge tape storage cell. The library returns a value of 1.
I/E -> MT	This field identifies the support for the Move Medium command, where the source is a CAP cell, and the destination is the hand. The library returns a value of 0.
DT -> DT	This field identifies the support for the Move Medium command, where the source, and the destination is a tape drive. The library returns a value of 1.
DT -> I/E	This field identifies the support for the Move Medium command, where the source is a tape drive, and the destination is a CAP cell. The library returns a value of 1.
DT -> ST	This field identifies the support for the Move Medium command, where the source is a tape drive, and the destination is a cartridge tape storage cell. The library returns a value of 1.
DT -> MT	This field identifies the support for the Move Medium command, where the source is a tape drive, and the destination 1 element is the hand. The library returns a value of 0.
MT < > DT	This field identifies the support for the Exchange Medium command, where the source and destination 2 elements are the hand, and the destination 1 element is a tape drive. The library returns a value of 0.
MT < > I/E	This field identifies the support for the Exchange Medium command, where the source and destination 2 elements are the hand, and the destination 1 element is a CAP cell. The library returns a value of 0.

Device Capabilities Page Definitions:

MT < > ST	This field identifies the support for the Exchange Medium command, where the source and destination 2 elements are the hand, and the destination 1 element is a cartridge tape storage cell. The library returns a value of 0.
MT < > MT	This field identifies the support for the Exchange Medium command, where the source and destination 2 elements are the hand, and the destination 1 element is the hand. The library returns a value of 0.
ST < > DT	This field identifies the support for the Exchange Medium command, where the source and destination 2 elements are a cartridge tape storage cell, and the destination 1 element is a tape drive. The library returns a value of 0.
ST < > I/E	This field identifies the support for the Exchange Medium command, where the source and destination 2 elements are a cartridge tape storage cell, and the destination 1 element is a CAP cell. The library returns a value of 0.
ST < > ST	This field identifies support for the Exchange Medium command, where the source and destination 2 elements are a cartridge tape storage cell, and the destination 1 element is a cartridge tape storage cell. The library returns a value of 0.
ST < > MT	This field identifies the support for the Exchange Medium command, where the source and destination 2 elements are a cartridge tape storage cell, and the destination 1 element is the hand. The library returns a value of 0.
I/E < > DT	This field identifies the support for the Exchange Medium command, where the source and destination 2 elements are a CAP cell, and the destination 1 element is a tape drive. The library returns a value of 0.
I/E < > I/E	This field identifies the support for the Exchange Medium command, where the source and destination 2 elements are a CAP cell, and the destination 1 element is a CAP cell. The library returns a value of 0.
I/E < > ST	This field identifies the support for the Exchange Medium command, where the source and destination 2 elements are a CAP cell, and the destination 1 element is a cartridge tape storage cell. The library returns a value of 0.
I/E < > MT	This field identifies the support for the Exchange Medium command, where the source and destination 2 elements are a CAP cell, and the destination 1 element is the hand. The library returns a value of 0.
DT < > DT	This field identifies the support for the Exchange Medium command, where the source and destination 2 elements are a tape drive, and the destination 1 element is a tape drive. The library returns a value of 0.
DT < > I/E	This field identifies the support for the Exchange Medium command, where the source and destination 2 elements are a tape drive, and the destination 1 element is a CAP cell. The library returns a value of 0.

Device Capabilities Page Definitions:

DT < > ST	This field identifies the support for the Exchange Medium command, where the source and destination 2 elements are a tape drive, and the destination 1 element is a cartridge tape storage cell. The library returns a value of 0.
DT < > MT	This field identifies the support for the Exchange Medium command, where the source and destination 2 elements are a tape drive, and the destination 1 element is the hand. The library returns a value of 0.

Mode Sense (10)

The 10-byte Mode Sense command (5Ah) enables the library to report its operating mode parameters to the initiator.

TABLE 4-63 Mode Sense (10) Command

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Operation Code (5Ah)							
1	Ignored			LLBA (0)	DBD	Reserved (0)		
2	Page Control		Page Code					
3	SubPage Code							
4 to 6	(MSB) Reserved (LSB)							
7 to 8	(MSB) Allocation Length (LSB)							
9	Control Byte							

Mode Sense (10) Command Definitions:

LLBA	The library returns a value of 0, indicating the LONGBLA bit shall be zero in the parameter data returned by the library.
DBD	Disable Block Descriptors is ignored.
Page Control	Defines the type of parameters to be returned for the Mode Sense command, values include:
	0h (00b) = Current Values: The library returns the current parameter values, including: Parameters set in the last successful Mode Select command. Default values if saved values are unavailable or invalid. Saved values if a MODE command has not been executed since the last power-on, interface reset, or Task Management Reset.
	1h (01b) = Changeable Values: The library returns the changeable parameter masks. All requested pages are returned Pages indicate which parameters are changeable by the initiator All bits of changeable parameters are set to 1 All bits of parameters that are not changeable are set to 0

Page Control	2h (10b) = Default Values: The library returns the default values. Requested pages are returned with each supported parameter set to its default Parameters not supported by the library are set to 0. Default values for the Element Address Assignment page are based on the configuration of the library.
	3h (11b) = Saved Values: The library returns the saved values. Requested pages are returned with supported parameters set to saved values. Parameters not supported by the library are set to 0. This option is valid only with mode pages that can be saved.
Page Code	Specifies which pages the library returns, including: 00h = Physical Configuration Page 02h = Protocol Specific Disconnect/Reconnect page 18h = Protocol Specific Logical Unit page 19h = Protocol Specific Port Control page 1Ch = Informational Exceptions TapeAlert Control page 1Dh = Element Address Assignment page 1Eh = Transport Geometry page 1Fh = Device Capabilities page 3Fh = All pages (in the above order) except Physical Configuration Page
SubPage Code	The field indicates the Serial Attached SCSI Port Control Subpage, when the protocol is Serial Attached SCSI and the Page Code is set to 19h. 01h = Serial Attached SCSI Phy Control and Discover Mode Subpage 02h = Serial Attached SCSI Shared Port Control Mode Subpage 03h = Serial Attached SCSI Enhanced Phy Control Mode Subpage
Allocation Length	Specifies the length of the parameter list the library returns. The maximum length is 1A4h (420d) bytes. The length varies based on the Page Code and Sub-Page Code selected: 8 bytes for the parameter list header (always present) 16 additional bytes for the Fibre Channel Disconnect/Reconnect page 16 additional bytes for the SAS Disconnect/Reconnect page 8 additional bytes for the Fibre Channel Logical Unit Control page 8 additional bytes for the SAS Logical Unit Control page 8 additional bytes for the Fibre Channel Port Control page 16 additional bytes for the SAS Port Control page 104 additional bytes for the SAS Phy Control and Discover Mode Subpage 16 additional bytes for the SAS Shared Port Control Mode Subpage 48 additional bytes for the SAS Enhanced Phy Control Mode Subpage 12 additional bytes for the Informational Exceptions TapeAlert page 20 additional bytes for the Element Address Assignment page 4 additional bytes for the Transport Geometry page 20 additional bytes for the Device Capabilities page 412 additional bytes for the Physical Configuration Page

Mode Sense (10) Data

The library returns the following mode sense data:

- A eight-byte Mode Parameter Header followed by:

- One mode page or all mode pages in the order specified in the Page Code list.

- The mode pages available are:

"Mode Sense (10) Parameter Header Page" on page 123

"Fibre Channel Disconnect/reconnect Page" on page 124

"SAS Disconnect/Reconnect Page" on page 126

"Fibre Channel Logical Unit Page" on page 128

"SAS Logical Unit Page" on page 129

"Fibre Channel Port Control Page" on page 129

"SAS Port Control Page" on page 132

"SAS Phy Control and Discover Mode Subpage" on page 134

"SAS Shared Port Control Mode Subpage" on page 137

"SAS Enhanced Phy Control Subpage" on page 138

"Informational Exceptions TapeAlert Control Page" on page 141 or

"Element Address Assignment Page Definition" on page 142

"Transport Geometry Mode Page Definition" on page 144

"Device Capabilities Page Definition" on page 145

"Physical Configuration Page Definition" on page 149

- The data can be truncated to the length specified in the allocation length field.

Mode Sense (10) Parameter Header Definition

TABLE 4-64 shows the Mode Sense Parameter Header page.

TABLE 4-64 Mode Sense (10) Parameter Header Page

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	MSB of Mode Data Length							
1	LSB of Mode Data Length							
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	MSB of Block Descriptor Length							
7	LSB of Block Descriptor Length							

Mode Sense (10) Parameter Header Page Definitions:

Mode Data Length	This field indicates the number of bytes of parameter information available to be transferred to the initiator, regardless of the allocation length. This field excludes the Mode Data Length byte but includes three additional Mode Parameter Header bytes and any mode pages that follow.
Block Descriptor Length	The library does not support block descriptors (00h).

Fibre Channel Disconnect/Reconnect Page

TABLE 4-65 shows the format of the Mode Sense Fibre Channel Disconnect/
Reconnect page.

TABLE 4-65 Fibre Channel Disconnect/reconnect Page

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	PS	SPF	Page Code (02h)					
1	Page length (0Eh)							
2	Buffer Full Ratio							
3	Buffer Empty Ratio							
4 to 5	(MSB)	Bus Inactivity Limit						(LSB)
6 to 7	(MSB)	Disconnect Time Limit						(LSB)
8 to 9	(MSB)	Connect Time Limit						(LSB)
10 to 11	(MSB)	Maximum Burst Size						(LSB)
12	EMPD	FAA	FAB	FAC	Restricted			
13	Reserved							
14 to 15	(MSB)	First Burst Size						(LSB)

Mode Sense: Fibre Channel Disconnect/Reconnect Page Definitions

PS	The parameters Saveable bit is set to 0.
SPF	The library returns a value of 0 = the SubPage Format bit, indicating page_0 format is being used.
Page Code	This field is set to: 02h = identifies the page as the Disconnect/Reconnect page.
Buffer Full Ratio	This field indicates the device server, during read operations, how full the buffer should be prior to requesting an interconnect tenancy.
Buffer Empty Ratio	This field indicates the device server, during write operations, how empty the buffer should be prior to transmitting an FCP_XFER_RDY IU that requests the initiator to send data.
Bus Inactivity Limit	This field indicates the maximum time that the target is permitted to maintain an interconnect tenancy without data or information transfer, measured in transmission word increments. n 0000h indicates that there is no bus inactivity limit.
Disconnect Time Limit	This field indicates the minimum delay between interconnect tenancies measured in increments of 128 transmission words. n 0000h indicates that the disconnect time limit does not apply.
Connect Time Limit	The field indicates the maximum duration of a single interconnect tenancy, measured in increments of 128 transmission words. n 0000h indicates that there is no connect time limit.
Maximum Burst Size	This field indicates the maximum size of FCP_DATA IU that the device server shall transfer to the initiator or request from the initiator. This value is expressed in increments of 512 bytes. n 0000h indicates there is no limit on the amount of data transferred per data transfer operation.
EMPD	The Enable Modify Data Pointers bit indicates whether or not the target may use the random buffer access capability to reorder FCP_DATA IUs for a single SCSI command. n 0 = The target shall generate continuously increasing relative offset values for each FCP_DATA IU for a single SCSI command. n 1 = The target may transfer the FCP_DATA IUs for a single SCSI command in any order.
FAA, FAB, FAC	The fairness access (FA) bits, FAA, FAB, and FAC, indicate whether a target in a loop configuration shall use the access fairness algorithm. A value of 0 indicates that the target does not use fairness, while a value of 1 indicates that the target does use a fairness algorithm. n The **FAA bit** controls arbitration when the target wishes to send one or more FCP_DATA IU frames to an initiator. n The **FAB bit** controls arbitration when the initiator wishes to send one or more FCP_XFER_RDY IU frames to a target. n The **FAC bit** controls arbitration when the target wishes to send an FCP_RSP IU frame to an initiator.
First Burst Size	This field value is expressed in increments of 512. n 0000h indicates that there is no first burst size limit.

SAS Disconnect/Reconnect Page

TABLE 4-66 shows the format of the Mode Sense Serial Attached SCSI Disconnect/Reconnect page.

TABLE 4-66 SAS Disconnect/Reconnect Page

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	PS	SPF	Page Code (02h)					
1	Page Length (0Eh)							
2	Reserved (00h)							
3	Reserved (00h)							
4 to 5	(MSB) Bus Inactivity Time Limit (LSB)							
6	Reserved (00h)							
7	Reserved (00h)							
8 to 9	(MSB) Maximum Connect Time Limit (LSB)							
10 to 11	(MSB) Maximum Burst Size (LSB)							
12	Reserved (00h)							
13	Reserved (00h)							
14 to 15	(MSB) First Burst Size (LSB)							

Mode Sense: SAS Disconnect/Reconnect Page Definitions:

PS	The parameters Saveable bit is set to 0.
SPF	The library returns a value of: 0 = SubPage Format bit, indicating page_0 format is being used.
Page Code	This field is set to: 02h = identifies the page as the Disconnect/Reconnect page.
Bus Inactivity Time Limit	This field contains the maximum time in 100 μs increments that an SSP target port is permitted to maintain a connection without transferring a frame to the SSP initiator port. n 0000h indicates that there is no bus inactivity limit.
Maximum Connect Time Limit	This field contains the maximum duration of a connection in 100 μs increments. n 0000h specifies that there is no maximum connection time limit.
Maximum Burst Size	For read data, this field contains the maximum amount of data in 512-byte increments that is transferred during a connection by an SSP target port per I_T_L_Q nexus without transferring at least one frame for a different I_T_L_Q nexus. For write data, the value shall specify the maximum amount of data that an SSP target port requests via a single XFER_RDY frame. n 0000h in this field specifies that there is no maximum burst size.
First Burst Size	If the ENABLE FIRST BURST bit in the COMMAND frame is set to zero, then the FIRST BURST SIZE field is ignored. If the ENABLE FIRST BURST bit in the COMMAND frame is set to one, then the value in the FIRST BURST SIZE field contains the maximum amount of write data in 512-byte increments that may be sent by the SSP initiator port to the SSP target port without having to receive an XFER_RDY frame from the SSP target port.

Fibre Channel Logical Unit Page

TABLE 4-67 shows the format of the Fibre Channel Logical Unit page.

TABLE 4-67   Fibre Channel Logical Unit Page

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	PS (0)	SPF (0)	Page Code (18h)					
1	Page Length (06h)							
2	Reserved				Protocol Identifier (0)			
3	Reserved							EPDC
4 to 7	(MSB) Reserved (LSB)							

Fibre Channel Logical Unit Page Definitions:

PS	The Parameters Saveable bit is set to 0.
SPF	The library returns a value of 0 for the SubPage Format bit, indicating page_0 format is being used.
Protocol Identifier	This field is set to 0h indicating the Fibre Channel protocol.
EPDC	The Enable Precise Delivery Checking bit is defined as follows: • 0 = The target shall not use the precise delivery function and shall ignore the contents of the CRN field. • 1 = The logical unit shall use precise delivery function defined in the FCP-2 standard.

SAS Logical Unit Page

TABLE 4-68 shows the format of the Serial Attached SCSI (SAS) Logical Unit Page.

TABLE 4-68 SAS Logical Unit Page

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	PS (0)	SPF (0)	Page Code (18h)					
1	Page Length (06h)							
2	Reserved			TLR	Protocol Identifier (6h)			
3 to 7	(MSB)	Reserved						(LSB)

Serial Attached SCSI Logical Unit Page Definitions:

PS	The Parameters Saveable bit is set to 0.
SPF	The library returns a value of 0 for the SubPage Format bit, indicating page_0 format is being used.
Protocol Identifier	The field is set to 6h indicating the Serial Attached SCSI (SAS) protocol.
TLR	0b = Transport Layer Retries are disabled.
	1b = Transport Layer Retries are enabled for Transfer Ready and Data Frames for the logical unit

Fibre Channel Port Control Page

TABLE 4-69 shows the format of the Fibre Channel Port Control page.

TABLE 4-69 Fibre Channel Port Control Page

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	PS (0)	SPF (0)	Page Code (19h)					
1	Page Length (06h)							
2	Reserved				Protocol Identifier (0)			
3	DTFD	PLPB	DDIS	DLM	RHA	ALWI	DTIPE	DTOLI
4	Reserved							
5	Reserved							
6	Reserved					RR_TOV units		
7	Resource Recovery Time Out Value (RR_TOV)							

Fibre Channel Port Control Page Definitions:

PS	The Parameters Saveable bit is set to 0.
SPF	SPF = The library returns a value of: 0 = SubPage Format bit, indicating page_0 format is being used.
Protocol Identifier	This field is set to 0h indicating the Fibre Channel protocol.
DTFD	Disabled Target Fabric Discovery. If the library is not attached to an arbitrated loop, it shall ignore the DTFD bit. 0 = The target attached by an arbitrated loop shall discover a fabric loop port if present on the loop and perform the public loop functions defined for targets by FC-FLA. 1 = The target attached by an arbitrated loop shall not recognize the presence of a fabric loop port on the loop.
PLPB	Prevent Loop Port Bypass. If the library is not attached to an arbitrated loop, it shall ignore the PLPB bit. 0 = The target allows the Loop Port Bypass (LPB) and Loop Port Enable (PBE) primitive sequences to control the port bypass circuit and participation on the loop as specified by FC-AL-2. 1 = The target attached to an FC-AL-2 loop shall ignore any Loop Port Bypass (LPB) and Loop Port Enable (LPE) primitive sequences.
DDIS	Disable Discovery. If the library is not attached to an arbitrated loop, it shall ignore the DDIS bit. 0 = The target shall wait to complete target discovery as defined by FC-PLDA, FC-FLA, and FC-TAPE before allowing processing of tasks to resume. 1 = The target without a valid FLOGI attached to an arbitrated loop shall not require receipt of Address or Port Discovery (ADISC or PDISC ELSs) following loop initialization as described in FC-PLDA and FC-FLA.
DLM	Disable Loop Master. If the library is not attached to an arbitrated loop, it shall ignore the DLM bit. 0 = The target may participate in loop master arbitration in the normal manner and, if successful, may become loop master during the loop initialization process. 1 = The target attached to an FC-AL-2 loop shall not participate in loop master arbitration and shall not become loop master. The target shall only repeat LISM frames it receives.
RHA	Require Hard Address. If the library is not attached to an arbitrated loop, it shall ignore the RHA bit. 0 = The target follows the normal initialization procedure, including the possibility of obtaining a soft address during the loop initialization. 1 = The target attached to an arbitrated loop shall only attempt to obtain its hard address. If there is a conflict for the hard address selection during loop initialization or the target does not have a valid hard address available, the target shall enter the nonparticipating state.

ALWI	Allow Login Without Loop Initialization. If the library is not attached to an arbitrated loop, it shall ignore the ALWI bit.
	0 = The target shall perform the normal loop initialization procedure before entering the monitoring mode and accepting a login ELS.
	1 = The target attached to an FC-AL-2 loop shall use the hard address available in the connector or in device address jumpers, enter the monitoring state in participating mode, and accept logins without using the loop initialization procedure (see FC-AL-2).
DTIPE	Disabled Target Initiated Port Enabled. If the library is not attached to an arbitrated loop, it shall ignore the DTIPE bit.
	0 = The target shall enable itself onto the loop in according to the rules specified in FC-AL-2.
	1 = The target attached to an arbitrated loop shall wait for an initiator to send the Loop Port Enable (LPE) primitive sequence before inserting itself into a loop (see FC-AL-2)
DTOLI	Disable Target Originated Loop Initialization. If the library is not attached to an arbitrated loop, it shall ignore the **DTOLI** bit.
	0 = The target attached by an arbitrated loop shall generate LIP(F7,xx) after it enables a port into a loop.
	1 = The target attached by an arbitrated loop shall not generate a LIP following insertion into the loop.
RR_TOV units	Resource Recovery Time Out Value Units will always be:
	011b = 0.1 second units
RR_TOV	Resource Recovery Time Out Value will always be:
	F0h = 24 seconds

SAS Port Control Page

TABLE 4-70 shows the format of the Serial Attached SCSI (SAS) Port Control page.

TABLE 4-70 SAS Port Control Page

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	PS (0)	SPF (0)	Page Code (19h)					
1	Page Length (0Eh)							
2	RSVD	Continue AWT	BAE	LED	Protocol Identifier (6h)			
3	Reserved							
4 to 5	(MSB) I_T Nexus Loss Time (LSB)							
6 to 7	(MSB) Initiator Response Timeout (LSB)							
8 to 9	(MSB) Reject to Open Limit (LSB)							
10 to 15	(MSB) Reserved (00h) (LSB)							

Serial Attached SCSI Port Control Page Definitions:

PS	The parameters Saveable bit is set to 0.
SPF	The library returns a value of: 0 = SubPage Format bit, indicating page_0 format is being used.
Page Code	This field is set to: 19h = identifies the page as the SAS Port Control mode page.
Protocol Identifier	This field is set to: 06h = indicates the Serial Attached SCSI protocol.
Continue AWT	Continuous Arbitration Wait Time (AWT) 0 = The SAS port shall stop the AWT timer and set the AWT timer to zero when it receives an OPEN_REJECT (RETRY). 1 = The SAS port shall not stop the AWT timer and shall not set the AWT timer to zero when the SAS port receives an OPEN_REJECT (RETRY).
BAE	Broadcast Asynchronous Event (BAE). The device server shall: 0 = Disable origination of Broadcast (Asynchronous Event). 1 = Enable origination of Broadcast (Asynchronous Event).
Ready LED Meaning	The Ready LED Meaning bit specifies the READY LED signal behavior.
I_T Nexus Loss Time	This field contains the minimum time that the SSP Target Port shall retry connection requests to an SSP initiator port that are rejected with responses indicating the SSP initiator port may no longer be present before recognizing an I_T nexus loss: 0000h = Vendor-specific amount of time. 0001h - FFFFh = Time in milliseconds. FFFFh = The SSP target port shall never recognize an I_T nexus loss.
Initiator Response Timeout	This field contains the minimum time in milliseconds that the SSP target port shall wait for the receipt of a frame before aborting the command associated with that frame. • 0000h indicates that the SSP target port shall wait forever.
Reject to Open Limit	This field contains the minimum time in 10 microsecond increments that the target port shall wait to establish a connection request with an initiator port on an I_T nexus after receiving an OPEN_REJECT (RETRY), OPEN_REJECT (RESERVED CONTINUE 0), or OPEN_REJECT (RESERVED CONTINUE 1) • 0000h indicates that minimum time is vendor specific.

SAS Phy Control and Discover Mode Subpage

TABLE 4-71 shows the format of the Serial Attached SCSI (SAS) Phy Control and Discover Mode Subpage.

TABLE 4-71 SAS Phy Control and Discover Mode Subpage

Byte	\>\> Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	PS (0)	SPF (1)	Page Code (19h)					
1	Subpage Code (01h)							
2 to 3	(MSB)	Page Length (64h)						
								(LSB)
4	Reserved							
5	Reserved				Protocol Identifier (6h)			
6	Generation Code							
7	Number of Phys							
SAS Phy Mode Descriptor List								
8 to 55	(MSB)	First SAS Phy Mode Descriptor						
								(LSB)
56 to 103	(MSB)	Second SAS Phy Mode Descriptor						
								(LSB)

Serial Attached SCSI Phy Control and Discover Mode Subpage Definitions:

PS	The parameters Saveable bit is set to 0.
SPF	The library returns a value of: 1 = SubPage Format bit, indicates this page uses the sub_page mode.
Page Code	19h = identifies the page as the SAS Port Control mode page.
Sub-Page Code	A value of 01h identifies the sub-page as the SAS Phy Control and Discover Mode Subpage.
Protocol Identifier	06h indicates the Serial Attached SCSI (SAS) protocol.
Generation Code	This field is a one-byte counter that shall be incremented by one by the device server every time the values in this mode page are changed.
Number of Phy	This field contains the number of Phy modes in the SAS target device and indicates the number of SAS Phy mode descriptors in the SAS Phy mode descriptor list.
SAS Phy Mode Descriptor Data	See TABLE 4-72 for more information.

SAS Phy Mode Descriptor Data

TABLE 4-72 SAS Phy Mode Descriptor Data

Byte	Bit 7	6	5	4	3	2	1	0
0	Reserved (00h)							
1	Phy Identifier							
2	Reserved (00h)							
3	Reserved (00h)							
4	RSVD	Attached Device Type		Reserved (0)				
5	Reserved				Negotiated Physical Link Rate			
6	Reserved				Attach SSP Init Port	Attach STP Init Port	Attach SMP Init Port	RSVD
7	Reserved				Attach SSP Tgt Port	Attach STP Tgt Port	Attach SMP Tgt Port	RSVD
8 to 15	(MSB)			SAS Address				(LSB)
16 to 23	(MSB)			Attached SAS Address				(LSB)
24	Attached Phy Address							
25 to 31	Reserved (00h)							
32	Programmed Minimum Physical Link Rate				Hardware Minimum Physical Link Rate			
33	Programmed Maximum Physical Link Rate				Hardware Maximum Physical Link Rate			
34 to 41	Reserved (00h)							
42 to 43	(MSB)			Vendor Specific				(LSB)
44 to 47	Reserved (00h)							

Serial Attached SCSI Phy Mode Descriptor Data Definitions:

PS	The parameters Saveable bit is set to 0.
Phy Identifier	A unique Phy Identifier is returned for each Phy.

Attached Device Type	This field indicates the device type attached to this Phy: 000b = No device attached 001b = SAS device 010b = Expander device 011b = Expander device compliant with a previous version of the SAS standard
Negotiated Physical Link Rate	This field indicates the logical link rate being used by the Phy: 0h = UNKNOWN. Phy is enabled. Unknown Physical Link Rate. 1h = DISABLED. Phy is disabled. 2h = PHY_RESET_PROBLEM 3h = SPINUP_HOLD 4h = PORT_SELECTOR 8h = G1. Physical Link Rate is 1.5 Gb/s 9h = G2. Physical Link Rate is 3.0 Gb/s Ah =G3. Physical Link Rate is 6.0 Gb/s
Attached SSP Initiator Port	This bit indicates the value of the SSP Initiator Port field received in the IDENTIFY address frame during the identification sequence.
Attached STP Initiator Port	This bit indicates the value of the STP Initiator Port field received in the IDENTIFY address frame during the identification sequence.
Attached SMP Initiator Port	This bit indicates the value of the SMP Initiator Port field received in the IDENTIFY address frame during the identification sequence.
Attached SSP Target Port	This bit indicates the value of the SSP Target Port field received in the IDENTIFY address frame during the identification sequence.
Attached STP Target Port	This bit indicates the value of the STP Target Port field received in the IDENTIFY address frame during the identification sequence.
Attached SMP Target Port	This bit indicates the value of the SMP Target Port field received in the IDENTIFY address frame during the identification sequence.
SAS Address	This field indicates the SAS Address of the drive that is the bridged interface for the library or partition.
Attached SAS Address	This field contains the value of the SAS Address field transmitted in the IDENTIFY address frame during the identification sequence.
Attached Phy Address	This field indicates the value of Attached Phy Address field received in the IDENTIFY address frame during the identification sequence.
Programmed Minimum Physical Link Rate	8h = 1.5 Gb/s 9h = 3.0 Gb/s Ah = 6.0Gb/s
Hardware Minimum Physical Link Rate	8h = 1.5 Gb/s 9h = 3.0 Gb/s Ah = 6.0 Gb/s
Programmed Maximum Physical Link Rate	8h = 1.5 Gb/s 9h = 3.0 Gb/s Ah = 6.0 Gb/s
Hardware Maximum Physical Link Rate	8h = 1.5 Gb/s 9h = 3.0 Gb/s Ah = 6.0 Gb/s

SAS Shared Port Control Mode Subpage

TABLE 4-73 shows the format of the Serial Attached SCSI Shared Port Control Mode Subpage.

TABLE 4-73 SAS Shared Port Control Subpage

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	PS (0)	SPF (1)	Page Code (19h)					
1	Sub-Page Code (02h)							
2 to 3	MSB	Page Length (0Ch)						LSB
4	Reserved (00h)							
5	Reserved				Protocol Identifier (6h)			
6 to 7	MSB	Power Loss Timeout						LSB
8 to 15	Reserved (00h)							

Serial Attached SCSI Shared Port Control Mode Subpage Definitions:	
PS	The parameters Saveable bit is set to 0.
SPF	The library returns a value of 1 for the SubPage Format bit, indicating this page uses the sub_page mode page format.
Page Code	19h identifies the page as the SAS Port Control mode page.
Sub-Page Code	02h identifies the sub-page as the SAS Shared Port Control Mode Subpage.
Protocol Identifier	06h indicaties the Serial Attached SCSI protocol.
Power Loss Timeout	This field contains the maximum time, in one millisecond increments, that a target port shall respond to connection requests with OPEN_REJECT (RETRY) after receiving NOTIFY (POWER LOSSEXPECTED). • 0000h indicates that maximum time is vendor-specific.

SAS Enhanced Phy Control Subpage

TABLE 4-74 shows the format of the Serial Attached SCSI Enhanced Phy Control Mode Subpage.

TABLE 4-74 SAS Enhanced Phy Control Mode Subpage

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	PS (0)	SPF (1)	Page Code (19h)					
1	Sub-Page Code (03h)							
2 to 3	MSB	Page Length (2Ch)						LSB
4	Reserved							
5	Reserved				Protocol Identifier (6h)			
6	Generation Code							
7	Number of Phys							
Enhanced Phy Control Mode Descriptor List								
8 to 27	MSB First Enhanced Phy Control Mode Descriptor LSB							
28 to 47	MSB Second Enhanced Phy Control Mode Descriptor LSB							

SAS Enhanced Phy Control Mode Subpage Definitions:

PS	The parameters Saveable bit is set to 0.
SPF	The library returns a value of 1 for the SubPage Format bit, indicating this page uses the sub_page mode page format.
Page Code	19h identifies the page as the SAS Port Control mode page.
Sub-Page Code	03h identifies the sub-page as the SAS Enhanced Phy Control Mode Subpage.
Protocol Identifier	06h indicaties the Serial Attached SCSI protocol.
Generation Code	This field is a one-byte counter that shall be incremented by one by the device server every time the values in this mode page are changed.
Number of Phys	This field contains the number of phys in the SAS target device and indicates the number of Enhanced Phy Control Mode Descriptors in the Enhanced Phy Control Mode descriptor list.
SAS Phy Mode Descriptors	See TABLE 4-75 for more information.

Enhanced Phy Control Mode Descriptor Data

TABLE 4-75 Enhanced Phy Control Mode Descriptor Data

Byte	Bit							
	7	6	5	4	3	2	1	0
0	Reserved (00h)							
1	Phy Identifier							
2 to 3	(MSB)		Descriptor Length (10h)					(LSB)
4 to 7	(MSB)		Programmed Phy Capabilities					(LSB)
8 to 11	(MSB)		Current Phy Capabilities					(LSB)
12 to 15	(MSB)		Attached Phy Capabilities					(LSB)
16	Reserved (00h)							
17	Reserved (00h)							
18	Reserved			Neg. SSC	Negotiated Physical Link Rate			
19	Reserved							Hdware Muxing Support

Enhanced Phy Control Mode Descriptor Data Definitions:

Phy Identifier	A unique Phy Identifier is returned for each Phy.
Descriptor Length	The library returns a value of 10h (16d) bytes.
Programmed Phy Capabilities	This field indicates the SNW-3 (Speed Negotiation Window) Phy capabilities bits that are going to be transmitted in the next link reset sequence containing SNW-3 as defined in TABLE 4-76.
Current Phy Capabilities	This field indicates the outgoing SNW-3 Phy capabilities bits transmitted in the last link reset sequence as defined in TABLE 4-76. If the last link reset sequence did not include SNW-3, then the Current Phy Capablilities field shall be set to 00000000h.
Attached Phy Capabilities	This field indicates the incoming SNW-3 Phy capabilities bits received in the last SNW-3 as defined in TABLE 4-76. If the last link reset sequence did not include SNW-3, then the Attached Phy Capablilities field shall be set to 00000000h.
Negotiated SSC	The Negotiated SSC bit is only valid when the Negotiated Physical Link Rate is great than or equal to 8h. When valid: 0 = SSC is enabled 1 = SSC is disabled.
Hardware Muxing Supported	0 = The Phy does not support multiplexing. 1 = The Phy supports multiplexing.

Phy Capabilities Data

TABLE 4-76 Phy Capabilities Data

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Start (1B)	TX SSC Type	Reserved		Requested Logical Link Rate			
Supported Settings								
1	G1 Without SSC	G1 With SSC	G2 Without SSC	G2 With SSC	G3 Without SSC	G3 With SSC	Reserved	
2	Reserved (00h)							
3	Reserved							Parity

Phy Capabilities Data Definitions:

TX SSC Type	0 = Indicates that the phy's transmitter uses down-spreading SSC when SSC is enabled (for example, the phy is a SAS phy), or that the phy does not support SSC. 1 = Indicates that the phy's transmitter uses center-spreading SSC when SSC is enabled (for example, the phy is an expander phy).
Requested Logical Link Rate	This field indicates if the Phy device supports multiplexing and, if so, the logical link rate that the Phy device is requesting.
G1 Without SSC	The Phy: 0 = Does not support G1 – 1.5 Gbps without SSC. 1 = Supports G1 – 1.5 Gbps without SSC.
G1 With SSC	The Phy: 0 = Does not support – 1.5 Gbps with SSC. 1 = Supports G1 – 1.5 Gbps with SSC.
G2 Without SSC	The Phy: 0 = Does not support G2 – 3 Gbps without SSC. 1 = Supports G2 – 3 Gbps without SSC.
G2 With SSC	The Phy: 0 = Does not support G2 – 3 Gbps with SSC. 1 = Supports G2 – 3 Gbps with SSC.
G3 Without SSC	The Phy: 0 = Does not support G3 – 6 Gbps without SSC. 1 = Supports G3 – 6 Gbps without SSC.
G3 With SSC	The Phy: 0 = Does not support G3 – 6 Gbps with SSC. 1 = Supports G3 – 6 Gbps with SSC.
Parity	The Parity bit shall be set to one or zero such that the total number of SNW-3 Phy device capabilities bits that are set to one is even, including the Start bit and the Parity bit.

Informational Exceptions TapeAlert Control Page

TABLE 4-77 shows the format of the Mode Sense (10) Informational Exceptions TapeAlert Control page.

TABLE 4-77 Informational Exceptions TapeAlert Control Page

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	PS (0)	SPF (0)	Page Code (1Ch)					
1	Page Length (0Ah)							
2	Perf (0)	Rsvd (0)	EBF (0)	EWasc (0)	DExcpt (1)	Test	Rsvd (0)	LogErr (0)
3	Reserved (0h)				MRIE (3h)			
4 to 7	(MSB)	Interval Timer						(LSB)
8 to 11	(MSB)	Report Count						(LSB)

Informational Exceptions TapeAlert Control Page Definitions:

PS	The Parameters Saveable bit is set to 0.
SPF	The library returns a value of 0 for the SubPage Format bit, indicating page_0 format is being used.
Perf	The performance bit is 0, which indicates acceptance of informational exception operations that cause delays.
EBF	Enable Background Functions bit will always be 0.
EWasc	Enable Warning bit will always be 0.
DExcpt	The exception bit is 1, which indicates that the library disables all information exception operations ignoring the MRIE field. Note: In this mode the software must poll the TapeAlert Log page.
Test	The test operations bit is 0, which requests that the library not generate any false/test informational exception conditions.
LogErr	The log information exception conditions bit is 0, which indicates that logging of informational exception conditions is vendor-specific.
MRIE	This field indicates the method the tape library uses to report informational exception conditions. The field is set to 3h but is ignored because the DExcpt bit is on.
Interval Timer	Bytes 4 through 7 are set to 00h, which indicates that the library will only report the informational exception condition one time.
Report Count	Bytes 8 through 11 are set to the current report counter value.

Element Address Assignment Page Definition

TABLE 4-78 defines the Element Address Assignment page of the Mode Sense (10) command.

TABLE 4-78 Element Address Assignment Page

Byte	\multicolumn{8}{c}{Bit}							
	7	6	5	4	3	2	1	0
0	PS (1)	Rsvd (0)	\multicolumn{6}{c}{Page Code (1Dh)}					
1	\multicolumn{8}{c}{Parameter Length (12h)}							
2 to 3	(MSB)	\multicolumn{7}{c}{First Medium Transport Element Address (LSB)}						
4 to 5	(MSB)	\multicolumn{7}{c}{Number of Medium Transport Elements (LSB)}						
6 to 7	(MSB)	\multicolumn{7}{c}{First Storage Element Address (LSB)}						
8 to 9	(MSB)	\multicolumn{7}{c}{Number of Storage Elements (LSB)}						
10 to 11	(MSB)	\multicolumn{7}{c}{First Import/Export Element Address (LSB)}						
12 to 13	(MSB)	\multicolumn{7}{c}{Number Import/Export Elements (LSB)}						
14 to 15	(MSB)	\multicolumn{7}{c}{First Data Transfer Element Address (LSB)}						
16 to 17	(MSB)	\multicolumn{7}{c}{Number Data Transfer Elements (LSB)}						
18 to 19	\multicolumn{8}{c}{Reserved (00h)}							

Element Address Assignment Page Definitions:

PS	The Parameters Saveable bit specifies that the library can save this page to non-volatile memory and returns a value of 1.
Page Code	Identifies the Element Address Assignment mode page and returns a value of 1Dh.
Parameter Length	Indicates the amount of element address data following this byte and returns a value of 12h.
First Medium Transport Element Address	Identifies the address of the robot and returns a value of 0h.
Number of Medium Transport Elements	Identifies the number of hands within the library and returns a value of 0001h.
First Storage Element Address	Identifies the starting address of the cartridge tape storage cells. The default starting address is 03E8h
Number of Storage Elements	Identifies the number of cartridge tape storage cells within the library. The total number of cartridge tape storage cells depends on how the library is configured.
First Import / Export Element Address	Identifies the address of the first Import/Export element. The default starting address is 000Ah.
Number of Import / Export Elements	Identifies the total number of import/export cells.
First Data Transfer Element Address	Identifies the address of the first tape transport installed in the library. The default address is 1F4h.
Number of Data Transfer Elements	Identifies the number of tape drives in the library, and the library returns the configured count.

Transport Geometry Mode Page Definition

TABLE 4-79 defines the Mode Sense Transport Geometry Mode page.

TABLE 4-79 Transport Geometry Mode Page

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	PS (0)	Rsvd (0)	Page Code (1Eh)					
1	Parameter Length (02h)							
2	Reserved (0)							Rotate (0)
3	Member Number in Transport Element Set (00h)							

Transport Geometry Mode Page Definitions:

PS	The Parameters Saveable bit is set to 0.
Page Code	This field identifies the Transport Geometry mode page. The library returns a value of 1Eh.
Parameter Length	This field indicates the number of additional types of transport geometry descriptor data to follow the header. Each descriptor has two bytes of information. The library has one transport mechanism and returns a value of 02h.
Rotate	This field identifies the ability of the transport mechanism to handle two-sided media. The library does not use multiple-sided media and returns a value of 0.
Member Number in Transport Element Set	This field identifies the specific transport element in the system to which this descriptor is applied. The library has one transport element and returns a value of 00h.

Device Capabilities Page Definition

TABLE 4-80 defines the Device Capabilities page of the Mode Sense (10) command.

TABLE 4-80 Device Capabilities Page

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	PS (0)	Rsvd (0)	Page Code (1Fh)					
1	Parameter Length (12h)							
2	Reserved (0h)				StorDT[1] (1)	StorI/E[2] (1)	StorST[3] (1)	StorMT[4] (0)
3	Reserved (0h)							
4	Reserved (0h)				MT->DT (0)	MT->I/E (0)	MT->ST (0)	MT->MT (0)
5	Reserved (0h)				ST->DT (1)	ST->I/E (1)	ST->ST (1)	ST->MT (0)
6	Reserved (0h)				I/E->DT (1)	I/E->I/E (1)	I/E->ST (1)	I/E->MT (0)
7	Reserved (0h)				DT->DT (1)	DT->I/E (1)	DT->ST (1)	DT->MT (0)
8 to 11	Reserved (00h)							
12	Reserved (0h)				MT<>DT (0)	MT<>I/E (0)	MT<>ST (0)	MT<>MT (0)
13	Reserved (0h)				ST<>DT (0)	ST<>I/E (0)	ST<>ST (0)	ST<>MT (0)
14	Reserved (0h)				I/E<>DT (0)	I/E<>I/E (0)	I/E<>ST (0)	I/E<>MT (0)
15	Reserved (0h)				DT->DT (0)	DT<>I/E (0)	DT<>ST (0)	DT<>MT (0)
16 to 19	Reserved (00h)							

Notes:
DT - Data Transfer Element (tape drive)
I/E = Import/Export Element (cartridge access port cell and the PTP cells)
ST = Storage Element (cartridge tape storage cell)
MT= Medium Transport (hand)

Device Capabilities Page Definitions:

PS	The Parameters Saveable bit is set to 0.
Page Code	The Page Code field identifies the Device Capabilities mode page and always contains a value of 1Fh.
Parameter Length	This field indicates the amount of device capabilities data following this byte. The library returns a value of 12h (18d).
StorDT	This field identifies the ability of a tape drive to perform the function of element storage. The library returns a value of 1.
StorI/E	This field identifies the ability of a CAP cell to perform the function of element storage. The library returns a value of 1.
StorST	This field identifies the ability of the cartridge tape storage cells to perform the function of element storage. The library returns a value of 1.
StorMT	This field identifies the ability of the hand to perform the function of element storage. The hand cannot be used as the source or destination of a move. The library returns a value of 0.
MT -> DT	This field identifies the support for the Move Medium command, where the source is the hand, and the destination is a tape drive. The library returns a value of 0.
MT -> I/E	This field identifies the support for the Move Medium command, where the source is the hand, and the destination is a CAP cell. The library returns a value of 0.
MT -> ST	This field identifies the support for the Move Medium command, where the source is the hand, and the destination is a cartridge tape storage cell. The library returns a value of 0.
MT -> MT	This field identifies the support for the Move Medium command, where both the source and the destination is the hand. The library returns a value of 0.
ST -> DT	This field identifies the support for the Move Medium command, where the source is a cartridge tape storage cell, and the destination is a tape drive. The library returns a value of 1.
ST -> I/E	This field identifies the support for the Move Medium command, where the source is a cartridge tape storage cell, and the destination is a CAP cell. The library returns a value of 1.
ST -> ST	This field identifies the support for the Move Medium command, where the source is a cartridge tape storage cell, and the destination is a cartridge tape storage cell. The library returns a value of 1.
ST -> MT	This field identifies the support for the Move Medium command, where the source is a cartridge tape storage cell, and the destination is the hand. The library returns a value of 0.
I/E -> DT	This field identifies the support for the Move Medium command, where the source is a CAP cell, and the destination is a tape drive. The library returns a value of 1.

I/E -> I/E	This field identifies the support for the Move Medium command, where both the source, and the destination is a CAP cell. The library returns a value of 1.
I/E -> ST	This field identifies the support for the Move Medium command, where the source is a CAP cell, and the destination is a cartridge tape storage cell. The library returns a value of 1.
I/E -> MT	This field identifies the support for the Move Medium command, where the source is a CAP cell, and the destination is the hand. The library returns a value of 0.
DT -> DT	This field identifies the support for the Move Medium command, where the source, and the destination is a tape drive. The library returns a value of 1.
DT -> I/E	This field identifies the support for the Move Medium command, where the source is a tape drive, and the destination is a CAP cell. The library returns a value of 1.
DT -> ST	This field identifies the support for the Move Medium command, where the source is a tape drive, and the destination is a cartridge tape storage cell. The library returns a value of 1.
DT -> MT	This field identifies the support for the Move Medium command, where the source is a tape drive, and the destination 1 element is the hand. The library returns a value of 0.
MT < > DT	This field identifies the support for the Exchange Medium command, where the source and destination 2 elements are the hand, and the destination 1 element is a tape drive. The library returns a value of 0.
MT < > I/E	This field identifies the support for the Exchange Medium command, where the source and destination 2 elements are the hand, and the destination 1 element is a CAP cell. The library returns a value of 0.
MT < > ST	This field identifies the support for the Exchange Medium command, where the source and destination 2 elements are the hand, and the destination 1 element is a cartridge tape storage cell. The library returns a value of 0.
MT < > MT	This field identifies the support for the Exchange Medium command, where the source and destination 2 elements are the hand, and the destination 1 element is the hand. The library returns a value of 0.
ST < > DT	This field identifies the support for the Exchange Medium command, where the source and destination 2 elements are a cartridge tape storage cell, and the destination 1 element is a tape drive. The library returns a value of 0.
ST < > I/E	This field identifies the support for the Exchange Medium command, where the source and destination 2 elements are a cartridge tape storage cell, and the destination 1 element is a CAP cell. The library returns a value of 0.
ST < > ST	This field identifies support for the Exchange Medium command, where the source and destination 2 elements are a cartridge tape storage cell, and the destination 1 element is a cartridge tape storage cell. The library returns a value of 0.

ST < > MT	This field identifies the support for the Exchange Medium command, where the source and destination 2 elements are a cartridge tape storage cell, and the destination 1 element is the hand. The library returns a value of 0.
I/E < > DT	This field identifies the support for the Exchange Medium command, where the source and destination 2 elements are a CAP cell, and the destination 1 element is a tape drive. The library returns a value of 0.
I/E < > I/E	This field identifies the support for the Exchange Medium command, where the source and destination 2 elements are a CAP cell, and the destination 1 element is a CAP cell. The library returns a value of 0.
I/E < > ST	This field identifies the support for the Exchange Medium command, where the source and destination 2 elements are a CAP cell, and the destination 1 element is a cartridge tape storage cell. The library returns a value of 0.
I/E < > MT	This field identifies the support for the Exchange Medium command, where the source and destination 2 elements are a CAP cell, and the destination 1 element is the hand. The library returns a value of 0.
DT < > DT	This field identifies the support for the Exchange Medium command, where the source and destination 2 elements are a tape drive, and the destination 1 element is a tape drive. The library returns a value of 0.
DT < > I/E	This field identifies the support for the Exchange Medium command, where the source and destination 2 elements are a tape drive, and the destination 1 element is a CAP cell. The library returns a value of 0.
DT < > ST	This field identifies the support for the Exchange Medium command, where the source and destination 2 elements are a tape drive, and the destination 1 element is a cartridge tape storage cell. The library returns a value of 0.
DT < > MT	This field identifies the support for the Exchange Medium command, where the source and destination 2 elements are a tape drive, and the destination 1 element is the hand. The library returns a value of 0.

Physical Configuration Page Definition

The following table defines the Physical Configuration Page of the Mode Sense (10) command. This Mode Sense command enables the library to report a Physical description of the library configuration.

This table provides an example of the information contained in each 5-byte group:

The list in TABLE 4-81 describes the possible modules and physically accessible cell combinations. For instance, depending on the module type, the last row or rows, in the last module of the library, are not accessible. Only the accessible cells are listed in the number of the cells for that specific module and column. The physical module types do not account for customer configured options.

There are customer configured options, such as restricting the total cell count, changing caps to cells, and setting aside reserved cells. These options are reflected in the cell counts for the columns and modules.

To count physical rows of a cell type using the above information, always add storage cell rows last in a column. Generally a column within a module only has one cell type.

Two exceptions for this are the base unit CAP column (column number 8) which has CAP cells and storage cells below it. The base unit also has an area for reserved cells in column 1. If reserved cells are configured, they will come first in the row numbering.

To map SCSI addresses to module, row, column addresses, assign starting with the lowest numbered row, column and module for a cell type. Increase by row within a column of a module, and then increase columns for that module, then increase to the next module.

TABLE 4-81 Physical ConfigurPhysical Configuration Page

Byte	\multicolumn{8}{c}{Bit}							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	PS (0)	Rsvd (0)	\multicolumn{6}{c}{Page Code (0)}					
1 to 2	(MSB)	\multicolumn{6}{c}{Parameter Length (199h)}						(LSB)
3	\multicolumn{8}{c}{Number of installed modules}							
4	\multicolumn{8}{c}{**Module Type—Module 1**}							
5	\multicolumn{8}{c}{Number of columns in Module 1}							
6 to 10	\multicolumn{8}{c}{Numbers for column 1, module 1}							
11	\multicolumn{8}{c}{Reserved (0h)}							
12 to 16	\multicolumn{8}{c}{Numbers for column 2, module 1}							
17	\multicolumn{8}{c}{Reserved (0)}							
18 to 22	\multicolumn{8}{c}{Numbers for column 3, module 1}							
23	\multicolumn{8}{c}{Reserved (0)}							
24 to 28	\multicolumn{8}{c}{Numbers for column 4, module 1}							
29	\multicolumn{8}{c}{Reserved (0)}							
30 to 34	\multicolumn{8}{c}{Numbers for column 5, module 1}							
35	\multicolumn{8}{c}{Reserved (0)}							
36 to 40	\multicolumn{8}{c}{Numbers for column 6, module 1}							
41	\multicolumn{8}{c}{Reserved (0)}							
42 to 46	\multicolumn{8}{c}{Numbers for column 7, module 1}							
47	\multicolumn{8}{c}{Reserved (0)}							
48 to 52	\multicolumn{8}{c}{Numbers for column 8, module 1}							
53	\multicolumn{8}{c}{Reserved (0)}							

TABLE 4-81 Physical ConfigurPhysical Configuration Page

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
54 to 58	Numbers for column 9, module 1							
59	Reserved (0)							
60 to 64	Numbers for column 10, module 1							
65	Reserved (0)							
66 to 70	Numbers for column 11, module 1							
71	Reserved (0)							
72	**Module Type—Module 2**							
73	Number of columns in module 2							
74 to 78	Numbers for column 1, module 2							
79	Reserved (0)							
80 to 84	Numbers for column 2, module 2							
85	Reserved (0)							
86 to 90	Numbers for column 3, module 2							
91	Reserved (0)							
92 to 96	Numbers for column 4, module 2							
97	Reserved (0)							
98 to 102	Numbers for column 5, module 2							
103	Reserved (0)							
104 to 108	Numbers for column 6, module 2							
109	Reserved (0)							

TABLE 4-81 Physical ConfigurPhysical Configuration Page

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
110 to 114	Numbers for column 7, module 2							
115	Reserved (0)							
116 to 120	Numbers for column 8, module 2							
121	Reserved (0)							
122 to 126	Numbers for column 9, module 2							
127	Reserved (0)							
128 to 132	Numbers for column 10, module 2							
133	Reserved (0)							
134 to 138	Numbers for column 11, module 2							
139	Reserved (0)							
140	**Module Type—Module 3**							
141	Number of columns in module 3							
142 to 146	Numbers for column 1, module 3							
147	Reserved (0)							
148 to 152	Numbers for column 2, module 3							
153	Reserved (0)							
154 to 158	Numbers for column 3, module 3							
159	Reserved (0)							
160 to 164	Numbers for column 4, module 3							
165	Reserved (0)							

TABLE 4-81 Physical ConfigurPhysical Configuration Page

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
166 to 170	Numbers for column 5, module 3							
171	Reserved (0)							
172 to 176	Numbers for column 6, module 3							
177	Reserved (0)							
178 to 182	Numbers for column 7, module 3							
183	Reserved (0)							
184 to 188	Numbers for column 8, module 3							
189	Reserved (0)							
190 to 194	Numbers for column 9, module 3							
195	Reserved (0)							
196 to 200	Numbers for column 10, module 3							
201	Reserved (0)							
202 to 206	Numbers for column 11, module 3							
207	Reserved (0)							
208	**Module Type—Module 4**							
209	Number of columns in module 4							
210 to 214	Numbers for column 1, module 4							
215	Reserved (0)							
216 to 220	Numbers for column 2, module 4							
221	Reserved (0)							

TABLE 4-81 Physical ConfigurPhysical Configuration Page

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
222 to 226	Numbers for column 3, module 4							
227	Reserved (0)							
228 to 232	Numbers for column 4, module 4							
233	Reserved (0)							
234 to 238	Numbers for column 5, module 4							
239	Reserved (0)							
240 to 244	Numbers for column 6, module 4							
245	Reserved (0)							
246 to 250	Numbers for column 7, module 4							
251	Reserved (0)							
252 to 256	Numbers for column 8, module 4							
257	Reserved (0)							
258 to 262	Numbers for column 9, module 4							
263	Reserved (0)							
264 to 268	Numbers for column 10, module 4							
269	Reserved (0)							
270 to 274	Numbers for column 11, module 4							
275	Reserved (0)							

TABLE 4-81 Physical ConfigurPhysical Configuration Page

Byte	Bit							
	7	6	5	4	3	2	1	0
276	Module Type—Module 5							
277	Number of columns in module 5							
278 to 282	Numbers for column 1, module 5							
283	Reserved (0)							
284 to 288	Numbers for column 2, module 5							
289	Reserved (0)							
290 to 294	Numbers for column 3, module 5							
295	Reserved (0)							
296 to 300	Numbers for column 4, module 5							
301	Reserved (0)							
302 to 306	Numbers for column 5, module 5							
307	Reserved (0)							
308 to 312	Numbers for column 6, module 5							
313	Reserved (0)							
314 to 318	Numbers for column 7, module 5							
319	Reserved (0)							
320 to 324	Numbers for column 8, module 5							
325	Reserved (0)							
326 to 330	Numbers for column 9, module 5							
331	Reserved (0)							

TABLE 4-81 Physical ConfigurPhysical Configuration Page

Byte	\multicolumn{8}{c|}{Bit}							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
332 to 336	\multicolumn{8}{c|}{Numbers for column 10, module 5}							
337	\multicolumn{8}{c|}{Reserved (0)}							
338 to 342	\multicolumn{8}{c|}{Numbers for column 11, module 5}							
343	\multicolumn{8}{c|}{Reserved (0)}							
344	\multicolumn{8}{c|}{**Module Type—Module 6**}							
345	\multicolumn{8}{c|}{Number of columns in module 6}							
346 to 350	\multicolumn{8}{c|}{Numbers for column 1, module 6}							
351	\multicolumn{8}{c|}{Reserved (0)}							
352 to 356	\multicolumn{8}{c|}{Numbers for column 2, module 6}							
357	\multicolumn{8}{c|}{Reserved (0)}							
358 to 362	\multicolumn{8}{c|}{Numbers for column 3, module 6}							
363	\multicolumn{8}{c|}{Reserved (0)}							
364 to 368	\multicolumn{8}{c|}{Numbers for column 4, module 6}							
369	\multicolumn{8}{c|}{Reserved (0)}							
370 to 374	\multicolumn{8}{c|}{Numbers for column 5, module 6}							
375	\multicolumn{8}{c|}{Reserved (0)}							
376 to 380	\multicolumn{8}{c|}{Numbers for column 6, module 6}							
381	\multicolumn{8}{c|}{Reserved (0)}							
382 to 386	\multicolumn{8}{c|}{Numbers for column 7, module 6}							
387	\multicolumn{8}{c|}{Reserved (0)}							

TABLE 4-81 Physical ConfigurPhysical Configuration Page

Byte	Bit							
	7	6	5	4	3	2	1	0
388 to 392	Numbers for column 8, module 6							
393	Reserved (0)							
394 to 398	Numbers for column 9, module 6							
399	Reserved (0)							
400 to 404	Numbers for column 10, module 6							
405	Reserved (0)							
406 to 410	Numbers for column 11, module 6							
411	Reserved (0)							

TABLE 4-82 Module Type Definitions

Module Type Field Definitions	
0	Module not installed
1	The last installed 4U module with drives
2	The last installed 4U module with storage cells in the back
3	A 4U module with drives
4	A 4U module with storage cells followed by a module with drives
5	A 4U module with storage cells followed by a module with storage cells
6	The last installed 4U card unit
7	A 4U card unit
8	The last installed 8U module with drives
9	The last installed 8U module with storage cells in the back, below a module with drives in the back
10	The last installed 8U module with storage cells in the back, below a module with storage cells in the back
11	An 8U module with drives
12	An 8U module with storage cells in the back between modules with drives in the back
13	An 8U module with storage cells in the back below a module containing storage cells, and above a module with drives in the back

TABLE 4-82 Module Type Definitions

Module Type Field Definitions	
14	An 8U module with storage cells in the back below a module containing drives, and above a module with storage cells in the back
15	An 8U module with storage cells in the back between modules with storage cells in the back
16	The last installed 8U module (with CAP) with drives in the back
17	An 8U module (with CAP) with drives in the back
18	The last installed 8U module (with CAP) with with storage cells in the back below a module containing drives
19	The last installed 8U module (with CAP) with with storage cells in the back below a module containing storage cells in the back
20	An 8U module (with CAP) with storage cells in the back between modules with drives in the back
21	An 8U module (with CAP) with storage cells in the back below a module containing storage cells, and above a module with drives in the back
22	An 8U module (with CAP) with storage cells in the back below a module containing drives, and above a module with storage cells in the back
23	An 8U module (with CAP) with storage cells in the back between modules with storage cells in the back
24	BASE module only, no other modules
25	BASE module with drives in the back
26	The last installed 8U multi-media module with drives
27	The last installed 8U multi-media module with storage cells in the back, below a module with drives in the back
28	The last installed 8U multi-media module with storage cells in the back, below a module with storage cells in the back
29	An 8U multi-media module with drives
30	An 8U multi-media module with storage cells in the back between modules with drives in the back
31	An 8U multi-media module with storage cells in the back below a module containing storage cells, and above a module with drives in the back
32	An 8U multi-media module with storage cells in the back below a module containing drives, and above a module with storage cells in the back
33	An 8U multi-media module with storage cells in the back between modules with storage cells in the back
34	The last installed 8U multi-media module with drives in the back
35	An 8U multi-media module (with CAP) with drives in the back
36	The last installed 8U multi-media module (with CAP) with storage cells in the back, below a module with drives in the back
37	The last installed 8U multi-media module (with CAP) with storage cells in the back, below a module with storage cells in the back

TABLE 4-82 Module Type Definitions

Module Type Field Definitions	
38	An 8U multi-media module (with CAP) with storage cells in the back between modules with drives in the back
39	An 8U multi-media module (with CAP) with storage cells in the back below a module containing storage cells, and above a module with drives in the back
40	An 8U multi-media module (with CAP) with storage cells in the back below a module containing drives, and above a module with storage cells in the back
41	An 8U multi-media module (with CAP) with storage cells in the back between modules with storage cells in the back
42	BASE multi-media module only, no other modules
43	BASE multi-media module with drives in the back

Move Medium

The Move Medium command (A5h) moves a cartridge tape from one specific element location to another specific element location.

The Mode Sense command provides a matrix with the valid source and destination element combinations for the Move Medium command.

The Fast Load option on the library controls the completion of the move command when the destination element is a tape drive. If the fast load option is disabled, the library performs the move motion, and waits until the tape drive load operation completes before returning status for the move command. When the fast load option is enabled, the library performs the move motion, and verifies the tape drive load starts before returning status for the move command.

TABLE 4-83 Move Medium Command

Byte	Bit							
	7	6	5	4	3	2	1	0
0	Operation Code (A5h)							
1	Ignored				Reserved (00h)			
2 to 3	(MSB) Transport Element Address (LSB)							
4 to 5	(MSB) Source Element Address (LSB)							
6 to 7	(MSB) Destination Element Address (LSB)							
8	Reserved (00h)							
9	Reserved (00h)							
10	Reserved (00h)							Invert (0)
11	Move Option		Control Byte (00h)					

Move Medium Command Definitions:

Transport Element Address	This field defines the robot element to use and should contain the element address 00h. A value of 00h indicates use of the default hand. If any other value is entered it will be ignored.
Source Element Address	This field is the element address from which the cartridge tape is to be removed. This may be a storage cell, a CAP cell, or a tape drive.
Destination Element Address	This field is the element address where the cartridge tape is to be placed. This may be a storage cell, a CAP cell, or a tape drive.
Invert	The library does not support this function and requires a value of 0.
Move Option	These two bits define optional operations associated with the Move Medium command. 00 = The library performs a normal move medium operation 10 = The library performs a mount operation with write protect enabled. That is, the user can read the data on the cartridge but cannot write to the cartridge. This option is valid only when the destination element address is a data transfer element. If the destination data transfer element (tape drive) does not support this feature or fails to acknowledge the write-protected mount option, the mount fails. In either case, the library returns the Hardware Error sense key (04) with an ASC of 40 and an ASCQ of 02 (Drive Error). 11 = The data transfer element specified in the source element field performs a rewind, followed by a unload operation and then the move medium operation. This option is valid only when the source element address is a data transfer element. Use this option with care because it might interfere with operations being performed on the data path of the data transfer element.

Persistent Reserve In

The Persistent Reserve In (5Eh) and Persistent Reserve Out (5Fh) commands resolve contention among multiple initiators and multiple-port targets within the system.

The Persistent Reserve In command is used by initiators to obtain information about active registrations or an active reservation.

TABLE 4-84 Persistent Reserve In Command

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Operation Code (5Eh)							
1	Ignored			Service Action				
2	Reserved (00h)							
3	Reserved (00h)							
4	Reserved (00h)							
5	Reserved (00h)							
6	Reserved (00h)							
7 to 8	(MSB) Allocation Length (LSB)							
9	Control (00h)							

Persistent Reserve In Command Descriptions:

Service Action	This field defines the type of request that is being made to the initiator.
	Valid values are 00h, 01h, 02h, and 03h.
	00h = Returns Read Keys Data (see TABLE 4-85)
	01h = Returns Read Reservations Data (see TABLE 4-86)
	02h = Returns Report Capabilities Data (see TABLE 4-88)
	03h = Returns Full Status Data (see TABLE 4-90)
	Values 04h through 1Fh are reserved.
Allocation Length	This field indicates how much space has been reserved for the returned parameter list. If the length is not sufficient to contain the entire parameter list, the parameter list will be incomplete. However, a partial list is not an error.

Read Keys Data

The Read Keys service action requests that the library returns a list of all the current Reservation keys it has registered.

TABLE 4-85 shows the format of the parameter data returned in response to a Persistent Reserve In command with the Read Keys service action.

TABLE 4-85 Read Keys Data

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0								
0 to 3	(MSB) PRGeneration							(LSB)
4 to 7	(MSB) Additional Length (n-7)							(LSB)
	Reservation Key List							
8 to 15	(MSB) First Reservation Key							(LSB)
More	Additional Reservation Keys							
n-7 to n	(MSB) Last Reservation Key							(LSB)

Read Keys Data Definitions:

PRGeneration	This value is a 32-bit counter that is incremented every time a Persistent Reserve Out command requests a Register, Register & Ignore, a Clear, a Preempt, or a Preempt and Abort operation. It allows the application client to determine if another application client has changed the configuration. This counter is set to zero after a Power-On-Reset.
Additional Length	This field indicates the number of bytes in the reservation key list.
Reservation Key List	These fields contain all the eight-byte reservation keys that have been registered with the library through a Persistent Reserve Out command.

Read Reservations Data

The Read Reservations service action requests that the library return a description of all current Reservation keys it has registered.

See TABLE 4-86 for the format of the parameter data returned in response to a Persistent Reserve In command with the Read Reservations service action.

TABLE 4-86 Read Reservations Data

Byte	Bit							
	7	6	5	4	3	2	1	0
0 to 3	(MSB) PRGeneration (LSB)							
4 to 7	(MSB) Additional Length (n-7) (LSB)							
8 to n	(MSB) Reservation Descriptor (LSB)							

Read Reservations Data Definitions:

PRGeneration	This value is a 32-bit counter that is incremented every time a Persistent Reserve Out command requests a Register, Register & Ignore, a Clear, a Preempt, or a Preempt and Abort operation.
	It allows the application client to determine if another application client has changed the configuration.
	This counter is set to zero after a Power-On-Reset.
Additional Length	This field indicates the number of bytes in the list of reservation descriptors: 0 = No Reservation held 16 = Active Reservation Data
Reservation Descriptors	Each persistent reservation for a logical unit has one reservation descriptor that has the format shown in TABLE 4-87.

TABLE 4-87 Reservation Descriptors Format

Byte	Bit							
	7	6	5	4	3	2	1	0
0 to 7	(MSB)			Reservation Key				(LSB)
8 to 11	(MSB)			Obsolete				(LSB)
12	Reserved (00h)							
13	Scope				Type			
14 to 15	Obsolete (00h)							

Reservation Descriptors Format Definitions:

Reservation Key	This value indicates the reservation key for the descriptor data that follows.
Scope	The value in the Scope field indicates whether a persistent reservation applies to an entire logical unit or to an element. The only valid value is 0h. 0h = The persistent reservation applies to the logical unit
Type	This value specifies the characteristics of the persistent reservation. Valid values are 3h, 6h, and 8h. 3h = Exclusive Access: This value indicates that the initiator holding the persistent reservation has exclusive access. Some commands (such as Move Medium) are only allowed for the persistent reservation holder. 6h = Exclusive Access, Registrants Only: This value indicates that any currently registered initiator has exclusive access. Some commands (such as Move Medium) are only allowed for registered I_T nexuses. 8h = Exclusive Access, Registrants Only: This value indicates that any currently registered initiator has exclusive access. Some commands (such as Move Medium) are only allowed for registered I_T nexuses.

Report Capabilities Data

The format for the parameter data provided in response to a Persistent Reserve In command with the Report Capabilities service action is shown in TABLE 4-88.

TABLE 4-88 Report Capabilities Data

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0 to 1	(MSB) Length (0008h)							(LSB)
2	Reserved (000b)			CRH (1)	SIP_C (1)	ATP_C (0)	Rsvd (0)	PTPL_C (1)
3	TMV (1)	Reserved (00h)						PTPL_A
4 to 5	(MSB) Persistent Reservation Mask							(LSB)
6 to 7	Reserved (00h)							

Report Capabilities Data Definitions:

Length	This field indicates the length in bytes of the parameter data.
CRH	The Compatibility Reservation Handling bit is set to a value of 1 indicating the library supports the exceptions to the SPC-2 RESERVE and RELEASE commands as described in SPC-3.
SIP_C	The library will return a value of 1 for the Specify Initiator Ports Capable bit, indicating the SPEC_I_PT bit in the PERSISTENT RESERVE OUT command parameter data is supported.
ATP_C	All Target Ports Capable bit 0 = The library does not support the ALL_TG_PT bit in the PERSISTENT RESERVE OUT command parameter data. 1 = The library supports the ALL_TG_PT bit in the PERSISTENT RESERVE OUT command parameter data.
PTPL_C	Persist Through Power Loss Capable bit 0 = The library does not support the persist through power loss capability for persistent reservations and the APTPL bit in the in PERSISTENT RESERVE OUT command parameter data 1 = The library supports the persist through power loss capability for persistent reservations and the APTPL bit in the in PERSISTENT RESERVE OUT command parameter data

TMV	Type Mask Valid bit
	0 = The PERSISTENT RESERVATION TYPE MASK field shall be ignored 1 = The PERSISTENT RESERVATION TYPE MASK field contains a bit map indicating which persistent reservation types are supported by the library.
PTPL_A	Persist Through Power Loss Activated bit
	0 = The persist through power loss capability is not activated. 1 = The persist through power loss capability is activated.

The Persistent Reservation Type Mask field contains a bit map that indicates the persistent reservation types that are supported by the library.

TABLE 4-89 Read Reservations Parameter Data

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
4	WR_EX_AR (0)	EX_AC_RO (1)	WR_EX_RO (0)	Rsvd	EX_AC (1)	Rsvd	WR_EX (0)	Rsvd
5	Reserved							EX_AC_AR (0)

Read Reservations Parameter Data Definitions:

WR_EX_AR	The library returns a value of 0, indicating the Write Exclusive-All Registrants persistent reservation type is not supported.
EX_AC_RO	The library returns a value of 1, indicating the Exclusive Access-Registrants Only persistent reservation type is supported.
WR_EX_RO	The library returns a value of 0, indicating the Write Exclusive-Registrants Only persistent reservation type is not supported.
EX_AC	The library returns a value of 1, indicating the Exclusive Access- persistent reservation type is supported.
WR_EX	The library returns a value of 0, indicating the Write Exclusive persistent reservation type is not supported.
EX_AC_AR	The library returns a value of 0, indicating the Exclusive Access-All Registrants persistent reservation type is not supported.

Read Full Status Data

The Read Full Status service action requests that the library return a list of all the current Reservation keys it has registered along with information about each initiator.

TABLE 4-90 shows the format of the parameter data returned in response to a Persistent Reserve In command with the Read Full Status service action.

TABLE 4-90 Read Full Status Data

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0 to 3	(MSB) PRGeneration (LSB)							
4 to 7	(MSB) Additional Length (n-7) (LSB)							
Full Status Descriptors								
8 to 55	(MSB) First Full Status Descriptor (LSB)							
n-47 to n	(MSB) Last Full Status Descriptor (LSB)							

Read Full Status Data Definitions:

PRGeneration	This value is a 32-bit counter that is incremented every time a Persistent Reserve Out command requests a Register, Register & Ignore, a Clear, a Preempt, or a Preempt and Abort operation. It allows the application client to determine if another application client has changed the configuration. This counter is set to zero after a Power-On-Reset.
Additional Length	This field indicates the number of bytes in the list of full status descriptors
Full Status Descriptor	See TABLE 4-91 for more information.

TABLE 4-91 Read Full Status Descriptor Data

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0 to 7	(MSB) Reservation Key (LSB)							
8 to 11	(MSB) Reserved (LSB)							
12	Reserved						ALL_TG _PT	R_HOL DER
13	Scope				Type			
14 to 17	(MSB) Reserved (LSB)							
18 to 19	(MSB) Relative Target Port Identifier (LSB)							
20 to 23	(MSB) Additional Descriptor Length (18h) (LSB)							
24 to 47	(MSB) Transport ID Data (LSB)							

Read Full Status Descriptor Data Definitions:

Reservation Key	The reservation key.
ALL_TG_PT	A value of 0 in the All Target Port Groups bit indicates this full status descriptor represents a single I_T nexus.

	A value of 1 in the All Target Port Groups bit indicates that:
	 • This full status descriptor represents all the I_T nexuses that are associated with both:
	  • The initiator port specified by the Transport ID Data; and
	  • Every target port in the SCSI target device;
	 • All the I_T nexuses are registered with the same reservation key; and
	 • All the I_T nexuses are either reservation holders or not reservation holders as indicated by the R_HOLDER bit.

Read Full Status Descriptor Data Definitions:

R_Holder	The Reservation Holder Bit is defined as follows:
	0 = All I_T nexuses described by this full status descriptor are registered but are not persistent reservation holders. 1 = All I_T nexuses described by this full status descriptor are registered and are persistent reservation holders.
Type	When the Reservation Holder Bit is 1, this field indicates the type of Persistent Reservation:
	3h = Exclusive Access 6h = Exclusive Access - Registrants Only 8h = Exclusive Access - All Registrants
Relative Target Port Identifier	1 = Target Port 1 2 = Target Port 2
Transport ID Data	This field identifies the initiator port that is part of the I_T nexus or I_T nexuses described by this full status descriptor.
	• TABLE 4-92 shows the Transport ID returned for a Fibre Channel Host.
	• TABLE 4-93 shows the transport ID data returned for a SAS Host.

TABLE 4-92 Fibre Channel Transport ID Data

	Bit							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Format Code (00b)		Reserved		Protocol Identifier (0h)			
1 to 7	Reserved							
8 to 15	N_Port_Name							
16 to 23	Reserved							

Fibre Channel Transport ID Data Definitions:

Protocol Identifier	This field is set to 0h indicating the Fibre Channel protocol
N_PORT_NAME	This field specifies the N_Port_Name that is returned by the initiator in the PLOGI extended link service frame.

TABLE 4-93 SAS Transport ID Data

	Bit							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Format Code (00b)		Reserved		Protocol Identifier (6h)			
1 - 3	Reserved							
4 - 11	SAS Address							
12 - 23	Reserved							

SAS Transport ID Data Definitions:

Protocol Identifier	This field is set to 6h indicating the Serial Attached SCSI protocol
SAS Address	This field specifies the SAS Address of the Initiator Port.

Persistent Reserve Out

The Persistent Reserve Out (5Fh) command reserves a target for the exclusive or shared use of an initiator.

TABLE 4-94 Persistent Reserve Out Command

Byte	Bit							
	7	6	5	4	3	2	1	0
0	Operation Code (5Fh)							
1	Ignored			Service Action				
2	Scope				Type			
3	Reserved (00h)							
4	Reserved (00h)							
5 to 8	(MSB) Parameter List Length (LSB)							
9	Control							

Persistent Reserve Out Command Definitions:

Service Action	This value indicates the action that will result from the Persistent Reservation Command:
	00h = Register: Register or Unregister a reservation key with the library without generating a reservation.
	01h = Reserve: Create a persistent reservation of the scope and type specified in Byte 2.
	02h = Release: Remove an active persistent reservation.
	03h = Clear: Clear all persistent reservations for all initiators and reset all reservation keys to 0, if the requesting initiator is registered.
	04h = Preempt: Remove all reservations and registrations for the initiators associated with the service action reservation key in the parameter list.
	05h = Preempt and Abort: Perform a Preempt action and, additionally, clear the task set for all initiators associated with the service action reservation key. Also, clear any CAP locks and contingent allegiance in effect for these initiators.
	06h = Register and Ignore Existing Key: Register a reservation key with the library
	07h = Register and Move: Register a reservation key for another I_T nexus with the device server and move a persistent reservation to that I_T nexus.
Scope	The value in the Scope field indicates whether a persistent reservation applies to an entire logical unit or to an element. The only valid value is 0h.
	0h = The persistent reservation applies to the logical unit
Type	This value specifies the characteristics of the persistent reservation. Valid values are 3h, 6h and 8h.
	3h = Exclusive Access: Some commands (for example, Move Medium) are only allowed for the persistent reservation holder. There is only 1 persistent reservation holder.
	6h = Exclusive Access, Registrants Only: Some commands (for example, Move Medium) are only allowed for registered I_T nexuses. There is only 1 persistent reservation holder.
	8h = Exclusive Access, All Registrants: Some commands (for example, Move Medium) are only allowed for registered I_T nexuses. Each registered I_T nexus is a persistent reservation holder.
Parameter List Length	The parameter data for the Persistent Reserve Out command includes all fields, even when a field is not required for the specified service action.

The parameter list for the Persistent Reserve Out command has this format:

TABLE 4-95 Persistent Reserve Out Parameter List

Byte	Bit							
	7	6	5	4	3	2	1	0
0 to 7	(MSB) Reservation Key (LSB)							
8 to 15	(MSB) Service Action Reservation Key (LSB)							
16 to 19	(MSB) Obsolete (LSB)							
20	Reserved (0h)				SPEC-I-PT	ALL-TGT-PT (0)	Rsvd (0)	APTPL
21	Reserved (00h)							
22 to 23	Obsolete (00h)							

Persistent Reserve Out Parameter List Definitions:

Reservation Key	This field contains an eight-byte value that identifies the initiator.
Service Action Reservation Key	This field contains information needed for five service actions: Register, Register and Ignore Existing Key, Preempt, Preempt and Abort, and Register and Move.
SPEC_I_PT	The Specify Initiator Ports bit is only applicable to the Register and Register and Ignore Service Actions: 0 = The library shall apply the registration only to the I_T nexus that sent the Persistent Reservation Out command. 1 = The additional parameter data shall include a list of Transport IDs and the library shall also apply the registration to the I_T nexus for each initiator port specified by a TransportID.
ALL-TG-PT	The All Target Ports bit is not supported and must be set to 0.
APTPL	The Activate Persist Through Power Loss bit is only valid for the Register, Register and Ignore, and Register and Move service actions and is defined as follows: 0 = The library shall not preserve any persistent reservation and all registrations if power is lost and later returned. 1 = The library preserves any persistent reservation and all registrations if power is lost and later returned.

TABLE 4-96 summarizes which fields are set by the application client and interpreted by the library for each service action and scope value.

TABLE 4-96 Persistent Reserve Out Service Actions and Valid Parameters

Service Action	Allowed Scope	Type	Reservation Key	Service Action Reservation Key	APTPL	ALL_TG_PT	SPEC_I_PT
REGISTER	ignored	ignored	valid	valid	valid	valid	valid
REGISTER AND IGNORE EXISTING KEYS	ignored	ignored	ignored	valid	valid	valid	valid
RESERVE	LU_SCOPE	valid	valid	ignored	ignored	ignored	ignored
RELEASE	LU_SCOPE	valid	valid	ignored	ignored	ignored	ignored
CLEAR	ignored	ignored	valid	ignored	ignored	ignored	ignored
PRE-EMPT	LU_SCOPE	valid	valid	valid	ignored	ignored	ignored
PRE-EMPT & ABORT	LU_SCOPE	valid	valid	valid	ignored	ignored	ignored
Register & Move	LU_SCOPE	valid	valid	valid	valid	valid	ignored

TABLE 4-97 Service Action Reservation Key Information

If the service action is...	Then the information in the field is...
Register	the new reservation key to be registered
Register and Ignore Existing Key	the new reservation key to be registered
Preempt	the reservation key of the persistent reservation being pre-empted
Preempt and Abort	the reservation key of the persistent reservation being pre-empted
Register and Move	the reservation key to be registered on the specified I_T nexus.
See list of service action values .	

Position to Element

The Position to Element command (2Bh) is supported only for compatibility with existing applications. It causes the hand to be positioned to the specified destination element address.

TABLE 4-98 Position to Element Command

Byte	Bit							
	7	6	5	4	3	2	1	0
0	Operation Code (2Bh)							
1	Ignored			Reserved (00h)				
2 to 3	(MSB) Transport Element Address (LSB)							
4 to 5	(MSB) Destination Element Address (LSB)							
6	Reserved (00h)							
7	Reserved (00h)							
8	Reserved (00h)							Invert (0)
9	Control Byte (00h)							

Position to Element Command Definitions:

Transport Element Address	This field defines the hand element to use and should contain the element address of the hand or 00h (0d). A value of 00h (0d) indicates use of the default hand.
Destination Element Address	This field defines the address of the element where the hand is to be positioned.
Invert	The library does not support this function and requires a value of 0.

Prevent/Allow Medium Removal

The Prevent/Allow Medium Removal command (1Eh) requests that the library enable or disable operator access to the cartridge access port (CAP).

- If allowed, the CAP may be unlocked and opened using the operator panel.

- If prevented, the CAP cannot be unlocked or opened.

This command is independent of device reservations if the Prevent bit is 0.

The library keeps Prevent/Allow data on a per-initiator basis.

- If any initiator has set a prevent state, the library prevents anyone from opening the CAP.

During power-on and following a reset, all initiators are set to an allow state, which enables operator panel access to the CAP.

TABLE 4-99 Prevent/Allow Medium Removal Command

Byte	Bit							
	7	6	5	4	3	2	1	0
0	Operation Code (1Eh)							
1	Ignored			Reserved (00h)				
2	Reserved (00h)							
3	Reserved (00h)							
4	Reserved (00h)							Prevent
5	Control Byte (00h)							

Prevent/Allow Medium Removal Command Definitions:

Prevent Bit	The Prevent bit values are:
	0 = The library allows operator panel access to unlock and open the indicated CAPs in the Library or Partition.
	1 = The library prevents access to the indicated CAPs in the Library or Partition.

Read Element Status

The Read Element Status command (B8h) requests that the library return the status of the elements in the library.

TABLE 4-100 Read Element Status Command

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Operation Code (B8h)							
1	Ignored			VolTag	Element Type Code			
2 to 3	(MSB) Starting Element Address							(LSB)
4 to 5	(MSB) Number of Elements							(LSB)
6	Reserved (00h)						CurData	DvcID
7 to 9	(MSB) Allocation Length							(LSB)
10	Reserved (00h)							
11	Control Byte (00h)							

Read Element Status Command Definitions:

VolTag	This bit indicates whether volume tag (VolTag) information is to be reported in response to this command:
	0 = Volume Tag information is not reported
	1 = Volume Tag information is reported.
Element Type Code	This field specifies the particular element types selected for reporting:
	0h = All Element Types reported
	1h = Medium Transport Element (hand)
	2h = Storage Element (cartridge tape storage cells)
	3h = Import/Export Element (CAP cells and PTP cells)
	4h = Data Transfer Element (tape drive)
	For an Element Type Code of 0h, the element types are reported in ascending element address order, beginning with the first element greater than or equal to the Starting Element Address.

Starting Element Address	This field specifies the minimum element address to report. Only elements with an element address greater than or equal to the Starting Element Address are reported.
	Element descriptor blocks are not generated for undefined element addresses.
	The Starting Element Address is set to a valid address for the library but does not have to be an address of the type requested in the Element Type Code.
Number of Elements	This field represents the maximum number of element descriptors to be transferred. This is an actual number of element descriptors to be transferred, not an element address range.
CurData	The current data bit specifies that the library shall return element status data without causing device motion.
	0 = Library operations are normal, and library mechanics may become active if needed to gather element static data.
	1 = The library is responding with data only; no mechanical operations are active
	The CurData bit is effectively ignored by the library. The library will perform or not perform mechanical operations to obtain proper information at it's discretion independently of the setting of this bit.
DvcID	The device identification bit indicates whether the return data will contain device identification information.
	0 = The library will not return device identification information.
	1 = The library will return device identification information only for data transfer elements.
Allocation Length	This field specifies the length in bytes of the space allocated by the initiator for the transfer of element descriptors. Only complete element descriptors are transferred. Element descriptors are transferred until one of the following conditions is met:
	All available element descriptors of the type specified in the Element Type Code have been transferred, or
	The number of element descriptors specified in the Number of Elements field have been transferred, or
	There is less allocation length space available than required for the next complete element descriptor or header to be transferred.

Read Element Status Data

The library returns data for a Read Element Status command with this structure:

- An eight-byte Element Status Data header, followed by
  - One to four element pages, one page per element type.

A page consists of:

- An eight-byte Element Status Page header, followed by
  - One or more Element Descriptors. The format of the descriptor is based on the element type reported in this page. Each element type receives a separate Element Descriptor format.

Data can be truncated based on the length specified in the allocation field.

Element Status Data Header Definition

The library sends this header once for each Read Element Status command.

TABLE 4-101 Element Status Data Header Definition

Byte	Bit							
	7	6	5	4	3	2	1	0
0 to 1	(MSB) First Element Address Reported (LSB)							
2 to 3	(MSB) Number of Elements Available (LSB)							
4	Reserved (00h)							
5 to 7	(MSB) Byte Count of Report Available (all pages, n-7) (LSB)							
8 to n	Element Status pages							

Element Status Data Header Definitions:

First Element Address Reported	This field indicates the lowest element address found of the type specified in the Element Type Codes and greater than or equal to the Starting Element Address.
Number of Elements Available	This field indicates the number of elements found of the type specified in the Element Type Codes and greater than or equal to the Starting Element Address. This number is adjusted to be less than or equal to the count specified in the Number of Elements field in the Read Element Status command.
Byte Count of Report Available	This field indicates the number of bytes of element status data available for all elements meeting the requirements of the Read Element Status command. This count does not include the Element Status Data header bytes. This value is not adjusted to match the allocation length from the command.

Element Status Page Header Definition

The library sends this header once for each type of element descriptors.

TABLE 4-102 Element Status Page Header

Byte	\multicolumn{8}{c}{Bit}							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	\multicolumn{4}{c}{Reserved}				\multicolumn{4}{c}{Element Type Code}			
1	PVolTag	AVolTag (0)	\multicolumn{6}{c}{Reserved (0)}					
2 to 3	\multicolumn{8}{l}{(MSB) Element Descriptor Length (LSB)}							
4	\multicolumn{8}{c}{Reserved (00h)}							
5 to 7	\multicolumn{8}{l}{(MSB) Byte Count of Report Available (all pages, n-7) (LSB)}							
8 to n	\multicolumn{8}{c}{Element Descriptors}							

Element Status Page Header Definitions:

Element Type Code	This field indicates the specific element type being reported by this element descriptor page. The types are: 01h = Medium Transport Element (hand) 02h = Storage Element (cartridge tape storage cells) 03h = Import/Export Element (CAP cells) 04h = Data Transfer Element (tape drive)
PVolTag	This bit indicates if primary volume tag (PVolTag) information has been requested and is present. The possible values indicate: 0 = Volume Tag information has not been requested. The data is omitted from the element descriptors. 1 = Volume Tag information has been requested to be reported and is present.
AVolTag	The library does not support alternative volume tags (AVolTag) and returns a value of 0.
Element Descriptor Length	This field indicates the total number of bytes contained in a single element descriptor.
Byte Count of Descriptor Data Available	This field indicates the total number of bytes of element descriptor data available for the elements of this element type that meet the requirements of the Read Element Status command. This count does not include the Element Status Page header bytes. This value is not adjusted to match the allocation length.
Element Descriptors	The following sections contain the field definitions for the four types of library elements, which are: Medium Transport Element (the hand) Storage Element (cartridge tape storage cells) Import/Export Element (CAP cells and PTP cells) Data Transfer Element (tape drives) Each element descriptor includes the element address and status flags. Each element descriptor might also contain sense key information as well as other information, depending on the element type. The element descriptors for the four types of elements are similar, with the exception of a few fields. Note: The differences in Bytes 02, 06, and 07 for the four element descriptors. The library does not support alternate volume tags. This information is not included in any of the element descriptors.

Medium Transport Element Descriptor Definition

Medium transport elements are robotic components capable of physically moving cartridges. The Medium Transport Element Descriptor defines the robot characteristics.

TABLE 4-103 Medium Transport Element Descriptor

Byte	Bit 7	6	5	4	3	2	1	0
0 to 1	(MSB) Element Address							(LSB)
2	Reserved (00h)					Except	Rsvd (0)	Full
3	Reserved (00h)							
4	Additional Sense Code							
5	Additional Sense Code Qualifier							
6	Reserved (00h)							
7	Reserved (00h)							
8	Reserved (00h)							
9	SValid	Invert (0)	Reserved (00h)		ED	Medium Type		
10 to 11	(MSB) Source Storage Element Address							(LSB)
12 to 47	Primary Volume Tag Information Field omitted if PVolTag=0							
48	Reserved (0h)				Code Set (0)			
49	Reserved (0h)				Identifier Type (0)			
50	Reserved (00h)							
51	Identifier Length (0)							
52	Media Domain Field moved up if Primary Volume Tag Information is omitted.							
53	Media Type Field moved up if Primary Volume Tag Information is omitted.							
54 to 55	Reserved (00h) Field moved up if Primary Volume Tag Information is omitted.							

Medium Transport Element Descriptor Definitions:

Element Address	This field contains the element address of the robot.
Except	This bit indicates the current operational state of the robot:
	0 = The hand is operational.
	1 = The hand is in an abnormal state. The Additional Sense Code (ASC) and the Additional Sense Code Qualifier (ASCQ) fields contain information regarding the abnormal state. Other fields in the descriptor might be invalid and should be ignored.
Full	This bit indicates if the hand contains a cartridge tape:
	0 = The hand does not contain a cartridge tape.
	1 = The hand contains a cartridge tape.
	An initiator would see a cartridge in the hand during a Read Element Status only in the case of an anomaly.
Additional Sense Code	This field is valid only if the Except bit is set. In the case of an exception, it contains an ASC as defined for Request Sense data.
Additional Sense Code Qualifier	This field is valid only if the Except bit is set. In the case of an exception, it contains an ASCQ as defined for Request Sense data.
SValid	This bit indicates if the Source Element Address and Invert fields are valid:
	0 = The Source Element Address and Invert fields are not valid.
	1 = The Source Element Address and Invert fields are valid.
Invert	The library does not support multi-sided media and returns a value of 0.
ED	0 = The element is enabled (for example a magazine or drive has been installed or has been logically enabled)
	1 = The element is disabled
Medium Type	This field provides the type of medium currently present in the element as determined by the medium changer.
	The library returns the following values:
	0h = Unspecified - the medium changer cannot determine the medium type.
	1h = Data Medium
	2h = Cleaning Medium
Source Storage Element Address	This field is valid only if the SValid field is 1. This field contains the address of the last element from which the data cartridge was moved.

Primary Volume Tag Information	When the PVolTag bit is set to 1, the library returns volume tag information. When PVolTag is set to 0, this field is omitted, and the reserved fields below it are moved up.
	The library volume tag information includes six bytes of left-justified ASCII data that represents volume/serial number data from the cartridge tape.
	The field is padded to 32 bytes with 26 ASCII spaces. If the label on the cartridge tape is not readable, these 32 bytes will be set to 0.
	The last four bytes of the Volume Tag Information typically consist of two reserved bytes and two volume sequence bytes. The library does not support sequence numbers. These four bytes are set to 0.
Code Set	This field specifies the code set used for the identifier field and is set to 0 (not supported) for the Medium Transport Element Descriptor:
	0h = Reserved
Identifier Type	The Identifier Type field indicates the format and assignment authority for the identifier and is set to 0 (not supported) for the Medium Transport Element Descriptor: 0h = Vendor Specific
Identifier Length	This field indicates the length of the Identifier field and is set to 0 (not supported) for the Medium Transport Element Descriptor. Note: That the combined length of the identifier field and the Identifier Pad is 32 bytes.
Media Domain	The Media Domain field along with the Media Type field provides a hierarchy of information that indicates the type of media in the element:
	01h or 53h = The element contains a DLT form factor cartridge.
	43h = The element contains an LTO (or future) cleaning form factor cartridge (43h is 'C').
	4Ch = The element contains an LTO form factor cartridge (4Ch is 'L').
	FFh = The media domain cannot be determined.
	This field is not valid if the Full bit is not set.

Media Type	The Media Type field along with the Media Domain field provides a hierarchy of information that indicates the type of media in the element.

If the Media Domain field is 01h, the value reported for the Media Type field identifies in ASCII the type of DLT cartridge:

S = The element contains an SDLT I cartridge.
2 = The element contains an SDLT II cartridge.
4 = The element contains a DLTtape S4 cartridge.
FFh = The media type cannot be determined.

If the Media Domain field is 53h (53h is 'S'), the value reported for the Media Type field identifies in ASCII the type of DLT/SDLT cartridge:

1= The element contains an SDLT I cartridge.
2 = The element contains an SDLT I cartridge.
3 = The element contains an SDLT II cartridge.
4 = The element contains a DLTtape S4 cartridge.
FFh = The media type cannot be determined.

If the Media Domain field is 43h (43h is 'C'), the value reported for the Media Type field identifies in ASCII the type of LTO cleaning cartridge:

1 = The element contains an HP Generation 1 LTO cleaning cartridge.
2 = The element contains an IBM Generation 1 LTO cleaning cartridge.
3 = The element contains a Quantum Generation 1 LTO cleaning cartridge.
U = The element contains a Universal LTO cleaning cartridge.
FFh = The media type cannot be determined.

This field is not valid if the Full bit is not set.

If the Media Domain field is 4Ch (4Ch is 'L'), the value reported for the Media Type field identifies in ASCII the type of LTO cartridge:

1 = The element contains a 100 GB Generation 1 LTO cartridge.
2 = The element contains a 200 GB Generation 2 LTO cartridge.
3 = The element contains a 400 GB Generation 3 LTO cartridge.
4 = The element contains an 800 GB Generation 4 LTO cartridge.
5 = The element contains a 1500 GB Generation 5 LTO cartridge.
6 = The element contains a 2500 GB Generation 6 LTO cartridge.
T = The element contains a 400 GB Generation 3 LTO WORM cartridge.
U = The element contains an 800 GB Generation 4 LTO WORM cartridge.
V = The element contains a 1500 GB Generation 5 LTO WORM cartridge.
W = The element contains a 2500 GB Generation 6 LTO WORM cartridge.
FFh = The media type cannot be determined

This field is not valid if the Full bit is not set.

Storage Element Descriptor Definition

Storage elements are the main cartridge tape storage cells of the library.The Storage Element Descriptor describes a storage cell.

TABLE 4-104 Storage Element Descriptor

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0 to 1	(MSB) Element Address							(LSB)
2	Reserved (00h)				Access (1)	Except	Rsvd (0)	Full
3	Reserved (00h)							
4	Additional Sense Code							
5	Additional Sense Code Qualifier							
6	Reserved (00h)							
7	Reserved (00h)							
8	Reserved (00h)							
9	SValid	Invert (0)	Reserved (00h)		ED	Medium Type		
10 to 11	(MSB) Source Storage Element Address							(LSB)
12 to 47	Primary Volume Tag Information (Field omitted if PVolTag=0)							
48	Reserved (0h)				Code Set (0)			
49	Reserved (0h)				Identifier Type (0)			
50	Reserved (00h)							
51	Identifier Length (0)							
52	Media Domain (Field moved up if Primary Volume Tag Information omitted.)							
53	Media Type (Field moved up if Primary Volume Tag Information omitted.)							
54 to 55	Reserved (00h, 00h) (Field moved up if Primary Volume Tag Information omitted.)							

Storage Element Descriptor Definitions:

Element Address	This field contains the element address of the storage element reported.
Access	This bit indicates access is allowed to the storage element by the hand.
	The library returns a value of 1.
Except	This bit indicates the operational state of the storage element:
	0 = The storage element is in a normal state.
	1 = The storage element is in an abnormal state, and the Additional Sense Code and the Additional Sense Code Qualifier fields contain information regarding the abnormal state. Other fields in the descriptor might be invalid, and should be ignored.
Full	This field indicates if the storage element contains a cartridge tape:
	0 = The storage element does not contain a cartridge tape.
	1 = The storage element does contain a cartridge tape.
Additional Sense Code	This field is valid only if the Except bit is set. In the case of an exception, it contains an ASC as defined for Request Sense data.
Additional Sense Code Qualifier	This field is valid only if the Except bit is set. In the case of an exception, it contains an ASCQ as defined for Request Sense data.
SValid	This bit indicates if the Source Element Address and Invert fields are valid:
	0 = The Source Element Address and Invert fields are not valid.
	1 = The Source Element Address and Invert fields are valid.
Invert	The library does not support multi-sided media and returns a value of 0.
ED	0 = The element is enabled (for example a magazine or drive has been installed or has been logically enabled)
	1 = The element is disabled
Medium Type	This field provides the type of medium currently present in the element as determined by the medium changer.
	The library returns the following values:
	0h = Unspecified - the medium changer cannot determine the medium type.
	1h = Data Medium
	2h = Cleaning Medium
Source Storage Element Address	This field is valid only if the SValid bit is 1. It contains the address of the last element from which the data cartridge was moved.
Primary Volume Tag Information	When the PVolTag bit is set to 1, the library returns Volume Tag Information. When PVolTag is set to 0, this field is omitted, and the reserved fields below it are moved up.
	The library Volume Tag Information includes six bytes of left-justified ASCII data, which represents volume/serial number data from the cartridge tape. The field is padded to 32 bytes with 26 ASCII spaces.
	If the label on the cartridge tape is not readable, these 32 bytes are set to 0.
	The last four bytes of the Volume Tag Information typically consist of two reserved bytes and 2 volume sequence bytes. The library does not support sequence numbers. These four bytes are set to 0.
Code Set	This field specifies the code set used for the identifier field and is set to 0 (not supported) for the Storage Element Descriptor: 0h = Reserved

Identifier Type	The Identifier Type field indicates the format and assignment authority for the identifier and is set to 0 (not supported) for the Storage Element Descriptor: 0h = Vendor Specific
Identifier Length	This field indicates the length of the Identifier field and is set to 0 (not supported) for the Storage Element Descriptor. Note: That the combined length of the identifier field and the Identifier Pad is 32 bytes.
Media Domain	The Media Domain field along with the Media Type field provides a hierarchy of information that indicates the type of media in the element:
	01h or 53h = The element contains a DLT form factor cartridge.
	43h = The element contains an LTO (or future) cleaning form factor cartridge (43h is 'C').
	4Ch = The element contains an LTO form factor cartridge (4Ch is 'L').
	FFh **=** The media domain cannot be determined.
	This field is not valid if the Full bit is not set.

Media Type	The Media Type field along with the Media Domain field provides a hierarchy of information that indicates the type of media in the element.

If the Media Domain field is 01h, the value reported for the Media Type field identifies in ASCII the type of DLT/SDLT cartridge:

S = The element contains an SDLT I cartridge.
2 = The element contains an SDLT II cartridge.
4 = The element contains a DLTtape S4 cartridge.
FFh = The media type cannot be determined.

If the Media Domain field is 53h (53h is 'S'), the value reported for the Media Type field identifies in ASCII the type of DLT/SDLT cartridge:

1 = The element contains an SDLT I cartridge.
2 = The element contains an SDLT I cartridge.
3 = The element contains an SDLT II cartridge.
4 = The element contains a DLTtape S4 cartridge.
FFh = The media type cannot be determined

If the Media Domain field is 43h (43h is 'C'), the value reported for the Media Type field identifies in ASCII the type of LTO cleaning cartridge:

1 = The element contains an HP Generation 1 LTO cleaning cartridge.
2 = The element contains an IBM Generation 1 LTO cleaning cartridge.
3 = The element contains a Quantum Generation 1 LTO cleaning cartridge.
U = The element contains a Universal LTO cleaning cartridge.
FFh = The media type cannot be determined.

If the Media Domain field is 4Ch (4Ch is 'L'), the value reported for the Media Type field identifies in ASCII the type of LTO cartridge:

1 = The element contains a 100 GB Generation 1 LTO cartridge.
2 = The element contains a 200 GB Generation 2 LTO cartridge.
3 = The element contains a 400 GB Generation 3 LTO cartridge.
4 = The element contains an 800 GB Generation 4 LTO cartridge.
5 = The element contains a 1500 GB Generation 5 LTO cartridge.
6 = The element contains a 2500 GB Generation 6 LTO cartridge.
T = The element contains a 400 GB Generation 3 LTO WORM cartridge.
U = The element contains an 800 GB Generation 4 LTO WORM cartridge.
V = The element contains a 1500 GB Generation 5 LTO WORM cartridge.
W = The element contains a 2500 GB Generation 6 LTO WORM cartridge.
FFh = The media type cannot be determined.
This field is not valid if the Full bit is not set.

Import/Export Element Descriptor Definitions

Import/Export elements are the CAP and/or Pass-thru cells of the library. The Import/Export Element Descriptor describes a CAP cell.

TABLE 4-105 Import/Export Element Descriptor

	Bit							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0 to 1	(MSB)			Element Address				(LSB)

TABLE 4-105 Import/Export Element Descriptor

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
2	OIR	CMC	InEnab (1)	ExEnab (1)	Access	Except	ImpExp	Full
3	Reserved (00h)							
4	Additional Sense Code							
5	Additional Sense Code Qualifier							
6	Reserved (00h)							
7	Reserved (00h)							
8	Reserved (00h)							
9	SValid	Invert (0)	Reserved (00h)		ED	Medium Type		
10 to 11	(MSB) Source Storage Element Address (LSB)							
12 to 47	Primary Volume Tag Information (Field omitted if PVolTag=0)							
48	Reserved (0h)				Code Set (0)			
49	Reserved (0h)				Identifier Type (0)			
50	Reserved (00h)							
51	Identifier Length (00h)							
52	Media Domain (Field moved up if Primary Volume Tag Information omitted.)							
53	Media Type (Field moved up if Primary Volume Tag Information omitted.)							
54 to 55	Reserved (00h, 00h) (Field moved up if Primary Volume Tag Information omitted.)							

Import/Export Element Descriptor Definitions:

Element Address	This field contains the element address of the import/export element reported.
OIR	Operator Intervention Required bit 0 = No operator intervention required to make the CAP accessible 1 = Operator intervention required to make the CAP accessible

CMC	This bit is set to zero to indicate the import/export element is a CAP.
	A CMC bit of zero indicates that exports are to the operator's domain and imports are from the operator's domain.
	Media shall not leave the domain of the media changer when prevented by the PREVENT ALLOW MEDIA REMOVAL command (see SPC).
InEnab	This bit indicates the import/export element supports the movement of cartridge tapes into the library.
	The library returns a value of 1.
ExEnab	This bit indicates that the import/export element supports the movement of cartridge tapes out of the library.
	The library returns a value of 1.
Access	This bit indicates whether access is allowed to the CAP element by the hand.
	0 = The CAP is open and cannot be accessed by the hand. Or the magazine at the requested Element Address has been removed. Thus the Full and Primary Volume Tag information cannot be determined, and should be ignored. More information about this condition is available through the Additional Sense Code and Additional Sense Code Qualifier fields.
	1 = The CAP is closed and accessible.
Except	This bit indicates the operational state of the import/export element:
	0 = The import/export element is in the normal state. 1 = The import/export element is in an abnormal state, and the Additional Sense Code and the Additional Sense Code Qualifier fields contain information regarding the abnormal state. Other fields in this descriptor might be invalid, and should be ignored.
ImpExp	This bit indicates how the cartridge tape was placed in the element:
	0 = The cartridge tape in the import/export element was placed there by the library hand as part of an export operation.
	1 = The cartridge tape in the import/export element was placed there by an operator as part of an import operation.
Full	This bit indicates if the import/export element contains a cartridge tape:
	0 = The import/export element does not contain a cartridge tape. 1 = The import/export element does contain a cartridge tape.
Additional Sense Code	This field is valid only if the Except bit is set. In the case of an exception, it contains an ASC as defined for Request Sense data.
Additional Sense Code Qualifier	This field is valid only if the Except bit is set. In the case of an exception, it contains an ASCQ as defined for Request Sense data.
SValid	This bit indicates if the Source Element Address and Invert fields are valid:
	0 = The Source Element Address and Invert fields are not valid. 1 = The Source Element Address and Invert fields are valid.
Invert	The library does not support multi-sided media. The information reported is 0.
ED	0 = The element is enabled (for example a magazine or drive has been installed or has been logically enabled) 1 = The element is disabled

Medium Type	This field provides the type of medium currently present in the element as determined by the medium changer.
	The library returns the following values:
	0h = Unspecified - the medium changer cannot determine the medium type. 1h = Data Medium 2h = Cleaning Medium
Source Storage Element Address	This field is valid only if the SValid bit is 1. It contains the address of the last element from which the data cartridge was moved.
Primary Volume Tag Information	When the PVolTag bit is set to 1, the library returns Volume Tag Information. When PVolTag is set to 0, this field is omitted, and the reserved fields below it are moved up.
	The library Volume Tag Information includes 6 bytes of left-justified ASCII data which represents volume/serial number data read from the cartridge tape. The field is padded to 32 bytes with 26 ASCII spaces. If the label on the cartridge tape is not readable, these 32 bytes will be set to 0.
	The last four bytes of the Volume Tag Information consist of two reserved bytes and two-volume sequence bytes. The library does not support sequence numbers. These four bytes are set to 0.
Code Set	This field specifies the code set used for the identifier field and is set to 0 (not supported) for the Import/Export Element Descriptor
	0h = Reserved
Identifier Type	The Identifier Type field indicates the format and assignment authority for the identifier and is set to 0 (not supported) for the Import/Export Element Descriptor:
	0h = Vendor Specific
Identifier Length	This field indicates the length of the Identifier field and is set to 0 (not supported) for the Import/Export Element Descriptor.
	Note: That the combined length of the identifier field and the Identifier Pad is 32 bytes.
Media Domain	The Media Domain field along with the Media Type field provides a hierarchy of information that indicates the type of media in the element:
	01h or 53h = The element contains a DLT form factor cartridge.
	43h = The element contains an LTO (or future) cleaning form factor cartridge (43h is 'C').
	4Ch = The element contains an LTO form factor cartridge (4Ch is 'L').
	FFh **=** The media domain cannot be determined.
	This field is not valid if the Full bit is not set.

Media Type	The Media Type field along with the Media Domain field provides a hierarchy of information that indicates the type of media in the element.

If the Media Domain field is 01h, the value reported for the Media Type field identifies in ASCII the type of DLT cartridge:

S = The element contains an SDLT I cartridge.
2 = The element contains an SDLT II cartridge.
4 = The element contains a DLTtape S4 cartridge.
FFh = The media type cannot be determined.

If the Media Domain field is 53h (53h is 'S'), the value reported for the Media Type field identifies in ASCII the type of DLT/SDLT cartridge:

1 = The element contains an SDLT I cartridge.
2 = The element contains an SDLT I cartridge.
3 = The element contains an SDLT II cartridge.
4 = The element contains a DLTtape S4 cartridge.
FFh = The medium type cannot be determined.

If the Media Domain field is 43h (43h is 'C'), the value reported for the Media Type field identifies in ASCII the type of LTO cleaning cartridge:

1 = The element contains a HP Generation 1 LTO cleaning cartridge.
2 = The element contains an IBM Generation 1 LTO cleaning cartridge.
3 = The element contains a Quantum Generation 1 LTO cleaning cartridge.
U = The element contains a Universal LTO cleaning cartridge.
FFh = The media type cannot be determined.
This field is not valid if the Full bit is not set.

If the Media Domain field is 4Ch (4Ch is 'L'), the value reported for the Media Type field identifies in ASCII the type of LTO cartridge:

1 = The element contains a 100 GB Generation 1 LTO cartridge.
2 = The element contains a 200 GB Generation 2 LTO cartridge.
3 = The element contains a 400 GB Generation 3 LTO cartridge.
4 = The element contains an 800 GB Generation 4 LTO cartridge.
5 = The element contains a 1500 GB Generation 5 LTO cartridge.
6 = The element contains a 2500 GB Generation 6 LTO cartridge.
T = The element contains a 400 GB Generation 3 LTO WORM cartridge.
U = The element contains an 800 GB Generation 4 LTO WORM cartridge.
V = The element contains a 1500 GB Generation 5 LTO WORM cartridge
W = The element contains a 2500 GB Generation 6 LTO WORM cartridge.
FFh = The media type cannot be determined.
This field is not valid if the Full bit is not set.

Data Transfer Element Descriptor Definitions

Data transfer elements are the tape drives in the library. The Data Transfer Element Descriptor Definitions page describes a tape drive. The following table shows the data returned when the **DvcID bit in the command is set to 0**.

TABLE 4-106 Data Transfer Element Descriptor When DvcID = 0

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0 to 1	(MSB)			Element Address				(LSB)
2	Reserved (0h)				Access	Except	Rsvd (0)	Full
3	Reserved (00h)							
4	Additional Sense Code							
5	Additional Sense Code Qualifier							
6	Reserved (00h)							
7	Reserved (00h)							
8	Reserved (00h)							
9	SValid	Invert (0)	Reserved (00h)		ED	Medium Type		
10 to 11	(MSB)			Source Storage Element Address				(LSB)
12 to 47	Primary Volume Tag Information (Field omitted if PVolTag = 0)							
48	Reserved (0h)				Code Set (0)			
49	Reserved (0h)				Identifier Type (0)			
50	Reserved (00h)							
51	Identifier Length (0)							
52	Media Domain (Field moved up if Primary Volume Tag information omitted.)							
53	Media Type (Field moved up if Primary Volume Tag information omitted.)							
54	Transport Domain (Field moved up if Primary Volume Tag information omitted.)							
55	Transport Type (Field moved up if Primary Volume Tag information omitted.)							
56 to 87	(MSB)		Transport Serial Number					(LSB)

Data Transfer Element Descriptor When DvcID = 0 Definitions:

Element Address	This bit contains the element address of the data transfer element reported.
Access	This bit indicates access is allowed to the data transfer element by the hand:
	0 = Access is not allowed to the tape drive element by the hand. This will be the case when a cartridge tape is loaded and in use by the tape drive. The tape is set to ejected before it becomes accessible.
	1 = The tape drive is accessible.
Except	This bit indicates the operational state of the data transfer element:
	0 = The data transfer element is in the normal state.
	1 = The data transfer element is in an abnormal state, and the Additional Sense Code and the Additional Sense Code Qualifier fields contain information regarding the abnormal state. Other fields in this descriptor might be invalid, and should be ignored.
Full	This bit indicates if the data transfer element contains a cartridge tape:
	0 = The data transfer element does not contain a cartridge tape. 1 = The data transfer element does contain a cartridge tape.
Additional Sense Code	This field is valid only if the Except bit is set. In the case of an exception, it contains an ASC as defined for Request Sense data.
Additional Sense Code Qualifier	This field is valid only if the Except bit is set. In the case of an exception, it contains an ASCQ as defined for Request Sense data.
SValid	This bit indicates if the Source Element Address and Invert fields are valid:
	0 = The Source Element Address and Invert fields are not valid. 1 = The Source Element Address and Invert fields are valid.
Invert	The library does not support multi-sided media and returns a value of 0.
ED	0 = The element is enabled (for example a magazine or drive has been installed or has been logically enabled) 1 = The element is disabled
Medium Type	This field provides the type of medium currently present in the element as determined by the medium changer.
	The library returns the following values:
	0h = Unspecified - the medium changer cannot determine the medium type. 1h = Data Medium 2h = Cleaning Medium
Source Storage Element Address	This field is valid only if the SValid bit is 1. It contains the address of the last element from which the data cartridge was moved.

Primary Volume Tag Information	When the PVolTag bit is set to 1, the library returns Volume Tag Information. When PVolTag is set to 0, this field is omitted, and the reserved fields below it are moved up.
	The library Volume Tag Information includes 6 bytes of left-justified ASCII data which represents volume/serial number data read from the cartridge tape. The field is padded to 32 bytes with 26 ASCII spaces.
	If the label on the cartridge tape is not readable, these 32 bytes will be set to 0.
	The last four bytes of the Volume Tag Information have two reserved bytes and two volume sequence bytes. The library does not support sequence numbers. These four bytes are set to 0.
Code Set	This field specifies the code set used for the identifier field and is set to 0 (not supported) for the Data Transfer Element Descriptor (DvcID = 0): 0h = Reserved
Identifier Type	The Identifier Type field indicates the format and assignment authority for the identifier and is set to 0 (not supported) for the Data Transfer Element Descriptor (DvcID = 0): 0h = Vendor Specific
Identifier Length	This field indicates the length of the Identifier field and is set to 0 (not supported) for the Data Transfer Element Descriptor (DvcID = 0) **Note:** That the combined length of the identifier field and the Identifier Pad is 32 bytes.
Media Domain	The Media Domain field along with the Media Type field provides a hierarchy of information that indicates the type of media in the element:
	01h or 53h = The element contains a DLT form factor cartridge. 43h = The element contains an LTO (or future) cleaning form factor cartridge (43h is 'C'). 4Ch = The element contains an LTO form factor cartridge (4Ch is 'L'). FFh = The media domain cannot be determined. This field is not valid if the Full bit is not set.

Media Type	The Media Type field along with the Media Domain field provides a hierarchy of information that indicates the type of media in the element.
	If the Media Domain field is 01h, the value reported for the Media Type field identifies in ASCII the type of DLT cartridge:
	S = The element contains an SDLT I cartridge. 2 = The element contains an SDLT II cartridge. 4 = The element contains a DLTtape S4 cartridge. FFh = The media type cannot be determined.
	If the Media Domain field is 53h (53h is 'S'), the value reported for the Media Type field identifies in ASCII the type of DLT/SDLT cartridge:
	1 = The element contains an SDLT I cartridge. 2 = The element contains an SDLT I cartridge. 3 = The element contains an SDLT II cartridge. 4 = The element contains a DLTtape S4 cartridge. FFh = The media type cannot be determined.
	If the Media Domain field is 43h (43h is 'C'), the value reported for the Media Type field identifies in ASCII the type of LTO cleaning cartridge:
	1 = The element contains a HP Generation 1 LTO cleaning cartridge. 2 = The element contains an IBM Generation 1 LTO cleaning cartridge. 3 = The element contains a Quantum Generation 1 LTO cleaning cartridge. U = The element contains a Universal LTO cleaning cartridge. FFh = The media type cannot be determined. This field is not valid if the Full bit is not set.
Media Type (cont.)	If the Media Domain field is 4Ch (4Ch is 'L'), the value reported for the Media Type field identifies in ASCII the type of LTO cartridge:
	1 = The element contains a 100 GB Generation 1 LTO cartridge. 2 = The element contains a 200 GB Generation 2 LTO cartridge. 3 = The element contains a 400 GB Generation 3 LTO cartridge. 4 = The element contains an 800 GB Generation 4 LTO cartridge. 5 = The element contains a 1500 GB Generation 5 LTO cartridge. 6 = The element contains a 2500 GB Generation 6 LTO cartridge. T = The element contains a 400 GB Generation 3 LTO WORM cartridge. U = The element contains an 800 GB Generation 4 LTO WORM cartridge. V = The element contains a 1500 GB Generation 5 LTO WORM cartridge. W = The element contains a 2500 GB Generation 6 LTO WORM cartridge. FFh = The media type cannot be determined
	This field is not valid if the Full bit is not set.
Transport Domain	The Transport Domain field with the Transport Type field provide a hierarchy of information that indicates the type of data transfer element installed:
	01h = The transport supports DLT/SDLT form factor cartridges. 4Ch = The transport supports LTO form factor cartridges (4Ch is 'L'). FFh = The transport domain cannot be determined.

Transport Type	If the Transport Domain field is 01h, the value in the Transport Type field indicates that the drive installed is:
	15h = A Quantum SDLT 320 drive 17h = A Quantum SDLT 600 drive 18h = A Quantum DLT S4 drive FFh = The type cannot be determined.
	If the Transport Domain field is 4Ch (4Ch is 'L'), the value in the Transport Type field indicates that the drive installed is:
	33h = An HP Generation 2 LTO drive. 34h = An IBM Generation 2 LTO drive. 35h = A Quantum Generation 2 LTO drive. 36h = An HP Generation 3 LTO drive. 37h = An IBM Generation 3 LTO drive. 38h = A Quantum Generation 3 LTO drive. 39h = An HP Generation 4 LTO drive. 3Ah = An IBM Generation 4 LTO drive. 3Bh = An HP Generation 5 LTO drive. 3Ch = An IBM Generation 5 LTO drive. 3Dh = An HP Generation 6 LTO drive. FFh = The type cannot be determined.
Transport Serial Number	Thirty-two ASCII characters represent the unique transport serial number.
	For tape drives with less than 32 bytes of ASCII serial number data, the value is left-justified and the unused LSB bytes contain ASCII blanks.
	If the serial number is not available from a tape drive that should support an ASCII serial number, ASCII blanks are returned.
	Left justification in this 32-byte field provides space for serial numbers of varying lengths.

Data Transfer Element Descriptor Definitions

Data transfer elements are the tape drives in the library. The Data Transfer Element Descriptor Definitions page describes a tape drive. The following table shows the data returned when the **DvcID bit in the command is set to 1**.

TABLE 4-107 Data Transfer Element Descriptor When DvcID = 1

Byte	\multicolumn{8}{c}{Bit}
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0 to 1	(MSB)			Element Address				(LSB)
2	Reserved (0)				Access	Except	Rsvd (0)	Full
3	Reserved (00h)							
4	Additional Sense Code							
5	Additional Sense Code Qualifier							
6	Reserved (00h)							
7	Reserved (00h)							
8	Reserved (00h)							
9	SValid	Invert (0)	Reserved (00h)		ED	Medium Type		
10 to 11	(MSB)			Source Storage Element Address				(LSB)
12 to 47	Primary Volume Tag Information (Field omitted if PVolTag = 0)							
48	Reserved (0h)				Code Set (2)			
49	Reserved (0h)				Identifier Type (0)			
50	Reserved (00h)							
51	Identifier Length (x)							
52 to 52+x-1 (x bytes)	Identifier (Tape Drive ASCII Serial Number)							
32-x bytes	Identifier Pad							
84	Media Domain							
85	Media Type							
86	Transport Domain							
87	Transport Type							

Data Transfer Element Descriptor (DvcID = 1) Definitions:

Element Address	This bit contains the element address of the data transfer element reported.
Access	This bit indicates access is allowed to the data transfer element by the hand:
	0 = Access is not allowed to the tape drive element by the hand. This will be the case when a cartridge tape is loaded and in use by the tape drive. The tape must be ejected before it becomes accessible.
	1 = The tape drive is accessible.
Except	This bit indicates the operational state of the data transfer element:
	0 = The data transfer element is in the normal state. 1 = The data transfer element is in an abnormal state, and the Additional Sense Code and the Additional Sense Code Qualifier fields contain information regarding the abnormal state. Other fields in this descriptor might be invalid, and should be ignored
Full	This bit indicates if the data transfer element contains a cartridge tape:
	0 = The data transfer element does not contain a cartridge tape. 1 = The data transfer element does contain a cartridge tape.
Additional Sense Code	This field is valid only if the Except bit is set. In the case of an exception, it contains an ASC as defined for Request Sense data.
Additional Sense Code Qualifier	This field is valid only if the Except bit is set. In the case of an exception, it contains an ASCQ as defined for Request Sense data.
SValid	This bit indicates if the Source Element Address and Invert fields are valid:
	0 = The Source Element Address and Invert fields are not valid. 1 = The Source Element Address and Invert fields are valid.
Invert	The library does not support multi-sided media and returns a value of 0.
ED	0 = The element is enabled (for example a magazine or drive has been installed or has been logically enabled) 1 = The element is disabled
Medium Type	This field provides the type of medium currently present in the element as determined by the medium changer.
	The library returns the following values:
	0h = Unspecified - the medium changer cannot determine the medium type. 1h = Data Medium 2h = Cleaning Medium
Source Storage Element Address	This field is valid only if the SValid bit is 1. It contains the address of the last element from which the data cartridge was moved.
Primary Volume Tag Information	When the PVolTag bit is set to 1, the library returns Volume Tag Information. When PVolTag is set to 0, this field is omitted, and the reserved fields below it are moved up.
	The library Volume Tag Information includes 6 bytes of left-justified ASCII data which represents volume/serial number data read from the cartridge tape. The field is padded to 32 bytes with 26 ASCII spaces.
	If the label on the cartridge tape is not readable, these 32 bytes will be set to 0.
	The last four bytes of the Volume Tag Information have two reserved bytes and two volume sequence bytes. The library does not support sequence numbers. These four bytes are set to 0.

Code Set	This field specifies the code set used for the identifier field:
	2h = The identifier contains ASCII graphic codes (code values 20h through 7Eh).
Identifier Type	The Identifier Type field indicates the format and assignment authority for the identifier:
	0h = No assignment authority was used, and consequently there is no guarantee that the identifier is globally unique. In other words, the identifier is vendor specific.
Identifier Length	This field indicates the length of the Identifier field. Note: That the combined length of the Identifier field and the Identifier Pad is 32 bytes.
Identifier	This field contains the ASCII Serial Number for the tape drive associated with this data transfer element.
Identifier Pad	This field contains ASCII blanks. The number of blanks depends on the length of the Identifier field. Note: That the combined length of the Identifier field and the Identifier Pad is 32 bytes.
Media Domain	The Media Domain field along with the Media Type field provides a hierarchy of information that indicates the type of media in the element:
	01h or 53h = The element contains a DLT form factor cartridge. 43h = The element contains an LTO (or future) cleaning form factor cartridge (43h is 'C'). 4Ch = The element contains an LTO form factor cartridge (4Ch is 'L'). FFh = The media domain cannot be determined. This field is not valid if the Full bit is not set
Media Type	The Media Type field, along with the Media Domain field, provides a hierarchy of information that indicates the type of media in the element.
	If the Media Domain field is 01h, the value reported for the Media Type field identifies in ASCII the type of DLT/SDLT cartridge:
	S = The element contains an SDLT I cartridge. 2 = The element contains an SDLT II cartridge. 4 = The element contains a DLTtape S4 cartridge. FFh = The media type cannot be determined.
	If the Media Domain field is 53h (53h is 'S'), the value reported for the Media Type field identifies in ASCII the type of DLT/SDLT cartridge:
	1 = The element contains an SDLT I cartridge. 2 = The element contains an SDLT I cartridge. 3 = The element contains an SDLT II cartridge. 4 = The element contains a DLTtape S4 cartridge. FFh = The media type cannot be determined.
	If the Media Domain field is 43h (43h is 'C'), the value reported for the Media Type field identifies in ASCII the type of LTO cleaning cartridge:
	1 = The element contains an HP Generation 1 LTO cleaning cartridge. 2 = The element contains an IBM Generation 1 LTO cleaning cartridge. 3 = The element contains a Quantum Generation 1 LTO cleaning cartridge. U = The element contains a Universal LTO cleaning cartridge. FFh = The media type cannot be determined. This field is not valid if the Full bit is not set.

Media Type (cont.)	If the Media Domain field is 4Ch (4Ch is 'L'), the value reported for the Media Type field identifies in ASCII the type of LTO cartridge:
	1 = The element contains a 100 GB Generation 1 LTO cartridge. 2 = The element contains a 200 GB Generation 2 LTO cartridge. 3 = The element contains a 400 GB Generation 3 LTO cartridge. 4 = The element contains an 800 GB Generation 4 LTO cartridge. 5 = The element contains a 1500 GB Generation 5 LTO cartridge. 6 = The element contains a 2500 GB Generation 6 LTO cartridge. T = The element contains a 400 GB Generation 3 LTO WORM cartridge. U = The element contains an 800 GB Generation 4 LTO WORM cartridge. V = The element contains a 1500 GB Generation 5 LTO WORM cartridge. W = The element contains a 2500 GB Generation 6 LTO WORM cartridge. FFh = The media type cannot be determined. This field is not valid if the Full bit is not set.
Transport Domain	The Transport Domain field with the Transport Type field provide a hierarchy of information that indicates the type of data transfer element installed:
	01h = The transport supports DLT/SDLT form factor cartridges. 4Ch = The transport supports LTO form factor cartridges (4Ch is 'L'). FFh = The transport domain cannot be determined.
Transport Type	If the Transport Domain field is 01h, the value in the Transport Type field indicates that the drive installed is:
	15h = A Quantum SDLT 320 drive 17h = A Quantum SDLT 600 drive 18h = A Quantum DLT S4 drive FFh = The type cannot be determined
	If the Transport Domain field is 4Ch (4Ch is 'L'), the value in the Transport Type field indicates that the drive installed is:
	33h = An HP Generation 2 LTO drive 34h = An IBM Generation 2 LTO drive 35h = A Quantum Generation 2 LTO drive 36h = An HP Generation 3 LTO drive. 37h = An IBM Generation 3 LTO drive. 38h = A Quantum Generation 3 LTO drive. 39h = An HP Generation 4 LTO drive. 3Ah = An IBM Generation 4 LTO drive. 3Bh = An HP Generation 5 LTO drive. 3Ch = An IBM Generation 5 LTO drive. 3Dh = An HP Generation 6 LTO drive. FFh = The type cannot be determined.

Release (6)

The 6-byte Release command (17h) enables the initiator to release a unit reservations of the library as set using a previous Reserve command.

Performing a unit release of a library that has no active reservations is not considered an error. Only the initiator that performed the reservation can release the reservation. If another initiator attempts to release a unit reservation, the library returns good status, but does not release the reservation.

TABLE 4-108 Release Command (6)

Byte	Bit							
	7	6	5	4	3	2	1	0
0	Operation Code (17h)							
1	Ignored			Obsolete (0h)				
2	Obsolete (00h)							
3	Reserved (00h)							
4	Reserved (00h)							
5	Control Byte							

Release (10)

The 10-byte Release command (57h) enables the initiator to release unit reservations of the library as set using a previous Reserve command and optionally to perform a release for a third party initiator.

Performing a unit release of a library that has no active reservations is not considered an error. Only the initiator that performed the reservation or the third party for which the reservation was made can release the reservation. If another initiator attempts to release a unit reservation, the library returns good status, but does not release the reservation.

TABLE 4-109 Release (10) Command

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Operation Code (57h)							
1	Ignored			3rdpty	Reserved (0h)		LongID	Obsolete (0)
2	Reserved (00h)							
3	Third Party Device Id							
4-6	Reserved (00h)							
7 to 8	(MSB) Parameter List Length (LSB)							
9	Control Byte							

Release (10) Command Definitions:

3rdpty	This field indicates whether the reservation is on behalf of a third party or not.
	0 = The reservation is on behalf of the calling requester. 1 = The reservation is on behalf of a specified Third party Device Id.
LongID	This field is ignored. LongIDs are not supported.
Third Party Device ID	The ID of the third Party device.
Parameter List Length	This field is ignored. (LongIDs are not supported.)

Report LUNS

The Report LUNS command (A0h) returns to the initiator the known LUNs to which the initiator can send commands.

TABLE 4-110 Report LUNs Command

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Operation Code (A0h)							
1	Ignored			Reserved (0h)				
2	Select Report							
3 to 5	Reserved (0h)							
6 to 9	(MSB) Allocation Length (LSB)							
10	Reserved (00h)							
11	Control Byte							

Report LUNs Command Definitions:

Select Report	This field specifies the type of logical unit addresses that shall be reported.
	
	• 00h = LUN addresses reported shall be limited to the following addressing:
	
	  • LUN addressing method;
	
	  • Peripheral device addressing method; and
	
	  • Flat space addressing method.
	
	• 02h = All LUNS accessible to the initiator for this port are accessible

Allocation Length	This field specifies the number of bytes that the initiator has allocated for data to be returned from the Report LUNs command. The Allocation must be at least 16 bytes. If it is less, a check condition is returned with the sense key set to illegal request and the additional sense data set to invalid field in the command descriptor block (CDB).

Report LUNs Data Definition

The library returns the following data for the Report LUNs command.

TABLE 0-2 Report LUNs Data

Byte	Bit							
	7	6	5	4	3	2	1	0
0 to 3	(MSB)			LUN list length				(LSB)
4 to 7	Reserved (00h)							
8 to 15	(MSB)			First LUN Descriptor				(LSB)
n -7 to n	(MSB)			Last LUN Descriptor (n)				(LSB)

Report LUNs Data Definitions:

LUN list length	The library returns the length in bytes of the LUN list that is available for transfer. It is equal to 8 times the number of available logical units for the initiator. For example: If the allocation length is 16 bytes and 2 logical units are available, this command will return the 8-byte header and 1 logical unit descriptor; however, the LUN list length will still be 16 because 16 bytes were available if the allocation length was sufficient.

TABLE 4-111 LUN Descriptor

Byte	Bit							
	7	6	5	4	3	2	1	0
0	Address Method		Bus ID (0h)					
1	Single Level LUN Address							
2 to 3	Second Level LUN Address (00h)							
4 to 5	Third Level LUN Address (00h)							
6 to 7	Fourth Level LUN Address (00h)							

LUN Descriptor Data Definitions:

Address Method	This is set to 0h indicating single level LUN addressing is used.
Bus ID	This is set to 0h indicating a logical unit at the current level.
Single Level LUN Address	This is the value of the LUN
Second, Third, and Fourth Level LUN Address	Set to 00h for single level addressing

Report Target Port Groups

The Report Target Port Groups command (A3h) requests that the library return the Target Port Group data for all ports.

TABLE 4-112 Report Target Port Groups Command

Byte	\ 7	\ 6	\ 5	Bit\ 4	\ 3	\ 2	\ 1	\ 0
0	Operation Code (A3h)							
1	Ignore			Service Action (0Ah)				
2 to 5	(MSB) Reserved (00h)							(LSB)
6 to 9	(MSB) Allocation Length							(LSB)
10	Reserved (00h)							
11	Control Byte (00h)							

Report Target Port Group Command Definitions:

Service Action	0Ah
Allocation Length	Specifies the length of the parameter list the library returns. The library transfers the number of bytes specified by the Allocation Length or the available Report Target Port Groups data, whichever is less.

Report Target Port Group Data Definitions

The library returns the following data for the Report Target Port Groups command.

TABLE 4-113 Report Target Port Groups Data

Byte	Bit							
	7	6	5	4	3	2	1	0
0 to 3	(MSB) Returned Data Length (LSB)							
Target Port Group Descriptors								
4 to x	(MSB) First Target Port Group Descriptor (LSB)							
x+1 to n	(MSB) Last Target Port Group Descriptor (LSB)							

Report Target Port Group Data Definitions:

Returned Data Length   Indicates the length in bytes of the Target Port Descriptor data available to the initiator.

Target Port Group Descriptor Data

TABLE 4-114 Target Port Group Descriptor Data

Byte	Bit							
	7	6	5	4	3	2	1	0
0	PREF	Reserved (00h)			Asymmetric Access State			
1	T_Sup	Reserved (00h)			U_Sup	S_Sup	AN_Sup	AO_Sup
2 to 3	(MSB) Target Port Group (LSB)							
4	Reserved (00h)							
5	Status Code (02h)							
6	Reserved (00h)							
7	Target Port Group Count							
Target Port Descriptors								
8 to 11	(MSB) First Target Port Descriptor (LSB)							
n-3 to n	(MSB) Last Target Port Descriptor (LSB)							

Target Port Group Descriptor Data Definitions:

PREF	This bit indicates if the target port group is a preferred target port group.
	0b = Indicates the target port group is not a preferred target port group.
	1b = Indicates that the target port group is a preferred target port group.
	Note: All ports in the Active/Optimized group are preferred
Asymmetric Access State	This field contains the target port group's current asymmetric access state.
	The library supports the following Asymmetric Access States:
	0h = Active/Optimized. This state indicates the ports in the group are fully operational.
	3h = Unavailable. This state indicates that the ports in the group are not available.
T_Sup	The library returns a Transitioning Support bit of 0, indicating the Transitioning asymmetric access state is not supported.
U_Sup	0 = The Unavailable asymmetric access state is not supported.
	1 = The Unavailable asymmetric access state is supported.
S_Sup	The library returns a Standby Support bit of 0, indicating the Standby asymmetric access state is not supported.
AN_Sup	The library returns an active/non-optimized support bit of 0, indicating the Active/non-optimized asymmetric access state is not supported.
AO_Sup	0 = The Active/Optimized asymmetric access state is not supported.
	1 = The Active/Optimized asymmetric access state is supported.
Target Port Group	The target port group field contains an identification of the group.
	00h = Target Port Group 0
	01h = Target Port Group 1
Status Code	The library returns a status code value of 2, indicating the target port group asymmetric access state is altered by implicit asymmetrical logical unit access behavior.
Target Port Group Count	The target port count field indicates the number of target ports that are in the target port group and the number of target port descriptors in the target port group descriptor. The target port group count can range from a value of 1 to 2.

Target Port Descriptor Data

TABLE 4-115 Target Port Descriptor Data

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0 to 1	Reserved (00h)							
2 to 3	Relative Target Port Identifier							

Target Port Descriptor Data Definitions:

Relative Target Port Identifier	0000h = No Target Port 0001h = Relative Target Port 1 0002h = Relative Target Port 2

Request Sense

The Request Sense command (03h) requests the library transfer sense data to the initiator.

TABLE 4-116 Request Sense Command

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Operation Code (03h)							
1	Ignored			Reserved (00h)				Desc (0h)
2	Reserved (00h)							
3	Reserved (00h)							
4	Allocation Length							
5	Control Byte							

Request Sense Command Definitions:

Desc	The Desc bit indicates which sense data format shall be returned. The library returns a value of 0, indicating fixed format sense data is returned.
Allocation Length	This field specifies the number of bytes that the initiator has allocated for returned sense data. The library provides a maximum of 14h (20d) bytes of sense data.

Sense Data

Sense data is available when:

- The previous command to the specified I_T_L nexus terminated with Check Condition status. Multiple errors might occur during the processing of a single SCSI command. The sense key reflects the first error that occurred.

- The Request Sense command was issued to an unsupported LUN. In this case, the library does not return a check condition and returns sense data:

  - Sense Key set to Illegal Request (05h)

  - ASC set to Logical Unit Not Supported (25h)

  - ASCQ set to 00h

If no sense data is available for the specified I_T_L nexus, the library returns sense data:

- Sense Key set to No Sense (0h)

- ASC set to No Additional Sense Information (00h)

- ASCQ set to 00h

The library returns Check Condition status for a Request Sense command only to report errors specific to the command itself.

For example: A non-zero reserved bit is detected in the CDB.

If a recovered error occurs during the execution of a Request Sense command, the library returns the sense data with Good status. If the library returns a Check Condition status for a Request Sense command, the sense data might be invalid.

For example: A non-zero reserved bit is detected in the CDB.

If a recovered error occurs during the execution of a Request Sense command, the library returns the sense data with Good status. If the library returns a Check Condition status for a Request Sense command, the sense data might be invalid.

Request Sense Data Definitions

TABLE 4-117 shows the Request Sense Data Definitions.

TABLE 4-117 Request Sense Data

Byte				Bit				
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Valid (0)	Error Code (70h)						
1	Segment Number (00h)							
2	Reserved (0h)				Sense Key			
3 to 6	(MSB) Information (00h) (LSB)							
7	Additional Sense Length (n-7)							
8 to 11	(MSB) Command Specific Information (00h) (LSB)							
12	Additional Sense Code							
13	Additional Sense Code Qualifier							
14	Field Replaceable Unit Code (00h)							
15	SKSV	C/D	Reserved (0)		BPV (0)	Bit Pointer (0h)		
16 to 17	(MSB) Field Pointer (LSB)							
18	Reserved (00h)							
19	Reserved (00h)							

Request Sense Data Definitions:

Valid	This bit indicates if the Information field contains valid data. The library does not return data in the Information field. The value is 0.
Error Code	This bit indicates if the error is current or deferred. The library returns only current errors. The value is 70h.
Segment Number	The library does not support segment numbers and returns a value of 00h.
Sense Key	The Sense Key (SK) field, with the Additional Sense Code and Additional Sense Code Qualifier fields, describes the error.
Information	The library does not support this field and returns a value of 00h.
Additional Sense Length	This field indicates the Additional Sense Length provided by the library excluding this byte. The typical value is 0Ch (12d).
Command Specific Information	The library does not support this field and returns a value of 00h.
Additional Sense Code	The Additional Sense Code (ASC) field, with the Sense Key and Additional Sense Code Qualifier fields, describes the error.
Additional Sense Code Qualifier	The Additional Sense Code Qualifier (ASCQ) field, with the Sense Key and Additional Sense Code fields, describes the error.
Field Replaceable Unit Code	The library does not support this field and returns a value of 00h.
SKSV (Sense Key Specific Valid)	When the Sense Key Specific Valid bit is set to 1, the fields C/D, BPV, and Field pointers are valid. Otherwise, ignore these fields.
C/D (Command/Data)	Command/Data indicates whether the Check Condition status resulted from an illegal parameter in either the command descriptor block (Command) or the parameter list (Data) 0 = Illegal parameter in the parameter list. 1 = Illegal parameter in the command descriptor block.
BPV (Bit Pointer Valid)	0 = Indicates that the value in the bit pointer field is not valid. 1 = Indicates that the bit pointer field specifies which bit of the byte designated by the Field Pointer field is in error.
Bit Pointer	When the Bit Pointer Valid field is set to 1, this value indicates which bit of the byte designated by the Field Pointer field is in error.
Field Pointer	This field contains the number of the byte where the error occurred. Byte numbers start at 00. When a multiple-byte field is in error, the Field Pointer contains the value of the most significant byte of the field, which is the byte with the lowest byte number. For example, if a field consists of bytes 02, 03, and 04, the most significant byte is 02.

Sense Key

The Sense Key field provides basic information about an error.

TABLE 4-118 lists the Sense Keys with an explanation for each code. The Sense Key field, with the Additional Sense Code and Additional Sense Code Qualifier fields, provides a description about the error.

See for more information.

TABLE 4-118 Sense Key Code Descriptions

Code	Error	Description
0h	No Sense	Indicates there is no specific sense key information to be reported. A sense key of 0 indicates a successful command.
2h	Not Ready	Indicates the addressed logical unit is not ready for library motion commands (library is not initialized, device is not ready).
4h	Hardware Error	Indicates the device detected an unrecoverable hardware failure while performing the command or during a self-test.
5h	Illegal Request	Indicates an illegal parameter in the command descriptor block or in the parameter list data.
6h	Unit Attention	Indicates a power-on or reset has occurred to the device, or a not ready-to-ready transition has occurred, or an I/O element has been accessed. Also, this may indicate mode parameters have changed, or the microcode has been changed.
Bh	Aborted Command	Indicates the device aborted the command. The initiator might be able to recover by trying the command again.

Additional Sense Codes and Qualifiers

Bytes 12 and 13 of the sense data contain the Additional Sense Code (ASC) and Additional Sense Code Qualifier (ASCQ) fields. These codes provide additional device- specific information about the error or exception.

Each code contains a unique combination of the sense key, additional sense code, and additional sense code qualifier. The following pages describe the error codes for the library grouped by type of sense key.

No Sense Key

The library returns a No Sense Key (00h) when sense is requested, but no error has occurred. The ASC and ASCQ values are zero.

Not Ready Sense Key Codes

If a command is sent when the library is not ready, it generates a Not Ready error code. The following codes describe the conditions of the library that can generate Not Ready codes.

TABLE 4-119 Not Ready Sense Keys

Description	Sense Key	ASC	ASCQ
Not Ready, Cause Not Reportable	2h	04h	00h
Not Ready, In Process of Becoming Ready	2h	04h	01h
Not Ready, Manual Intervention Required	2h	04h	03h
Not Ready, Logical Unit Not Ready, Operation in Progress	2h	04h	07h
Not Ready, Logical Unit Offline	2h	04h	12h
Not Ready, Maintenance Mode	2h	04h	81h
Not Ready, Cleaning Cartridge Installed	2h	30h	03h
Not Ready, Cartridge Access Port Open	2h	3Ah	02h

Not Ready, Cause Not Reportable

The library detected a not ready state after execution of the command was started.

Not Ready, In Process of Becoming Ready

The library is initializing and performing an audit. Initialization occurs in a number of situations, including power-on, after the door has been opened then closed, as part of the Send Diagnostic command, when requested from the operator panel, and as part of a recovery during certain failures.

Not Ready, Manual Intervention Required

Manual intervention errors include: the front door is open, the CAP is open, the library is in maintenance mode, or the library is in an inoperable state.

- If the library front door is open, closing the door causes the library to reinitialize and go into a ready state.

- If the library is in an inoperable state, reinitialize the library using the operator panel.

- If the library is in maintenance mode, take the library out of this mode using the operator panel or CSE port.

Not Ready, Logical Unit Not Ready, Operation in Progress

This sense data indicates that the library is busy processing another command.

Not Ready, Logical Unit Offline

This sense data indicates that the library is offline and cannot process the command.

Not Ready, Maintenance Mode

The library was placed in maintenance mode from the operator panel or CSE port.

Not Ready, Cleaning Cartridge Installed

The library is performing an Auto Clean function on the data transfer element (tape drive) requested.

Note – While the cleaning cartridge remains in the drive, the library processes host commands normally. If a host requests a data mount to the drive being cleaned, then the library rejects the command and sends the Not Ready sense key (02), with ASC 30h and ASCQ 03 (Cleaning Cartridge Installed).

The host receives the data mount error for the duration of the cleaning time. Cleaning times vary, depending on the type of drive, the cleaning cartridge, robotic times, and potential retry operations. The time required to clean a 9840 is about 30 seconds. The time required to clean a DLT drive varies with the number of times the cleaning tape is used. The tape is good for 20 uses. Each time you use it takes longer than the last time because the operation goes farther on the tape cartridge. The longest cycle, cleaning cycle (20), takes approximately 5 minutes and 15 seconds.

Not Ready, Cartridge Access Port Open

The library detected that the CAP is open and a SCSI command was issued to access the CAP.

Hardware Error Sense Key

The library generates a Hardware Error sense key if a hardware or firmware error is detected during command execution. The following pages describe the conditions that generate hardware errors.

TABLE 4-120 Hardware Error Sense Keys

Description	Sense Key	ASC	ASCQ
Hardware Error, General	4h	40h	01h
Hardware Error, Tape Drive	4h	40h	02h
Hardware Error, Cartridge Access Port	4h	40h	03h
Hardware Error, Imbedded Software	4h	44h	00h
Hardware Error/Media Load/Eject Failed	4h	53h	00h

Hardware Error, General

The library generates a general hardware error when it detects an internal electronics error during a command. This includes the electronics, vision system, and robotics of the library.

Hardware Error, Tape Drive

The library generates a tape-drive error when an operation to the drive fails. The problem could be the tape drive or the interface between the library and tape drive.

Hardware Error, CAP

The library generates a hardware error when the CAP fails.

Hardware Error, Embedded Software

The library generates a hardware error when an unexpected condition is detected by the embedded software that controls the SCSI interface. This error is used for arbitrary limitations of the embedded software.

Hardware Error, Media Load/Eject Failed

The library generates a hardware error when a load or eject fails to complete.

Illegal Request Sense Key

Any illegal parameters in a command descriptor block (CDB) or parameter list for a particular command generate an Illegal Request sense key (see TABLE 4-121).

In some cases, additional information is available in Byte 15 of the sense data, which includes the sense-key-specific-value (SKSV) and command/data (C/D) fields. This information indicates the byte in the command descriptor block or the parameter list, which is in error.

If available, the SKSV bit in the sense data is set to 1.

See "Request Sense" on page 212 for more information.

TABLE 4-121 Illegal Request Sense Keys

Description	Sense Key	ASC	ASCQ
Invalid Field in Command information Unit	5h	0Eh	03h
Parameter Length Error	5h	1Ah	00h
Invalid Command	5h	20h	00h
Invalid Element	5h	21h	01h
Invalid Field in CDB	5h	24h	00h
Logical Unit Not Supported	5h	25h	00h
Invalid Field in Parameters	5h	26h	00h
Invalid Release of Persistent Reservation	5h	26h	04h
Incompatible Medium	5h	30h	00h
Saving Parameters Not Supported	5h	39h	00h
Medium Not Present, Drive Not Unloaded	5h	3Ah	00h
Destination Element Full	5h	3Bh	0Dh
Source Element Empty	5h	3Bh	0Eh
Magazine Removed	5h	3Bh	12h
Insufficient Resources	5h	55h	03h

Unit Attention Sense Key

The library generates a Unit Attention sense key for *all* initiators if the library needs to inform the host of an asynchronous event. The following pages describe library conditions that generate Unit Attention errors.

TABLE 4-122 Unit Attention Sense Keys

Description	Sense Key	ASC	ASCQ
Not Ready-to-Ready Transition	6h	28h	00h
CAP Element Accessed	6h	28h	01h
Power-On Occurred	6h	29h	01h
SCSI Bus or Target Reset	6h	29h	02h
LUN Reset	6h	29h	03h
Device Internal Reset	6h	29h	04h
Mode Parameters Changed	6h	2Ah	01h
Reservations Preempted	6h	2Ah	03h
Reservations Released	6h	2Ah	04h
Registrations Preempted	6h	2Ah	05h
Asymmetric Access State Changed	6h	2Ah	06h
Microcode Has Been Changed	6h	3Fh	01h
LUN Data Has Changed	6h	3Fh	0Eh

Not Ready-to-Ready Transition

The library generates this type of Unit Attention when the library transitions to a ready state from a not ready state. This transition can occur following any conditions that cause a not ready state. A Unit Attention is generated for all initiators.

CAP Element Accessed

The library generates this type of Unit Attention when the operator opens and closes the CAP. Issue a Read Element Status command to obtain an updated inventory. A Unit Attention is generated for all initiators.

Note – After running Send Diagnostic page code 80 or 81, this Unit Attention sense key will be returned at completion, which indicates that the inventory has changed.

Power-On Occurred

The library generates this type of Unit Attention when the library is powered-on, IPLed from the operator panel, or reset over the interface. A Unit Attention is generated for all initiators.

SCSI Bus or Target Reset

The library generates this type of Unit Attention to all initiators after the library is clear of all I/O processes following the SCSI Bus or Target reset.

LUN Reset

The library generates this type of Unit Attention to all initiators after the library is clear of all I/O processes following the LUN reset.

Device Internal Reset

The library generates this type of Unit Attention to all initiators after the library is clear of all I/O processes following an internal device reset.

Mode Parameters Changed

The library generates this type of Unit Attention when a different initiator performs a Mode Select operation. Issuing a Mode Sense command can retrieve the current parameters. This Unit Attention is issued for all initiators except the one that performed the Mode Select.

Persistent Reservations/Registrations Preempted or Released

The library generates these types of Unit Attention sense keys when one initiator has its persistent reservations or registrations cleared by another initiator.

Asymmetric Access State Changed

The library generates this Unit Attention when an event occurs that causes the Report Target Port Groups data to change.

Microcode Has Been Changed

The library issues this Unit Attention sense key after executing a Write Buffer command to update the functional microcode for the library.

LUN Data Has Changed

The library generates this type of Unit Attention to all initiators that are affected when the library LUN configuration has changed.

Aborted Command Sense Key

The library generates an Aborted Command error code when a SCSI command is aborted because of a SCSI protocol error. The initiator might not register a Check Condition status related to these errors because of the nature of the aborted commands, but the sense data is available. The following pages describe the conditions of the library that generates Aborted Commands.

TABLE 4-123 Aborted Command Sense Keys

Description	Sense Key	ASC	ASCQ
Logical Unit Communication Failure	0Bh	08h	00h
Mechanical Positioning Error	0Bh	15h	01h
Command Phase Error	0Bh	4Ah	00h
Data Phase Error	0Bh	4Bh	00h
Command Overlap	0Bh	4Eh	00h
Incompatible Firmware Download	0Bh	73h	04h

Logical Unit Communication Failure

The drive returns this status when there is a logical unit communication failure that prevents the library from processing the command.

Mechanical Positioning Error

The library detected an error while trying to position the PTP and the operation could not be completed.

Command Phase Error

The library detected a command phase error and the operation could not be completed.

Data Phase Error

The library detected a data phase error and the operation could not be completed.

Command Overlap

The library detected another command from an initiator while one was already in process.

Incompatible Firmware Download

Library code versions previous to 1426 will not support the version of operator control panel on this machine, download has been terminated.

Request Volume Element Address

The Request Volume Element Address command (B5h) requests that the library return the results of a previous Send Volume Tag command.

TABLE 4-124 Request Volume Element Address Command

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Operation Code (B5h)							
1	Ignored			VolTag		Reserved (0h)		
2 to 3	(MSB) Starting Element Address (LSB)							
4 to 5	(MSB) Number of Elements (LSB)							
6	Reserved (00h)							
7 to 9	(MSB) Allocation Length (LSB)							
10	Reserved (00h)							
11	Control Byte (00h)							

Request Volume Element Address Command Descriptions:

VolTag (Volume Tag)	This bit indicates whether volume tag (VolTag) information is to be reported in response to this command: 0 = Volume Tag information is not reported. 1 = Volume Tag information is reported.
Starting Element Address	Specifies the minimum element address to report. Only elements with an address greater than or equal to the Starting Element Address are reported. The Starting Element Address must be a valid address for the library but does not have to be an address of the type requested in the Element Type Code.
Number of Elements	Represents the maximum number of element descriptors to be transferred.
Allocation Length	Specifies the length in bytes of the space allocated by the initiator for the transfer of element descriptors. Only complete element descriptors are transferred. Element descriptors are transferred until one of the following conditions is met: All available element descriptors of the type specified in the Element Type Code have been transferred. The number of element descriptors specified in the Number of Elements field has been transferred. There is less allocation length space available than required for the next complete element descriptor or header to be transferred.
Request Volume Element Address Data	The library returns data for a Request Volume Element Address command in: An eight-byte Volume Element Address header, followed by One to four element pages, one page per element type. A page consists of: An eight-byte Element Status Page header, followed by One or more Element Descriptors. The format of the descriptor is based on the element type reported in this page. There is a separate Element Descriptor format for each element type. The data can be truncated based on the length specified in the allocation length field.

Volume Element Address Header Definition

The Volume Element Address Header is sent once for each command.

TABLE 4-125 Volume Element Address Header

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0 to 1	(MSB)			First Element Address Reported				
								(LSB)
2 to 3	(MSB)			Number of Elements Available				
								(LSB)
4	Reserved (0h)				Send Action Code (5h)			
5 to 7	(MSB)			Byte Count of Report Available (all pages, n-7)				
								(LSB)
8 to n	Element Status pages							

Volume Element Address Header Definitions:

First Element Address Reported	This field indicates the lowest element address found of the type specified in the Element Type Codes and greater than/equal to the starting address.
Number of Elements Available	This field indicates the number of elements found of the type specified in the Element Type Codes and greater than or equal to the Starting Element Address.
	This number is adjusted to be less than or equal to the count specified in the Number of Elements field.
Send Action Code	This field contains the value of the send action code field from the previous Send Volume Tag command. The value is 5h.
Byte Count of Report Available	This field indicates the number of bytes of element status data available for all elements that meet the requirements of the Request Volume Element Address command.
	This count does not include the Element Status Data header bytes.
	This value is not adjusted to match the allocation length from the command.
Element Status Pages	The element pages returned by a Request Volume Element Address command are the same format as returned by the Read Element Status command.
	See "Read Element Status" on page 178 for more information.

Reserve (6)

The 6-byte Reserve command (16h) allows the initiator to perform unit reservations. Unit reservations are reservations of the library as a whole.

TABLE 4-126 Reserve Command

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Operation Code (16h)							
1	Ignored			Obsolete (0h)				
2	Obsolete (00h)							
3 to 4	Obsolete (00h)							
5	Control Byte							

Other Commands and Reservations

Unit reservations are released or canceled by:

- A "Release" command from the same initiator

- A Task Management reset:

  - Target Reset

  - LUN Reset

- An interface reset

- A power-on reset of the library

If the library is reserved as a unit, the library processes only the following commands from another initiator:

- Prevent/Allow Medium Removal with Prevent bits set to 0

- Inquiry

- Log Sense

- Release (the reservation is not released)

- Request Sense

- Report LUNs

- Report Target Port Groups

All other commands result in a Reservation Conflict status (18h).

Reserve (10)

The 10-byte Reserve command (56h) allows the initiator to perform unit reservations. Unit reservations are reservations of the library as a whole.

Another capability of the Reserve (10) command as opposed to the Reserve (6) command is the ability to do third party reservations. The third party reservation allows the reservation of a logical unit within a logical unit on behalf of another SCSI device.

Note: New host applications should not use 3rd party reservations. These are legacy SPC-2 commands. Persistent Reservations should instead be implemented.

TABLE 4-127   Reserve (10) Command

Byte	Bit							
	7	6	5	4	3	2	1	0
0	Operation Code (56h)							
1	Ignored			3rd Pty	Reserved		LongID	Obsolete (0)
2	Obsolete (00h)							
3	Third Party Device Id							
4-6	Reserved							
7 to 8	(MSB) Parameter List Length (LSB)							
9	Control Byte							

Reserve (10) Command Descriptions:

3rd Pty	This field indicates whether the reservation is on behalf of a third party or not:
	0 = The reservation is on behalf of the calling requester.
	1 = The reservation is on behalf of a specified Third party Device Id.
LongID	This field is ignored. LongIDs are not supported.
Third Party Device Id	The ID of the third-party device.
Parameter List Length	This field is ignored. (LongIDs are not supported.)

Other Commands and Reservations

Unit reservations are released or canceled by:

- A Release command from the initiator that owns the reservation (original initiator or the third party)

- A Task Management reset:

  - Target Reset

  - LUN Reset

- An interface reset

- A power-on reset of the library

If the library is reserved as a unit, the library processes only the following commands from another initiator:

- Prevent/Allow Medium Removal with Prevent bits set to 0

- Inquiry

- Log Sense

- Release (the reservation is not released)

- Request Sense

- Report LUNs

- Report Target Port Groups

All other commands result in a Reservation Conflict status (18h).

Send Diagnostic

The Send Diagnostic command (1Dh) requests the library to perform a self-diagnostic test. The library may support some self tests in the future but for now considers this command to be a no-operation.

The self-test includes initialization diagnostics and calibration of the library. The extended diagnostics provide random cartridge motions and additional calibration features.

The library disconnects while a diagnostic test is being performed, then reconnects when the diagnostic test completes. This disconnected time can be several minutes, and time- outs should be adjusted accordingly.

The library returns status based on the diagnostic test result. The Receive Diagnostic command is not used.

TABLE 4-128 Send Diagnostic Command

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Operation Code (1Dh)							
1	Ignored			PF	Rsvd (0)	SelfTest (1)	DevOfl (0)	UnitOfl (0)
2	Reserved (00h)							
3 to 4	(MSB) Parameter List Length (LSB)							
5	Control Byte (00h)							

Send Diagnostic Command Descriptions:

PF	The library supports the page format (PF) specified by SCSI-3.
	The value of PF should be 1. However, the library accepts a 0 for self test.
SelfTest	The library returns a value of 1, indicating a request to the library to complete the library's default test.
DevOfl	This feature is not supported by the library; the value is set to 0.
UnitOfl	This feature is not supported by the library; the value is set to 0.
Parameter List Length	For the self-test option, a value of 0h is required.
	For extended diagnostics, a value of 8h is required. (not supported)

Send Diagnostic Data

For extended diagnostics, the initiator must provide Send Diagnostic parameter data in a parameter list that include.

- A page code
- Diagnostic parameters

TABLE 4-129 Send Diagnostic Data

Byte	Bit							
	7	6	5	4	3	2	1	0
0	Page Code							
1	Reserved (00h)							
2 to 3	(MSB) Page Length (0004h) (LSB)							
4 to 7	(MSB) Diagnostic Parameters (LSB)							

Send Diagnostic Data Definitions:

Page Code	This field specifies which extended diagnostic test is to be executed: 90h = Uncalibrate
Page Length	This field specifies the number of bytes in the parameter list, which follows. The value is always 0004h.
Diagnostic Parameters	This field is reserved and is set to 0h.

Diagnostic Operations

Because the Receive Diagnostic command is not supported, check the error log (also referred to as the events log) following a diagnostic failure. This provides specific details of the error. The error log is available via a log sense command or from the operator panel.

The uncalibrate diagnostic (page code 90h) uncalibrates all target data. This forces the library to recalibrate during subsequent operations.

Note – The library generates a Not Ready to Ready Unit Attention Sense Key for all other initiators after diagnostic operations have completed.

Send Volume Tag

The Send Volume Tag command (B6h) is a request for the library to transfer a volume tag template. The template corresponds to a VOLSER label template and is used by the library to search for desired elements. A subsequent Request Volume Element Address command is used to transfer the results of this search.

TABLE 4-130 Send Volume Tag Command

Byte	Bit							
	7	6	5	4	3	2	1	0
0	Operation Code (B6h)							
1	Ignored			Rsvd (0)	Element Type Code			
2 to 3	(MSB) Starting Element Address (LSB)							
4	Reserved (00h)							
5	Reserved (00h)			Send Action Code (5h)				
6	Reserved (00h)							
7	Reserved (00h)							
8 to 9	(MSB) Parameter List Length (LSB)							
10	Reserved (00h)							
11	Control Byte (00h)							

Send Volume Tag Command Descriptions:

Element Type Code This field specifies the element types selected for reporting by this command:

0h = All Element Types reported
1h = Medium Transport Element (hand)
2h = Storage Element (cartridge tape storage cells)
3h = Import/Export Element (CAP cells and PTP cells)
4h = Data Transfer Element (tape drive)

For an Element Type Code of 0h, the element types are reported in ascending element address order, beginning with the first element greater than or equal to Starting Element Address.

Starting Element Address This field specifies the element address at which to start the search. Only elements with an element address greater than or equal to the Starting Element Address are reported.

The Starting Element Address must be a valid address for the library, but does not have to be an address of the type requested in the Element Type Code.

Send Action Code This field specifies the function to be performed. The library only supports the translate and search primary volume tag function. The value is 5h.

Parameter List Length	This field indicates the length in bytes of the Parameter List that follows the command:
	00h = No data is transferred
	28h = A Volume Identification Template is transferred
	A value of 0 is not considered an error.

Send Volume Tag Parameter List

The Send Volume Tag command requires a parameter list that defines the volume template to search for.

TABLE 4-131 Send Volume Tag Parameter List

Byte	Bit							
	7	6	5	4	3	2	1	0
0 to 31	(MSB)		Volume Identification Template					(LSB)
32	Reserved (00h)							
33	Reserved (00h)							
34 to 35	(MSB)		Minimum Volume Sequence Number					(LSB)
36	Reserved (00h)							
37	Reserved (00h)							
38 to 39	(MSB)		Maximum Volume Sequence Number					(LSB)

- **Volume Identification Template**
  This ASCII field specifies a volume identification search template. A maximum of 6 ASCII characters may be used. The first 00 hex terminates the volume identification search template. The remaining characters are set to 0.

- Characters allowed are the same as those used on the cartridge VOLSER labels and include characters A through Z, digits 0 through 9, and special characters that include the dollar sign ($), the pound character (#), and the ASCII space character.

  The wild-card characters "*" and "?" (2Ah and 3Fh) also may be used.

- **Minimum Volume Sequence Number**
  Sequence numbers are not supported on the library; ignore this field.

- **Maximum Volume Sequence Number**
  Sequence numbers are not supported on the library; ignore this field.

Test Unit Ready

The Test Unit Ready command (00h) allows the initiator to determine if the library is powered-on and ready to accept additional commands. This is not a request for a library self-test.

The Test Unit Ready command returns a Good status if the library is ready to accept additional commands. This command also returns a Check Condition if the library is not ready or if there are pending Unit Attentions.

TABLE 4-132 Test Unit Ready Command

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Operation Code (00h)							
1	Ignored			Reserved (00h)				
2	Reserved (00h)							
3	Reserved (00h)							
4	Reserved (00h)							
5	Control Byte (00h)							

Write Buffer

The Write Buffer command (3Bh) updates the functional microcode for the library. A sequence of one or more Write Buffer commands that updates the microcode is called a download.

A change in the initiator from one Write Buffer command to another in a multiple-transfer download is considered a new download process request, and terminates the active process.

This allows another initiator to download microcode if the first initiator goes down before completing its download request.

> **Caution –** *Potential IPL problem:* Make sure that the download of the microcode has completed successfully before you attempt to IPL the library. The IPL will fail if the download has been unsuccessful. For more information about downloading microcode, refer to the library installation manual.

A successful download writes new microcode to the flash memory and resets the library after the final Write Buffer command completes.

The library performs block verification on the first 32 bytes of data and a CRC over the entire image after the last command. A unit attention is set for all initiators other than the initiator that requested the download with the additional sense code set to Microcode Has Been Changed.

TABLE 4-133 Write Buffer Command

Byte	Bit							
	7	6	5	4	3	2	1	0
0	Operation Code (3Bh)							
1	Ignored			Reserved (0h)		Mode		
2	Buffer ID (00h)							
3 to 5	(MSB) Buffer Offset (LSB)							
6 to 8	(MSB) Parameter List Length (LSB)							
9	Clear Partial Images		Control Byte (00h)					

Write Buffer Command Descriptions:

Mode	This field indicates the type of download to be performed. The library supports two modes:
	110b = Download Microcode with Offsets
	This mode is used for multiple transfer downloads.
	The first Write Buffer command must contain data for the start of the image
	The remaining commands must send data in order.
	The library does not check for data overlap. It is up to the initiator to keep track of the amount of microcode transferred and the microcode placement.
	This mode cannot be used exclusively to download microcode. It is used for all Write Buffer commands in a download except for the last one.
	111b = Download Microcode with Offsets and Save
	This is the last Write Buffer command to tell the library that the download is finished.
	A change to this mode from any other mode is considered a new download request, and terminates any active download.
Buffer ID	This field defines the region of memory to be modified.
	Currently only a value of 00h is supported.
	A non-zero value returns a Check Condition status with an Illegal Request sense key.
	The additional sense code is set to Invalid Field in CDB that identifies Byte 2.
Buffer Offset	This field identifies the offset from the start address of the load area into which the data is placed.
	For modes 100b and 101b, this field is set to 0.
	A non-zero results in a Check Condition status with an Illegal Request Sense Key. The additional sense code set to Invalid Field in CDB that identifies Byte 3 (the parameter list length).
	For modes 110b and 111b, this field is ignored.
Parameter List Length	This field indicates the number of bytes being sent to the library.
	A length of 0 is allowed for mode 111b only.
	Blocks are limited to a maximum of 16,384 bytes.
	The length value must be an even number; an odd number results in a Check Condition with an Illegal Request sense key.
	The ASC will be set the Invalid Field in CDB identifying Byte 6.
	Any other error also results in a Check Condition status with an Illegal Request sense key. The ASC will be set to Invalid Field in CDB identifying Byte 6.
Clear Partial Images	This field is used to clear any partial images currently stored as a result of prior Write Buffer commands using the Download Microcode With Offsets mode.
	The value is set to 01b and
	The mode is set to Download Microcode With Offsets.

A

Locations

This appendix describes the SL500 Modular Library System walls, cartridges cells (slots), and location scheme.

Library Walls

There are three types of walls in the library:

1. *Left side wall*, which consists of 4-cartridge cell arrays

2. *Right side wall*, which consists of 3-cartridge cell arrays and 1 CAP array

3. *Rear wall*, which consists of either 3-cartridge expansion cell arrays or 1 drive array

FIGURE A-1 and FIGURE A-2 show valid slot and drive locations.

Cartridges placed in cells lie flat, hub down and parallel to the floor. To prevent slippage, cartridges are held within their cell by internal retainer clips.

Cartridge Cell Locations – Data Cartridges

Cartridge locations in previous libraries were listed by Panel, Row, and Column.

Cartridge cell designations within a SL500 library require four parameters LSM, Module, Column, Row:

1. **LSM (Library number)** — Within a library or library complex

2. **Module** — Modules are numbered 1,2,3... etc., from the top of the library to the bottom

3. **Column number** – Columns are represented by numbers 1 through 11. Column 1 is the front most column on the left side of the library, and columns increase to column 4 along the left wall. Column 5 is on the right side of the library closest to the rear wall, and the columns increase to column 8 at the front of the right wall. The rear wall of the library is column 9 for drives, or 9 through 11 for expansion cells.

4. **Row number** – The row numbers start at 1 in a module for the first accessible row within a column. Columns under drives start row 1 in the third cell position since the top two cells are not accessible.

FIGURE A-1 through FIGURE A-2 illustrate where these terms apply; TABLE A-135 shows slot counts for different LTO cartridge configurations.

Column numbering starts with 1 at the front of the front column and continues to 4 at the back left. Then column 5 is at the back right and proceeds to column 8 at the right front. If drives are in the module, the drives are column 9. If Storage cells are in the back, column 9 starts at the left back column and proceeds to the right to column 11 in the back.

Cell Maps

FIGURE A-1 and FIGURE A-2 show valid slot and drive locations.

TABLE A-135 shows slot counts for different LTO cartridge configurations.

Default Element Mapping

The following rules apply to the default element mapping

- The medium transport element (hand) is element 0d

- The first import/export element (CAP) is element 10d

- The first data transfer element (drive) is element 500d

- The first storage element (slot) is element 1000d

The following tables shows the default first element and last element addresses in the SL500 library.

TABLE A-134 First and Last Element Addresses

Type of Element	First Element Address	Variables Affecting Last Element Address	Last Element Address
Hand	0d	None	0d
SL500 CAP slots	10d	None	55d
Drives	500d	None	518d
SL500 capacity	1000d	None	1628d

FIGURE A-1 Base Module Slots

1.	Slots available for customer data cartridges
2.	Slots only available when an expansion module is installed
3.	Slots for cleaning and diagnostic cartridges
4.	Array targets
5.	Tape drives
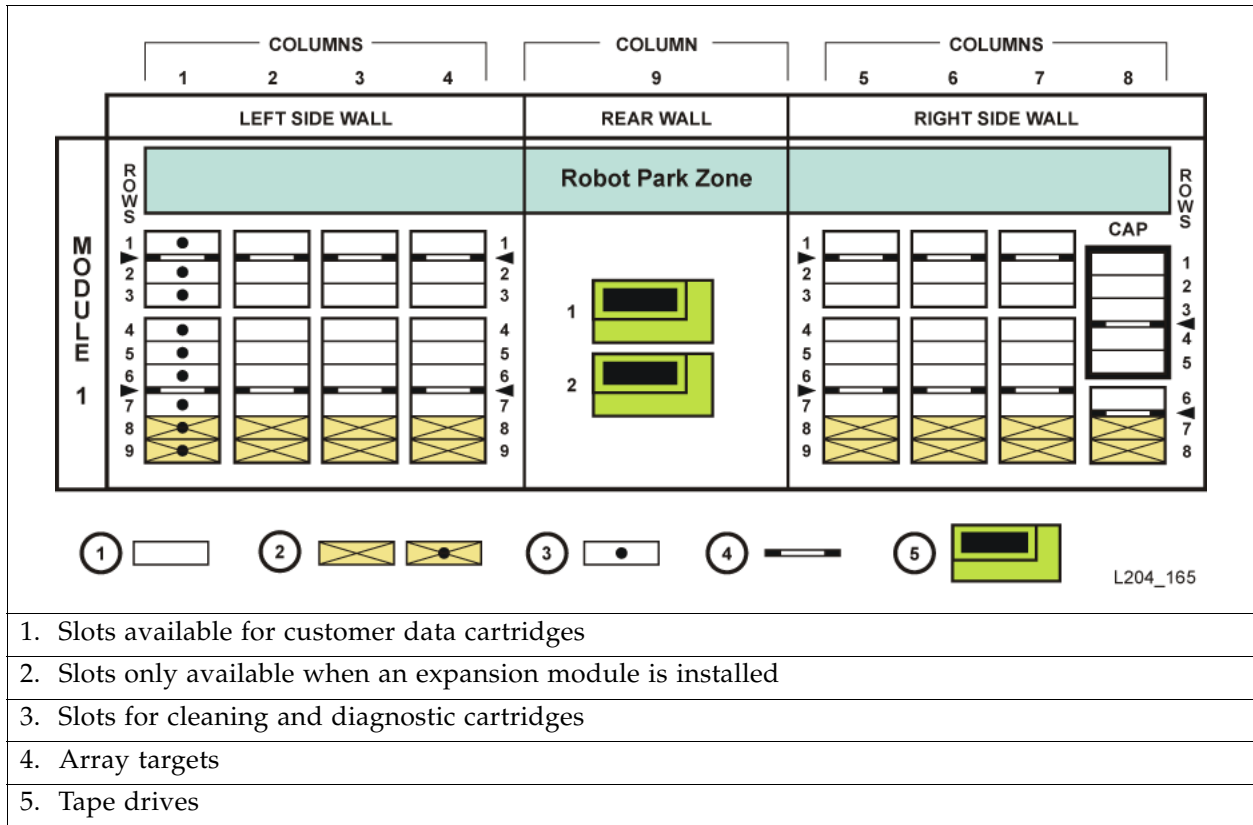
FIGURE A-2 Base Module and Drive Expansion Module Slots

1.	Slots available for customer data cartridges
2.	Slots only available when an expansion module is installed
3.	Slots for cleaning and diagnostic cartridges
4.	Array targets
5.	Tape drives
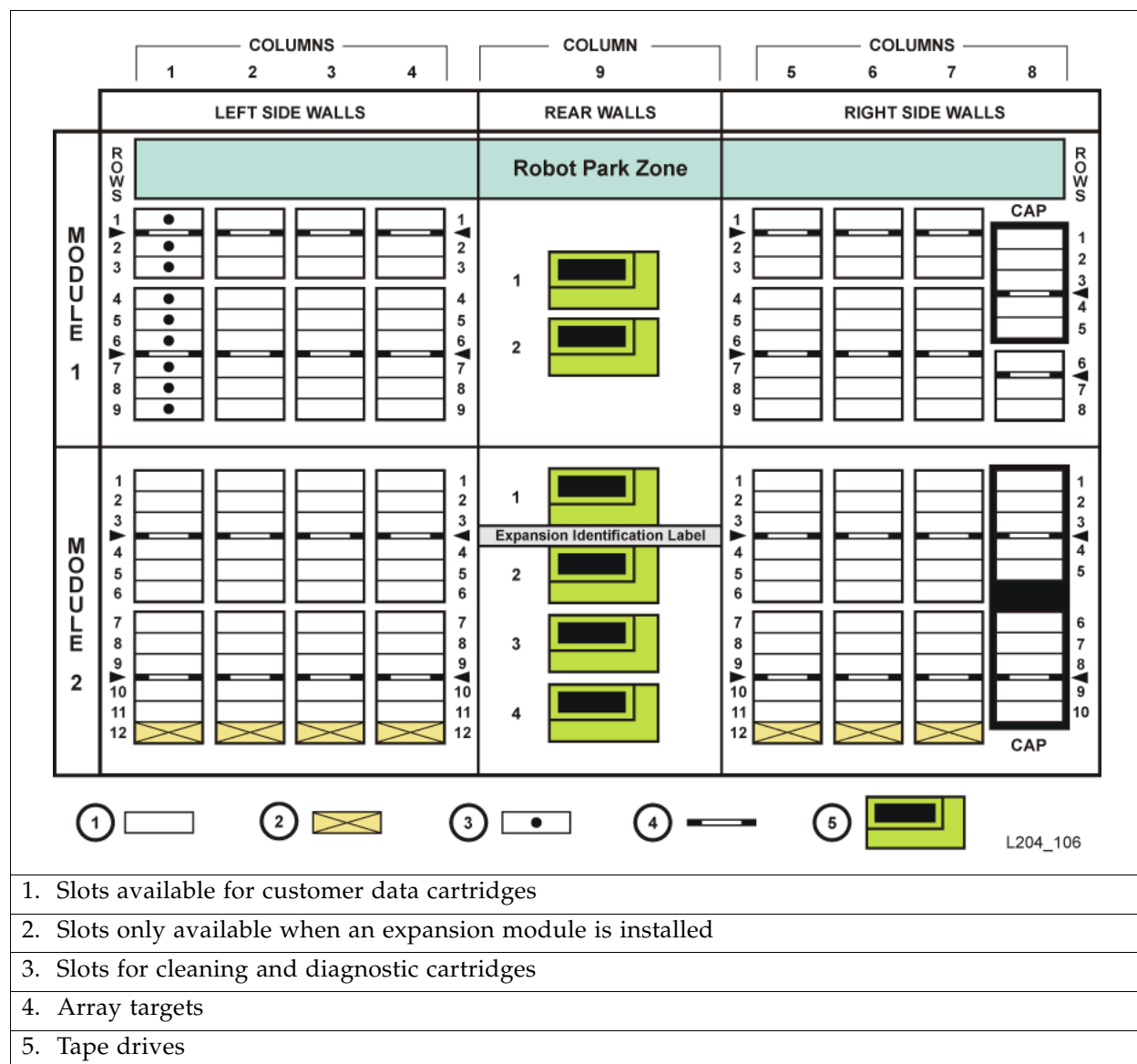
At FRS, the library only supports LTO Ultrium Linear Tape-Open (LTO) Generation 2 tape drives.The following table shows how many LTO cartridges can be placed in the library, depending on the modules installed.

TABLE A-135 Slot Counts for Different Configurations

	Base module	Drive Expansion Module	Total Slots	Playground	CAPs as Storage Slots	Maximum Drives
Base module	43		43	7		2
Base module + 1 drive expansion module	57	77	134	9	10	6
Base module + 2 drive expansion modules	57	161	218	9	20	10
Base module + 3 drive expansion modules	57	245	302	9	30	14
Base module + 4 drive expansion modules	57	329	386	9	40	18

Note – When the CAP slots are used for storage slots, add the number in that column to the number in the total slots column.

Diagnostic and Cleaning Cartridge Locations

A total of 7 cells (base unit only) or 9 cells (with expansion modules) may contain diagnostic and cleaning cartridges. The customer may elect to not set any reserved cells, in which case these are just normal storage cells.

Locations of these cells are within the arrays positioned on Column 1, the front most column on the left side of the library in the Base Module.

Since the safety barrier may be moved during a maintenance activity, online customer access to these cell locations would not be allowed; this is why the area is reserved for non-data cartridges.

B

Partitioning Overview

The SL500 library can be partitioned into various sections.

Briefly stated, this means that instead of one library—with all its cartridge slots, tape drives, and CAPs—being a single entity, the library and these components can now be divided into multiple sections, up to a maximum of eight partitions. Each partition can be accessed by one host or multiple hosts.

Partitioning—Feature

If your customer has ordered the partitioning feature for the library, you must work with the systems administrators who will be involved with assigning the partitions.

Important: You must enable the partitioning feature through installation of a Hardware Activation Key. Refer to the SL500 Users guide for information about how to do this.

Clear communication and cooperation among system programmers, network administrators and service representatives are essential. Be sure to share this information with all those involved in the partitioning effort and, if need be, correspond with other members of the service community when assistance is required.

Note – *It is best that all questions are answered before attempting to partition a library.*

Partitioning—General

Partitioning has terms associated with it that you and your customer must understand to effectively use the feature. In certain cases, these terms redefine some concepts that are familiar with users of the traditional, non-partitioned library configuration.

A "partition" is defined as the process of dividing portions of a library into discrete sections. The partitioning feature offers great flexibility for users. A partition can be as small as a single storage slot, a single CAP slot, or one tape drive if desired. A library can also contain multiple partitions. Customers could also set up a single and/or multiple partitions that are accessible by single or multiple hosts.

The key to understanding partitioning is knowing what partitions exist, their boundaries, and who has access to the specific partitions that are configured.

Setting up a partition requires some important considerations:

- If one partition designates several tape drives solely to its partition, no other partitions can use these tape drives.

- Partition users must also anticipate how much storage area is needed for their resident tape volumes and the amount of free slots required.

- CAP assignments are also critical. CAP slots can be specifically assigned to certain partitions or left open for common use. This will be discussed in detail later.

Storage slots and drives that are *not* assigned a partition within a partitioned library cannot be accessed. A customer could leave an area of slots unassigned, for example, in preparation for a planned future partition.

The SCSI element numbering within partitioned libraries is continuous for each partition, even if slot locations for each partition are non-contiguous.

Using EXAMPLE B-1 as an example, if one partition owns the base and cartridge expansion modules, SCSI element numbering begins at the first available slot in the base module and continues through the cartridge expansion module slots. For the partition owning the driving expansion module, the first slot in that module will begin the element numbering for that partition and continue throughout the module.

Partitioning—Access Control

All hosts that issues commands to a bridged HP LTO-5 or HP LTO-6 drive may also send commands to the library partition. Commands are processed by the partition in which the bridged drive resides.   The host sends commands to the drive on LUN 0 and to the library on LUN 1.

When there is more than 1 HP LTO-5 or HP LTO-6 tape drive in the library partition, it is up to the operator to select the drive that will be used for bridging. The operator will use SLC to select the bridged drive.

Note: It is not currently possible to select the bridge drive when no partitions are defined on a library with a partition Hardware Activation Key.

EXAMPLE B-1 Partitioning a Library
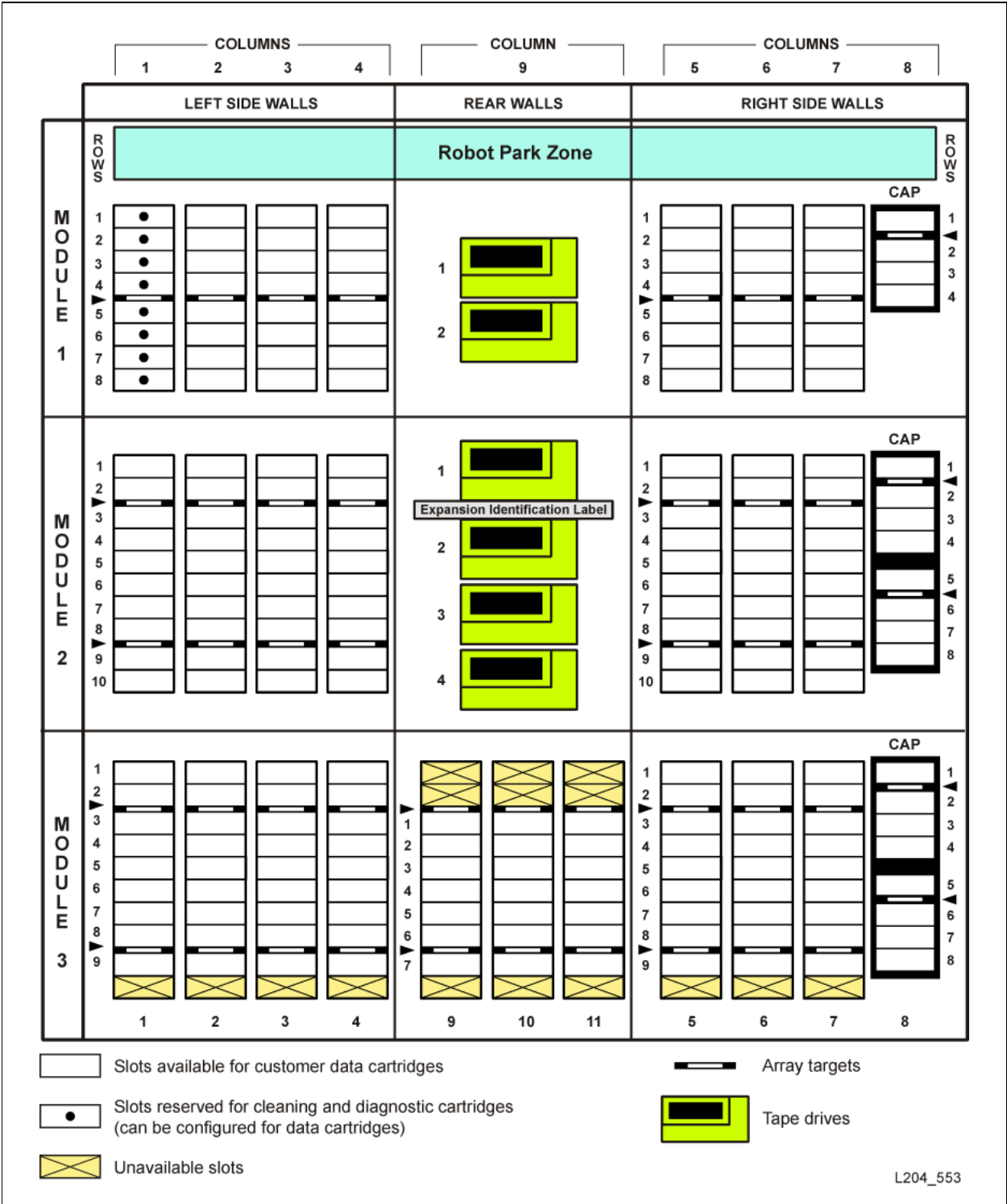
Partitioning—Location Numbering

Location numbering is composed of four digits: Library number, Module number, Row number, and Column number.

In a non-partitioned library configuration, the location number for the library always begins with the number "0." For partitioned libraries, however, the library number will change to the partition number.

- If Partition 1 was composed of the entire base module, locating a cartridge in module 1, row 8, column 1 in the base module would translate into the following: 1, 1, 8, 1.

- If Partition 2 was composed of the entire drive expansion module, row 10, column 1 would translate into 2, 2, 10, 1.

Partitioning—CAP Behavior

Whereas cartridge slots and drives can be partitioned, CAPs (or CAP slots) can be configured for:

- Assignment to a specific partition only (split assigned CAP)

- Common use for the partitions that do not specifically assign slots (common CAP)

- A combination of specific slots and common slots (mixed CAP)

Customers could conceivably partition two slots in an 8-slot CAP to a single partition and the remaining slots to a second partition, for example.

For partitioned libraries, these three configuration options for CAP assignments are explained below.

Split Assigned CAPs

As cartridge slots and tape drives can be partitioned, CAPs or CAP slots can be assigned to the sole use of a partition. When specific CAP slots are assigned to a *specific partition*, the split assigned CAP option is enabled

Careful planning in regard to anticipated CAP usage is required when using this option. *Only those CAP slots designated as split assigned can be used by the partition assigning them*.

Split Assigned CAPs—Example

The library (see EXAMPLE B-1) is composed of a base, drive and cartridge expansion modules. All cartridge slots, drives and CAP slots in the base module comprise Partition 1. All cartridge slots, drives and CAP slots in the drive expansion and cartridge expansion modules are assigned to Partition 2. Each partition has access to *only* the components configured for it.

If Partition 1 requests a CAP *import* operation, the procedure is:

- The operator selects Partition 1's CAP through either the local operator panel or StreamLine Library Console.

- The CAP button on the base module is pressed.

- The top CAP door is opened. All remaining CAP doors remain closed.

- The operator completes the operation.

If Partition 2 requests a CAP *import* operation, the procedure is:

- The operator selects Partition 2's CAP through either the local operator panel or StreamLine Library Console.

- The CAP button on the base module is pressed.

- The top CAP door remains closed. All remaining CAP doors open.

- The operator completes the operation.

Multiple split CAP assignments are available within a library. This is in contrast to common assigned CAPs (see below).

> **Note –** As the default behavior, if *no* partition has selected a CAP through the operator panel or StreamLine Library Console, the library will behave as if all split configured CAPs have been assigned to the CAP button. When the button is pressed, all CAP doors that are designated as split assigned will open to expose *all* split configured CAP slots, provided that no common configured CAP slot containing a cartridge is exposed.

Common Unassigned CAPs

The common (or unassigned) CAP configuration is present when there are no specified CAP slots designated (split assigned) to a partition or partitions. Strictly speaking, one does not "configure" or "assign" a CAP as common—any CAP slots that are not split assigned are available for mutual use among the remaining, unassigned partitions. Keep in mind that common CAPs are a single unit, shared among those partitions that have no split assigned CAPs.

Common Unassigned CAPs—Example

Referring to EXAMPLE B-1, Partition 1 is set up to contain all cartridge slots and drives in the base module for a single host. The remaining cartridge slots and drives are a second partition used only by a second host. However, no CAP slots are explicitly assigned for a partition—both partitions can use all CAP slots.

An example of an *import* operation sequence for a common CAP would be:

- The operator selects the CAP through either the local operator panel or StreamLine Library Console.

- An operator presses the CAP button.

- All CAP doors open.

- A cartridge is placed in any CAP slot.

- The CAP door is closed.

- The cartridge is placed into a slot within the requesting host's partition.

In a second instance, assume that Partition 2 requests a CAP *export* operation of a cartridge. Since it is a common CAP, the operation would be:

- The operator selects the CAP through either the local operator panel or StreamLine Library Console.

- The VOLSER of the cartridge to be exported is entered.

- The cartridge is placed in any CAP slot.

- All CAP doors open.

- The operator completes the operation.

For common CAPs, slots may be used by all partitions who do not specifically assign them. However, only one partition can select a CAP for operation at one time. The operation must be completed before the CAP is released to someone else through either the operator panel or StreamLine Library Console.

Mixed CAPs

A mixed CAP option is present when both split CAP and common CAP configurations are present within a library.

Mixed CAPs—Example

Referring again to EXAMPLE B-1, Partition 1 contains only the cartridge in module 1, column 5, row 1, and drive number 1 and the single CAP slot 1 in the base module. The remaining storage slots and drives are divided among partitions 2, 3, and 4. The remaining CAP slots are left unassigned.

These unassigned CAP slots are usable by partitions 2, 3, and 4, but CAP slot 1 in the base module can only be used by Partition 1.

If Partition 1 requests a CAP *export* operation, the procedure is:

- The operator selects its CAP through either the local operator panel or StreamLine Library Console.

- The VOLSER of the cartridge to be exported is entered.

- The cartridge is placed into the top CAP slot of module 1's CAP.

- The top CAP door is opened. All remaining CAP doors remain closed.

- The operator completes the operation.

If Partitions 2 through 4 request an *export* operation, the procedure is:

- The operator selects a CAP through either the local operator panel or StreamLine Library Console. For this example, assume that Partition 2 has selected the top CAP for placement of the cartridge.

- The VOLSER of the cartridge to be exported is entered.

- The cartridge is placed into any module 1 CAP slot *except* the top one.

- All CAP doors open.

- The operator closes all CAP doors.

Within mixed assigned CAP environments:

- For common CAPs, one or more partitions can share those CAP slots not designated as split assigned.

- For split assigned CAPs, *several* configurations are possible. For example, the 4-slot CAP in a base module could be split assigned to Partition 1; the top four slots in the drive expansion module's CAP could be split assigned to Partition 2; the bottom four slots in the drive expansion module's CAP could be split assigned to Partition 3, and so forth. To fulfill the mixed definition, however, there must also be common CAP slots available.

The CAP Button—Its Function in Partitioned Libraries

A significant difference between a non-partitioned library's CAPs and those of a partitioned library must be noted. For a non-partitioned library, pressing the CAP button opens all CAPs that are configured as CAPs. *In a partitioned library, each partition must first have its CAP selected, using the operator panel or StreamLine Library Console. This will dedicate the CAP button to the use of those partitions that selected a CAP or CAPs for operation.* After selection, pressing the CAP button will open *only* the CAP doors assigned to that partition.

If *not* selected by any partition, pressing the CAP button will open only those CAP slots that are split assigned (see the note).

An important thing to remember is that if multiple partitions are assigned to the same CAP slots (that is, common slots)—and that CAP is selected for use by one partition—the CAP import/export operation must be completed and the new partition assignment made, before another member of that partition can gain access for CAP operations.

Partitioning—Problem Scenarios

This section describes problems that may arise in partitioned libraries. Generally speaking, customers who use the partition feature must:

- Know the partition boundaries

- Know the CAP assignment characteristics for each partition

- Select a CAP before performing a CAP operation

- Complete the CAP operation in order to release the CAP to other partitions. As a safeguard, a CAP will *not* open to expose a cartridge that belongs to a partition that has *not* selected the CAP.

Cartridge Importing

The customer wishes to import a cartridge into a partitioned library's CAP. The operator presses the CAP button, but no CAP doors open.

- In this case, a CAP owned by that partition was not selected through the operator panel or StreamLine Library Console. In partitioned libraries, CAPs must be assigned to a partition.

The customer has the CAP in module 1 configured as a split CAP. The top slot belongs to Partition 1 and the remaining slots belong to Partition 2. Partition 2 selects the CAP in the base module, presses the CAP button and opens the CAP to import a cartridge. The operator places the cartridge into the *top slot* and closes the CAP door.

- In this case, Partition 2 does not own the top slot; therefore, the CAP door will re-open and the cartridge must be removed by the operator and placed in the proper CAP slot.

The customer selects the correct CAP for an import operation, but the CAP does not open.

- One possibility is that there are no empty cartridge slots for the operation—the cartridge partition is full.

A customer tries to select a CAP, but its status is listed as "inaccessible" (or CAP open, or a unit check is posted, depending on host software)

- The CAP requested is currently selected by another partition which can also access the CAP. That host's CAP operation has not been completed. This exemplifies the need for cooperation and communication among hosts using a partitioned library.

Cartridge Exporting

The customer has four cartridge slots within a base module as Partition 1; one CAP slot (the top one again) is a split CAP with only the top CAP slot configured. Partition 1 selects the top CAP, then follows the procedure to export all four cartridges.

- In this situation, the top CAP will open each time a cartridge is placed in the top slot. The CAP must be opened/closed four times to complete the command.

A customer tries to select a CAP, but its status is listed as "inaccessible."

- The CAP requested is currently selected by another partition which can also access that CAP.

- Another partition has exported a cartridge to one of the three bottom slots in the CAP, but the CAP door has not been opened yet to retrieve the cartridge. Remember:

  - A CAP will *not* open to expose a cartridge for a partition that is not assigned to the CAP button.

  - A CAP operation must be completed in order to release the CAP to other partitions.

Partitioning—Removing the Feature

If the customers for your library decide that they wish to remove the partitioning feature, they simply remove all partitions and it will revert to a non-partitioned library configuration.

Partitioning—Configurations

For CLI configuration entries, you must keep the following in mind for partitioned libraries:

1. Library firmware must be version 1220 or higher.

2. Be sure you have configured the reserved slots for diagnostic cartridges (use the reserved <number of cell> | <print> command) *before* enabling partitioned. The reserved slots will appear as black (unavailable, masked from the customer's cartridge database) when the customer displays the library interior in StreamLine Library Console.

Note – You cannot adjust reserved slots *after* the library is partitioned.

3. To configure CAP characteristics for entry/ejection of cartridges (as opposed to storage) you must use the cap <module#> <io|storage> command in TABLE B-136), to specify the CAPs in *each module* as "io" (input/output) *before* enabling partitioning.

Note – Once a library is partitioned, any change to CAP configurations requires the library resource affected to be re-partitioned.

4. You must know the cartridge label orientation used by each partition within a partitioned library and enter this information through the orientlabel <host|oppanel> command (see TABLE B-136).

5. You must login to the CLI port with the advsrv user ID to enable the feature (see TABLE B-136)

Library and Tape Drive Configurations

Note – You might not be able to use the Library Console to configure the library and tape drives. In that case, use the CLI commands in the following tables or type `help lib` or `help drive` for a list of the commands.

TABLE B-136 CLI Commands for Library Configuration

allowpartitions <print|on|off>	Enables/disables the partitioning feature. **Note:** You must have an advsrv password for this command.
autoclean print (firmware level 1022)	Shows the library's current setting
autoclean <on|off> (firmware level 1022)	Sets the auto clean option on or off. *On* causes tape drives to be automatically cleaned when needed. *Off* disables automatic cleaning. If the host software is handling tape drive cleaning, set the option to off.
cap <module#> <io|storage>	Configures the specific module's CAP as input/output or storage
cartridge print	Shows the location, volume serial number, and media type for all cartridges

TABLE B-136 CLI Commands for Library Configuration (Continued)

cartridge print reserved (firmware level 1022)	Shows the location, volume serial number, and media type for reserved cartridges
clearcartcount print (firmware level 1022)	Shows the library's current list of cleaning cartridges and cleaning counts
clearcartcount <label> count (firmware level 1022)	Sets the number of times a particular cleaning cartridge can be used. The cartridge must be in the cleaning list. The cleaning list is not complete until the audit is finished.
cleanwarnthreshold print (firmware level 1022)	Shows the library's current warning threshold count for cleaning cartridges
cleanwarnthreshold <count> <drivetype> (firmware level 1022)	Sets a warning threshold count for the number of cleans a cartridge can perform for a given tape drive type before a warning is issued. <drivetype> is "lto" or "dlt". If the value is set to 0, no warning is issued.
lib getconfig	Shows the library configuration
lib setconfig	Sets the specified library's Fibre Channel or SCSI configuration
orientlabel <host | oppanel> <all | left8 | left7 | left6 | right6 | right7 | right8> *<partition>**See Note at Right*	Sets the host orientlabel parameter. This option causes the bar-code label on the cartridge to be presented to the host interface as all or fewer characters, selected from the left or right of the Physical label. **Note:** For partitioned libraries, you must enter the label orientation for each partition (the "<partition>" field has been added for this feature.
upsidedowndetect <on | off>	Sets the upsidedowndetect option. **On** is the default setting and allows the library to detect upside down SDLT cartridges in *mixed-media* libraries. **Off** disables the checking function.

TABLE B-137 CLI Commands for Tape Drive Configuration

drive all (firmware level 1022)	Shows information for all tape drives
drive <addr> clean (firmware level 1022)	Cleans the specified tape drive. A label may be specified when prompted.
drive <addr> getconfig drive 0,1,1,9 getconfig	Shows a specified tape drive's Fibre Channel or SCSI configuration
drive <addr> gettime	Shows a specified tape drive's time of day (TOD) clock setting
drive <addr> info	Shows a specified tape drive's information
drive <addr> setconfig	Sets a specified tape drive's Fibre Channel or SCSI configuration
drive <addr> settime	Sets a specified tape drive's time of day (TOD) clock
drive <addr> state	Shows a specified tape drive's operational state.

Partitioning—Library Console

Once enabled, customers can set a library's partitions through the StreamLine Library Console interface. The basic procedures are described in the *SL500 User's Guide*, part number 96116.

C

Controlling Contaminants

Control over contaminant levels in a computer room is extremely important because tape libraries, tape drives, and tape media are subject to damage from airborne particulates.

Environmental Contaminants

Most particles smaller than ten microns are not visible to the naked eye under most conditions, but these particles can be the most damaging. As a result, the operating environment must adhere to the following requirements:

- ISO 14644-1 Class 8 Environment

- The total mass of airborne particulates must be less than or equal to 200 micrograms per cubic meter

- Severity level G1 per ANSI/ISA 71.04-1985

Oracle currently requires the ISO 14644-1 standard approved in 1999, but require any updated standards for ISO 14644-1 as they are approved by the ISO governing body.

The ISO 14644-1 standard primarily focuses on the quantity and size of particulates as well as the proper measurement methodology, but does not address the overall mass of the particulates. As a result, the requirement for total mass limitations is also necessary as a computer room or data center could meet the ISO 14644-1 specification, but still damage equipment because of the specific type of particulates in the room. In addition, the ANSI/ISA 71.04-1985 specification addresses gaseous contaminations as some airborne chemicals are more hazardous. All three requirements are consistent with the requirements set by other major tape storage vendors.

Required Air Quality Levels

Particles, gasses and other contaminants may impact the sustained operations of computer hardware. Effects can range from intermittent interference to actual component failures. The computer room must be designed to achieve a high level of cleanliness. Airborne dusts, gasses and vapors must be maintained within defined limits to help minimize their potential impact on the hardware.

Airborne particulate levels must be maintained within the limits of *ISO 14644-1 Class 8 Environment*. This standard defines air quality classes for clean zones based on airborne particulate concentrations. This standard has an order of magnitude less particles than standard air in an office environment.

Particles ten microns or smaller are harmful to most data processing hardware because they tend to exist in large numbers, and can easily circumvent many sensitive components' internal air filtration systems. When computer hardware is exposed to these submicron particles in great numbers they endanger system reliability by posing a threat to moving parts, sensitive contacts and component corrosion.

Excessive concentrations of certain gasses can also accelerate corrosion and cause failure in electronic components. Gaseous contaminants are a particular concern in a computer room both because of the sensitivity of the hardware, and because a proper computer room environment is almost entirely recirculating. Any contaminant threat in the room is compounded by the cyclical nature of the airflow patterns. Levels of exposure that might not be concerning in a well ventilated site repeatedly attack the hardware in a room with recirculating air. The isolation that prevents exposure of the computer room environment to outside influences can also multiply any detrimental influences left unaddressed in the room.

Gasses that are particularly dangerous to electronic components include chlorine compounds, ammonia and its derivatives, oxides of sulfur and petrol hydrocarbons. In the absence of appropriate hardware exposure limits, health exposure limits must be used.

While the following sections will describe some best practices for maintaining an ISO 14644-1 Class 8 Environment in detail, there are some basic precautions that must be adhered to:

- Do not allow food or drink into the area

- Cardboard, wood, or packing materials must not be stored in the data center clean area

- Identify a separate area for unpacking new equipment from crates and boxes

- Do not allow construction or drilling in the data center without first isolating sensitive equipment and any air targeted specifically for the equipment. Construction generates a high level of particulates that exceed ISO 14644-1 Class 8 criteria in a localized area. Dry wall and gypsum are especially damaging to storage equipment.

Contaminant Properties and Sources

Contaminants in the room can take many forms, and can come from numerous sources. Any mechanical process in the room can produce dangerous contaminants or agitate settled contaminants. A particle must meet two basic criteria to be considered a contaminant:

- It must have the physical properties that could potentially cause damage to the hardware

- It must be able to migrate to areas where it can cause the physical damage

The only differences between a potential contaminant and an actual contaminant are time and location. Particulate matter is most likely to migrate to areas where it can do damage if it is airborne. For this reason, airborne particulate concentration is a useful measurement in determining the quality of the computer room environment. Depending on local conditions, particles as big as 1,000 microns can become airborne, but their active life is very short, and they are arrested by most filtration devices. Submicron particulates are much more dangerous to sensitive computer hardware, because they remain airborne for a much longer period of time, and they are more apt to bypass filters.

Operator Activity

Human movement within the computer space is probably the single greatest source of contamination in an otherwise clean computer room. Normal movement can dislodge tissue fragments, such as dander or hair, or fabric fibers from clothing. The opening and closing of drawers or hardware panels or any metal-on-metal activity can produce metal filings. Simply walking across the floor can agitate settled contamination making it airborne and potentially dangerous.

Hardware Movement

Hardware installation or reconfiguration involves a great deal of subfloor activity, and settled contaminants can very easily be disturbed, forcing them to become airborne in the supply air stream to the room's hardware. This is particularly dangerous if the subfloor deck is unsealed. Unsealed concrete sheds fine dust particles into the airstream, and is susceptible to efflorescence -- mineral salts brought to the surface of the deck through evaporation or hydrostatic pressure.

Outside Air

Inadequately filtered air from outside the controlled environment can introduce innumerable contaminants. Post-filtration contamination in duct work can be dislodged by air flow, and introduced into the hardware environment. This is particularly important in a downward-flow air conditioning system in which the sub-floor void is used as a supply air duct. If the structural deck is contaminated, or if the concrete slab is not sealed, fine particulate matter (such as concrete dust or efflorescence) can be carried directly to the room's hardware.

Stored Items

Storage and handling of unused hardware or supplies can also be a source of contamination. Corrugated cardboard boxes or wooden skids shed fibers when moved or handled. Stored items are not only contamination sources; their handling in the computer room controlled areas can agitate settled contamination already in the room.

Outside Influences

A negatively pressurized environment can allow contaminants from adjoining office areas or the exterior of the building to infiltrate the computer room environment through gaps in the doors or penetrations in the walls. Ammonia and phosphates are often associated with agricultural processes, and numerous chemical agents can be produced in manufacturing areas. If such industries are present in the vicinity of the

data center facility, chemical filtration may be necessary. Potential impact from automobile emissions, dusts from local quarries or masonry fabrication facilities or sea mists should also be assessed if relevant.

Cleaning Activity

Inappropriate cleaning practices can also degrade the environment. Many chemicals used in normal or "office" cleaning applications can damage sensitive computer equipment. Potentially hazardous chemicals outlined in the "Cleaning Procedures and Equipment" section should be avoided. Out-gassing from these products or direct contact with hardware components can cause failure. Certain biocide treatments used in building air handlers are also inappropriate for use in computer rooms either because they contain chemicals, that can degrade components, or because they are not designed to be used in the airstream of a re-circulating air system. The use of push mops or inadequately filtered vacuums can also stimulate contamination.

It is essential that steps be taken to prevent air contaminants, such as metal particles, atmospheric dust, solvent vapors, corrosive gasses, soot, airborne fibers or salts from entering or being generated within the computer room environment. In the absence of hardware exposure limits, applicable human exposure limits from OSHA, NIOSH or the ACGIH should be used.

Contaminant Effects

Destructive interactions between airborne particulate and electronic instrumentation can occur in numerous ways. The means of interference depends on the time and location of the critical incident, the physical properties of the contaminant and the environment in which the component is placed.

Physical Interference

Hard particles with a tensile strength at least 10% greater than that of the component material can remove material from the surface of the component by grinding action or embedding. Soft particles will not damage the surface of the component, but can collect in patches that can interfere with proper functioning. If these particles are tacky they can collect other particulate matter. Even very small particles can have an impact if they collect on a tacky surface, or agglomerate as the result of electrostatic charge build-up.

Corrosive Failure

Corrosive failure or contact intermittence due to the intrinsic composition of the particles or due to absorption of water vapor and gaseous contaminants by the particles can also cause failures. The chemical composition of the contaminant can be very important. Salts, for instance, can grow in size by absorbing water vapor from the air (nucleating). If a mineral salts deposit exists in a sensitive location, and the environment is sufficiently moist, it can grow to a size where it can physically interfere with a mechanism, or can cause damage by forming salt solutions.

Shorts

Conductive pathways can arise through the accumulation of particles on circuit boards or other components. Many types of particulate are not inherently conductive, but can absorb significant quantities of water in high-moisture environments. Problems caused by electrically conductive particles can range from intermittent malfunctioning to actual damage to components and operational failures.

Thermal Failure

Premature clogging of filtered devices will cause a restriction in air flow that could induce internal overheating and head crashes. Heavy layers of accumulated dust on hardware components can also form an insulative layer that can lead to heat-related failures.

Room Conditions

All surfaces within the controlled zone of the data center should be maintained at a high level of cleanliness. All surfaces should be periodically cleaned by trained professionals on a regular basis, as outlined in the "Cleaning Procedures and Equipment" section. Particular attention should be paid to the areas beneath the hardware, and the access floor grid. Contaminants near the air intakes of the hardware can more easily be transferred to areas where they can do damage. Particulate accumulations on the access floor grid can be forced airborne when floor tiles are lifted to gain access to the sub-floor.

The subfloor void in a downward-flow air conditioning system acts as the supply air plenum. This area is pressurized by the air conditioners, and the conditioned air is then introduced into the hardware spaces through perforated floor panels. Thus, all air traveling from the air conditioners to the hardware must first pass through the subfloor void. Inappropriate conditions in the supply air plenum can have a dramatic effect on conditions in the hardware areas.

The subfloor void in a data center is often viewed solely as a convenient place to run cables and pipes. It is important to remember that this is also a duct, and that conditions below the false floor must be maintained at a high level of cleanliness. Contaminant sources can include degrading building materials, operator activity or infiltration from outside the controlled zone. Often particulate deposits are formed where cables or other subfloor items form air dams that allow particulate to settle and accumulate. When these items are moved, the particulate is re-introduced into the supply airstream, where it can be carried directly to hardware.

Damaged or inappropriately protected building materials are often sources of subfloor contamination. Unprotected concrete, masonry block, plaster or gypsum wall-board will deteriorate over time, shedding fine particulate into the air. Corrosion on post-filtration air conditioner surfaces or subfloor items can also be a concern. The subfloor void must be thoroughly and appropriately decontaminated on a regular basis to address these contaminants. Only vacuums equipped with High Efficiency Particulate Air (HEPA) filtration should be used in any decontamination procedure. Inadequately filtered vacuums will not arrest fine particles, passing them through the unit at high speeds, and forcing them airborne.

Unsealed concrete, masonry or other similar materials are subject to continued degradation. The sealants and hardeners normally used during construction are often designed to protect the deck against heavy traffic, or to prepare the deck for the

application of flooring materials, and are not meant for the interior surfaces of a supply air plenum. While regular decontaminations will help address loose particulate, the surfaces will still be subject to deterioration over time, or as subfloor activity causes wear. Ideally all of the subfloor surfaces will be appropriately sealed at the time of construction. If this is not the case, special precautions will be necessary to address the surfaces in an on-line room.

It is extremely important that only appropriate materials and methodology are used in the encapsulation process. Inappropriate sealants or procedures can actually degrade the conditions they are meant to improve, impacting hardware operations and reliability. The following precautions should be taken when encapsulating the supply air plenum in an on-line room.

- Manually apply the encapsulant. Spray applications are totally inappropriate in an on-line data center. The spraying process forces the sealant airborne in the supply airstream, and is more likely to encapsulate cables to the deck.

- Use a pigmented encapsulant. The pigmentation makes the encapsulant visible in application, ensuring thorough coverage, and helps in identifying areas that are damaged or exposed over time.

- It must have a high flexibility and low porosity in order to effectively cover the irregular textures of the subject area, and to minimize moisture migration and water damage.

- The encapsulant must not out-gas any harmful contaminants. Many encapsulants commonly used in industry are highly ammoniated or contain other chemicals that can be harmful to hardware. It is very unlikely that this out-gassing could cause immediate, catastrophic failure, but these chemicals will often contribute to corrosion of contacts, heads or other components.

Effectively encapsulating a subfloor deck in an on-line computer room is a very sensitive and difficult task, but it can be conducted safely if appropriate procedures and materials are used. Avoid using the ceiling void as an open supply or return for the building air system. This area is typically very dirty and difficult to clean. Often the structural surfaces are coated with fibrous fire-proofing, and the ceiling tiles and insulation are also subject to shedding. Even prior to filtration, this is an unnecessary exposure that can adversely affect environmental conditions in the room. It is also important that the ceiling void does not become pressurized, as this will force dirty air into the computer room. Columns or cable chases with penetrations in both the subfloor and ceiling void can lead to ceiling void pressurization.

Exposure Points

All potential exposure points in the data center should be addressed to minimize potential influences from outside the controlled zone. Positive pressurization of the computer rooms will help limit contaminant infiltration, but it is also important to minimize any breaches in the room perimeter. To ensure the environment is maintained correctly, the following should be considered:

- All doors should fit snugly in their frames.

- Gaskets and sweeps can be used to address any gaps.

- Automatic doors should be avoided in areas where they can be accidentally triggered. An alternate means of control would be to remotely locate a door trigger so that personnel pushing carts can open the doors easily. In highly

sensitive areas, or where the data center is exposed to undesirable conditions, it may be advisable to design and install personnel traps. Double sets of doors with a buffer between can help limit direct exposure to outside conditions.

- Seal all penetrations between the data center and adjacent areas.

- Avoid sharing a computer room ceiling or subfloor plenum with loosely controlled adjacent areas.

Filtration

Filtration is an effective means of addressing airborne particulate in a controlled environment. It is important that all air handlers serving the data center are adequately filtered to ensure appropriate conditions are maintained within the room. In-room process cooling is the recommended method of controlling the room environment. The in-room process coolers re-circulate room air. Air from the hardware areas is passed through the units where it is filtered and cooled, and then introduced into the subfloor plenum. The plenum is pressurized, and the conditioned air is forced into the room, through perforated tiles, and then travels back to the air conditioner for reconditioning. The airflow patterns and design associated with a typical computer room air handler have a much higher rate of air change than typical comfort cooling air conditioners so air is filtered much more often than in an office environment. Proper filtration can capture a great deal of particulates. The filters installed in the in-room, re-circulating air conditioners should have a minimum efficiency of 40% (Atmospheric Dust-Spot Efficiency, ASHRAE Standard 52.1). Low-grade pre-filters should be installed to help prolong the life of the more expensive primary filters.

Any air being introduced into the computer room controlled zone, for ventilation or positive pressurization, should first pass through high efficiency filtration. Ideally, air from sources outside the building should be filtered using High Efficiency Particulate Air (HEPA) filtration rated at 99.97% efficiency (DOP Efficiency MILSTD-282) or greater. The expensive high efficiency filters should be protected by multiple layers of pre-filters that are changed on a more frequent basis. Low-grade pre-filters, 20% ASHRAE atmospheric dust-spot efficiency, should be the primary line of defense. The next filter bank should consist of pleated or bag type filters with efficiencies between 60% and 80% ASHRAE atmospheric dust-spot efficiency.

ASHRAE 52-76	Fractional Efficiencies %		
Dust spot efficiency %	3.0 micron	1.0 micron	0.3 micron
25-30	80	20	<5
60-65	93	50	20
80-85	99	90	50
90	>99	92	60
DOP 95	--	>99	95

Low efficiency filters are almost totally ineffective at removing sub-micron particulates from the air. It is also important that the filters used are properly sized for the air handlers. Gaps around the filter panels can allow air to bypass the filter as it passes through the air conditioner. Any gaps or openings should be filled using appropriate materials, such as stainless steel panels or custom filter assemblies.

Positive Pressurization and Ventilation

A designed introduction of air from outside the computer room system will be necessary in order to accommodate positive pressurization and ventilation requirements. The data center should be designed to achieve positive pressurization in relation to more loosely controlled surrounding areas. Positive pressurization of the more sensitive areas is an effective means of controlling contaminant infiltration through any minor breaches in the room perimeter. Positive pressure systems are designed to apply outward air forces to doorways and other access points within the data processing center in order to minimize contaminant infiltration of the computer room. Only a minimal amount of air should be introduced into the controlled environment. In data centers with multiple rooms, the most sensitive areas should be the most highly pressurized. It is, however, extremely important that the air being used to positively pressurize the room does not adversely affect the environmental conditions in the room. It is essential that any air introduction from outside the computer room is adequately filtered and conditioned to ensure that it is within acceptable parameters. These parameters can be looser than the goal conditions for the room since the air introduction should be minimal. A precise determination of acceptable limits should be based on the amount of air being introduced and the potential impact on the environment of the data center.

Because a closed-loop, re-circulating air conditioning system is used in most data centers, it will be necessary to introduce a minimal amount of air to meet the ventilation requirements of the room occupants. Data center areas normally have a very low human population density, thus the air required for ventilation will be minimal. In most cases, the air needed to achieve positive pressurization will likely exceed that needed to accommodate the room occupants. Normally, outside air quantities of less than 5% make-up air should be sufficient (ASHRAE Handbook: Applications, Chapter 17). A volume of 15 CFM outside air per occupant or workstation should sufficiently accommodate the ventilation needs of the room.

Cleaning Procedures and Equipment

Even a perfectly designed data center will require continued maintenance. Data centers containing design flaws or compromises may require extensive efforts to maintain conditions within desired limits. Hardware performance is an important factor contributing to the need for a high level of cleanliness in the data center.

Operator awareness is another consideration. Maintaining a fairly high level of cleanliness will raise the level of occupant awareness with respect to special requirements and restrictions while in the data center. Occupants or visitors to the data center will hold the controlled environment in high regard and are more likely to act appropriately. Any environment that is maintained to a fairly high level of cleanliness and is kept in a neat and well organized fashion will also command respect from the room's inhabitants and visitors. When potential clients visit the room they will interpret the overall appearance of the room as a reflection of an

overall commitment to excellence and quality. An effective cleaning schedule must consist of specially designed short-term and long-term actions. These can be summarized as follows:

Frequency	Task
Daily Actions	Rubbish removal
Weekly Actions	Access floor maintenance (vacuum and damp mop)
Quarterly Actions	Hardware decontamination
	Room surface decontamination
Bi-Annual Actions	Subfloor void decontamination
	Air conditioner decontamination (as necessary)

Daily Tasks

This statement of work focuses on the removal of each day's discarded trash and rubbish from the room. In addition, daily floor vacuuming may be required in Print Rooms or rooms with a considerable amount of operator activity.

Weekly Tasks

This statement of work focuses on the maintenance of the access floor system. During the week, the access floor becomes soiled with dust accumulations and blemishes. The entire access floor should be vacuumed and damp mopped. All vacuums used in the data center, for any purpose, should be equipped with High Efficiency Particulate Air (HEPA) filtration. Inadequately filtered equipment cannot arrest smaller particles, but rather simply agitates them, degrading the environment they were meant to improve. It is also important that mop-heads and dust wipes are of appropriate non-shedding designs.

Cleaning solutions used within the data center must not pose a threat to the hardware. Solutions that could potentially damage hardware include products that are:

- Ammoniated
- Chlorine-based
- Phosphate-based
- Bleach enriched
- Petro-chemical based
- Floor strippers or re-conditioners.

It is also important that the recommended concentrations are used, as even an appropriate agent in an inappropriate concentration can be potentially damaging. The solution should be maintained in good condition throughout the project, and excessive applications should be avoided.

Quarterly Tasks

The quarterly statement of work involves a much more detailed and comprehensive decontamination schedule and should only be conducted by experienced computer room contamination-control professionals. These actions should be performed three to four times per year, based on the levels of activity and contamination present.

All room surfaces should be thoroughly decontaminated including cupboards, ledges, racks, shelves and support equipment. High ledges and light fixtures and generally accessible areas should be treated or vacuumed as appropriate. Vertical surfaces including windows, glass partitions, doors, etc. should be thoroughly treated. Special dust cloths that are impregnated with a particle absorbent material are to be used in the surface decontamination process. Do not use generic dust rags or fabric cloths to perform these activities. Do not use any chemicals, waxes or solvents during these activities.

Settled contamination should be removed from all exterior hardware surfaces including horizontal and vertical surfaces. The unit's air inlet and outlet grilles should be treated as well. Do not wipe the unit's control surfaces as these areas can be decontaminated by the use of lightly compressed air. Special care should also be taken when cleaning keyboards and life-safety controls. Specially treated dust wipes should be used to treat all hardware surfaces. Monitors should be treated with optical cleansers and static-free cloths. No Electro-Static Discharge (ESD) dissipative chemicals should be used on the computer hardware, since these agents are caustic and harmful to most sensitive hardware. The computer hardware is sufficiently designed to permit electrostatic dissipation thus no further treatments are required. After all of the hardware and room surfaces have been thoroughly decontaminated, the access floor should be HEPA vacuumed and damp mopped as detailed in the Weekly Actions.

Bi-Annual Tasks

The subfloor void should be decontaminated every 18 months to 24 months based on the conditions of the plenum surfaces and the degree of contaminant accumulation. Over the course of the year, the subfloor void undergoes a considerable amount of activity that creates new contamination accumulations. Although the weekly above floor cleaning activities will greatly reduce the subfloor dust accumulations, a certain amount of surface dirt will migrate into the subfloor void. It is important to maintain the subfloor to a high degree of cleanliness since this area acts as the hardware's supply air plenum. It is best to perform the subfloor decontamination treatment in a short time frame to reduce cross contamination. The personnel performing this operation should be fully trained to assess cable connectivity and priority. Each exposed area of the subfloor void should be individually inspected and assessed for possible cable handling and movement. All twist-in and plug-in connections should be checked and fully engaged before cable movement. All subfloor activities must be conducted with proper consideration for air distribution and floor loading. In an effort to maintain access floor integrity and proper psychrometric conditions, the number of floor tiles removed from the floor system should be carefully managed. In most cases, each work crew should have no more than 24 square feet (six tiles) of open access flooring at any one time. The access floor's supporting grid system should also be thoroughly decontaminated, first by vacuuming the loose debris and then by damp-sponging the accumulated residue. Rubber gaskets, if present, as the metal framework that makes up the grid system should be removed from the grid work and cleaned with a damp sponge as well. Any unusual conditions, such as damaged floor suspension, floor tiles, cables and surfaces, within the floor void should be noted and reported.

Activity and Processes

Isolation of the data center is an integral factor in maintaining appropriate conditions. All unnecessary activity should be avoided in the data center, and access should be limited to necessary personnel only. Periodic activity, such as tours, should be limited, and traffic should be restricted to away from the hardware so as to avoid accidental contact. All personnel working in the room, including temporary employees and janitorial personnel, should be trained in the most basic sensitivities of the hardware so as to avoid unnecessary exposure. The controlled areas of the data center should be thoroughly isolated from contaminant producing activities. Ideally, print rooms, check sorting rooms, command centers or other areas with high levels of mechanical or human activity should have no direct exposure to the data center. Paths to and from these areas should not necessitate traffic through the main data center areas.

Index