Sun microsystems

StorageTek L180/L700e

Tape Libraries and PTP

Interface Reference Manual

Part Number: 95869
Revision: K

L180/L700e Tape Libraries and PTP

Interface Reference Manual

SCSI and Fibre Channel

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Please include the publication name, part number, and edition number in your correspondence if they are available. This will expedite our response.

Summary of Changes

EC	Date	Edition	Revision	Change
111222	Nov. 1999	Initial Release	A	Initial release
111507	July 2000	Second	B	Changes are summarized in the second edition document.
111580	Nov. 2000	Third	C	Changes are summarized in the third edition document.
111644	May. 2001	Fourth	D	Changes are summarized in the fourth edition document.
111747	April 2002	Fifth	E	Changes are summarized in the fifth edition document.
111805	October 2002	Sixth	F	Added 9940B, SDLT220 and SDLT320 drive support. Added Universal Cleaning Cartridge.
111814	Nov. 2002	Seventh	G	Added Ultrium 2 LTO drive support.
111832	March. 2003	Eighth	H	Changed reference to capacity of LTO Gen 2 cartridge from 200MB to 200GB
114124	January 2006	Ninth	J	Made changes to the Initialize Element Status With Range command to include the 'Fast' bit. Changed the Normal Inquiry Data (SCSI) specification to indicate that the library supports the current ANSI version of the SCSI-3 specification. A Transport Type field '0Bh- A Sun StorageTek 9840C drive' has been added to the Transport Type field of the Read Element Status.

EC	Date	Edition	Revision	Change
114124	January 2006	Ninth	J	Added an extra drive type (LTO Generation 3) for the Media Type field of the Media Domain field - 4Ch in "Medium Transport Element Descriptor Definition" on page 6-118", the "Storage Element Descriptor Definition" on page 6-123, the "Import/Export Element Descriptor Definitions" on page 6-128, the "Data Transfer Element Descriptor Definitions (DvcID = 0)" on page 6-134, the "Data Transfer Element Descriptor Definitions (DvcID = 1)" on page 6-142, and the "Playground Element Descriptor Definition" on page 6-150 of the Read Element Status Command.
				Added an extra value (36h) for the Transport Type field of the Transport Domain field - 4Ch of the "Data Transfer Element Descriptor Definitions (DvcID = 0)" on page 6-134 and the "Data Transfer Element Descriptor Definitions (DvcID = 1)" on page 6-142 of the Read Element Status Command.
				Added T10000 drive information
114191	March 2007	Tenth		Added information regarding Sun StorageTek T10000 and Encryption drives and media, LTO Generation 3/4 drives and media, and DLTtape S4 tape drives and media.

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Contents

Figures

Tables

Preface

This manual is intended to be used by service representatives, hardware engineers, software engineers, and operating system designers and developers responsible for implementing Sun StorageTek's version of the small computer system interface (SCSI) or Fibre Channel interface (FC) for the L700, L700e and/or L180 tape library (referred to in this manual as "the L700 library," the L700e library", "the L180 library," or "the library").

This manual contains information about the small computer system interface, including SCSI characteristics, library features, SCSI bus operations, SCSI commands, status byte data, and sense data. This manual also contains information about the Fibre Channel interface, including Fibre Channel operations, command implementations, topologies, cables, and connectors. The manual's title has changed from the L700/L180 Tape Libraries Interface Reference Manual to the L180/L700e Tape Libraries and PTP Interface Reference Manual.

Note: This manual *does not* describe the SCSI bus controls and commands or the Fibre Channel operations and commands for the *tape drives* in the library.

Organization

This manual contains six chapters, one appendix, a glossary, and an index:

Chapter 1	"General Information" contains a high-level overview about the small computer system interface and the Fibre Channel interface.
Chapter 2	"SCSI Bus Physical Description" describes both the single-ended and differential alternatives for the interface attachments.
Chapter 3	"SCSI Bus Operations" explains the seven elements that the small computer system interface uses for controlling the interface, transferring data, issuing commands, and returning status.
Chapter 4	"Fibre Channel Physical Interface" explains the ports, topologies and cable requirements for Fibre Channel.
Chapter 5	"Fibre Channel Operations" explains the structure of the Fibre Channel standard and its implications for library operation in an arbitrated loop topology.
Chapter 6	"SCSI Commands" lists and defines the commands for the library.
Appendix A	"Element Mapping" shows the cell mappings and configurations for both libraries.
Glossary	contains a list of terms and abbreviations.

Index helps you locate information in this manual.

Alert Messages

Alert messages call your attention to information that is especially important or that has a unique relationship to the main text or graphic.

Note: A note provides additional information that is of special interest. A note might point out exceptions to rules or procedures. A note usually, but not always, follows the information to which it pertains.

CAUTION:
A caution informs the reader of conditions that might result in damage to hardware, corruption of data, corruption of application software, or long-term health problems in people. A caution always precedes the information to which it pertains.

WARNING:
A warning alerts the reader to conditions that might result in injury or death. A warning always precedes the information to which it pertains.

Conventions

Typographical conventions highlight special words, phrases, and actions in this publication.

Item	Example	Description of Convention
Buttons	MENU	Font and capitalization follows label on product
Commands	Mode Select	Initial cap
Document titles	*System Assurance Guide*	Italic font
Emphasis	*not* or *must*	Italic font
File names	`fsc.txt`	Monospace font
Hypertext links	Figure 2-1 on page 2-5	Blue (prints black in hardcopy publications)
Indicators	*Open*	Font and capitalization follows label on product
Jumper names	TERMPWR	All uppercase
Keyboard keys	<Y> <Enter> or <Ctrl+Alt+Delete>	Font and capitalization follows label on product; enclosed within angle brackets

Item	Example	Description of Convention
Menu names	Configuration Menu	Capitalization follows label on product
Parameters and variables	Device = *xx*	Italic font
Path names	`c:/mydirectory`	Monospace font
Port or connector names	SER1	Font and capitalization follows label on product; otherwise, all uppercase
Positions for circuit breakers, jumpers, and switches	ON	Font and capitalization follows label on product; otherwise, all uppercase
Screen text (including screen captures, screen messages, and user input)	`downloading`	Monospace font
Switch names	Power	Font and capitalization follows label on product
URLs	http://www.storagetek.com	Blue (prints black in hardcopy publications)

Related Publications

For your convenience, the following sections list publications that provide information about the interfaces and libraries mentioned in this manual. Listed publications are subject to change without notice.

SCSI

The following publications contain information related to the Small Computer System Interface (SCSI).

Publication	Part Number
American National Standard Dictionary for Information Processing Systems	X3/TR-1-82
American National Standard Metric Practice	ANSI/IEEE 268-1982
Data Processing Equipment, CSA Standard C22.2	154-M1983
DLTx Tape Drive SCSI Interface SCSI Reference Manual	000825-*XX*
Electronic Industries Association Standards	RS-301B and RS-485
Electronic Data Processing Systems and Units	UL478, 5th Edition
Encapsulated SCSI Protocol	T002
FCC Rules and Regulations	http://www.fcc.gov/oet/info/rules
Volume 2, Subpart J, Parts 2 and 15	
Office Equipment Safety	VDE 0686/18.81
Radio Interference Suppression	VDE 0871/18.81
Safety of Electrically Energized Office Machines	IEC 380/435
Underwriters Laboratories, Inc. Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances	UL94
TapeAlert Diagnostic Specification Document (Hewlett Packard)	http://www.hp.com/tape/tapealert/talog.html
SCSI–3 Primary Commands (SPC)	X3.301–1997
SCSI–3 Primary Commands (SPC–2)	T10/Project 1236D
SCSI–3 Medium Changer Commands (SMC)	T10/Project 1383D
SCSI–3 Architecture Model (SAM)	X3.270–1996
SCSI Architecture Model – 2 (SAM–2)	T10/Project 1157D
VIPER 2000 LTO Tape Drive SCSI Reference Manual	T001
VIPER 2000 LTO Tape Drive SCSI Reference Manual	10006952-*XXX*

Fibre Channel

The following specifications helped Sun StorageTek define its implementation of Fibre Channel in the L700, L700e and L180 libraries.

Specification	**Revision**
Fibre Channel Physical and Signaling Interface (FC–PH)	X3.230–1994 Revision 4.3
	X3.230–1996 (Amendment 1)
	X3.230–1997 (Amendment 2)
Fibre Channel Physical and Signaling Interface (FC–PH–2)	X3.297–1996 Revision 7.4
Fibre Channel Physical and Signaling Interface (FC–PH–3)	X3.303–199x Revision 9.3
Fibre Channel Arbitrated Loop (FC–AL)	X3.272–1996 Revision 4.5
Fibre Channel Arbitrated Loop (FC–AL–2)	X3.272–199x Revision 7.0
Fibre Channel Protocol for SCSI (FCP)	X3.269–1996 Revision 12
Fibre Channel Protocol for SCSI (FCP–2)	T10/Project 1144D Revision 01
Fibre Channel Tape (FC–Tape)	NCITS TR–XX Revision 1.17

The following Sun StorageTek manual contains information about the Fibre Channel interface to Sun StorageTek's 9840 Tape Drive.

Publication	**Part Number**
9840 Tape Drive Fibre Channel Reference Manual	95784

The following Sun StorageTek manual contains information about the Fibre Channel.

Publication	**Part Number**
Fibre Optics User's Guide	9433

Libraries

The following Sun StorageTek publications contain information related to the L700, L700e and L180 tape libraries.

Publication	**Part Number**
L180 Tape Library Field Replaceable Units Parts List	300074601
L180/L700e Tape Libraries General Information Manual	MT9111
L180 Tape Library System Assurance Guide	MT5009
L180 Tape Library Illustrated Parts Catalog	95898

Publication	Part Number
L180 Tape Library Installation Manual	95896
L180 Tape Library Operator's Guide	95895
L180 Tape Library Service Manual	95897
L180/L700e Tape Libraries Ordering and Configuration Guide	MT9112
L700 Tape Library System Assurance Guide	MT5001
L700 Tape Library Illustrated Parts Catalog	95847
L700e Tape Library and L700 Pass-Thru-Port Installation Manual	95843
L700e Tape Library and L700-PTP Operator's Guide	95845
L700e Tape Library and L700 Pass-Thru-Port Service Manual	95846

Tape Drives

The following publications contain information about the drives supported by the L180, L700 and L700e tape libraries.

Tape Drive Publications	Part Number
DLT7000 Tape Drive Product Manual	313134501 (Sun StorageTek part number) 81-60000-0x (Quantum part number)
DLT8000 Tape System Product Manual	81-60118-0x (Quantum part number)
3580 IBM Ultrium Tape Drive Setup, Operator, and Service Guide	IBM part number: GA32.0415.xx
Hewlett-Packard Einstein Ultrium Tape Drive Manual	HP part number:
Seagate Viper 200 LTO Tape Drive Product Manual	Seagate part number 100006955-xxx
9840 Tape Drive SCSI Reference Manual	Sun StorageTek part number: 9163
9840 Tape Drive Fibre Channel Reference Manual	Sun StorageTek part number: 95784
9840 Tape Drive Product Manual	Sun StorageTek part number: 95741
T9940 Tape Drive Operator's Guide	Sun StorageTek part number: 95989

Additional Information

Sun StorageTek offers several methods for you to obtain additional information.

Sun StorageTek's External Web Site

Sun StorageTek's external Web site provides marketing, product, event, corporate, and service information. The external Web site is accessible to anyone with a Web browser and an Internet connection.

The URL for the Sun StorageTek external Web site is http://www.storagetek.com

The URL for Sun StorageTek™ brand-specific information is:
http://www.sun.com/storagetek/

Customer Resource Center

Sun StorageTek's CRC is a Web site that enables members to resolve technical issues by searching code fixes and technical documentation. CRC membership entitles you to other proactive services, such as HIPER subscriptions, technical tips, answers to frequently asked questions, addenda to product documentation books, and online product support contact information. Customers who have a current warranty or a current maintenance service agreement may apply for membership by clicking on the Request Password button on the CRC home page. Sun StorageTek employees may enter the CRC through PowerPort.

The URL for the CRC is http://www.support.storagetek.com.

e-Partners Site

Sun StorageTek's e-Partners site is a Web site that provides information about products, services, customer support, upcoming events, training programs, and sales tools to support Sun StorageTek's e-Partners. Access to this site, beyond the e-Partners Login page, is restricted. On the e-Partners Login page, Sun StorageTek employees and current partners who do not have access can request a login ID and password and prospective partners can apply to become Sun StorageTek resellers.

The URL for the Sun StorageTek Partners site is http://members.storagetek.com.

The URL for partners with a Sun StorageTek Partner agreement is
http://www.sun.com/partners/

Global Services Support Tools

Sun StorageTek's Global Services Support Tools site provides tools that aid in the sales and support of Sun StorageTek's products and services. This is an internal Web site for Sun StorageTek employees.

The URL for the Global Services Support Tools is http://sunsolve.central.com/handbook_internal/FieldTools/

Documents on CD

Documents on CD (3106600xx) contains portable document format (PDF) files of Sun StorageTek's hardware product publications. To order Documents on CD, contact your local Customer Services Logistics Depot. *Documents on CD* is only for Sun StorageTek employees.

Hardcopy Publications

You may order paper copies of publications listed on the CRC or included on the *Documents on CD*.

Service publications have *numeric* part numbers. To order paper copies of service publications, contact your local Customer Services Logistics Depot.

Marketing publications have *alphanumeric* part numbers. To order paper copies of marketing publications, do one of the following:

- Visit Sun StorageTek's PowerPort and select alphabetical listings under "L" or select `Online Forms`. Then search for Literature Distribution. Follow the instructions on the Literature Distribution Web page.
- Send e-mail to DistrL@louisville.stortek.com.

Comments and Suggestions

We welcome your feedback. Please contact the Sun Learning Services Feedback System at:

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or

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One StorageTek Drive
Louisville, CO 80028-3256
USA

Please include the publication name, part number, and edition number in your correspondence if they are available. This will expedite our response.

Safety

Fiber Optic Safety

WARNING:
***Eye hazard*. Never look directly into a fiber-optic cable, a fiber-optic connector, or a laser transceiver module. Hazardous conditions might exist from laser power levels that are capable of causing injury to the eye.**

Be especially careful when using optical instruments with this equipment. Such instruments might increase the likelihood of eye injury.

The laser transceivers in fiber-optic equipment can pose dangers to personal safety. Ensure that anyone who works with this Sun StorageTek equipment understands these dangers and follows safety procedures. Ensure that the optical ports of every laser transceiver module are terminated with an optical connector, a dust plug, or a cover.

Each fiber-optic interface in this Sun StorageTek Fibre Channel equipment contains a laser transceiver that is a Class 1 Laser Product. Each laser transceiver has an output of less than 70 μW. Sun StorageTek's Class 1 Laser Products comply with EN60825-1(+A-11) and with sections 21 CFR 1040.10 and 1040.11 of the Food and Drug Administration (FDA) regulations.

The following translations are for users in Finland and Sweden who wish to identify laser safety and classification:

CLASS 1 LASER
LUOKAN 1 LASERLAITE
KLASSE 1 LASER APPARAT

Laser Product Label

In accordance with safety regulations, a label on each Sun StorageTek Fibre Channel product identifies the laser class of the product and the place and date of the manufacturer. The label appears on top of a Fibre Channel tape drive and near the Fibre Channel connectors on a Fibre Channel tape library. A copy of the label is shown here:

CLASS 1 LASER PRODUCT
LASER KLASSE 1
APPAREIL A LASER DE CLASSE 1
COMPLIES WITH 21 CFR 1040.10 AND 1040.11

Electrostatic Discharge Damage Prevention

Before you touch any internal components in the library, including drives, you must take precautions against electrostatic discharge (ESD).

CAUTION:
Components are sensitive to static electricity: **Even a small electrostatic discharge can damage an electrical component that is inside the library. A damaged component might not fail immediately, but over time, it will become worse and might eventually cause an "intermittent" problem. Be sure that you touch an *unpainted* metal surface of the library before you reach inside the library or touch the drives.**

Before you touch any internal components:

1. With your finger, touch an *unpainted* metal surface of the library. In some libraries, you can touch the library's frame. In other libraries, you might have to touch a bolt on the wall or on the door frame.
2. Keep your body movement to a minimum as you touch the drives or the library components.

Antistatic wrist straps that have clip-on ends are commercially available.

General Information

1

This chapter describes the small computer system interface (SCSI) and the Fibre Channel interface (FC) for the L700, L700e and L180 libraries. This manual does not describe the Fibre Channel interface to the tape drives.

The SCSI Bus Interface

The libraries' SCSI interface conforms to SCSI specifications and is accepted by:

- American National Standards Institute (ANSI X3.131)
- European Computer Manufacturing Association (ECMA-111)
- Federal Information Processing Standard (FIPS-131)
- International Standards Organization (ISO-9316)

Overview

The small computer system interface operates locally as an input and output (I/O) bus that uses a common command set to transfer controls and data to all devices. The main purpose of this interface, called the SCSI bus, is to provide host computer systems with connections to a variety of peripheral devices, including disk subsystems, tape subsystems, printers, scanners, CD-ROMs, optical devices, communication devices, and libraries.

The SCSI bus design for the library provides a peer-to-peer, I/O interface that supports up to 16 devices and accommodates multiple hosts.

Peer-to-peer interface communication can be from:

- Host to host
- Host to peripheral device
- Peripheral device to peripheral device

SCSI terms defining communication between devices on the SCSI bus include:

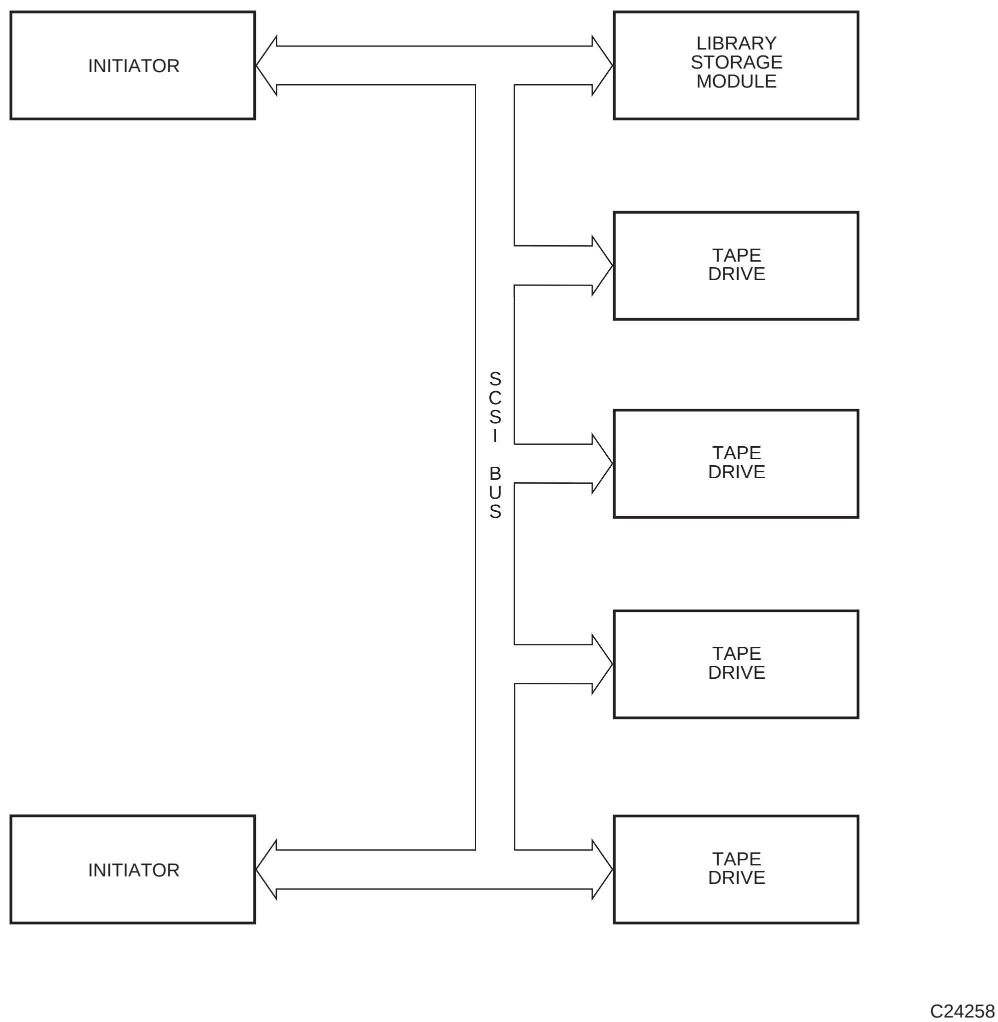
- *Initiator* is the device that requests an operation.
- *Target* is the device that performs the operation requested

Some targets are control units that can access one or more physical or virtual peripheral devices addressable through the control unit. These peripheral devices are called logical units and are assigned specific addresses or logical unit numbers (LUNs).

The library supports SCSI-3 commands. Thus the library supports only LUN 0 and will reject any selection with a LUN set to anything other than LUN 0. Also, the LUN field in the command descriptor blocks is ignored because the library supports SCSI-2 selection protocol.

The library and the tape drives have separate connections for attachment to the SCSI bus. Daisy-chain cables are available to interconnect devices on the SCSI bus but keep the total cable length to a minimum. Figure 1-1 is an example of a library and four tape drives that are daisy-chained to two initiators (or hosts).

Figure 1-1. Example of a Library Configuration on the SCSI Bus (C24258)



Benefits

Figure 1-1 is an example of a multi-initiator, multi-target configuration using a library and four tape drives.

A small computer system interface also provides these benefits:

- Low overhead

- High transfer rates
- A high-performance buffered interface
- Conformance to industry standards
- Plug compatibility for easy integration
- Error recovery, parity, and sequence checking provides high reliability
- Provisions in the command set for vendor-unique fields
- Standard or common command sets with an intelligent interface that provides device independence

The SCSI bus uses seven elements for interface control, data transfer, commands, and status. Chapter 3, “SCSI Bus Operations,” explains each of these elements in more detail.

Implementation

Implementation of the SCSI bus for the library supports:

- 8-bit wide transfers, asynchronous; 16-bit wide selection
- Disconnect and reselect
- Multiple initiator
- Hard resets
- Single-ended, HVD, and LVD
- SCSI-3, 68-pin P-cable

Implementation for the library *does not* support:

- Soft resets
- Command queuing
- Command linking
- Asynchronous event notification
- Extended contingent allegiance
- Synchronous or wide transfers

The Fibre Channel Standard

StorageTek'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 protocols (such as SCSI, IP, HIPPI, IPI-3)
- Information transparent
- 100 MB/s data transfer rates (and higher)
- Scalable for media rates, distance, media, and protocols

Benefits

In 1994, the Fibre Channel Physical and Signaling Interface (FC-PH), or ANSI X3.230-1994, was completed, differing from every other architecture at the time. This specification married the strengths of channels, including high throughput and low overhead, with the strengths of networks, including flexibility, long distance capability, and high connectivity.

Implementation

Library:

- Arbitrated loop
- Conformance to FC–Tape
- 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
- Dual port connections (future)

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

Note: See Chapter 4, “Fibre Channel Physical Interface” for more information about the hubs, cables, and connectors.

Switch:

- Attachment to FL_Ports is supported.

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SCSI Bus Physical Description

2

This chapter contains the physical description for the small computer system interface (SCSI) bus for the L700, L700e and L180 libraries, including:

- Characteristics
- Interface cables
- Special signals
- P-cable to A-cable adapters

Characteristics

The library supports single-ended/LVD (low-voltage differential) and high-voltage differential (HVD) alternatives for the SCSI bus connection. The following paragraphs describe the characteristics for these alternatives.

The single-ended alternative has the following characteristics:

- Maximum cable length of 3 m (9.8 ft)
- Minimum cable length of 0.3 m (1 ft)
- Primarily for connections within a cabinet
- 0.1 m (4 in.) stubs (the distance from the on-board device to the bus)
- Twisted-pairs cables (sometimes)
- Less power than the differential alternative
- Low cost
- Lower performance data rates than LVD or HVD

The LVD alternative has the following characteristics:

- Maximum cable length of 12 m (39.4 ft)
- Minimum cable length of 0.36 m (14.2 in.)
- 0.1 m (4 in.) stubs (the distance from the on-board device to the bus)
- Less power than the HVD alternative
- Higher data transfer rate than the HVD alternative
- Usable for outside cabinet connections
- LVD- or Universal-rated cables
- Higher performance data rates than single-ended or HVD

The HVD alternative has the following characteristics:

- Maximum cable length of 25 m (82 ft)
- Minimum cable length of 0.3 m (1 ft)
- Usable for outside cabinet connections
- 0.2 m (7.8 in.) stubs (the distance from the on-board device to the bus)
- Twisted-pairs cables required

- Low and high frequency noise rejection
- Greater signal strength than the single-ended alternative
- Usable in less than ideal situations
- Intermediate performance data rates

SCSI Options

CAUTION:
Potential equipment damage: **The single-ended, LVD, and HVD alternatives are not compatible and cannot be mixed on the same SCSI bus.**

Note: You can use the Configuration menu from the library operator panel to check the valid SCSI bus connections. The screen that displays the SCSI ID of the library should indicate either single-ended or differential. If the screen displays “Invalid Configuration,” you have mixed single-ended devices with differential devices somewhere on the bus. Correct the bus connection; then use the feature to verify the bus connection.

The SCSI interface is built into the library’s MPC or MPCL card. The MPC card is configured for Single-Ended (SE) or HVD operation, while the MPCL card can be configured for HVD or LVD/SE operation. The cards support 16-bit addressing and *eight*-bit transfers only. The cards will not support synchronous or wide transfers.

Note: To connect a host to a SCSI bus for LVD devices, you must have a host-bus adapter (HBA) that is specifically for an LVD SCSI bus.

Interface Cables

The cable that attaches devices to the SCSI bus is very important. Marginal quality cables can cause intermittent parity errors and might corrupt data during transfer.

We recommend SCSI cables that have these general characteristics:

- Twisted pairs (two insulated wires twisted together) to help eliminate noise and crosstalk
- Discrete lines for the asserted and negated version of each signal
- Shielding that provides an impedance rating that matches the requirement for the SCSI alternative:
  - 122 Ω nominal for HVD
  - 84 Ω nominal for single-ended
  - 110 Ω to 135 Ω for LVD

CAUTION:
Potential interference: **To minimize discontinuities and signal reflections, do not mix cables of different impedances on the same bus.*****Stringent LVD requirements:*** **Because of stringent requirements for LVD cable impedance-matching, you must use only LVD-specified cables or universal cables with LVD specifications for all LVD applications.**

- A 26 to 30 American Wire Gauge (AWG) conductor to minimize the effects of noise on the bus and to ensure proper distribution of terminator power (when terminator power is required).

  Note: The Terminator Power jumper on the LLC card in the library is selectable and is normally set to ON.

The style of the cable, flat or round, does not matter.

The library supports the following cable types and specifications:

P-cable	The SCSI-3 P-cable consists of 68 conductors: 16 data lines 9 control lines 2 parity lines 7 ground, reserved, or special signal lines
A-cable	The SCSI-2 A-cable consists of 50 conductors: 8 data lines 9 control lines 1 parity lines 7 ground, reserved, or special signal lines

Note: If the SCSI bus uses an A-cable, you must use an adapter to terminate the eight additional data lines in the P-cable. You then must use the P-cable to connect the SCSI bus to the library and tape drives.

External

Sun StorageTek supplies a variety of external SCSI bus cables to connect the library and tape drives to the SCSI bus. Types of cables include:

- 50-pin Centronics
- 68-pin Micro D-type
- 68-pin micro-centronix
- 68-pin AS/400 recessed hardware
- 68-pin RS6000 (2416 IOP)
- 68-pin 4-40 hardware

Contact a marketing representative or refer to the system assurance guide for your library for information about SCSI cables.

Daisy-Chain

The library and the tape drives may be daisy chained on the SCSI bus using short SCSI cables. The library and the tape drives each have two SCSI connectors wired in parallel. To daisy chain these devices, connect a SCSI cable from the bus to one of the connectors; then connect a SCSI daisy-chain cable from the other connector to the next device. Daisy-chain cables are available from Sun StorageTek.

Note: If a device is first or last on the SCSI bus, then it must be terminated. See "Terminator" for information and part numbers.

Connector

The SCSI connector for the library and the tape drives is a high-density (HD), shielded, 68-pin, D-type connector for P-cable attachments.

Terminator

You must terminate all SCSI signals at *each* end of the SCSI bus by connecting a terminator to one of the SCSI connectors on the device at each end of the SCSI bus. Table 2-1 lists the terminators for the single-ended, LVD, and HVD alternatives as well as the adapter:

Table 2-1. SCSI Terminators

Part Number	Description
10148002	68-pin, fast/narrow single-ended
10097653	68-pin LVD-SE multi-mode (actively switches between LVD and single-ended mode)
10148003	68-pin, fast/narrow HVD
10148010	50- to 68-pin, feed-through HVD

■ Special Signals

The library supports two special SCSI bus signals:

- Differential Sense (DIFFSENS)
- Terminator Power (TERMPWR)

Differential Sense

The differential sense (DIFFSENS) is a DC voltage level that distinguishes among the three SCSI alternatives: single-ended, LVD, and HVD:

Single-ended:	-0.35 V to +0.5 V
LVD:	+0.7 V to +1.9 V
HVD:	+2.4 V to +5.5 V

The DIFFSENS signal helps prevent damage to the SCSI bus and other equipment when the SCSI device is incompatible with the SCSI bus. Some potential for device damage still exists, however, depending on the type of incompatibility. The following table (Table 2-2) shows the effects of different types of incompatibility.

Table 2-2. SCSI Device Types into SCSI Bus Types

If you plug this device type into this SCSI bus type . . .	**Single-Ended (SE) Bus**	**LVD Bus**	**HVD Bus**
Single-ended (SE) device	No effect. This is a proper connection.	The entire bus will run in SE mode (with all SE restrictions).	The HVD bus will be disabled.
LVD device	The LVD device will run in SE mode.	No effect. This is a proper connection.	The LVD device will be disabled (potential damage to the device).
HVD device	The HVD device will be disabled.	The LVD bus and all LVD devices will be disabled (potential damage to LVD devices)	No effect. This is a proper connection.

Terminator Power

The library is capable of providing terminator power on the SCSI bus. All devices supporting the differential alternatives (LVD and HVD) must have the ability to provide terminator power (TERMPWR) with the following characteristics:

VTerm (HVD)	+4.0 to +5.25 VDC 1000 mA minimum source drive capability 2.0 A current limiting

VTerm (LVD)	+3.0 to +5.25 VDC 500 mA minimum source drive capability 2.0 A current limiting

Note: Industry standards dictate that no more than three devices should provide terminator power on the bus. This ensures that voltage on the bus stays high (+5 VDC) without over-driving the signal or overloading the bus.

Jumpers on the library enable terminator power.

P-cable to A-cable Adapter

Problems can occur when you mix SCSI devices that use P-cables with devices that use A-cables:

- The terminator power (TERMPWR) requirements for devices using a P-cable have been increased to support a 16-bit data bus. Devices using an A-cable and supporting the SCSI-1 standard may not supply sufficient TERMPWR to operate on the SCSI bus.

  Two reserved lines on the A-cable (23 and 24) must provide TERMPWR to P-cable lines (33 and 34).

- When buses of different widths are connected on the same bus, data bus signals from wider cables are left open and must be terminated using an adapter.

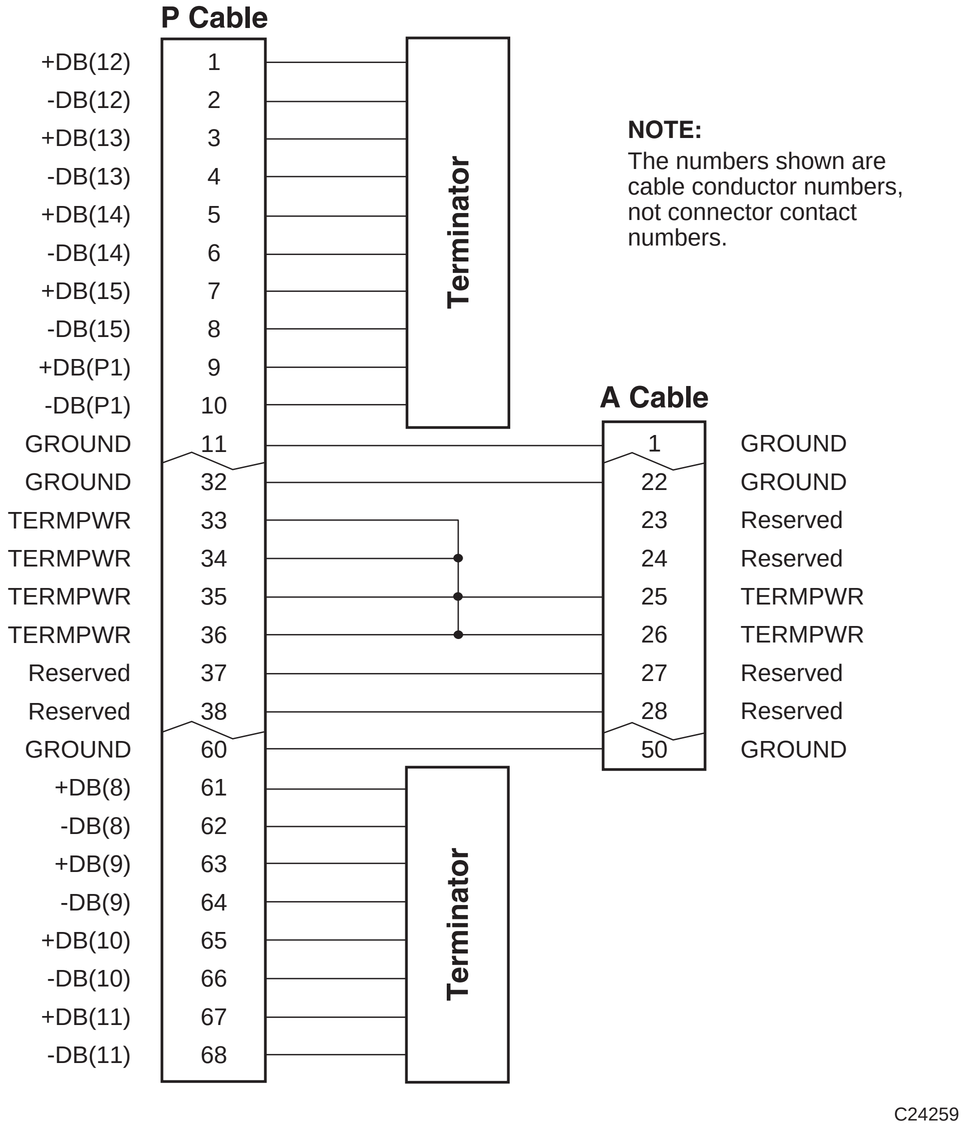
When connecting a P-cable to an A-cable for eight-bit (narrow) data transfers, the following signals are left open. A special adapter must terminate these signals:

- +DB (15-8)
- +DB (P1)
- -DB (15-8)
- -DB (P1)

The adapter is part number 10148010.

See Figure 2-1 on page 2-7 for an example of this adapter and the terminated signals.

Figure 2-1. A-cable to P-cable Adapter (C24259)



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SCSI Bus Operations

3

This chapter describes the seven elements that SCSI uses for controlling the interface, transferring data, issuing commands, and returning status for the L700, L700e or the L180 library:

- Bus phases
- Bus signals
- Bus conditions
- Pointers
- Messages
- Commands
- Status byte

Bus Phases

The SCSI bus uses eight states, called bus phases, to establish and control connections between the initiator and the target:

- Bus Free
- Arbitration
- Selection
- Reselection

Information Transfer phases:

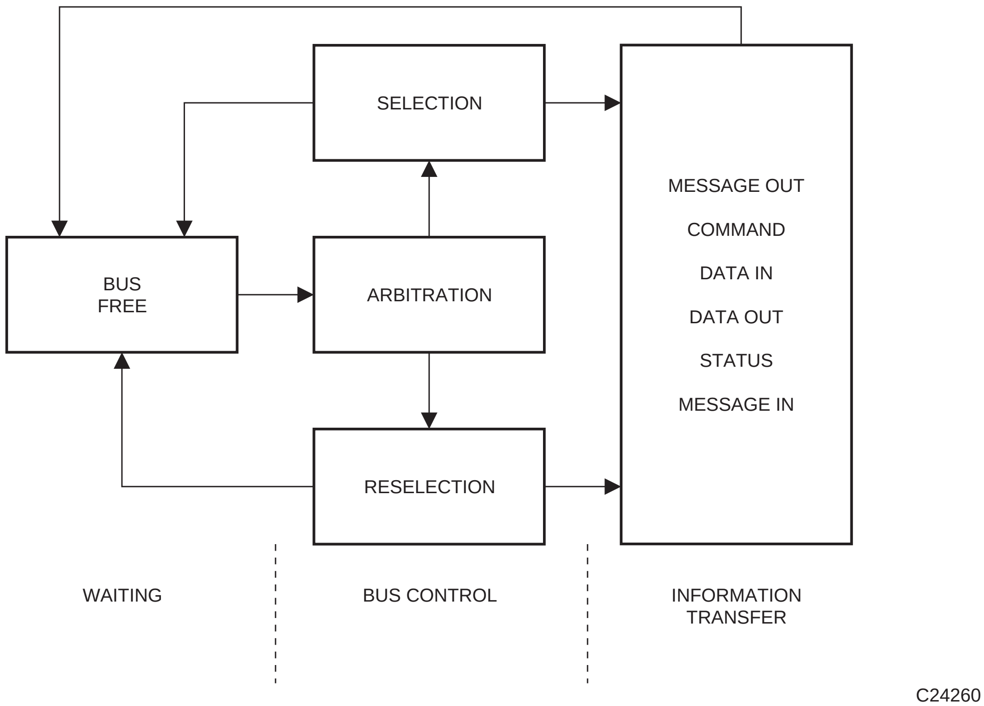
- Message (in or out)
- Command
- Data (in or out)
- Status

Each bus phase is governed by a predetermined set of rules established by SCSI.

Note: The SCSI bus can only be in *one* phase at a time.

The SCSI bus follows a specific sequence to go from one phase to another, shown in Figure 3-1 on page 3-2.

Figure 3-1. SCSI Bus Phases (C24260)



The normal progression of the SCSI bus is from:

1. Bus Free phase to the Arbitration phase
2. Arbitration phase to the Selection or Reselection phase
3. Selection or Reselection phase to one or more of the Information Transfer phases
4. Information Transfer phases to the Bus Free phase

Notes:

1. At any time, any phase can be followed by the Bus Free phase.
2. There are no restrictions on the sequences in the Information Transfer phase. Any Information Transfer phase can be followed by the same phase or any other Information Transfer phase.
3. A Reset condition can abort any phase and is always followed by the Bus Free phase.

Bus Free

During the Bus Free phase, the SCSI bus is available for use by any device (initiator or target) connected to it.

Arbitration

The Arbitration phase allows an initiator (or target during reselection) to gain control of the SCSI bus. All devices requiring use of the bus assert their SCSI IDs to gain control.

If multiple devices attempt to gain control of the bus at the same time, the device with the highest-priority SCSI ID obtains control over the bus.

Selection

The Selection phase allows an initiator to select a target to perform some operation. In the Selection phase, the initiator asserts both its SCSI ID and the SCSI ID of the target being selected on the bus.

This selection process informs the device that it is being selected and identifies the initiator that is performing the selection.

Reselection

The Reselection phase allows the target to reconnect to an initiator after disconnecting.

Information Transfer

Four Information Transfer phases transfer data or provide status over the SCSI bus:

Command The Command phase allows the device to request command information from the initiator.

Data Two types of Data phases transfer data in asynchronous modes:

- **Data In** The target sends data to the initiator.
- **Data Out** The initiator sends data to the target.

Message There are two types of Message phases:

- **Message In** The target sends messages to the initiator.
- **Message Out** The target receives messages from the initiator. The target invokes this phase when the initiator asserts the attention (ATN) signal.

Status	The Status phase allows the target to send status information to the initiator.

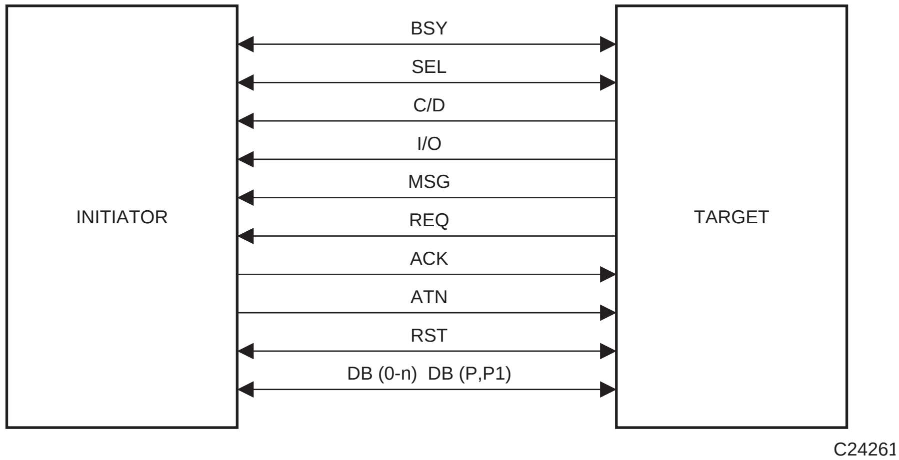
Bus Signals

Communication between two devices on the SCSI bus occurs any time after they establish connection using the bus phases. When two devices communicate, one device acts as an *initiator* and the other device acts as a *target*.

Figure 3-2 on page 3-5 shows the source and direction of the SCSI bus signals

BSY	Busy is a control signal that indicates the SCSI bus is in use.
SEL	Select is a control signal that selects a target or initiator.
C/D	Control and Data signals are driven by the target to indicate whether control or data information is being transferred.
I/O	Input and Output are control signals driven by the target to control the direction data travels on the bus (with respect to the initiator).
MSG	Message is a control signal driven by the target.
REQ	Request is a control signal driven by the target to indicate a request for a REQ/ACK data transfer handshake.
ACK	Acknowledge is a control signal driven by an initiator to indicate an acknowledgment for a REQ/ACK data transfer handshake.
ATN	Attention is a control signal driven by an initiator to indicate an Attention condition.
RST	Reset is a control signal that generates a Reset condition when asserted.
DB(0-n)	Data bus signals (0-n) transfer data where *n* indicates the number of data bus signals.
DB(P,P1)	Data bus parity signals (P,P1) are undefined during the Arbitration phase and are defined as *odd* parity during data transfer.

Figure 3-2. Signal Source and Direction (C24261)



Signal Sources

Table 3-1 indicates the source and phase of the SCSI bus signals.

Table 3-1. Signal Source

Bus Phase	Bus Signals				
	BSY	**SEL**	**C/D I/O MSG REQ**	**ACK ATN**	**DB**
Bus Free	N	N	N	N	N
Arbitration	A	W	N	N	ID
Selection	I & T	I	N	I	I
Reselection	I & T	T	T	I	I
Command	T	N	T	I	I
Data In	T	N	T	I	T
Data Out	T	N	T	I	I
Status	T	N	T	I	T
Message In	T	N	T	I	T
Message Out	T	N	T	I	I

A The signal is driven by all SCSI devices arbitrating.

I If this signal is driven, it is driven only by the active initiator.

ID	A unique data bit (the SCSI ID) is driven by each SCSI device that is arbitrating. The other 15 data bits are released (not driven) by this SCSI device. The parity bit DB(P,P1) may be driven or undriven to the asserted state but will never be driven to the negated state during this phase.
I&T	The signal is driven by the initiator, target, or both, as specified in the Selection and Reselection phases.
N	The signal is released—that is, not driven—by any SCSI device. The bias circuitry of the bus terminators pulls the signal to the negated state.
T	If the signal is driven, it is driven only by the active target.
W	The signal is driven by the device that *wins* during the arbitration phase.

Bus Conditions

SCSI uses bus conditions to interrupt operations and to handle errors. These conditions cause a SCSI device to accomplish certain actions by altering the bus phase sequence.

The library supports five types of bus conditions:

- Attention
- Parity Errors
- Reset
- Contingent Allegiance
- Unit Attention

Example: A device has a problem executing a command or something happens to that device during an I/O operation, such as a device reset. In this case, a Contingent Allegiance condition is flagged to indicate to the initiator that a problem exists with the device.

Attention

The Attention condition allows an initiator to inform a device that a message is ready for transfer. The target obtains this message by going to the Message Out phase.

The initiator creates the Attention condition by asserting the ATN signal on the SCSI bus any time, except during the Arbitration or Bus Free phases.

Parity Errors

A Parity Error condition occurs if the target detects one or more parity errors in the message bytes received. The target retries the message by asserting the REQ signal after detecting the negated ATN signal and before changing to another bus phase. When the initiator detects this condition, it resends the message bytes in the same order as before.

If a parity error occurs during Command Out, Data Out, or Status In, the target sends a "Restore Pointers" message to the initiator and retries the command, data, or status phase.

Reset

The library recognizes three types of resets. It implements the SCSI hard reset alternative and the Bus Device Reset message. In addition, the library generates an implicit reset when the library is powered on.

When a reset condition is detected, the library performs these actions:

- Clears all I/O processes and discontinues any current command in progress.
- Clears logical unit and element reservations, except for persistent reservations, for all initiators.
- Sets the parameters for mode page 1Dh to the saved values (or to the default values if the saved values are in error).

Upon completion of a reset condition, the library generates a Unit Attention to all initiators to indicate that a reset occurred.

Contingent Allegiance

The target—the library or a drive—generates a Contingent Allegiance Condition for the initiator that caused the error after:

- The target returns a Check Condition status because it has detected an error, failure or other exception condition
- An unexpected, optional disconnect occurs between the target and the initiator. (In other words, the target unexpectedly returns to the Bus Free phase.)

When the target generates a Contingent Allegiance Condition, a series of activities occurs:

- The target preserves the sense data in case it is requested by the initiator.
- If the next command from the initiator to the target (following the Contingent Allegiance Condition) is Request Sense, the target returns the sense data. If the target receives any command other than Request Sense, the sense data is lost and the target processes the command.

Unit Attention

The Unit Attention Condition is a specific form of the Contingent Allegiance Condition. The target generates a Unit Attention condition for each initiator for:

- A hard reset condition
- A power-on reset
- A SCSI Bus Device Reset message

Example: A library is installed on the SCSI bus, but the library is powered off. When powering-on, the library generates a Unit Attention condition to all initiators attached to the SCSI bus. The initiator must clear the Unit Attention condition before communication with the library can occur.

A target also generates a Unit Attention condition for:

- Changing the removable medium
- Changing the Mode Select parameters
- Preempting Persistent Reservations

The Unit Attention condition persists for each initiator until that initiator issues a command to the target or logical unit (other than Request Sense or Inquiry commands) for which the device returns a Check Condition status.

- If the next command from that initiator to the logical unit (following the Check Condition status) is Request Sense, the Unit Attention sense key is returned. If the target receives any command other than Request Sense, the Unit Attention condition is lost.
- If the target receives an Inquiry command from an initiator with a pending Unit Attention condition (before the device reports Check Condition status), the device completes an Inquiry command and does not clear the condition.
- If the target receives a Request Sense command from an initiator with a pending Unit Attention condition (before the device reports Check Condition status), the device reports any pending sense data and preserves the unit attention condition.
- If an initiator issues a command other than Inquiry or Request Sense while a Unit Attention condition exists for that initiator, the device returns Check condition status with the Unit Attention sense key and clears the Unit Attention condition.

Pointers

SCSI uses pointers to indicate the relative locations in memory of the initiator. The SCSI pointer architecture has two elements

Current The current element points to the next byte of information to be transmitted. This set of pointers is shared by all devices.

Saved The saved element points to the beginning or initial I/O block being transmitted. There is one set of saved pointers for each *active* I/O process.

Each pointer element has three pointers for each I/O process:

Command The command pointer indicates the start of the command descriptor block.

Data The saved data pointer indicates the start of the data area. If the target issues a Save Pointer Message during that I/O process, the initiator updates and stores the new value in the saved data pointer.

Status The status pointer indicates the start of the status area.

The following explains how pointers are used during the I/O process:

Example: Because a device needs time to process commands or multiple data blocks, the target disconnects from the initiator to free the SCSI bus for other operations.

The target directs the initiator to save data pointers by sending a Save Data Pointer message before disconnection.

Note: Whenever the target detects an error or receives a message from the initiator indicating an error has occurred, the target requests that the initiator return to the location specified by the pointers to re-execute the operation. The target makes this request by sending a Restore Pointers message.

Message System

The message system allows SCSI devices to communicate for physical path management. There are two ways to transfer messages during the Information Transfer phase:

Message In Messages from the target to the initiator

Message Out Messages from the initiator to the target

The ATN signal prompts the target to start the Message Out phase. The Message Out phase is the next phase entered by the target; however, it can start at any time after detecting an Attention condition.

If the target receives any message other than Identify, Abort, or Bus Device Reset as the *first* message after selection, the target aborts the operation and enters the Bus Free phase. Table 3-2 lists the valid messages for the library:

Table 3-2. Message Codes

Hex Code	Description	Direction
00	Command Complete	In
01	Extended	Out
02	Save Data Pointers	In
03	Restore Pointers	In
04	Disconnect	In
05	Initiator Detected Error	Out

Table 3-2. Message Codes

Hex Code	Description	Direction
06	Abort	Out
07	Message Reject	In/Out
08	No Operation	Out
09	Message Parity Error	Out
0C	Bus Device Reset	Out
80–FF	Identify	In/Out
Note: In = Target to initiator, Out = Initiator to target		

Note: Table 3-2 lists only those messages supported by the library. The library does not support the use of linked or tagged commands.

In general, SCSI supports two types of messages:

- Messages containing a single byte
- Messages containing multiple bytes

The following sections describe the valid messages along with their hexadecimal code values.

Message Codes

The following paragraphs explain the messages.

Command Complete Message In

The library sends the Command Complete message (00) to the initiator to indicate that the execution of the command has completed and that valid status has been sent to the initiator.

Extended Message

The initiator might try to negotiate wide or synchronous transfers. The library accepts these negotiations but always negotiates to narrow and asynchronous transfers.

Save Data Pointers In

The library sends the Save Data Pointers message (02) to tell an initiator to save a copy of the active data pointer for the library. The library sends this message before sending the Disconnect message.

Restore Pointers Message In

The library sends the Restore Pointers message (03) to direct an initiator to restore the most recently saved command, data, and status pointers for the active I/O process. The message is sent after receiving an Initiator Detected Error message or Parity error during a transfer which can be retried. The transfer is then restarted.

Disconnect Message In

The library sends the Disconnect message (04) to inform an initiator that the present connection is going to be broken and that a later reconnect is required to complete the current command. After successfully sending this message, the library enters the Bus Free phase.

Initiator Detected Error Out

An initiator sends the Initiator Detected Error message (05) to inform the library that the initiator has detected an error. Depending on the active phase, the library aborts the current I/O, sends a Message Reject, or issues a Restore Pointers, and restarts the transfer.

Abort Out

An initiator sends the Abort message (06) to the library to halt a process. If an I_T_L nexus is established, any pending data and status is cleared and the process is aborted; otherwise, no action is taken.

Message Reject In/Out

Either an initiator or the library sends a Message Reject (07) to indicate the last message received was inappropriate or not supported.

No Operation Out

When a library receives a No Operation message (08), command processing continues without any action taken.

Message Parity Error Out

The library receives a Message Parity Error (09) when an initiator detects bad parity on a message byte. If the last phase was Message In, the library resends the message byte again.

Bus Device Reset Out

The Bus Device Reset message (0C) causes the library to immediately go to the Bus Free phase and resets the SCSI interface.

Identify Message In/Out

Either the initiator or the library sends the Identify message (80 to FF). The initiator sends this message to the library to enable the message system.

Identify messages are sent by either the initiator or the target to establish the physical path connection between an initiator and the target for a particular logical unit. The library sends this message to the initiator following the reselection sequence. The format of this message is

Bit	7	6	5-0
Value	Identify	DiscPriv	LUN

Identify This bit is set to 1 to distinguish the Identify message from all other messages.

DiscPriv This bit (disconnect privilege) is used by the initiator to grant the library disconnect privileges:

0 Disconnect is not allowed

1 Disconnect is allowed

When the Identify message is sent by the library, the DiscPriv is set to 0.

LUN The only supported Logical Unit Number (LUN) for the library is 0.

Additional information regarding the messaging system (or messaging) can be found in the SCSI-3 standard.

Message Sequencing and Handling

During the selection phase, the Identify message must be the first message out from the initiator to the library. This message initiates the message system. The library must receive an Identify message during the selection phase to enable it to respond to the attention line during subsequent phases. When the message system has been initiated by the Identify message during the selection phase, the library accepts messages from the initiator when the attention line is active.

Synchronous Negotiations

The library will accept negotiations for synchronous communication but will always negotiate to asynchronous communication.

Wide Negotiations

The library will accept negotiations for wide transfers but will always negotiate to narrow, 8-bit transfers.

Status Byte

The target returns a status byte to the initiator at the completion of each command during the Status phase unless the command is cleared or interrupted by:

- An Abort message
- Device Reset message
- A “hard” reset condition
- An unexpected disconnect

Table 3-3 shows the structure of the status byte.

Table 3-3. Status Byte

Bytes	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
1	Reserved		Status Byte Code					Reserved

The library supports four status byte codes:

- Good (00)
- Check Condition (02)
- Busy (08)
- Reservation Conflict (18)

Good

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

Check Condition

Check Condition status (02) 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 (08) 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 (18) whenever a SCSI initiator attempts to access a logical unit or element that is reserved by another initiator.

Multiple Initiator Support

The library architecture supports multiple initiators with the following details:

- Up to 16 SCSI devices are supported. The library can be on a bus with a maximum of 15 initiators. In this configuration, the tape drive SCSI interfaces would be required to be on a separate SCSI bus.
- Unit- and element-level Reserve and Release commands are supported. Persistent Reserve commands also are supported. An initiator may reserve elements that will then cause a reservation conflict if the reserved element is accessed by a different initiator. 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/allow medium removal status for each initiator. If any host/initiator has issued a prevent command, then no operator panel access to the Cartridge Access Port (CAP) door will be allowed.

Host TimeOut Characteristics

Host timeout values for the SCSI bus may require adjustment based on the configuration of the library. The maximum timeout value is 10 minutes (for the maximum library configuration.)

Automated Cleaning

The library architecture provides for automated drive cleaning. The user enables automated cleaning by adding valid cleaning cartridges to any of the cells that are reserved for cleaning and diagnostic cartridges. (For the locations of these cells, refer to Appendix A, "Element Mapping")

Note: To be valid, a cleaning cartridge must have "CLN" somewhere on its VOLSER label. 9840 and 9840B cleaning cartridges also must have a "U" on their media ID labels. 9940 must have a "W" on the Media ID label.With Linear Tape Open (LTO) the HPcleaning cartridge must also have a "C1", the IBM cleaning cartridge a "C2" and the Seagate cleaning cartridge a "C3" on their media ID labels.

When a drive requires cleaning, the library interleaves the cleaning cartridge mount with normal host operations. The "Fast Load" option is always enabled for cleaning cartridges, so the mount occurs within seconds. Typically, the cleaning mount occurs directly after a data cartridge dismount. Host applications see minimal processing interruptions (less than ten seconds) during the cleaning mount.

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 30 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.

■ Fast Load

The library architecture provides for optional fast load operations. The following applies only if the fast load option is disabled. (If the fast load option is disabled, then 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.)

If the fast load option is disabled, a SCSI move command may require additional time to complete. The library remains disconnected during this time. 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 library supports the Reserve/Release management method and also the Persistent Reservations management method. These methods are defined in the *ANSI SCSI-3 Primary Commands (SPC-2)* standard. For the reservation restrictions placed on commands for the Reserve/Release management method, see Table 3-4. For the reservation restrictions placed on the Persistent Reservations management method, see Table 3-5 on page 3-17.

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 3-4. Reserve/Release Management Method

Command	Action when Reserved by a different Initiator
Initialize Element (07h)	Conflict
Initialize Element with Range (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, unless the CurData bit is 1 (see note)
Release Unit (17h/57h)	Allowed, the reservation is not released.
Request Sense (03h)	Allowed
Request Volume Element Address (B5)	Conflict
Reserve Unit (16h/56h)	Conflict
Rezero Unit (01h)	Conflict
Send Diagnostic (1Dh)	Conflict
Send Volume Tag (B6h)	Conflict
Test Unit Ready (00h)	Conflict
Write Buffer (3Bh)	Conflict

Note: As of the publication date of this document, the CurData bit had not been fully implemented.

Table 3-5. Persistent Reservation Management Method

Command	From Non-registered Initiators	From Registered Initiators
Initialize Element (07h)	Conflict	Allowed
Initialize Element with Range (E7)	Conflict	Allowed
Inquiry (12h)	Allowed	Allowed
Log Sense (4Dh)	Allowed	Allowed
Mode Select (15h/55h)	Conflict	Allowed
Mode Sense (1Ah/5Ah)	Conflict	Allowed
Move Medium (A5h)	Conflict	Allowed
Persistent Reserve In (5Eh)	Allowed	Allowed
Persistent Reserve Out (5Fh)	Register, allowed Reserve, conflict Release, conflict Clear, conflict Preempt, conflict Pre/Abt, conflict Reg/Ign, allowed	Register, allowed Reserve, conflict Release, allowed Clear, allowed Preempt, allowed Pre/Abt, allowed Reg/Ign, allowed
Position to Element (2Bh)	Conflict	Allowed
Prevent/Allow Media Removal (1Eh)	Prevent = 0, allowed Prevent = 1, conflict	Allowed
Read Element Status (B8h)	CurData = 0, conflict CurData = 1, allowed	Allowed
Release Unit (17h/57h)	Conflict	Conflict
Request Sense (03h)	Allowed	Allowed
Request Volume Element Address (B5h)	Conflict	Allowed
Reserve Unit (16h/56h)	Conflict	Conflict
Rezero Unit (01h)	Conflict	Allowed
Send Diagnostic (1Dh)	Conflict	Allowed
Send Volume Tag (B6h)	Conflict	Allowed

Table 3-5. Persistent Reservation Management Method (Continued)

Command	From Non-registered Initiators	From Registered Initiators
Test Unit Ready (00h)	Conflict	Allowed
Write Buffer (3Bh)	Conflict	Allowed

Fibre Channel Physical Interface

4

This chapter describes how Sun StorageTek's L700, L700e and L180 tape libraries attach to Fibre Channel (FC), and it includes recommendations for hubs, cables, and connectors.

Ports

Library ports are N*_Ports in a Fibre Channel topology. (The "N*" here stands generically for a type of "node" port.) More specifically, the link at the library can be a N_Port in a point-to-point topology but is more often an NL_Port in an arbitrated loop topology.

An N*_Port supports one media type, one media rate, and one or more classes of service (currently, Class 3 Service is the only class of service that the libraries support). Thus data transmission between N*_Ports occurs only if the ports have the same media type, the same media rate, and at least one class of service in common. In addition, in arbitrated loop topologies, one N*_Port typically communicates with only one other N*_Port on the loop at a time. For more information about arbitrated loop topologies, see "Arbitrated Loop" on page 4-1.

When an N*_Port is connected to a Fibre Channel fabric, typically through an F*_Port, the breadth of possibilities for data transmission increases because the fabric topology permits:

- Many pairs of N*_Ports to communicate at the same time
- Communication between dissimilar N*_Ports

For more information about the Fibre Channel fabric topology, see "Direct Fabric Attachment" on page 4-6.

Topologies

Sun StorageTek libraries support the following topologies with single port attachment:

- Arbitrated Loop—private loop
- Arbitrated Loop—public loop
- Direct fabric attachment

Arbitrated Loop

In a Fibre Channel arbitrated loop, as with the SCSI protocol, when devices want to communicate on the bus, they must arbitrate and win the connection before communications can begin. Once a device is powered on and initialized on the loop, it must arbitrate and win to be able to communicate with other devices on the loop.

Private Arbitrated Loop

If the arbitrated loop is not attached to a Fibre Channel fabric (that is, to an F*_port), it is a private loop. A private arbitrated loop can connect up to 126 NL_ports. Again only point-to-point communication is possible between one initiator and one target at any time. (Other links on the loop act as repeaters.) In addition, initiator and target must reside within the same loop. Its best implementation includes a Fibre Channel hub (see "Arbitrated Loop with Hub" on page 4-2).

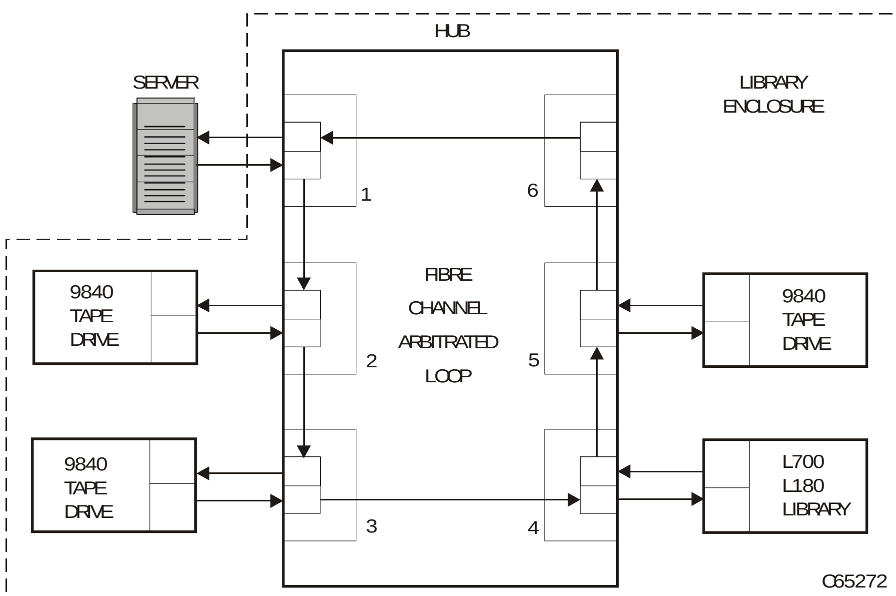
Public Arbitrated Loop

If the arbitrated loop contains at least one FL_port—that is, is attached to a Fibre Channel fabric—it is a public loop. A public loop can contain up to 126 NL_ports and one FL_port. If the fabric connects to another arbitrated loop, then an initiator on one public loop might be able to communicate with a target on another. For more about Fibre Channel fabric, see "Direct Fabric Attachment" on page 4-6.

Arbitrated Loop with Hub

Arbitrated loops become more viable when they include a hub, a device containing bypass circuitry for configurations of 8 to 16 ports. See Figure 4-1 on page 4-2.

Figure 4-1. Arbitrated Loop with Hub (C65272)



Hubs

Sun StorageTek libraries are designed to work with hubs that create an arbitrated loop with the following capabilities:

- Provides port bypass functionality for port failures
- Centralizes the attachment—within the arbitrated loop—of the tape drives in the library
- Establishes connections with either copper or fiber optic cables
- Provides translation of physical media (such as copper to optical fiber)
- Provides an external power supply for the port bypass
- Allows cascading to increase tape drive/library and initiator attachment
- Supports the ability to power on and off, install or deinstall tape drives or libraries
- Provides a central point of port management and monitoring of the tape drives and libraries
- Extends the distances between tape drives/libraries and initiators

The 19 in. rack space within the libraries supports the installation of Fibre Channel hubs or switches. This allows most of the fiber cabling to reside within the library enclosure.

Because of the fast growth and the increase in demand of Fibre Channel attachments, hubs can provide cascading (multiple) loops within a fibre channel network (see "Cascading Hubs" below).

Considerations for Hubs

Jitter is a consideration when selecting, installing, and configuring hubs within a Fibre Channel network. Jitter is the deviation of timing of an exchange.

The accumulation of jitter occurs and continues to grow within a chain of repeaters. As a signal is input to a repeater, jitter is not removed from the clock and is transferred to the data at the output. At some level within the network, jitter could exceed the allowable limit causing excessive errors. Assuring that there are N_Ports within the loop to reclock the signal, jitter will be minimized.

Loop Port State Machines (LPSM) are required to control the operation of the loop and ensure Loop Initialization Protocol (LIP) is executed whenever a reset or power-on occurs.

Cascading Hubs

There is no limit to cascading the number of hubs within a network as long as the following guidelines are followed:

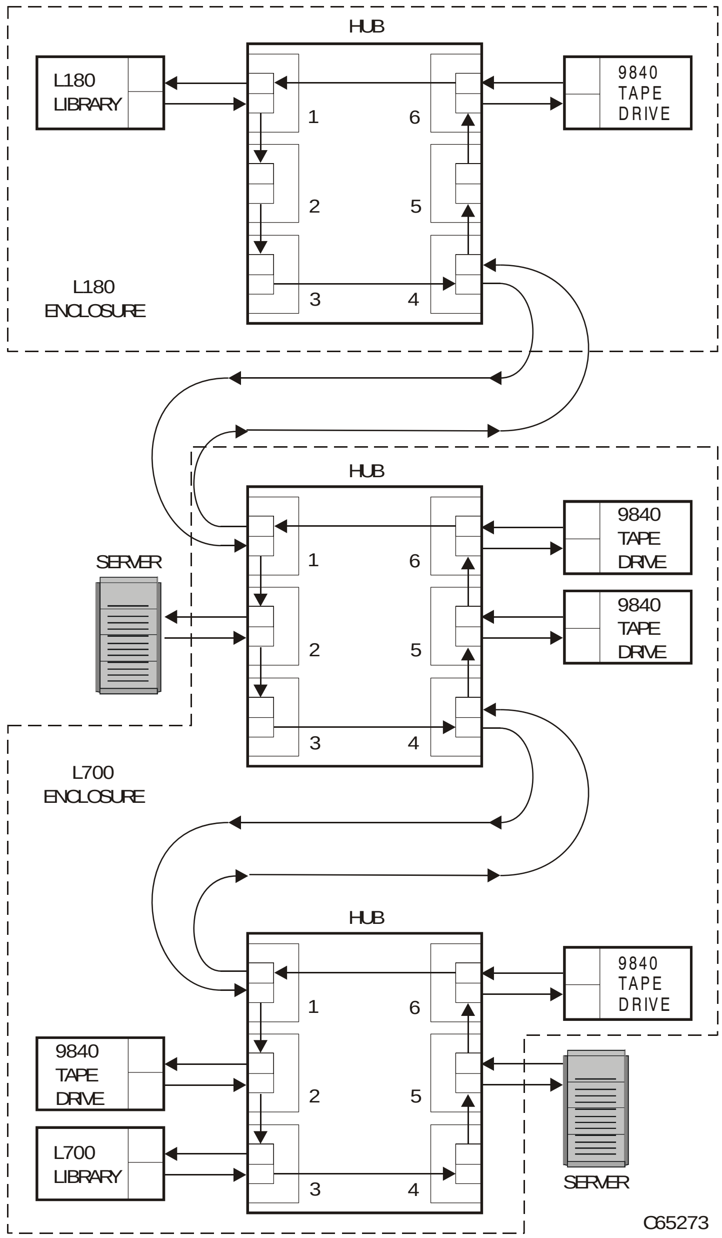
Note: Refer to the hub manufacturer's requirements for cascading, the following are just general guidelines.

- Note that the length of the cable affects the number of allowable ports.
- Note that the hub adds length to the cabling in the network. (See“Cable Guidelines for Hubs” on page 4-9.)
- Use ports 1 and 4 to cascade to other hubs. This increases the potential of dual port devices and redundant paths.
- Do not exceed the maximum number of hubs per cascade link.

  The maximum number of hubs before retiming is six (6) with short cables, two (2) with maximum length cascade cables.
- Configure the loop so the devices are properly positioned in relation to the hub.

Figure 4-2 on page 4-5 is an example of cascading hubs.

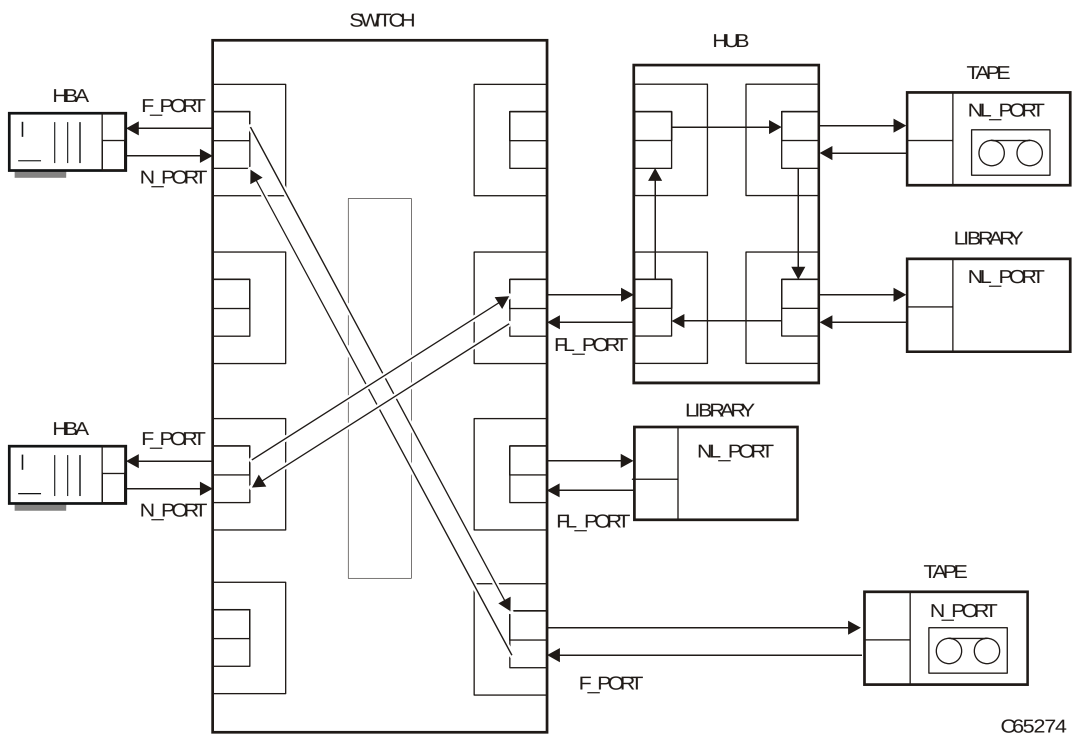
Figure 4-2. Cascading Hubs (C65273)



Loop with a Switch and a Hub

A public arbitrated loop can include a hub that is attached to a fabric element, in this case a switch (see Figure 4-3).

Figure 4-3. A Loop with a Hub Attached to a Switch (C65274)



Direct Fabric Attachment

The advantage of attaching a library to a fabric is that the fabric can aid the library's communication with a variety of devices. A fabric element might:

- Attach N*_Ports with different media types, media rates, or classes of service
- Attach arbitrated loops
- Serve as a root element for distributed fabric elements

A fabric element might support different:

- Port types
- Classes of service
- Media types
- Media rates
- Address assignment methods
- Frame routing techniques

After a frame leaves the source N*_Port and enters the fabric, each fabric element selects the next link toward the destination N*_Port. Usually the path includes two links between the source N*_Port and the destination N*_Port.

Cables and Connectors

Because the link to a port can be driven either optically or electrically, the term "fibre" in Fibre Channel refers to either a fiber optic or a copper cable.

- Optical transmission occurs over both single and multi–mode fibers using both laser and light emitting diodes (LEDs) for both short (770–850 nm) and long (1300–1360 nm) wavelengths.
- Electrical transmissions occur over video coax, miniature coax, twin coax (Twin Ax), or twisted pair.

Note: The two types of links, either fiber optic and/or copper, can be integrated into a single network, as long as there is a switch, hub, or other type of converter present.

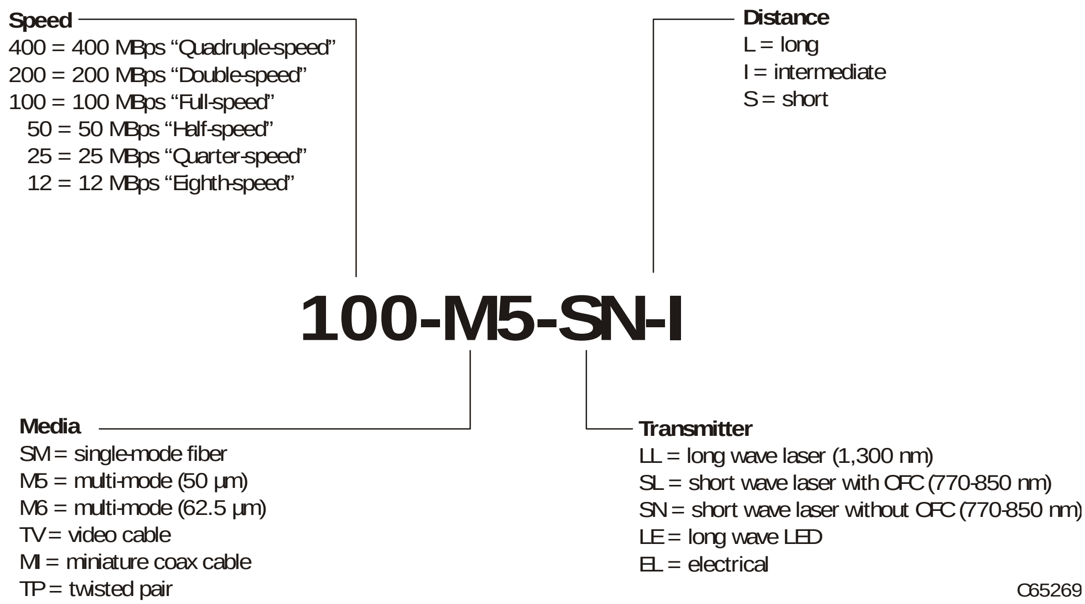
Table 4-1 lists the cable and connector specifications that the libraries support. See Figure 4-4 on page 4-8 for a description of the FC-0 code information. See Table 4-2 on page 4-9 for a list of cables that are available from Sun StorageTek.

Table 4-1. Sun StorageTek Library Cables and Connectors

Distance		FC-0 Code (see note)	Cable	Type	Connector
Meters	Feet				
2-150	6.5-490	200-M6-SN-1	62.5 µm Multimode	780 nm Shortwave laser w/o OFC	Keyed Duplex LC
2–300	6.5–985	100-M6-SN-I	62.5 µm Multimode	Shortwave laser w/o OFC	Keyed Duplex SC
2–500	6.5–1640	100-M5-SN-I	50 µm Multimode	Shortwave laser w/o OFC	Keyed Duplex SC

Note: See Figure 4-4 on page 4-8 for a description of the FC-0 code information. See Table 4-2 on page 4-9 for specific part numbers.

Figure 4-4. FC-0 Level Communication about Media (Cables) (C65269)



Cable Part Numbers

Part numbers and descriptions for Sun StorageTek Fibre Channel cables are listed in the table below. According to Figure 4-4 on page 4-8, these cables would prompt the following FC-0 media information: 100-M5-SN-I.

Table 4-2. Fiber-Optic Cables: 50 µm Multimode, SC-to-SC Connectors

Description—Plenum rated	Part Number
5 m (16.4 ft)	10800123
20 m (65.6 ft)	10800125
50 m (164 ft)	10800127
100 m (328.1 ft)	10800128
250 m (820.2 ft)	10800129
500 m (1640.4 ft)	10800130
Note: Plenum-rated cables can withstand higher temperatures and can be used for both under-floor and riser applications.	

Cable Guidelines for Hubs

Guidelines for cable lengths to a hub (per cascade) include:

- Minimum cable length is 2 m (6.5 ft)
- Maximum cable length depends on the type of connection:
  - Copper = 10 m (32.8 ft) intra cabinet
  - Copper = 30 m (98.4 ft) inter cabinet
  - Short-wave fiber optics = 500 m (1,640 ft)
  - Long-wave fiber optics = 10 kilometers (6.2 miles)

Giga-bit Interface Converters

Sun StorageTek hubs use Giga-bit Interface Converters (GBIC) to provide the physical connection to the libraries and drives. The GBICs are available with high speed serial data connectors (HSSDC), 9-pin shielded "D" connectors (DB9), shortwave non-OFC, and longwave laser connections.

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Fibre Channel Operations

5

This chapter describes how Sun StorageTek's L700, L700e and L180 libraries operate using Fibre Channel (FC).

Fibre Channel Levels

Transmission over Fibre Channel involves five levels. The following table shows the layering of the Fibre Channel levels. It also shows special FC-AL implementation requirements.

Table 5-1. Fibre Channel Levels

Levels/ Standard	Function
FC-4	**Upper Level Protocol Mapping** Mapping of ULP functions and constructs
FC-3	**Common Services**
FC-2	**Link Service** • Login and Logout services • Basic Link and Extended Link services
	Signaling Protocol • Frames, sequences, and exchanges • N_Ports, F_Ports, and topologies • Classes of Service (1, 2, and 3) • Buffer-to-buffer/end-to-end flow control
FC-AL	**Arbitrated Loop Functions** • Ordered sets for loop arbitration • Loop initialization • Physical address assignments
FC-1	**Transmission Protocol** • Encoding and decoding • Link management • Error monitoring

Table 5-1. Fibre Channel Levels (Continued)

Levels/ Standard	Function
FC-0	**Physical Interface** • Transmitters, receivers, and bandwidth
	Media • Cables and connectors

The remaining sections of this chapter explain how these levels work. The "Terms/ Definitions" section defines the abbreviations that are used throughout the chapter.

Terms/Definitions

Tables throughout this chapter use the following terms to show compliance with ANSI's Fibre Channel Tape (FC–Tape) Technical Report and to show Sun StorageTek's implementation.

FC–Tape Terms

Allowed (A): Can be used between an initiator and a target (library or tape drive). This status is typically dependent on the particular feature or parameter and its applicability to the request from an initiator.

Invokable (I): Can be used between an initiator and a target. For example, if a feature is invoked, the recipient must implement and respond to the feature or parameter.

Prohibited (P): Can *not* be used between an initiator and a target.

Required (R): *Must* be used between an initiator and a target. Both the initiator and target must implement the feature or parameter.

Dash (–): This parameter is not meaningful.

Blank ( ): The feature is not part of the feature set.

Initiator: SCSI device that originates commands.

Target: SCSI device that receives commands.

Sun StorageTek Terms

Yes (Y): Sun StorageTek's library conforms to that command, feature, or value.

No (N): Sun StorageTek's library does *not* conform to that command, feature, or value.

Originate (Orig.): Originates the exchange or SCSI command from the library.

Response (Resp.): Returns an acknowledgement (R_RDY and/or data) from the library.

Transmission Word: A four-byte character containing 32 bits of information. This is the smallest information unit transmitted on Fibre Channel. See the following table.

Word	Byte 0		Byte 1		Byte 2		Byte 3	
n	(MSB)			Bits				(LSB)
	31	24	23	16	15	8	7	**0**

Error Detection and Management Overview

In the Fibre Channel protocol, error detection falls into two categories: frame errors and link-level errors.

- Frame errors result in missing or corrupted frames, which may ultimately involve the SCSI protocol level to resolve.
- Link-level errors include errors such as loss of signal, loss of synchronization, and timeouts.

Some protocols provide for error detection and management by using timeouts, which is an inefficient mechanism to detect and recover from frame transmission errors.

A problem with Class 3 operation (currently the only FC-2 Service Class supported) is that it offers no confirmation of frame delivery. However, the originator can deduce some delivery of frames from:

- Successfully receiving a command when:
  - FCP Transfer Ready was sent by the command recipient
  - A response was received

Fibre Channel provides no error correction on data during transfers, but it does provide excellent error detection schemes, including:

- 8B/10B encoding and decoding (see “8B/10B Encoding and Decoding” on page 5-5)
- Disparity (see “Disparity” on page 5-5)
- Sequence errors and out-of-order delivery (see “Sequence Errors” on page 5-26)
- Cyclic redundancy checks (CRC) (see “CRC” on page 5-26)

FC-0 Features

The FC-0 level defines the physical level of the Fibre Channel protocol. This includes media types, connectors, and the optical characteristics that are necessary for connecting ports.

FC-0 and Initialization

A minimum level of initialization occurs at the FC-0 level. When the library is powered on, this level assures that the links are active and initializes any shortwave laser transmitters. (Longwave laser transmitters and all receivers are ready immediately.) The level conveys any loss of signal state to the FC-1 level, which reports it to the FC-2 level.

Device States (FC-0, FC-1, FC-2)

The following sections describe the relationships between library states and port states and between library states and incoming commands. Communication about device states involves the FC-0, FC-1 and FC-2 levels.

Power Up

When the library completes the power-on process, both of the Fibre Channel ports will be enabled and will attempt to initialize on the atached Fibre Channel topology.

When the library completes the power-on initialization process, the library (LUN=0) will transition from offline to online and be capable of media changer operations.

Not Ready

Commands like “Inquiry” that do not require the library to be online will still execute normally.

All other commands that require the library to be online will get a Check Condition status. The Sense Key will be 5. The ASC/ASCQ will be 2500h.

Ready

All available commands may now be executed with the library.

Power Down

CAUTION:
Potential loss of data: **When an operator powers down the library, operations on these ports and/or other ports on the loop might be adversely affected.**

In the process of powering down the library, the Fibre Channel Protocol chips will lose power. If the library is connected to a hub or switch, the hub/switch bypass will be activated. The library has no port bypass capability.

FC-1 Features

The FC-1 level of the Fibre Channel protocol defines the transmission protocol. This level includes the 8B/10B encoding/decoding scheme, word order transmission, and error detection.

FC-1 and Initialization

During initialization, the FC-1 level provides an encoded bit stream (primitive sequence) to the FC-0 level. When the FC-1 level, in turn, receives a proper bit stream, the FC-1 level converts the stream into a form used by the FC-2 level. The process achieves synchronization for both transmission characters and transmission words.

8B/10B Encoding and Decoding

Fibre Channel uses a special process called encoding and decoding that is designed to reduce distortion during transmission and to aid in the detection of errors at the receiving port. This process makes it highly likely that single and multiple bit errors are detected.

In addition to providing error detection, this process also balances the turning on and off of the light for the loading of the optical fiber transmitters.

The process of encoding uses an algorithm that takes the original 8 bits in each byte and transforms them into 10 bits for transmission. The result is an 8B/10B encoding of a byte which is referred to as a “transmission character.”

Disparity

Along with the 8B/10B encoding, Fibre Channel uses another scheme to protect transmission characters and aid in error detection: running disparity. Running disparity adds a second dimension to the transmission of characters. This dimension provides a balance of ones and zeros, which helps protect transmission characters and controls the heat output of the transmitter.

A negative running disparity is maintained following the transmission of the end-of-frame (EOF) delimiter. It remains negative until the transmission of the next start-of-frame delimiter.

Because the running disparity within a frame is variable, two different EOF delimiters are used (see Table 5-2 on page 5-6), depending on the content of the frame following the transmission of the CRC (see “CRC” on page 5-26).

Table 5-2. End of Frame Delimiters

Delimiter	Abbreviation	RD	Transmission Word Characters			
EOF Normal	EOFn	Neg.	K28.5	D21.4	D21.6	D21.6
		Pos.	K28.5	D21.5	D21.6	D21.6
EOF Terminate	EOFt	Neg.	K28.5	D21.4	D21.3	D12.3
		Pos.	K28.5	D21.5	D21.3	D21.3
EOF Abort	EOFa	Neg.	K28.5	D21.4	D21.7	D21.7
		Pos.	K28.5	D21.5	D21.7	D21.7

Table 5-2. End of Frame Delimiters (Continued)

Delimiter	Abbreviation	RD	Transmission Word Characters			
EOF Normal Invalid	EOFni	Neg.	K28.5	D10.4	D21.6	D21.6
		Pos.	K28.5	D10.5	D21.6	D21.6

FC-AL Features

Initialization and other processes take on special attributes and functions in an arbitrated loop topology. The following sections explain these attributes and functions as specified in the Fibre Channel Arbitrated Loop (FC-AL) specification.

Initialization

Arbitrated loop initialization protocol assigns up to a possible 126 addresses to different ports on the loop and builds a map of these addresses. The following sections describe some loop initialization features that Sun StorageTek libraries perform.

Loop initialization must occur before operations on the loop can begin. The Loop Initialization Primitive (LIP) sequence is a series of initialization frames that establish NL_Ports on the loop.

Any NL_Port on the loop is capable of starting an initialization sequence by transmitting LIP. When the next NL_Port detects the LIP sequence, it retransmits it to the next NL_Port until the LIP sequence travels around the loop to the NL_Port initiating the sequence. During loop initialization, NL_Port addresses (AL_PA) are assigned (00h to EFh).

NL_Port addresses (AL_PA) can be either hard (hardware assigned) or soft (system assigned) during loop initialization.

An NL_Port attempts to establish its previous acquired address before attempting to acquire another address. This occurs when the NL_Port is powered on, experiences a power-on reset, recognizes a LIP (AL_PD or AL_PS), or experiences any other event that causes the NL_Port to lose communications.

Note: Sun StorageTek's libraries may use a hard-assigned address (entered through the operator panel or with the Horizon Library Monitor) and attempt to assign that address during loop initialization. If unable to obtain that address, the libraries accept soft addresses by the system.

Address Processes

Initialization involves address acquisition as described in the following sections.

Arbitrated Loop Physical Address

When an NL_Port enters the loop (such as a power-on), it begins initialization to acquire an address and to notify other ports there is a change in configuration.

Note: If there is an exchange in process when a LIP begins, that exchange is disrupted and possible frame corruption could occur, which would result in an Upper Level Protocol timeout.

- If the NL_Port does *not* have a valid address, it begins the initialization sequence with LIP(F7,F7).
- If the NL_Port has a valid address, it begins initialization with LIP (F7,AL_PS).

Loop Initialization Fabric Assigned Address

Sun StorageTek libraries support the process of Loop Initialization Fabric Assigned (LIFA) addresses. This process is supported when the library is operating in Public Loop mode.

Loop Initialization Previously Acquired

Sun StorageTek libraries support the process of Loop Initialization Previously Acquired (LIPA) addresses. This process is supported when the library has previously acquired an address.

Loop Initialization Hard Assigned

Sun StorageTek libraries support the process of Loop Initialization Hard Assigned (LIHA) addresses. This process is supported when the library is first powered-on and a configuration parameter enables it.

Loop Initialization Soft Assigned

Sun StorageTek libraries support the process of Loop Initialization Soft Assigned (LISA) addresses. This process is supported when the hard-assigned address has been used by a different device or the hard-assigned addressing is disabled.

Failure to Obtain a Loop Address

If an NL_Port is unable to obtain an address (fabric assigned, previously assigned, hard assigned, or soft assigned), it goes into a non-participating mode and immediately implicitly logs out all NL_Ports.

If an NL_Port experiences a power-on reset or recognizes a LIP(AL_PD,AL_PS), it is not required to retain a previously acquired address to use during the next loop initialization.

Open State/Loop Initialization

The open initializing (OPEN-INIT) state performs the process of loop initialization. When ports are in this state, initialization frames are transmitted and received to identify the temporary loop master and to assign AL_PA values. Entering this state assumes the loop is operational and sets the Available BB_Credit equal to zero. (See “Login_BB_Credit Equals Zero” on page 5-11.)

Related Processes

The following processes might occur during initialization.

Loop Initialization Select Master

Sun StorageTek libraries support the process of selecting a Loop Initialization Select Master (LISM) by using the device with the lowest port address.

Note: If an FL_Port (fabric loop attachment) is present, it assumes the role of LISM.

Loop Initialization Report Position

Sun StorageTek libraries support the mapping process to build a map of the AL_PA values according to the library's position on the loop. The temporary loop master begins the procedure to create a Loop Initialization Report (LIRP).

This initialization report and map is done by using a 1-word frame identifier with an offset value of one (1). As the frame is transmitted around the loop, the next NL_Port increments the offset by a value of one and stores the information in the AL_PA map.

Selective Reset

Selective resets perform a reset on the receiving port. These resets are helpful for error recovery or reconfiguration of the loop. Any NL_Port that uses a selective reset transmits a LIP(AL_PD,AL_PS). Refer to Table 5-26 on page 5-42 for clearing effects.

- AL_PD field contains the address of the port being reset
- AL_PS contains the address of the port issuing the reset

Loop Failures

A loop failure is any of the following:

- A loss of signal
- A loss of synchronization for longer than R_T_TOV (For more information on R_T_TOV, see "Timers" on page 5-26.)

If a Loop Failure occurs, the L_Port that detects the failure issues a LIP(F8,AL_PS) if it has a valid AL_PA, or LIP(F8,F7) if it does not.

Loop Initialization Loop Position

Sun StorageTek libraries support the process of Loop Initialization Loop Position (LILP) by retransmitting this sequence when required.

Completion Processes

The following processes occur after loop initialization.

Private Loop Initialization Completion

At this point in loop initialization, a private loop library has completed initialization. It has acquired a private loop address of 00 00 xx. The xx is its assigned AL_PA.

The library now waits for initiators—on this loop only—to complete a Port Login (PLOGI), to complete a Process Login (PRLI), and then to start executing commands.

Public Loop Initialization Completion

At this point in initialization, the public loop library has acquired a loop address of 00 00 xx , where xx is its assigned AL_PA.

Next, the library will attempt a Fabric Login (FLOGI) with the loop FL_Port. If the login is not successful, the library will revert back to private loop operation (see “Private Loop Initialization Completion”).

With the successful completion of the FLOGI, the library has now acquired its public loop address: DD AA xx. DD is the fabric domain; AA is the fabric area; and xx is the AL_PA.

The library then attempts to Port Login (PLOGI) with the fabric directory server to register with an RFC-4 request with the name service.

The library now waits for initiators—on either this loop or fabric attached—to complete a Port Login (PLOGI), to complete a Process Login (PRLI), and then to start executing tape commands.

Feature Set

Sun StorageTek's libraries implement the following FC-AL feature set:

Table 5-3. FC-AL Feature Set

Feature	FC-TAPE		STK	Notes
	Initiator	Target		
Attempt to acquire Hard Address during LIHA sequence of loop initialization following loss of power, power-on reset, or recognition of LIP (AL_PD or AL_PS)	R	R	Y	4
LILP/LIRP:				
Loop Master can originate	R	R	Y	
Non-loop Master L_Ports accept	R	R	Y	
Login_BB_Credit:				
Advertise Login_BB_Credit = 0	A	A	Y	
Advertise Login_BB_Credit > 0	A	A	N	
Accept Login_BB_Credit = 0	R	R	Y	
Accept Login_BB_Credit > 0	R	R	Y	1
LPEyx/LPByx/LPEfx (origination)	A	P	N	2
MRKtx (origination)	P	P	N	3
Open Full Duplex - OPN(yx):				
Open Originator can send	I	I	N	
Open Recipient accepts	R	R	Y	5
Open Half Duplex - OPN(yy):				
Open Originator can send	I	I	Y	
Open Recipient accepts	R	R	Y	
Open Multicast/Selective Replicate OPN(yr), OPN(fr):				
Open Originator	P	P	N	

Table 5-3. FC-AL Feature Set (Continued)

Feature	FC-TAPE		STK	Notes
	Initiator	Target		

Notes:

1. The actual value is between 0 and the LOGIN_BB_Credit.
2. LPEfx is useful for resetting bypass circuits of NL_Ports that have lost their address.
3. Any NL_Port receiving an MRK attempts to forward it, STK does not originate it.
4. This feature is user-configured. The default setting is “Disabled.”
5. Our target will accept the Open Full Duplex, but the FCP simplex protocol does not take advantage of the full duplex capabilities.

Login_BB_Credit Equals Zero

Sun StorageTek libraries advertise Login_BB_Credit =0. When Login_BB_Credit=0 at the other L_Port, the following rules apply:

- The OPN originator must receive R_RDYs (receiver readys) from the library before transmitting a frame.
- The OPNed responder transmits R_RDYs for the number of buffers available to receive frames.

Note:

1. Sun StorageTek libraries respond with two to four R_RDYs on an OPN.
2. OPN Originators open as either *full* or *half* duplex, regardless of the value of the Login_BB_Credit.

Open and Close Latencies

When Login_BB_Credit=0, a latency exists while before the libraries respond with two (2) R_RDYs. This exists for every OPN before frame transmission can begin.

Some NL_Ports reduce CLS latency in another way:

To prevent buffer overruns, a CLS recipient is only required to have maximum Login_BB_Credit, granted to any L_Port buffers, available before receiving the next OPN.

■ Fabric F_PORT Attachment Initialization

In the absence of a loop environment, Sun StorageTek tape libraries will attempt to initialize with a fabric. This is accomplished by doing a Fabric Login (FLOGI). The FLOGI process will be attempted in each class of service that the library supports.

Once the FLOGI process is successful the library will attempt to login (PLOGI) with the fabric attached name server, if it exists. This process allows the device to register its presence with the name server such that other initiators may query the name server to find target tape libraries to use.

The library now waits for initiators on the fabric to complete a Port Login (PLOGI), a Process Login (PRLI), and then to start executing commands.

FC-2 Features

The FC-2 level provides the signaling protocol and specifies the rules and requirements to transfer blocks of data.

The FC-2 level is the most complex level in Fibre Channel protocol and provides the different classes of service, packetizing, sequencing, error detection, and reassembling the transmitted data.

Login Validation

After initialization is complete, a Sun StorageTek library communicates its ID for login validation. This ID is an IEEE-registered 64-byte identifier. The device identification page (36 bytes) of the Inquiry command indicates the vendor-specific portion of this ID. The vendor-specific portion of the ID includes the library's Port name, Node name, and N_Port ID. This information is unique for each Fibre Channel card in each library.

The remaining 28 bytes of the library's ID consist of:

- 5h (a Name Address Authority)
- 00104Fh (Sun StorageTek's company ID)

The following table shows the IEEE-registered format for the full 64-byte identification scheme. The format includes the Name Address Authority (NAA), company ID, and vendor-specific identifier.

Table 5-4. Library Identification Scheme

Most Significant Byte			**Least Significant Byte**
63 60	59 36	35	00
NAA	IEEE Company ID	Vendor Specific Identifier	
5h	00 10 4Fh	(assigned per FC board)	

Note: You can view this ID through the "Lib Fibre I/F Config Menu." See the library's operator's guide for instructions on accessing this menu.

Every device on the loop must have a unique ID for login validation.

All ports validate the logins by comparing Port Name, Node Name, and N_Port ID. All three identifiers must match or this indicates the configuration has changed and requires a Logout (LOGO).

A LOGO terminates all open exchanges between SCSI initiator and target.

Class of Service Parameters

Fibre Channel provides several different strategies to ensure reliable communications between devices. These strategies are called Classes of Service. The libraries support the Class 3 level of service which provides no notification of frame delivery or non-delivery. This class of service reduces the number of frames (traffic) on the loop.

The start-of-frame (SOF) delimiter specifies the type of service used for each frame during communications.

Table 5-5 indicates the two types of delimiters for Class 3 operations:

Table 5-5. Start of Frame Delimiters, Class 3

Delimiter	Abbreviation	Transmission Word Characters			
SOF Initiate Class 3	SOFi3	K28.5	D21.5	D22.2	D22.2
SOF Normal Class 3	SOFn3	K28.5	D21.5	D22.1	D22.1

Note: Intermixing different classes of service is not supported.

The libraries adhere to a set of operating characteristics that ensure inter-operability and reliability within a Class 3 loop environment are maintained. Table 5-6 on page 5-13 and Table 5-7 on page 5-15 list Class 3 Service Parameters supported.

Class 3 Service Parameters, Port Login

Table 5-6 lists Class 3 Service Parameters the libraries support for Port Login (PLOGI):

Table 5-6. Class 3 Service Parameters, Port Login

Parameters	Word	Bits	Value	FC-Tape
Class validity	0	31	1	1
Service Options:	0	30–16		
Intermix Mode	0	30	0	–
Stacked Connect Requests	0	29–28	00	–
Sequential Delivery	0	27	0	–
Dedicated Simplex	0	26	0	–
Camp-On	0	25	0	–
Buffered Class 1	0	24	0	–

Table 5-6. Class 3 Service Parameters, Port Login (Continued)

Parameters	Word	Bits	Value	FC-Tape
Priority	0	23	0	–
Initiator Control:	0	15–0		
Sequence Initiator X_ID reassignment	0	15–14	00	–
Initial Responder Process_Associator	0	13–12	00	00
Sequence Initiator ACK_0 capable	0	11	0	–
Sequence Initiator ACK_N Capable	0	10	0	–
ACK generation assistance	0	9	0	–
Initiator Data compression capable	0	8	0	0
Initiator Data compression history buffer size = 00b	0	7–6	00	–
Data Encryption Capable	0	5	0	0
Clock Synchronization Capable	0	4	0	P
Recipient Control:	1	31–16		
ACK_0 Capable	1	31	0	–
ACK_N Capable	1	30	0	–
X_ID Interlock	1	29	0	–
Error Policy Supported	1	28–27	01	01
Categories per sequence	1	25–24	00	00
Data compression capable	1	23	0	0
Data compression history buffer size	1	22–21	00	–
Data decryption capable	1	20	0	0
Clock synchronization capable	1	19	0	A
Reserved – fabric-specific	1	18–16	000	0
Receive data field size	1	15–0	0800h	256
Concurrent Sequences > 0	2	31–16	00FFh	1
N_Port End-to-end Credit	2	14–0	0000h	–
Open Sequences per Exchange > 0	3	31–16	0001h	1
Class 6 Multicast RX_ID	3	15–0	0000h	–

Class 3 Service Parameters, Fabric Login

Table 5-7 lists Class 3 Service Parameters the libraries support for Fabric Login (FLOGI):

Table 5-7. Class 3 Service Parameters, Fabric Login

Parameters	Word	Bits	Value	FC-Tape
Class validity	0	31	1	1
Service Options:				
Intermix Mode	0	30	0	–
Stacked Connect Requests	0	29–28	00	–
Sequential Delivery	0	27	1	1
Dedicated Simplex	0	26	0	–
Camp-On	0	25	0	–
Buffered Class 1	0	24	0	–
Reserved	0	23	0	–
Initiator Control:				
Reserved	0	15–0	0000h	–
Recipient Control:				
Reserved	1	31–16	0000h	–
Receive data field size (min, see note)	1	15–0	0800h	256
Concurrent Sequences (min)	2	31–16	00FFh	–
N_Port End-to-end Credit	2	14–0	0000h	–
Open Sequences per Exchange (min)	3	31–16	01	–
Reserved	3	15-0	0000h	–
Note: This is controlled by a configuration item.				

Other Signalling Formats and Controls

Table 5-8 lists other FC-2 features supported by the libraries:

Table 5-8. Other FC-2 Features

Feature	FC-Tape		STK
	Initiator	Target	
Addressing Scheme: (see note)			
Node Name Format (registered format)	R	R	Y
Port Name Format (registered format)	R	R	Y
Frame Control (F_CTL):			
Continue Sequence Condition	R	R	00
Continuously increasing sequence count during consecutive sequences within an Exchange	R	R	Y
Ignore non zero Continue Sequence values	A	A	Y
Sequence Chaining (C_S bit in F_CTL = 0)	R	R	Y
Optional Headers (all)	P	P	N
Routing Control (R_CTL):			
FC-4 Device_Data frame	R	R	0000
Extended Link_Data frame	R	R	0010
FC-4 Link_Data Frame	R	R	0011
Video_Data Frame	P	P	0100
Basic Link_Data frame	R	R	1000
Link_Control frame			
Class 2	R	R	1100
Class 3	P	P	1100
X_ID Interlock	–	–	N
Note: Node name and Port name are *not* identical.			

Link Service Commands

Fibre Channel uses link service commands to manage functions such as port management, Login, Logout, and abort operations. The libraries support both basic and extended link service commands to perform these operations.

Basic Commands

Table 5-9 lists the Basic Link Service commands:

Table 5-9. Basic Link Services

Command	FC-TAPE			STK	
	From Initiator	Target Response	From Target	Lib Orig.	Lib Resp.
No Operation (NOP)	P	–	P	–	N
Abort Sequence (ABTS)	I	R	A	Y	Y
Basic Accept (BA_ACC)	A		R	–	Y
Basic Reject (BA_RJT)	A		R	–	Y
Dedicated Connection Preempted (PRMT)	P	–	P	–	N
Remove Connection (RMC) Class 1	P	–	P	–	N

Extended Commands

Table 5-10 lists the Extended Link Service commands:

Note: If the library receives a request for Extended Link Services that are not supported, the library returns a Link Services Command Reject (LS_RJT) with a reason code of “Command Not Supported”.

Table 5-10. Extended Link Services

Command	FC-TAPE				STK	
	From Initiator	Target Response	From Target	Initiator Response	Lib Orig.	Lib Resp.
Abort Exchange (ABTX)	P		P		N	–
Accept (ACC)	A		R		Y	Y
Advise Credit (ADVC)	P		P		N	–
Discover Address (ADISC)	I	R	P		N	Y
Discover F_Port Parameters (FDISC)	I		I		N	–

Table 5-10. Extended Link Services (Continued)

Command	FC-TAPE				STK	
	From Initiator	**Target Response**	**From Target**	**Initiator Response**	**Lib Orig.**	**Lib Resp.**
Discover N_Port Parameters (PDISC)	I	R	P		–	Y
Echo	P		P		N	–
Establish Streaming (ESTS)	P		P		N	–
Estimate Credit (ESTC)	P		P		N	–
Fabric Activate Alias_ID (FACT)	P		P		N	–
Fabric Address Notification (FAN)	P	P	P	P	N	–
Fabric Deactivate Alias_ID (FDACT)	P		P		N	–
Fabric Login (FLOGI)	R	P	R	P	Y	–
Get Alias_ID (GAID)	P		P		N	–
Link Service Reject (LS__RJT)	A		R		Y	Y
Logout (LOGO)	R	R	R	R	Y	Y
Loop Initialize (LINIT)	I		P		N	Y
Loop Port Control (LPC)	I		P		N	N
Loop Status (LSTS)	I		P		N	N
N_Port Activate Alias_ID (NACT)	P		P		N	–
N_Port Deactivate Alias_ID (NDACT)	P		P		N	–
N_Port Login (PLOGI)	R	R	P		N	Y
Process Login: (PRLI)	R	R	P		N	Y
PRLI Common Service Parameters	P	–	P		N	N
Single Service Parameter page per request	R	R	P		N	Y

Table 5-10. Extended Link Services (Continued)

Command	FC-TAPE				STK	
	From Initiator	Target Response	From Target	Initiator Response	Lib Orig.	Lib Resp.
Multiple Service Parameter pages per request	P	–	P		N	N
ACC contains only those pages specified	–	R	P		N	Y
Accept Response code of Command executed	–	R	P		N	Y
Process Logout (PRLO)	I	R	I	R	Y	Y
Quality of Service Request (QoSR)	P		P		N	–
Read Connection Status Block (RCS)	P		P		N	–
Read Exchange Concise (REC)	I	R	P		N	Y
Read Exchange Status Block (RES)	P		P		N	–
Read Link Error Status Block (RLS)	I	R	P		N	Y
Request Sequence Initiative (RSI)	A	A	A	A	TBD	TBD
Read Sequence Status Block (RSS)	A	A	A	A	TBD	TBD
Read Timeout Value (RTV)	P		P		N	–
Read VC Status (RVCS)	P		P		N	–
Reinstate Recovery Qualifier (RRQ)	I	R	I	R	Y	Y
Registered State Change Notification (RSCN)	I	R	I	R	N	Y
Report Node Capabilities (RNC)	I	R	P		N	Y
State Change Notification (SCN)	P		P		N	–

Table 5-10. Extended Link Services (Continued)

Command	FC-TAPE				STK	
	From Initiator	Target Response	From Target	Initiator Response	Lib Orig.	Lib Resp.
State Change Registration (SCR)	I	P	I	P	N	N
Test	P		P		N	–
Test Process Login State	P		P		N	–
Third Party Process Logout (TPRLO)	I	R	P		N	Y

Responses to Link Services

Table 5-11 summarizes responses generated by the libraries when receiving different Link Service requests when the library NL_Port is not currently logged in with the sending NL_Port.

Table 5-11. Responses to Link Services from NL_Ports Not Logged-In

Frame Received	NL_Port Not Logged In	NL_Port Logged In	Notes
ABTS	Discard and send LOGO	BA_ACC, BA_RJT	2
ADISC	Discard and send LOGO	ACC and LS_RJT	1
FAN	Process the ELS request, no response required	Process the ELS request, no response required.	
LOGO	ACC	ACC	
PDISC	Discard and send LOGO	ACC and LS_RJT	1
PLOGI	ACC, LS_RJT	ACC	
PRLI	Discard and send LOGO	ACC	
PRLO	Discard and send LOGO	ACC and LS_RJT	3
RSCN	Process the ELS request, no response required.	Process the ELS request, no response required.	
Other Link Services	Discard and send LOGO	ACC and LS_RJT	

Table 5-11. Responses to Link Services from NL_Ports Not Logged-In (Continued)

Frame Received	NL_Port Not Logged In	NL_Port Logged In	Notes

Notes:

1. All three identifiers must match at login for Accepts (ACC) to be returned:
   - N_Port ID,
   - Port Name, and
   - Node Name

   If all three identifiers do not match, return a logout (LOGO).

   If other conditions prevent execution of the ADISC or PDICS ELS, return a reject (LS_RJT) with the appropriate reason code.
2. BA_ACC if valid RX_ID else BA_RJT
3. If PRLI has not been successfully completed, set the reason code to "Image Pair Does Not Exist."

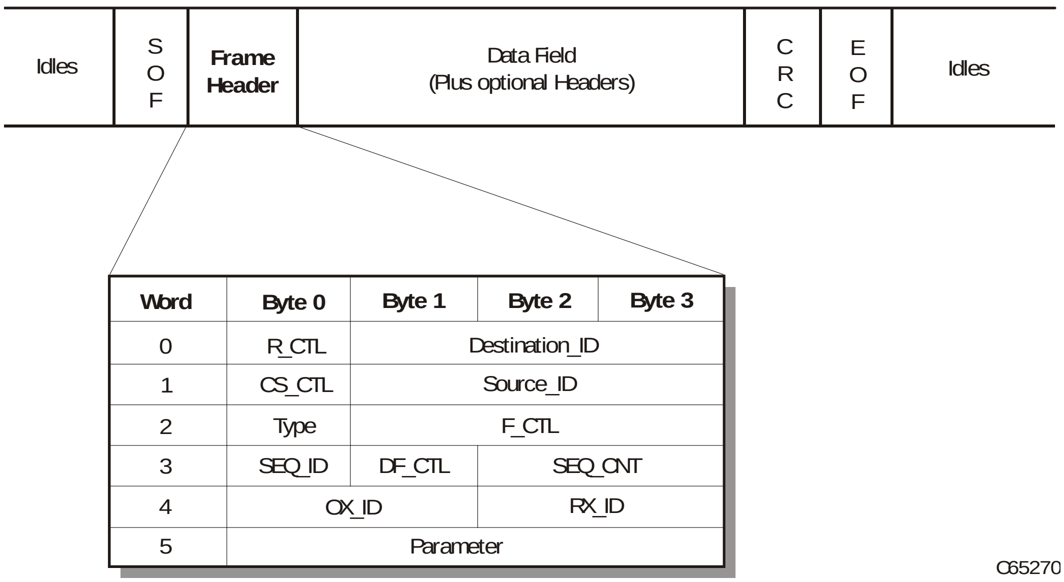
Table 5-12. FC-4 Link Services

Command	FC-TAPE				STK	
	From Initiator	Target Response	From Target	Initiator Response	Lib Orig.	Lib Resp.
Sequence Retransmission Request (SRR)	I	R	P		N	Y

Frame Format and Header

Figure 5-1 shows the frame format for transmission of data and commands over Fibre Channel.

Figure 5-1. Frame and Frame Header Format (C65270)



Word	Byte 0	Byte 1	Byte 2	Byte 3
0	R_CTL	Destination_ID		
1	CS_CTL	Source_ID		
2	Type	F_CTL		
3	SEQ_ID	DF_CTL	SEQ_CNT	
4	OX_ID		RX_ID	
5	Parameter			

R_CTL	Routing Control: Indicates the type of frame functions
Destination ID	Identifies the port destination
CS_CTL	Class specific control field
Source ID	Identifies the source
Type	Indicates the data structure
F_CTL	Frame Control: Controls information within the frame
SEQ_ID	Sequence Identifier: Identifies sequences within an exchange
DF_CTL	Data Field Control: Indicates optional headers
SEQ_CNT	Sequence Count: Contains frame number within exchange
OX_ID	Originator Exchange ID: Identifies originator of exchange
RX_ID	Responder Exchange ID: Identifies responder of exchange
Parameter	Contains unique parameters for exchange

Exchange Management

Exchange (X) management is the overall control of operations over the Fibre Channel interface between the originator and responder.

Refer to the FC–PH documents for rules and guidelines pertaining to Class 2 operation.

Note: For FCP, an exchange is a ***single*** SCSI command.

There are two fields in the frame header dealing with exchanges:

- OX_ID = Exchange originator
- RX_ID = Exchange responder

Table 5-13. Exchange Content Header

Word	Byte 0	Byte 1	Byte 2	Byte 3
0	R_CTL	Destination_ID		
1	CS_CTL	Source_ID		
2	Type	F_CTL		
3	SEQ_ID	DF_CTL	SEQ_CNT	
4	**OX_ID**		**RX_ID**	
5	Parameter			

Exchange Originator

The exchange originator assigns a unique OX_ID to the exchange for the transmission of in-order delivery of frames and assumes the frames are processed in the order received. The exchange is open from the time the first frame is sent until one of the following occurs:

- Timeout
- The exchange is aborted (ABTS or ABTX)
- An end-of-frame (EOF) delimiter is sent with the last sequence bit set
- A Logout (LOGO) is sent to or received from the Exchange responder
- A Link Service Command Reject (LS_RJT) is sent in response to an ADISC or PDISC during target discovery
- A PLOGI is sent to the Exchange responder

Exchange Responder

The exchange responders assign unique RX_ID values or use the value of “FFFF.” The exchange responder considers an exchange open from the time it receives the first frame of the first information unit until one of the following occurs:

- The last frame of the last information unit is sent with the last sequence bit set
- The exchange is aborted (ABTS)
- A Logout (LOGO) is sent to, or received from, the Exchange originator
- An LS_RJT is sent in response to an ADISC or PDISC during target discovery

- A PLOGI is received

Sequence Management

Sequence management deals with the actual order and transfer of frames across Fibre Channel. The SEQ_ID and SEQ_CNT identify the order of frames for reassembly at the responder.

Refer to the FC–PH documents for rules and guidelines pertaining to Class 2 operation.

Table 5-14. Sequence Content Header

Word	Byte 0	Byte 1	Byte 2	Byte 3
0	R_CTL	Destination_ID		
1	CS_CTL	Source_ID		
2	Type	F_CTL		
3	**SEQ_ID**	DF_CTL	**SEQ_CNT**	
4	OX_ID		RX_ID	
5	Parameter			

Sequence Open

The library considers a sequence open from the time that the first frame of the sequence (the frame with the SOFi3 delimiter) is sent until one of the following occurs:

- An end-of-frame (EOF) delimiter is sent with the last sequence bit set
- A LOGO is sent to, or received from, the sequence responder
- The sequence is aborted with ABTS

The library as a sequence responder considers a sequence open from the time that the first frame of the Sequence (the frame with the SOFi3 delimiter) is received until one of the following occurs:

- An end-of-frame (EOF) delimiter is sent with the last sequence bit set
- The Sequence is aborted using ABTS
- A LOGO is sent to, or received from, the Sequence originator

Sequence Identifier Usage

The sequence identifier (SEQ_ID) is a field in the frame header that sets one frame apart from another and indicates the order in which frames occur. The following paragraphs summarize the rules governing the reuse of SEQ_IDs.

For sequences that transfer Sequence Initiative:

- An NL_Port can reuse a SEQ_ID for the same Exchange following the confirmation of sequence delivery.

- An NL_Port can reuse the SEQ_ID with a different exchange (to the same, or a different destination NL_Port) immediately following transmission of the last frame of the sequence, without waiting for confirmation of Sequence delivery.

For sequences that do *not* transfer Sequence Initiative:

- Consecutive FCP_DATA Sequences for the same exchange follow the FC-PH rules for streamed sequences which include:
    1. The first FCP_DATA Sequence after transfer of sequence initiative is not a streamed sequence. It can use any eligible SEQ_ID, and the SEQ_CNT can be either zero or a continuously increasing number.
    2. The second and subsequent sequences within the same exchange are treated as streamed.
- Because frame delivery is not confirmed, the sequence initiator cannot reuse a SEQ_CNT within a given sequence.

  For sequences beginning with a SEQ_CNT of zero, the SEQ_CNT cannot wrap when reaching a hexadecimal count of “FFFF”.

  For sequences beginning with a SEQ_CNT of ‘*n*’ (where *n* is not zero), the SEQ_CNT can wrap when reaching a hexidecimal count of “FFFF” and continue from zero up to a value of *n*-1.

Sequence Errors

Sequence errors are managed as defined in FC–Tape with the following additions:

1. If a frame with an SOFi3 delimiter is received and the SEQ_CNT is not equal to zero or +1 from the SEQ_CNT of the last frame of the previous Sequence of that Exchange.
2. If the SEQ_CNT of a received frame with an SOFn3 delimiter is not +1 greater than the previous frame received for that Sequence (such as a frame was lost).

   This also detects the case where a frame with an SOFn3 delimiter is received for a SEQ_ID that is not currently open since the SEQ_CNT of the previous frame for that sequence is undefined.
3. If a frame with an SOFi3 delimiter is received and the previous sequence of that exchange is still open.
4. If the relative offset in the parameter field of a received frame with an SOFn3 delimiter is not equal to the (relative offset + the payload size) of the previous frame received for that Sequence.
5. If the next frame of a sequence is not received within E_D_TOV.
6. If, during the same sequence initiative, a sequence is received which has the same SEQ_ID as the previous sequence of that exchange.

When a sequence error is detected by the library, it discards that sequence, and all remaining sequences for the exchange containing the sequence in error. The library attempts to take the appropriate action as defined in FCP–2.

CRC

Fibre Channel adds another level of protection over the content of each frame called a cyclic redundancy check (CRC). Each frame is protected by a 4-byte CRC which provides a separate and independent error detection mechanism.

Timers

Sun StorageTek's libraries use the timer values in Table 5-15.

Table 5-15. Timer Summary

Timer	Value	Implemented By		
		Initiator	Target	STK
AL_TIME	15 ms	R	R	Y
R_T_TOV	100 ms	R	R	Y

Table 5-15. Timer Summary (Continued)

Timer	Value	Implemented By		
		Initiator	Target	STK
E_D_TOV	Private = 2 s	R	A	Y
	Public = supplied + 2 s	R	(note 2) R	Y
$R\_A\_TOV_{SEQ\_QUAL}$	Private = 0 s	R	A	Y
	Public = 10 s (See note 1)		(note 2)	
$R\_A\_TOV_{ELS}$	Private = 2 s	R	R	Y
	Public = 10 s			
RR_TOV	300 s		R	Y
REC_TOV	> = E_D_TOV + 1 s minimum	R	R	Y
ULP_TOV	>= Operation specific timer + 4 x REC_TOV	R		N

Notes:

1. The division of R_A_TOV usage differs from the FC-PH because of the unique characteristics of an Arbitrated Loop environment.
2. SCSI target devices that support Class 2 are required to implement this timer.

Arbitrated Loop Timeout

The Arbitrated Loop timeout value (AL_TIME) is two times the worst case round-trip latency of a very large loop.

Receiver_Transmitter Timeout

The Receiver_Transmitter timeout value (R_T_TOV) is used by the receiver logic to detect a loop failure.

Error_Detect Timeout

The Error Detect Timeout value (E_D_TOV) is the maximum time permitted for a Sequence Initiator between the transmission of consecutive data frames within a single sequence. This is also the minimum time that a Sequence Recipient waits for the reception of the next frame within a single sequence before recognizing a Sequence timeout.

E_D_TOV includes the time required to gain access to the loop in addition to the actual frame transmission time.

Resource Allocation Timeouts

The Resource Allocation Timeout (R_A_TOV) has two components:

- Sequence Qualifiers ($_{SEQ\_QUAL}$) defines the minimum time that an initiator waits before reusing the sequence qualifiers (SEQ_ID and SEQ_CNT).
- Extended Link Services ($_{ELS}$) determines the minimum time the Originator of an extended link service request waits for the response to a request as a target.

Resource Recovery Timeout

The Resource Recovery timeout (RR_TOV) value is the minimum time the target waits for an initiator to perform an exchange authentication following the completion of the loop initialization.

REC Timeout

The Read Exchange Concise timeout (REC_TOV) is used to time reply sequences and a polling interval for REC error detection. Refer to FCPP-2 for a detailed description.

Upper Level Protocol Timeout

The Upper Level Protocol Timeout (ULP_TOV) is used by the initiator to time the completion of exchanges associated with the Upper Level Protocol operations. The timeout values vary depending on the operations being timed.

FC-3 (Common Service) Features

Table 5-16 lists thee Common Service Parameters the libraries support for Port Login (PLOGI):

Table 5-16. NL_Port Common Service Parameters, Port Login

Parameter	Word	Bits	STK Value	FC-Tape
FC-PH Version:				
Highest Version	0	31–24	09h	X
Lowest Version	0	23–16	09h	20h
Buffer-to-Buffer Credit (min.)	0	15–0	0	0
Common Features:	1	31–16		
Continuously Increasing Relative Offset	1	31	1	1
Random Relative Offset	1	30	0	0
Valid Vendor Version Level	1	29	0	0
N_Port/F_Port	1	28	0	0

Table 5-16. NL_Port Common Service Parameters, Port Login (Continued)

Parameter	Word	Bits	STK Value	FC-Tape
Alternate BB_Credit Management	1	27	1	–
E_D_TOV Resolution	1	26	0	–
Reserved	1	25–23	0	–
Dedicated Simplex	1	22	0	–
Reserved	1	21–19	0	–
Dynamic Half Duplex – DHD	1	18	0	–
SEQ_CNT	1	17	0	X
Payload Length	1	16	0	–
Buffer-to-Buffer Receive Data Field Size (min.)	1	15–0	0800h	256
Total Concurrent Sequences (min.)	2	31–16	00FFh	1
Relative Offset by Information Category = (Information Category 1 and 5 only)	2	15–0	0003h	0002h
Error Detect Timeout (E_D_TOV) 2 seconds	3	31–0	000007D0h	000007D0h

Table 5-17 lists the Common Service Parameters the libraries support for Fabric Login (FLOGI):

Table 5-17. NL_Port Common Service Parameters, Fabric Login

Parameter	Word	Bits	STK Value	NL-Port Originator
FC-PH Version:				
Highest Version	0	31–24	09h	X
Lowest Version	0	23–16	09h	20h
Buffer-to-Buffer Credit (min.)	0	15–0	0	–
Common Features:				
Reserved	1	31–30	0	–
Valid Vendor Version Level	1	29	0	0
N_Port/F_Port	1	28	0	0
Alternate BB_Credit Management	1	27	1	1
Reserved	1	26–19	0	–

Table 5-17. NL_Port Common Service Parameters, Fabric Login (Continued)

Parameter	Word	Bits	STK Value	NL-Port Originator
Dynamic Half Duplex	1	18	0	–
Reserved	1	17	0	–
Payload Length	1	16	0	–
Buffer-to-Buffer Receive Data Field Size (min., see note)	1	15–0	0800h	256
Reserved	2	31–0	0	–
Reserved	3	31–0	0	–

Note: This is controlled by a configuration item.

FC-4 (FCP) Features

Fibre Channel Protocol (FCP) provides functions such as login and logout parameters and the transfer of commands and data through the use of Information Units. The FCP command set for the libraries is SCSI-3.

Note: Refer to Chapter 6, “SCSI Commands” for more information about the implementation of the SCSI-3 command set.

FCP Process Login Parameters

Table 5-18 lists Process Login (PRLI) parameters supported:

Table 5-18. PRLI Parameters

Feature	FC-Tape		STK
	Initiator	Target	
Command + Data in same Sequence (Write) = 1	P	P	N
Data Overlay Allowed = 1 (see note)	I	R	Y
Data + Response in same Sequence (Read) = 1	P	P	N
Establish Image Pair (bit 13) = 0	I	R	Y
Establish Image Pair (bit 13) = 1	R	R	Y
SRR/REC Recovery Supported = 0	A	R	N
Confirmed Completion Allowed =1	I	R	Y
Initiator Function =1	R	A	N
Originator Process Associator	P	P	N
Originator Process Associator Valid = 1	P	P	N
Responder Process Associator	P	P	N
Responder Process Associator Valid = 1	P	P	N
Read XFER_RDY Disabled = 1	R	R	Y
SCSI Target Function = 1	A	R	Y
Write XFER_RDY Disabled = 1	P	P	N

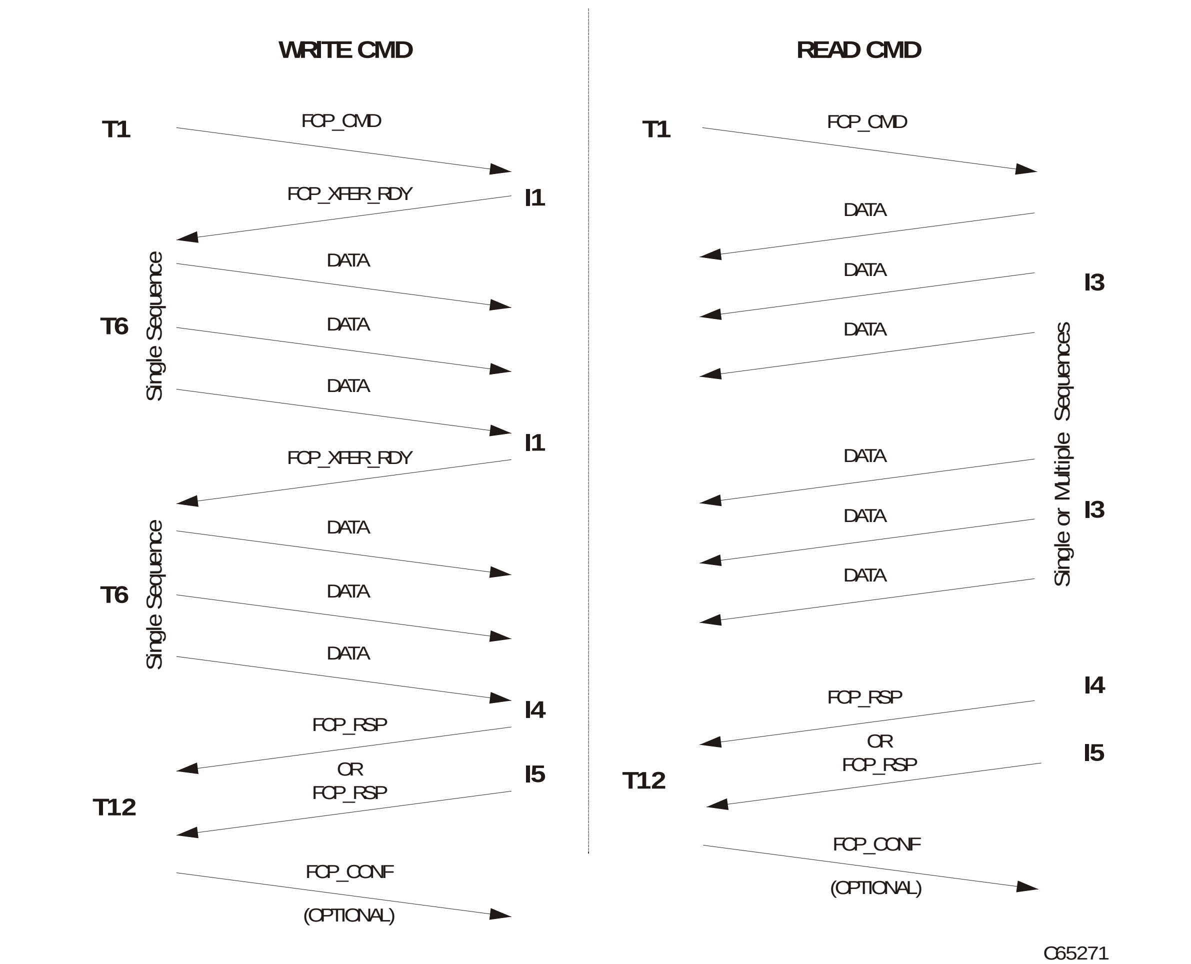
Note: If the initiator requests it, the use of data overlay is only allowed in response to an SRR (i.e., error recovery).

FCP Information Units

Information units transfer data to and from the SCSI initiator and SCSI target and include the following required units:

- T1 = Command and Task Management
- T6 = Write Data (such as Mode Select and Write commands)
- T12 = Response Received Confirmation
- I1 = Transfer Ready on a Write Command
- I3= Read Data (such as Mode Sense and Read commands)
- I4 = Response (such as Status)
- I5 = Response with Confirm Request

Figure 5-2. Examples of Read and Write Information Units (C65271)



Command Information Unit

The Command Information Unit (T1) is a single-frame sequence.

The library supports the "first level addressing" LUN field as defined in SAM–2. Table 5-19 illustrates this.

Table 5-19. FCP 8-B byte LUN

Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
00	LUN	00	00	00	00	00	00

For all commands that transfer data *to* the library:

- FCP_DL (data length) in the FCP_CMND payload always equals the number of bytes being transferred for the command.
- For SCSI commands that specify the transfer length in blocks in the Command Descriptor Block (CDB), the FCP_DL equals the Transfer_Length multiplied by the Block_Size.

Note: If the FCP_DL value is less than the transfer length, then FCP_DL data will be transferred and the command will be terminated with Check Condition. The Sense Key will be 5h, the ASC will be 4Bh, and the ASCQ will be 80h.

For all commands that transfer data *from* the library:

- The SCSI initiator is responsible for making sure the amount of data returned is equal to the amount specified by FCP_DL—even if Good Status is returned. If the amount does not match FCP_DL, a command-specific Upper Level Protocol recovery action must be invoked. Because there are no transfers of Sequence Initiative during read operations, once the SCSI Target receives the T1 Information Unit, it may return Good Status, even though some of the data was not received by the SCSI initiator. This can occur as the result of lost or corrupted frames in the read data.

Note: The way a SCSI initiator determines the correct amount of data is returned depends on the implementation and includes counting the number of bytes returned and computing the number of bytes received by use of the relative offsets.

- The FCP Command Reference Number (CRN) shall be used to ensure proper ordering of Exchange's (SCSI commands). CRN usage is enabled based on I_T_L nexus by setting the Enable Command Reference Number (ECRN) bit to 1b in the FC Mode Page (19h) for the LUN. Task Management functions shall set the CRN value to 0b. Refer to FCP-2 (4.3 Precise Delivery of SCSI Commands) for a detailed description.

Note: The library currently does not support command queuing; thus CRNs are not supported.

Transfer Ready Information Units

The Transfer Ready Information Unit (I1) is a single-frame sequence.

For write operations:

The FCP_XFER_RDY is sent before each write data sequence.

For read operations:

The FCP_XFER_RDY IU (I2) is not used during read type (data in) operations. This is indicated by setting the 'READ XFER_RDY DISABLED' bit during process login.

Data Information Unit

The Data Information Units (T6 and I3) are either single- or multiple-frame sequences.

The FCP_DATA IU transfers data associated with an operation. This data includes command parameter data (such as Mode Select data) or command response data (such as Mode Sense data).

Response Information Unit

The Response Information Units (I4) are single- or multiple-frame sequences.

The first two bits (30 and 31) of the first word of a command status frame payload fall into the following categories:

- 00 = Successful and complete
- 01 = Successful but incomplete
- 10 = Unsuccessful but complete
- 11 = Unsuccessful and incomplete

Because the first word of FCP_RSP frames are reserved in FCP, these bits are set to 0b, regardless of the content of the SCSI Status portion of the payload. SCSI initiators do not rely on word 0, bits 31 and 30 in FCP_RSP to determine success or completion status of a command. An FCP_RSP following a data-in sequence (I3) may or may not be treated as a streamed sequence.

Residual Checking

Residual checking falls under the following categories:

- SCSI targets that transfer exactly FCP_DL data bytes during the FCP_DATA IUs set the FCP_RESID_UNDER to a value of 0b.

  When FCP_RESID_UNDER is set to 0b, the SCSI initiator tries to determine if all of the expected data was transferred by comparing the FCP_DL to the actual number of bytes transferred. If these values are not the same, the ULP is notified so that the appropriate action can be taken.

- SCSI targets that transfer less than FCP_DL data bytes during the FCP_DATA IUs set the FCP_RESID_UNDER to a value of 1b.

  If the FCP_RESID_UNDER bit is set to 1b, a transfer that did not fill the buffer to the expected displacement. Failure to transfer FCP_DL bytes does not necessarily indicate an error for some devices and commands.

- If the FCP_RESID_OVER bit is set, the transfer was truncated because the data transfer required by the SCSI command extended beyond the displacement value of

FCP_DL. Those bytes that could be transferred without violating the FCP_DL value may or may not have been transferred.

- Commands that do not contain an FCP_DATA IUs, FCP_RESID_UNDER and FCP_RESID_OVER are set to 0b, and the value of the FCP_RESID is undefined.

Response Payload

Table 5-20 lists the FCP_RSP payload fields:

Table 5-20. FCP_RSP Payload

Feature	FC-Tape		STK
	Initiator	Target	
FCP_CONF_REQ	A	R	Y
FCP_SNS_INFO	R	I	Y
FCP_SNS_LEN (total)	R	≤ 128	28
FCP_SNS_LEN_VALID	R	I	Y
Length of Additional Sense Bytes in FCP_SNS_INFO	R	≤ 120	16
FCP_RSP_INFO	R	I	Y
FCP_RSP_LEN	R	0 or 8	8
FCP_RSP_LEN_VALID	R	I	Y
FCP_RESID	R	R	Y
FCP_RESID_OVER	R	I	Y
FCP_RESID_UNDER	R	I	Y

Response Codes

The Response Code field (FCP_RSP_INFO) contains information that describes the failures detected during the execution of an I/O operation and conforms to the following rules:

- The FCP_RSP_INFO does not contain link error information because FC-PH provides the mechanisms for presenting these errors.
- The FCP_RSP_INFO does not contain SCSI logical unit error information because that information is in the FCP_STATUS and FCP_SNS_INFO fields.
- RSP_CODE values of 04h and 05h are not valid responses to SCSI commands. The RSP_CODE is independent of the SCSI Status and should be examined before interpretation of the SCSI Status.
- For other non-zero values of the RSP_CODE, the SCSI Status may not be valid.
- Table 5-21 indicates the result of a Task Management function in the RSP_CODE of the FCP_RSP_INFO fields.

Table 5-21. FCP_RSP Codes

RSP_CODE	Description
00	No failure or Task Management complete
01	FCP_DATA length different than BURST_LEN
02	FCP_CMND fields invalid
03	FCP_DATA RO mismatch with FCP_XFER_RDY DATA_RO
04	Task Management function not performed or supported
05	Task Management function supported but not performed
06-FF	Reserved

The FCP_CONF IU is used by the target to confirm reception of an FCP_RSP IU at the initiator. Support for the FCP_CONF IU is negotiated via PRLI. A target request for an FCP_CONF IU from the initiator is indicated by the target setting the FCP_CONF_REQ bit in the FCP_STATUS field contained in the FCP_RSP. If the initiator does not need to perform any error detection or recovery procedure, the initiator will send an FCP_CONF IU if an FCP_RSP is received with the FCP_CONF_REQ bit set in the FCP_STATUS field.

The initiator will release Exchange information such as the Exchange Status Block (ESB) after the FCP_CONF is sent. The target will retain Exchange information and associated data until an FCP_CONF is received. See FCP-2 (4.4 Confirmed Completion of FCP-2 SCSI Commands) for a description of the FCP_CONF_REQ bit and FCP_CONF usage.

The following table lists each command and its supported usage of requesting an FCP_CONF:

No confirm The library will not set the FCP_CONF_REQ bit in the response to the command. As soon as the response has been transmitted, the exchange is terminated, and there is no FCP-2 Link Level error recovery possible.

Implicit confirm The library does not set the FCP_CONF_REQ bit in the response to the command. However, the exchange is not terminated until the same initiator sends the next command or until the Resource Recovery timer expires on this exchange. This will allow the initiator to do FCP-2 Link Level error recovery, if necessary, before sending the next command.

Explicit confirm The library will set the FCP_CONF_REQ bit in the response to a command if the condition in this column is met. This will allow the initiator to do FCP-2 Link Level error recovery, if necessary, before sending the FCP_CONF. If the initiator does not support FCP_CONF, as indicated in its PRLI payload, then the library will not set the FCP_CONF_REQ bit, regardless of the condition being met. But the library will treat it as an Implicit Confirm condition.

Table 5-22. Command Confirmation Usage

Command	No Confirm	Implicit Confirm	Explicit Confirm
Library Motion			
Move Medium	If not, check	Always	Check condition
Position to Element	Always		
Non Customer Data			
Inquiry	Always		
Log Sense	Always		
Mode Select	Always		
Mode Sense	Always		
Persistent Reserve In	Always		
Persistent Reserve Out	Always		
Read Element Status	Always		
Request Sense	Always		
Request Volume Element Address	Always		
Write Buffer	Always		
Misc.	Always		
Initialize Element Status	Always		
Initialize Element Status with Range	Always		
Prevent/Allow Medium Removal	Always		
Release	Always		
Reserve	Always		
Rezero Unit	Always		
Send Diagnostic	Always		
Send Volume Tag	Always		
Test Unit Ready	Always		

Notes:

1. Commands that report Check Condition with the Response Code of Deferred Error (71h) will follow the rules of Explicit Confirm.
2. Any command which responds with Check Condition of Overlapped Commands Attempted (Sense Key = Bh, ASC/ASCQ = 4E00h) will follow the rules of Explicit Confirm.

Task Management Flag and Information Units

All SCSI initiators send Task Management functions using T1.

All SCSI targets return FCP_RSP to Task Management functions using I4.

The RSP_CODE in the FCP_RSP_INFO field indicates the result of the Task Management function. The SCSI Status byte and FCP_SNS_INFO are ignored for I4 information units sent in response to a Task Management function.

Table 5-23 on page 5-38 lists the Task Management Flags the libraries support:

Table 5-23. FCP Task Management Flags

Feature	FC-Tape		STK
	Initiator	Target	
Terminate Task = 1	P	P	N
Clear ACA = 1 (command queuing)	R	R	N
Clear ACA = 1 (no command queuing)	P	P	N
Target Reset = 1	I	R	Y
Clear Task Set = 1	I	R	Y
Abort Task Set = 1	I	R	Y
Logical Unit Reset = 1	I	R	Y

Task Attributes

Table 5-24 lists the FCP Task Attributes supported by the libraries:

Table 5-24. FCP Task Attributes

Feature	FC-Tape		STK
	Initiator	Target	
Untagged	R	R	Y
Simple Queue Type (depth = 1)	I	A	Y
Ordered Queue Type	I	A	N
Head of Queue Type	I	A	N
Auto Contingent Allegiance Type	I	A	N

Other Features

Table 5-25 lists other FCP features supported:

Table 5-25. Other FCP Features

Feature	FC-TAPE		STK
	Initiator	Target	
FCP_LUN (in FCP_Command)	R	R	Y
FCP_LUN (0)	I	R	Y
Inquiry of FCP_LUN (0)	I	R	Y
Inquiry of FCP_LUN (>0)	I	R	Y
Auto Contingent Allegiance (ACA)	A	A	N

Public Loop SCSI Target Discovery

For public loop SCSI target discovery, the following private loop discovery is used except that discovery of SCSI targets will be performed via the Simple Name Server or RSCN, and the function performed by ADISC/PDISC will be replaced by FAN.

Private Loop SCSI Target Discovery

When the possibility of a configuration change exists, a SCSI initiator might want to rediscover the new configuration. The SCSI Target Discovery procedure for a SCSI initiator is:

For all valid AL_PAs:

```
OPN(AL_PA)
 IF OPN is successful, then
  Send ADISC or PDISC to D_ID = hex ’0000’ || AL_PA
   IF LOGO is returned or the Node Name or Port Name has changed, then
    Send PLOGI to D_ID = hex ’0000’ || AL_PA
     IF PLOGI is successful, then
   IF no hard address conflicts or application tolerant of hard
     address conflicts
       Send PRLI to D_ID = hex ’0000’ || AL_PA
        IF PRLI is successful, then
         Send FCP_CMND with INQUIRY CDB to D_ID = hex ’0000’
        ||AL_PA(LUN_0)
        ENDIF
       ENDIF
      ENDIF
     ENDIF
    ENDIF
NEXT AL_PA
```

To determine if an OPN was “successful,” the NL_Port must be able to:

1. Detect when an OPN has not been intercepted by the designated AL_PA.
2. Detect that an R_RDY or CLS has not been received from the AL_PA specified in an OPN within E_D_TOV of sending that OPN.
3. Detect that a CLS was received in response to the OPN.
   In this case, the Target Discovery procedure should be retried at a later time.
4. Detect that the OPN or frame Extended Link Service failed.

If the SCSI Target Discovery procedure revealed a Hard Address conflict (such as an NL_Port was unable to acquire its hard address), then the application may choose to operate in spite of that conflict.

If this is the case, then the discovery procedure can continue with the PRLI and subsequent SCSI INQUIRY command.

If the application is not tolerant of Hard Address conflicts, the SCSI initiator may choose not to use that NL_Port.

Using this SCSI Target Discovery procedure, the SCSI initiator has the ability to assemble a database consisting of Node name, Port name, and N_Port ID.

There are several confirmations a SCSI initiator can perform on that database to determine which SCSI targets it can continue to communicate with, but this document does not define them.

Note: Not all initiators perform the exact steps described in the above algorithm. However, a SCSI initiator is required to issue ADISC or PDISC to all SCSI targets it is logged in with within RR_TOV of receiving LIP if it wants to remain logged in with those SCSI Targets.

The ADISC/PDISC procedure is designed to avoid the abnormal termination of all open Exchanges when a new device is attached to the loop or when a device powers on.

Note: Because devices are not required to respond to Class 3 frames that have a D_ID that does not match the full 24-bit N_Port identifier of the receiving NL_Port, timeouts might occur during the SCSI target discovery process if a SCSI initiator sends a frame to a Public NL_Port using a D_ID of 0000h || AL_PA or to a Private NL_Port using a D_ID with the upper 16 bits non-zero.

Therefore, for performance reasons, SCSI initiators should originate PDISC or ADISC Exchanges by transmitting the ELS Sequence, without waiting for the response. SCSI initiators might need to originate multiple concurrent Exchanges to hide multiple timeouts from the user.

Clearing Effects of ULP, FCP, FC-PH, and FC-AL Actions

Table 5-26 lists the clearing effects of Fibre Channel actions:

Table 5-26. Clearing Effects

FCP SCSI Target Object	Power On Reset	LIP Reset	LOGO PLOGI	ABTS	PRLI PRLO	TPRLO	SCSI Target Reset	Clear Task Set	Abort Task Set	SCSI Log. Unit Reset
PLOGI parameters:										
All logged-in initiators	Y	Y	N	N	N	N	N	N	N	N
Only ports initiating action	–	–	Y	N	N	N	N	N	N	N
Open sequences terminated:										
For all initiator with OPN seq's	Y	Y	N	N	N	Y	Y	Y	N	Y
Only ports initiating action	–	–	Y	N	Y	–	–	–	Y	–
Only for seq. with aborted exchange	–	–	–	Y	–	–	–	–	–	–
Login BB_ Credit_CNT:										
All logged-in L_Ports	Y	Y	–	N	N	N	N	N	N	N
Only transmitting ports	–	–	Y							
Hard address acquisition attempted	Y	Y	N	N	N	N	N	N	N	N
PRLI parameters cleared:										
All logged-in initiators	Y	Y	N	N	N	N	N	N	N	N

Table 5-26. Clearing Effects (Continued)

FCP SCSI Target Object	Power On Reset	LIP Reset	LOGO PLOGI	ABTS	PRLI PRLO	TPRLO	SCSI Target Reset	Clear Task Set	Abort Task Set	SCSI Log. Unit Reset
Only ports of specific type	–	–	N	N	Y	Y	N	N	N	N
Only ports initiating action	–	–	Y	N	Y	N	N	N	N	N
Open exchanges aborted:										
All tasks, all initiators, open tasks	Y	Y	N	N	N	Y	Y	Y	N	Y
All tasks, port initiating action	–	–	Y	N	Y	–	–	–	Y	–
Specific task, port initiating action	–	–	N	Y	N	–	–	–	N	–
SCSI target mode page parameters restored from saved pages:										
All initiators	Y	Y	N	N	N	Y	Y	N	N	Y
Only ports initiating action	–	–	Y	N	Y	–	–	N	N	–
Pre-existing ACA, UA, and deferred error conditions cleared:										
All initiators	Y	Y	N	N	N	Y	Y	N	N	Y
Only ports initiating action	–	–	Y	N	Y	–	–	N	N	–
Device Reservations										
For all SCSI initiators	Y	Y	N	N	N	Y	Y	N	N	Y

Table 5-26. Clearing Effects (Continued)

FCP SCSI Target Object	Power On Reset	LIP Reset	LOGO PLOGI	ABTS	PRLI PRLO	TPRLO	SCSI Target Reset	Clear Task Set	Abort Task Set	SCSI Log. Unit Reset
Only for SCSI initiator port initiating action	–	–	Y	N	Y	–	–	N	N	–
Persistent Device Reservations										
For all SCSI initiators	Y	N	N	N	N	N	N	N	N	N
Only for SCSI initiator port initiating action	–	–	N	N	N	–	–	N	N	–
CRN (Command Reference Number)										
For all SCSI initiators	Y	Y	N	N	N	Y	Y	N	N	Y
Only for SCSI initiator port initiating action	–	–	Y	N	Y	–	–	N	N	–
Prevent Allow Medium Removal state										
For all SCSI initiators	Y	Y	N	N	N	Y	Y	N	N	Y
Only for SCSI initiator port initiating action	–	–	N	N	Y	–	–	N	N	–
Exchange Information										
For all SCSI initiators	Y	Y	N	N	N	Y	Y	N	N	Y
Only for SCSI initiator port initiating action	–	–	Y	N	Y	–	–	N	N	–

Device Reservations

L700, L700e and L180 tape libraries support the Reserve/Release management method and also the Persistent Reservations management method. These methods are defined in the ANSI SCSI-3 Primary Commands (SPC-2) standard. For the reservation restrictions placed on commands for the Reserve/Release management method, see Table 5-27. For the reservation restrictions placed on the Persistent Reservations management method, seeTable 5-28 on page 5-46.

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 5-27. Reserve/Release Management Method

Command	Action when Reserved by a different Initiator
Initialize Element	Conflict
Initialize Element with Range	Conflict
Inquiry (12h)	Allowed
Log Sense (4Dh)	Allowed
Mode Select (15h/55h)	Conflict
Mode Sense (1Ah/5Ah)	Conflict
Move Medium	Conflict
Persistent Reserve In (5Eh)	Conflict
Persistent Reserve Out (5Fh)	Conflict
Position to Element	Conflict
Prevent/Allow Removal (1Eh)	Prevent = 0, allowed
	Prevent = NZ, conflict
Read Element Status	Conflict, unless the CurData bit is 1
Release Unit (17h/57h)	Allowed, the reservation is not released.
Request Sense (03h)	Allowed
Request Volume Element Address	Conflict
Reserve Unit (16h/56h)	Conflict
Rezero Unit	Conflict
Send Diagnostic (1Dh)	Conflict
Send Volume Tag	Conflict

Table 5-27. Reserve/Release Management Method (Continued)

Command	Action when Reserved by a different Initiator
Test Unit Ready (00h)	Conflict
Write Buffer (3Bh)	Conflict

Table 5-28. Persistent Reservation Management Method

Command	From Non-registered Initiators	From Registered Initiators
Initialize Element	Conflict	Allowed
Initialize Element with Range	Conflict	Allowed
Inquiry (12h)	Allowed	Allowed
Log Sense (4Dh)	Allowed	Allowed
Mode Select (15h/55h)	Conflict	Allowed
Mode Sense (1Ah/5Ah)	Conflict	Allowed
Move Medium	Conflict	Allowed
Persistent Reserve In (5Eh)	Allowed	Allowed
Persistent Reserve Out (5Fh)	Register, allowed Reserve, conflict Release, conflict Clear, conflict Preempt, conflict Pre/Abt, conflict Reg/Ign, allowed	Register, allowed Reserve, conflict Release, allowed Clear, allowed Preempt, allowed Pre/Abt, allowed Reg/Ign, allowed
Position to Element	Conflict	Allowed
Prevent/Allow Media Removal (1Eh)	Prevent = 0, allowed Prevent = NZ, conflict	Allowed
Read Element Status	CurData = 0, allowed CurData = 1, conflict	Allowed
Release Unit (17h/57h)	Conflict	Conflict
Request Sense (03h)	Allowed	Allowed
Request Volume Element Address	Conflict	Allowed

Table 5-28. Persistent Reservation Management Method (Continued)

Command	From Non-registered Initiators	From Registered Initiators
Reserve Unit (16h/56h)	Conflict	Conflict
Rezero Unit	Conflict	Allowed
Send Diagnostic (1Dh)	Conflict	Allowed
Send Volume Tag	Conflict	Allowed
Test Unit Ready (00h)	Conflict	Allowed
Write Buffer (3Bh)	Conflict	Allowed

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SCSI Commands

6

This chapter lists and describes SCSI command structures for the L700, L700e and L180 libraries. Table 6-1 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 the tape drives. Refer to tape drive documentation for information about the SCSI commands for the tape drives.

Command List

Table 6-1. Supported Commands

Command	Hex Code	Page
Initialize Element Status	07	6-5
Initialize Element Status with Range	E7	6-6
Inquiry (SCSI)	12	6-8
Inquiry (Fibre)	12	6-16
Log Sense	4D	6-27
Mode Select (SCSI)	15	6-35
Mode Select (Fibre)	15	6-46
Mode Sense (SCSI)	1A	6-61
Mode Sense (Fibre)	1A	6-78
Move Medium	A5	6-98
Persistent Reserve In	5E	6-100
Persistent Reserve Out	5F	6-105
Position to Element	2B	6-109
Prevent/Allow Medium Removal	1E	6-110
Read Element Status	B8	6-112
Release	17	6-155
Report LUNs	A0	6-156
Request Sense	03	6-158

Table 6-1. Supported Commands (Continued)

Command	Hex Code	Page
Request Volume Element Address	B5	6-171
Reserve	16	6-175
Rezero Unit	01	6-178
Send Diagnostic	1D	6-179
Send Volume Tag	B6	6-182
Test Unit Ready	00	6-185
Write Buffer	3B	6-186

Implementation Requirements

The initiator sends commands to the target using command descriptor blocks (CDBs). The command descriptor blocks contain a format that includes:

- Operation code
- Logical unit number (LUN)
- Command parameters
- Control byte

Note: The library is SCSI-3 compliant.

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

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 Blocks

Initiators use command descriptor blocks (CDBs) to communicate commands to the targets. The library supports three types of command descriptor blocks:

- 6-byte commands (Table 6-2 on page 6-3)
- 10-byte commands (Table 6-3 on page 6-3)
- 12-byte commands (Table 6-4 on page 6-3)

The first byte in the command descriptor block contains a group code and a command code.

The three-bit group code provides eight groups of commands.

The five-bit command code provides 32 command codes for each group.

Table 6-2. 6-Byte Command Command Descriptor Blocks

Byte	Bit							
	7	6	5	4	3	2	1	0
0	Group Code (of operation code)			Command Code (of operation code)				
1	Logical Unit Number			Command Parameters				
2–4	Command Parameters							
5	Control Byte							

Table 6-3. 10-Byte Command Command Descriptor Blocks

Byte	Bit							
	7	6	5	4	3	2	1	0
0	Group Code (of operation code)			Command Code (of operation code)				
1	Logical Unit Number			Command Parameters				
2–8	Command Parameters							
9	Control Byte							

Table 6-4. 12-Byte Command Command Descriptor Blocks

Byte	Bit							
	7	6	5	4	3	2	1	0
0	Group Code (of operation code)			Command Code (of operation code)				
1	Logical Unit Number			Command Parameters				
2–10	Command Parameters							
11	Control Byte							

Control Byte

The control byte is the last byte of every command descriptor block (see Table 6-5).

Table 6-5. Control Byte

Byte	Bit							
	7	6	5	4	3	2	1	0
5 9 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)
  Causes an interrupt in the initiator allowing a device to respond with intermediate status. This bit should be 0.
- **Link** (not supported)
  Allows devices that support command linking to continue the I/O process. This bit should be 0.

■ Operator Entries for SCSI

The SCSI interface to the library requires that you set the following values:

- The library’s SCSI ID
- Each drive’s SCSI ID

You may set these values from the library’s operator panel or through the library’s Horizon Library Monitor if it is enabled on the library. See the library’s operator’s guide for instructions on setting these values.

■ Operator Entries for Fibre Channel

The Fibre Channel interface requires configuration of the library’s Port 0 address. You may configure the library for soft or hard addressing of this port.

If you configure the library for *hard addressing*, you may input the Port 0 address yourself through the library’s operator panel or through the library’s Horizon Library Monitor if it is enabled. Allowable loop addresses are 000d to 125d.

Note: Before you input a Port 0 address, you must first set the library's Fibre Channel hard address option to *enabled*.

If you configure the library for *soft addressing*, you are allowing the Fibre Channel software to configure the Port 0 address. Addresses are assigned in ascending order. For this addressing approach, you must *disable* the Fibre Channel hard address option.

Note: The default for the hard address option is *disabled*.

See the library's operator's guide for additional instructions on setting these values.

Initialize Element Status

The host uses the "Initialize Element Status" command (07) 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.

The library tabulates (or "performs an audit of") and maintains the inventory. It performs an audit after a user has opened and closed the front door.

The command descriptor block (see Table 6-6) is validated even though the command is not used. No checks are made of ignored fields.

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

Table 6-6. Initialize Element Status Command

Byte	Bit							
	7	6	5	4	3	2	1	0
0	Operation Code (07h)							
1	Logical Unit Number			Reserved (00h)				
2	Reserved (00h)							
3	Reserved (00h)							
4	Reserved (00h)							
5	NBL	Control Byte (00h)						

- **NBL**
  Ignore the No Bar Code Label (NBL) field.

Initialize Element Status With Range

The “Initialize Element Status With Range” command (E7) 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.

The library tabulates (or “performs an audit of”) and maintains the inventory. It performs an audit after a user has opened and closed the front door.

The command descriptor block is validated even though the command is not used. No checks are made of ignored fields (Table 6-7).

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

Table 6-7. Initialize Element Status with Range Command

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

- **Range**
  Ignore this field.
- **Element Address**
  Ignore this field.
- **Number of Elements**
  Ignore this field.
- **NBL**
  Ignore the No Bar Code Label (NBL) field.

- **Fast**

0 A FAST bit of one indicates that the specified elements shall be scanned for all relevant status.

1 A FAST bit of zero indicates that the specified elements shall be scanned for media presence only.

Inquiry (SCSI)

The "Inquiry" command (12) requests that the library send information regarding the library's parameters to the initiator (Table 6-8).

Table 6-8. Inquiry Command

<table>
<tr><th rowspan="2">Byte</th><th colspan="8">Bit</th></tr>
<tr><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>0</td><td colspan="8">Operation Code (12h)</td></tr>
<tr><td>1</td><td colspan="3">Logical Unit Number</td><td colspan="3">Reserved (00h)</td><td>CmdDt</td><td>EVPD</td></tr>
<tr><td>2</td><td colspan="8">Page Code</td></tr>
<tr><td>3</td><td colspan="8">Reserved (00h)</td></tr>
<tr><td>4</td><td colspan="8">Allocation Length</td></tr>
<tr><td>5</td><td colspan="8">Control Byte (00h)</td></tr>
</table>

- **CmdDT**
  The libraries do not support the optional Command Support Data; the value of this field must be 0.

- **EVPD**
  The enable vital product data (EVPD) bit indicates the type of inquiry data the initiator is requesting. Supported values are:

0	A request for normal inquiry data.
1	A request for a vital supported product data page

- **Page Code**
  If the EVPD value is 0, this field must be 00h. If the EVPD value is 1, this field must be 80h or 00h.

00h	Supported vital product pages
80h	Unit serial number 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 terminates the Data In phase when it has transferred 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 normal inquiry data the library returns is 38h (56d) bytes. The data length for page 0 is 06h (6d). The data length for the unit serial number page (80h) is 10h (16d) 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.

Normal Inquiry Data Definition (SCSI)

For SCSI implementation of the "Inquiry" command, the library returns 38h (56d) bytes of normal inquiry data in the format shown in Table 6-9.

Table 6-9. Normal Inquiry Data (SCSI)

Byte	Bit							
	7	6	5	4	3	2	1	0
0	Peripheral Qualifier			Peripheral Device Type				
1	RMB (1)	Device-Type Modifier (0)						
2	Obsolete (0h)					ANSI-Approved Version (3)		
3	AENC (0)	TrmIOP (0)	NACA (0)	Reserved (0h)	Response Data Format (2)			
4	Additional Length (n-4)							
5	Reserved (00h)							
6	BQue (0)	EncServ (0)	VS (0)	MultiP (0)	MChngr (0)	Reserved (00)		Addr16 (1)
7	RelAdr (0)	Obsolete (0)	WBus16 (0)	Sync (0)	Linked (0)	Reserved (0)	CmdQue (0)	SftRe (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 39	(MSB) PTP (LSB)							
40 to 43	(MSB) Partner (LSB)							

Table 6-9. Normal Inquiry Data (SCSI) (Continued)

Byte	Bit							
	7	6	5	4	3	2	1	0
44 to 55	MSB) Vendor Specific (LSB)							

- **Peripheral Qualifier**
  The library returns a value of 00h, which indicates that the library is a single logical unit. If a LUN other than 0 is sent, the value returned is 011b
  (b indicates binary notation).
- **Peripheral Device Type**
  The library returns a value of 8h, which indicates that the library is a medium changer device. If a LUN other than 0 is sent, the value returned is 1Fh.
- **RMB**
  The library returns a value of 1, which indicates that the medium is removable.
- **Device-Type Modifier**
  The library returns a value of 0, which indicates that there are no modifiers for the library.
- **ANSI-Approved Version**
  The library returns a value of 3, which indicates the library supports the current ANSI version of the SCSI-3 specification.
- **AENC**
  The library does not support the Asynchronous Event Notification Capability (AENC) function and returns a value of 0.
- **TrmIOP**
  The library does not support the Terminate I/O Process (TrmIOP) function and returns a value of 0.
- **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.
- **Response Data Format**
  The library returns a value of 2, which indicates that the data found is in accordance with the SCSI-2 specification.
- **Additional Length**
  The library returns a value of 33h, which indicates that there are 33h (51d) additional bytes of Inquiry data available to be returned to the initiator.

- **BQue**
  The library does not support tagged tasks (command queuing) and returns a value of 0 for the basic queuing bit as well as for the CmdQue bit.
- **EncSer**v
  The library does not contain an embedded enclosures services component and thus returns a value of 0.
- **VS**
  The vendor specific bit is set to 0 to indicate that there is no vendor-specific information with this command.
- **MultiP**
  The library does not have multiple ports and returns a value of 0.
- **MChngr**
  The library is not embedded in or attached to a medium transport element and returns a value of 0.
- **Addr16**
  The library supports 16 devices (addresses) on the SCSI bus and thus returns a value of 1.
- **RelAdr**
  The library does not support the Relative Address (RelAdr) function and returns a value of 0.
- **WBus 16**
  The library does not support 16-bit wide data bus transfers and returns a value of 0. (Thus the library supports only 8-bit wide data.)
- **Sync**
  The library does not support synchronous data transfer and returns a value of 0.
- **Linked**
  The library does not support linked commands and returns a value of 0.
- **CmdQue**
  The library does not support tag command queuing and returns a value of 0.
- **SftRe**
  The library does not support soft reset alternative in response to a reset condition and returns a value of 0.
- **Vendor Identification**
  This field 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 of the device model followed by blanks. For example, it could contain “L700,” “L700e,” or “L180.” If the logical unit is not supported, this field contains blanks.

- **Product Revision Level**
  This field contains an ASCII character sequence that represents the product revision level.
- **PTP**
  This field contains an unsigned 32-bit integer representing the integer part of the serial number of the Pass-Thru Port (PTP) controller and only applies to the L700e.

  For the L700e, if the PTP is not communicating, this field will have the value 0.
- **Partner**
  This field contains an unsigned 32-bit interger representing the interger part of the serial number of the neighbor library's controller card that shares the PTP.

  For the L700e, if the PTP or partner library is not communicating, this field will have the value of 0.
- **Vendor Specific**
  This field contains vendor-specific data that should be ignored.
- **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.

  If an "Inquiry" command is sent with a LUN other than 0, the value 7Fh is returned in the Peripheral Qualifier/Device Type byte. This is not an error.

The library returns 06h (6d) bytes of supported pages data in the format shown in the following table.

Supported Pages Definition (SCSI)

The supported pages definition (page 00h) for SCSI has six bytes.

Table 6-10. Supported Pages Definition

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 (02h)							
4	Supported Page (00h)							
5	Supported Page (80h)							

- **Peripheral Qualifier**
  The library returns a value of 00h, which indicates that the library is a single logical unit. If a LUN other than 0 is sent, the value returned is 011b
  (b indicates binary notation).

- **Peripheral Device Type**
  The library returns a value of 8h, which indicates the library as a medium changer device. If a LUN other than 0 is sent, the value returned is 011b.

- **Page Code**
  This field is set to 00h, which identifies the page as the supported pages page.

- **Page Length**
  This field is set to 02h, which indicates that two vital pages are supported

- **Supported Page**
  The first supported page value is set to 00h, which indicates that the first vital page is page 0 (the current page). The second supported page value is set to 80h, which indicates that the second vital page is page 80 (unit serial number page).

Unit Serial Number Page Definition (SCSI)

The library returns Fh (15d) bytes of unit serial number page data in the format shown in Table 6-11.

Table 6-11. Unit Serial Number Page Data

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 (0Bh)							
4 to 14	(MSB) Product Serial Number (LSB)							

- **Peripheral Qualifier**
  The library returns a value of 000, which indicates that the library is a single logical unit. If a LUN other than 0 is sent, the value returned is 011b
  (b indicates binary notation).

- **Peripheral Device Type**
  The library returns a value of 8h, which indicates the library as a medium changer device. If a LUN other than 0 is sent, the value returned is 1Fh.

- **Page Code**
  This field is set to 80h, identifying the page as the unit serial number page.

- **Page Length**
  This field is set to 0Bh, the number of bytes in the product serial number.

- **Product Serial Number**
  This field contains a unique 11-character ASCII identifier for the library.

  For example: MPC01001020

  Reading from left to right, the first three characters are the name, the next two characters are the site code, and the last six characters are the serial number. This product serial number is the MPC card Field Replaceable Unit identifier (FRU ID). If the card is replaced, the new MPC card FRU ID is returned.

Inquiry (Fibre)

The “Inquiry” command (12) requests that the library send information regarding the library’s parameters to the initiator (Table 6-12).

Table 6-12. Inquiry Command

Byte	Bit							
	7	6	5	4	3	2	1	0
0	Operation Code (12h)							
1	Logical Unit Number			Reserved (00h)			CmdDt	EVPD
2	Page Code							
3	Reserved (00h)							
4	Allocation Length							
5	Control Byte (00h)							

- **CmdDt**
  The command support data field must be 0

  0 Do not return command support data

- **EVPD**
  The enable vital product data (EVPD) bit indicates the type of inquiry data the initiator is requesting. Supported values are:

  0 A request for normal inquiry data

  1 A request for a vital supported product data page

- **Page Code**
  If the EVPD value is 0, this field must be 00h. If the EVPD value is 1, this field must be 80h, 83h, or 00h.

  00h Supported vital product pages

  80h Unit serial number page

  83h Device identification 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 terminates the Data In phase when it has transferred 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 normal inquiry data the library returns is 38h (56d) bytes. The data length for page 0 is 06h (6d). The data length for the unit serial number page (80h) is 10h (16d) bytes. The data length for the device identification page (83h) is 35d.

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.

Normal Inquiry Data Definition (Fibre)

For Fibre Channel implementation of the inquiry command, the library returns 38h (56d) bytes of normal inquiry data in the format shown in Table 6-13.

Table 6-13. Normal Inquiry Data (Fibre)

Byte	Bit							
	7	6	5	4	3	2	1	0
0	Peripheral Qualifier			Peripheral Device Type				
1	RMB (1)	Device-Type Modifier (0)						
2	ISO Version (0)		ECMA Version (0)			ANSI-Approved Version (3)		
3	AENC (0)	TrmIOP (0)	NACA (0)	Reserved (0)	Response Data Format (2)			
4	Additional Length (n-4)							
5	Reserved (00h)							
6	Reserved (0)	EncServ (0)	VS (0)	MultiP	MChngr (0)	Reserved (0)		
7	RelAdr (0)	Reserved (0)			Linked (0)	Reserved (0)	CmdQue (0)	SftRe (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 39	(MSB) PTP (LSB)							
40 to 43	(MSB) Partner (LSB)							

Table 6-13. Normal Inquiry Data (Fibre) (Continued)

Byte	Bit							
	7	6	5	4	3	2	1	0
44 to 55	(MSB) Vendor Specific (LSB)							
56 to 95	Reserved							
96 to n	(MSB) Vendor Specific (LSB)							

- **Peripheral Qualifier**
  The library returns a value of 00h, which indicates that the library is a single logical unit. If a LUN other than 0 is sent, the value returned is 011b (b indicates binary notation).
- **Peripheral Device Type**
  The library returns a value of 8h, which indicates that the library is a medium changer device. If a LUN other than 0 is sent, the value returned is 1Fh.
- **RMB**
  The library returns a value of 1, which indicates that the medium is removable.
- **Device-Type Modifier**
  The library returns a value of 0, which indicates that there are no modifiers for the library.
- **ANSI-Approved Version**
  The library returns a value of 3, which indicates the library supports the current ANSI version of the SCSI-3 specification.
- **AENC**
  The library does not support the Asynchronous Event Notification Capability (AENC) function and returns a value of 0.
- **TrmIOP**
  The library does not support the Terminate I/O Process (TrmIOP) function and returns a value of 0.
- **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.

- **Response Data Format**
  The library returns a value of 2, which indicates that the data found is in accordance with the SCSI-2 specification.

- **Additional Length**
  The library returns a value of 33h, which indicates that there are 33h (51d) additional bytes of Inquiry data available to be returned to the initiator.

- **EncServ (**Enclosure Services):

0	Not supported

- **VS**
  The vendor specific bit is set to 0 to indicate that there is no vendor-specific information with this command.

- **MultiP (**Multi-Port):

0	Does not support multiple port attachments
1	Supports dual port or multiple port attachments

- **MChngr (**Medium Changer):

0	Not supported

- **RelAdr**
  The library does not support the Relative Address (RelAdr) function and returns a value of 0.

- **Linked**
  The library does not support linked commands and returns a value of 0.

- **CmdQue**
  The library does not support tag command queuing and returns a value of 0.

- **SftRe**
  The library does not support soft reset alternative in response to a reset condition and returns a value of 0.

- **Vendor Identification**
  This field 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 of the device model followed by blanks. For example, it could contain "L700," "L700e," or "L180." If the logical unit is not supported, this field contains blanks.

- **Product Revision Level**
  This field contains an ASCII character sequence that represents the product revision level.

- **PTP**
  This field contains an unsigned 32-bit interger representing the interger part of the serial number of the Pass-Thru Port (PTP) controller and only applies to the L700e.

  For the L700e, if the PTP is not communicating this field will have the value 0.

- **Partner**
  This field contains an unsigned 32-bit interger representing the interger part of the serial number of the neighbor library's controller card that shares the PTP.

  For the L700e, if the PTP or partner library is not communicating this field will have the value of 0.

- **Vendor Specific**
  This field contains vendor-specific data that should be ignored.

- **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.

  If an "Inquiry" command is sent with a LUN other than 0, the value 7Fh is returned in the Peripheral Qualifier/Device Type byte. This is not an error.

The library returns 7d bytes of supported pages data in the format shown in Table 6-14.

Supported Pages Definition (Fibre)

The supported pages definition (page 00h) for Fibre Channel has seven bytes.

Table 6-14. Supported Pages Definition

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 (03h)							
4	Supported Page (00h)							
5	Supported Page (80h)							
6	Supported Page (83h)							

- **Peripheral Qualifier**
  The library returns a value of 00h, which indicates that the library is a single logical unit. If a LUN other than 0 is sent, the value returned is 011b
  (b indicates binary notation).

- **Peripheral Device Type**
  The library returns a value of 8h, which indicates the library as a medium changer device. If a LUN other than 0 is sent, the value returned is 011b.

- **Page Code**
  This field is set to 00h, which identifies the page as the supported pages page.

- **Page Length**
  This field is set to 03h, which indicates that three vital pages are supported

- **Supported Page**
  The first supported page value is set to 00h, which indicates that the first vital page is page 0 (the current page). The second supported page value is set to 80h, which indicates that the second vital page is page 80 (unit serial number page). The third supported page value is set to 83h, which indicates that the third vital page is page 83 (device identification page).

Unit Serial Number Page Definition (Fibre)

The library returns Fh (15d) bytes of unit serial number page data in the format shown in Table 6-15.

Table 6-15. Unit Serial Number Page Data

<table>
<tr><th rowspan="2">Byte</th><th colspan="8">Bit</th></tr>
<tr><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>0</td><td colspan="3">Peripheral Qualifier</td><td colspan="5">Peripheral Device Type</td></tr>
<tr><td>1</td><td colspan="8">Page Code (80h)</td></tr>
<tr><td>2</td><td colspan="8">Reserved (00h)</td></tr>
<tr><td>3</td><td colspan="8">Additional Page Length (0Bh)</td></tr>
<tr><td>4
to
14</td><td colspan="8">(MSB)
Product Serial Number
(LSB)</td></tr>
</table>

- **Peripheral Qualifier**
  The library returns a value of 000, which indicates that the library is a single logical unit. If a LUN other than 0 is sent, the value returned is 011b
  (b indicates binary notation).
- **Peripheral Device Type**
  The library returns a value of 8h, which indicates the library as a medium changer device. If a LUN other than 0 is sent, the value returned is 1Fh.
- **Page Code**
  This field is set to 80h, identifying the page as the unit serial number page.
- **Page Length**
  This field is set to 0Bh, the number of bytes in the product serial number.
- **Product Serial Number**
  This field contains a unique 11-character ASCII identifier for the library.

  For example: MPC01001020

  Reading from left to right, the first three characters are the name, the next two characters are the site code, and the last six characters are the serial number. This product serial number is the MPC card FRU ID. If the card is replaced, the new MPC card FRU ID is returned.

Device Identification Page (Fibre only)

The library returns 35d bytes of device identification page data (page 83h) in the format shown in Table 6-16.

Table 6-16. Device Identification Page (Fibre)

<table>
<tr><th rowspan="2">Byte</th><th colspan="8">Bit</th></tr>
<tr><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>0</td><td colspan="3">Peripheral Qualifier</td><td colspan="5">Peripheral Device Type</td></tr>
<tr><td>1</td><td colspan="8">Page Code (83h)</td></tr>
<tr><td>2</td><td colspan="8">Reserved</td></tr>
<tr><td>3</td><td colspan="8">Page Length (20h)</td></tr>
<tr><td colspan="9">Node Name Identifier</td></tr>
<tr><td>4</td><td colspan="4">Reserved</td><td colspan="4">Code Set (1)</td></tr>
<tr><td>5</td><td colspan="2">Reserved</td><td colspan="2">Association (0)</td><td colspan="4">Identifier Type (3)</td></tr>
<tr><td>6</td><td colspan="8">Reserved</td></tr>
<tr><td>7</td><td colspan="8">Identifier Length (08h)</td></tr>
<tr><td>8
thru
15</td><td colspan="8">MSB
Identifier (binary)
LSB</td></tr>
<tr><td colspan="9">Port Name Identifier</td></tr>
<tr><td>16</td><td colspan="4">Reserved</td><td colspan="4">Code Set (1)</td></tr>
<tr><td>17</td><td colspan="2">Reserved</td><td colspan="2">Association (1)</td><td colspan="4">Identifier Type (3)</td></tr>
<tr><td>18</td><td colspan="8">Reserved</td></tr>
<tr><td>19</td><td colspan="8">Identifier Length (08h)</td></tr>
<tr><td>20
thru
27</td><td colspan="8">MSB
Identifier (binary)
LSB</td></tr>
<tr><td colspan="9">Port Number Identifier</td></tr>
<tr><td>28</td><td colspan="4">Reserved</td><td colspan="4">Code Set (1)</td></tr>
<tr><td>29</td><td colspan="2">Reserved</td><td colspan="2">Association (1)</td><td colspan="4">Identifier Type (4)</td></tr>
<tr><td>30</td><td colspan="8">Reserved</td></tr>
<tr><td>31</td><td colspan="8">Identifier Length (04h)</td></tr>
</table>

Table 6-16. Device Identification Page (Fibre) (Continued)

Byte	Bit							
	7	6	5	4	3	2	1	0
32 thru 35	MSB Identifier (binary) LSB							

The device identification page (36 bytes) indicates the vendor-specific portion of the IEEE-registered 64-byte ID for a Fibre Channel library. The vendor-specific portion of the ID includes the library's Port name, Node name, and N_Port ID. This information is unique for each Fibre Channel card in each library.

The remaining 28 bytes of the library's ID consist of:

- 5h (a Name Address Authority)
- 00104Fh (Sun StorageTek's company ID)

The following table shows the IEEE-registered format for the full 64-byte identification scheme. The format includes the Name Address Authority (NAA), company ID, and vendor-specific identifier.

Note: You can view this ID through the "Lib Fibre I/F Config Menu." See the library's operator's guide for instructions on accessing this menu.

Table 6-17. Library Identification Scheme

Most Significant Byte			**Least Significant Byte**
63	60	59 36	35 00
NAA		IEEE Company ID	Vendor Specific Identifier
5h		00 10 4Fh	(assigned per FC board)

Every device on the loop must have a unique ID for login validation.

- **Peripheral Qualifier**

  000b Supported logical unit

  011b Unsupported logical unit

- **Peripheral Device Type**

  08h Media changer device (SMC) (library)

  1Fh Unsupported logical unit

- **Code Set**

  1 The identifier field contains binary values.

- **Identifier Type**

  3 The identifier field contains a 64-bit IEEE-registered format address.

- **Identifier Type**

  4 The identifier field contains a 4-byte port number.

- **Identifier Length**

  04h The identifier field is 4 bytes long.

  08h The identifier field is 8 bytes long.

- **Identifier**
  Contains the binary identifier

Log Sense

The “Log Sense” command (4Dh) enables the library to report its error logs and statistics to the initiator (Table 6-18).

Table 6-18. Log Sense Command

Byte	Bit							
	7	6	5	4	3	2	1	0
0	Operation Code (4Dh)							
1	Logical Unit Number			Reserved (0)			PPC (0)	SP (0)
2	PC (1)		Page Code					
3	Reserved (00h)							
4	Reserved (00h)							
5 to 6	(MSB) Parameter Pointer (LSB)							
7 to 8	(MSB) Allocation Length (LSB)							
9	Control (00h)							

- **PPC**
  The library does not support parameter pointer control (PPC). The value must be 0.
- **SP**
  The library does not support the save parameters (SP) feature. The value must be 0.
- **PC**
  The library supports only cumulative values for page control (PC). The value for bit 6 must be 1.

  Note: The library will accept values of 0 or 1 in the PC field if the Page Code is 2Eh.
- **Page Code**
  The library supports:

  0h List Supported Pages

  7h List n Errors Events Page

  2Eh TapeAlert Page (looks for 0 or 1 in PC field)

- **Parameter Pointer**
  The Parameter Pointer allows an initiator to request data starting at a specific parameter code. This value must be 00h for page code 0h.

- **Allocation Length**
  This field 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:

  0h (List Supported Pages) the length is 7h.

  7h (Last n Errors Events Page) the length is 3C4h.

  2Eh (TapeAlert Page) the length is 144h.

Supported Pages Format

The Supported Pages Format page lists all the Log Sense page codes supported by the library (Table 6-19).

Table 6-19. Supported Pages Format

Byte	Bit							
	7	6	5	4	3	2	1	0
0	Reserved (0)		Page Code (00h)					
1	Reserved (00h)							
2 to 3	(MSB) Page Length (n-3) (LSB)							
4	Supported Pages Page Code (00h)							
5	Last n Errors Events Page Code (07h)							
6	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), an optional mechanism, and a count of how many times the error occurred (Table 6-20). Each error event is 48-bytes long, and the list can contain up to 20 events.

Table 6-20. Last n Errors Events Page Format

Byte	**Bit**							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Reserved (0)		Page Code (07h)					
1	Reserved (00h)							
2 **to** **3**	(MSB) Page Length (n–3) (LSB)							
	ASCII String for Event Specified by Parameter Pointer							
4–7	Fault symptom code							
8–23	Mechanism							
24–27	Count							
28–31	Year							
32–33	Month							
34–35	Date							
36–37	Hour							
38–39	Minute							
40–42	Second							
43–51	Pad (ASCII spaces)							
	Additional Events (48d bytes per event)							
n–47 **to** **n**	ASCII String for Last Available Event							

TapeAlert Page

The TapeAlert Log Sense page is read from the library device at the following times as a minimum:

- 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 6-21 lists information about the TapeAlert page format. The “n” represents 64 one-byte alert flags. The TapeAlert page returns 144h bytes.

Table 6-21. TapeAlert Parameter Format

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

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

- **DU**
  The disable update (DU) is always 0, which indicates that the target updates the log parameter value instead of the initiator.
- **DS**
  The disable save (DS) is always 1, which indicates that saving the log is not supported.
- **TSD**
  The target save disable (TSD) value is always 0.
- **ETC**
  The enable threshold comparison (ETC) is always 0.
- **TMC**
  The threshold met criteria (TMC) is always 0.
- **LP**
  The list parameter (LP) bit is always 0, which indicates that the log parameter is a data counter.
- **Parameter Code**
  The Parameter Code is a 2-byte field which represents the TapeAlert Flag number.
- **Parameter Length**
  The Parameter Length is always 0x01. All are 1-byte flags.
- **Value of 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 6-22 lists information about TapeAlert flags. The flags are in sequential order, have valid values of 0 (off) or 1 (on) and all 64 are reported. *The flag names with asterisks (*) are currently supported.*

Table 6-22. TapeAlert Flags

Parameter Code	Flag Name	Flag Type	Description	Length (bytes)
0001h	Library Hardware A *	C	This flag is set when the library cannot communicate with a tape drive. This does *not* cause the library to stop operating.	1
0002h	Library Hardware B *	W	This flag is 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.	1
0003h	Library Hardware C	C	This flag is set when the library has a hardware fault.	1
0004h	Library Hardware D *	C	In the library, this flag is set when camera initialization, calibration, or mechanical initialization test fails.	1
0005h	Library Diagnostics Required	W	This flag is set when the library might have a hardware fault.	1
0006h	Library Interface *	C	This flag is 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.	1
0007h	Predictive Failure	W	This flag is set when a library hardware failure is predicted.	1
0008h	Library Maintenance	W	This flag is set when preventive maintenance is required.	1
0009h	Library Humidity Limits	C	This flag is set when general conditions inside the library exceed the humidity specifications.	1
000Ah	Library Temperature Limits	C	This flag is set when general conditions inside the library exceed the temperature specifications.	1
000Bh	Library Voltage Limits	C	This flag is set when the voltage supply exceeds specifications.	1
000Ch	Library Stray Tape	C	This flag is set when a cartridge was left in a drive because of a previous hardware fault.	1

Table 6-22. TapeAlert Flags (Continued)

Parameter Code	Flag Name	Flag Type	Description	Length (bytes)
000Dh	Library Pick Retry *	W	This flag is set if the hand requires more than one try to pick a cartridge from a cell or drive.	1
000Eh	Library Place Retry *	W	This flag is set if the hand requires more than one try to place a cartridge into a cell.	1
000Fh	Library Load Retry *	W	This flag is set if the hand requires more than one try to place a cartridge into a drive.	1
0010h	Library Door *	C	This flag is set if the door has been opened, and no library motions are allowed. When the door is closed, the library will initialize.	1
0011h	Library Mail slot *	C	This flag is set when the mail slot (cartridge access port) switch has failed.	1
0012h	Library Magazine	C	This flag is set when the library needs the magazine.	1
0013h	Library Security	W	This flag is set when the security was compromised.	1
0014h	Library Security Mode	I	This flag is set when the security mode was changed.	1
0015h	Library Offline *	I	This flag is set when the library has been placed into maintenance mode from the operator panel or a Web interface.	1
0016h	Library Drive Offline	I	This flag is set when a drive was taken offline.	1
0017h	Library Scan Retry *	W	This flag is 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.	1
0018h	Library Inventory	C	This flag is set when the library detected an inconsistency in its inventory.	1
0019h	Library Illegal * Operation	W	This flag is set when an unsupported SCSI command is sent to the library. This is *not* a corrupted command detected for flag 6.	1
001Ah	Dual-Port Interface Error	W	This flag is sent when a redundant interface port on the library has failed.	1
001Bh	Cooling Fan failure	W	This flag is sent when the library cooling fan has failed	1

Table 6-22. TapeAlert Flags (Continued)

Parameter Code	Flag Name	Flag Type	Description	Length (bytes)
001Ch	Power Supply	W	This flag is sent when a redundant power supply has failed inside the library. Check the library users manual for instructions on replacing the failed power supply.	1
001Dh	Power Consumption	W	This flag is sent when the library power consumption is outside the specified range	1
001Eh	Pass-Thru mechanism failure	C	This flag is sent when a failure has occurred in the cartridge Pass-Thru mechanism between two library modules.	1
001Fh	Cartridge in Pass-Thru mechanism	C	This flag is sent when a cartridge has been left in the Pass-Thru mechanism from a previous hardware fault. Check the library *User's Guide* for instructions on clearing this fault.	1
0020h	Unreadable bar code labels	I	The library was unable to read the bar code on a cartridge.	1
Flag Type Key: C - Critical W - Warning I - Information				

Mode Select (SCSI)

The “Mode Select” command (15) enables an initiator to specify certain operating parameters for the library (Table 6-23). The library uses the saved or default versions of these parameters to configure itself:

- During power-on
- Following a reset on the interface
- Upon receiving a Bus Device Reset message

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” 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 6-23. Mode Select Command (SCSI)

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

- **PF**
  The library supports the SCSI-2 page format (PF) 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**
  This field indicates the length of the entire parameter list:

  00h No data is transferred.

10h The Mode Select Parameter Header and the TapeAlert Mode Page are transferred, in that order.

18h The Mode Select Parameter Header and the Element Address Assignment Page are transferred, in that order.

24h The Mode Select Parameter Header and the Network Configuration page are transferred, in that order.

A value of 00h is not considered an error. Any other value is considered an error.

Mode Select Data

The initiator must provide mode parameter data in a parameter list that includes:

- A 4-byte Mode Parameter Header and
- A 20-byte Element Address Assignment Page, or
- A 12-byte TapeAlert Mode Select Page

The mode pages supported by the library for a "Mode Select" command on a SCSI bus are the Element Address Assignment Page and the TapeAlert Mode Select Page. 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 Parameter Header (SCSI)

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

Table 6-24. Mode Select Parameter Header (SCSI)

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

- **Mode Parameter Header Field Definitions**
  For the library, all fields must be 00h (Table 6-24).

Element Address Assignment Mode Page Definition (SCSI)

Table 6-25 defines the Element Address Assignment Mode page.

Table 6-25. Element Address Assignment Mode Page (SCSI)

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	PS (0)	Reserved (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)							

Table 6-25. Element Address Assignment Mode Page (SCSI) (Continued)

Byte	Bit							
	7	6	5	4	3	2	1	0
16 to 17	(MSB) Number of Data Transfer Elements (LSB)							
18	Reserved (00h)							
19	Reserved (00h)							

- **PS** (Page Savable)
  This bit must be 0 for a "Mode Select" command.
- **Page Code**
  A 1Dh identifies the Element Address Assignment mode page.
- **Parameter Length**
  This field 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**
  This field 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**
  This field 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**
  This field 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**
  This field 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**
  This field identifies the address of the first Import/Export element. On an L700 or L180 this address is the first CAP element 000Ah (10d). On an L700e this address is the first PTP element 0008h(8d).
- **Number of Import/Export Elements**
  This field identifies the number of Import/Export storage locations. This value is obtained by 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**
  This field identifies the address of the first tape drive; the default setting address is 1F4h (500d).
- **Number of Data Transfer Elements**
  This field identifies the total number of tape drives installed in the library. The number of Data Transfer Elements varies depending on 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 (SCSI)

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.

The maximum allowable element number that can be configured using a “Mode Select” command is 251Bh (9499d). An attempt to configure an element number greater than this will result in the “Mode Select” command being rejected with a Check Condition status.

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
- Following a reset on the interface
- Upon receiving a Bus Device Reset message

TapeAlert Page (SCSI)

Table 6-26 defines the Mode Select TapeAlert page.

Table 6-26. Mode Select TapeAlert Page (SCSI)

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

- **Perf**
  The performance bit must be 0, which indicates acceptance of informational exception operations that cause delays.
- **DExcpt**
  The exception bit must be 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 target does not generate any false/test informational exception conditions.

  1 The target generates false/test informational exception conditions
- **LogErr**
  The log information exception conditions must be 0, which indicates that the logging of informational exception conditions is vendor-specific.
- **MRIE**
  This field indicates the method that the target uses to report informational exception

conditions. The value must be 3h, which indicates that the target reports any informational exception conditions by returning Check Condition status.

- **Interval Timer**
  Bytes 4 through 7 must be 00h. The target 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, and Bytes 8 through 11 must be set to 00h. This indicates there is no limit to the number of times the target will report the informational exception condition. This value is returned with Mode Sense.

  - When the Flag bit is 1, this field is the test flag number.

  Two test mode options are supported in the current tape alert implementation:

  - Test modes are in the snapshot of all bits supported
  - Test modes for the setting of individual bits.

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 can then 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 can then 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.

See “TapeAlert Flags” on page 6-32 for supported TapeAlert flags.

Network Configuration Page

The following table defines the Network Configuration Page (2Eh), a vendor-specific page for the Sun StorageTek L700, L700e and L180 libraries.

CAUTION:
***Library reset required*: This Mode Select page is intended for use only during library installation. You must reset (re-IPL) the library after you have used this Mode Select page to update the network data.**

Table 6-27. Network Configuration Page

<table>
<tr><th rowspan="2">Byte</th><th colspan="8">Bit</th></tr>
<tr><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>0</td><td>PS (0)</td><td>Reserved (0)</td><td colspan="6">Page Code (2Eh)</td></tr>
<tr><td>1</td><td colspan="8">Parameter Length (1Eh)</td></tr>
<tr><td>2</td><td>Reserved (0)</td><td>SNMP Supp (0)</td><td>HTTP Supp (1)</td><td>IP Info Valid</td><td>DHCP Info Valid</td><td>Enet Info Valid (0)</td><td>Conn Info Valid</td><td>Mac Info Valid</td></tr>
<tr><td>3 to 8</td><td colspan="8">MAC Address (Ethernet)</td></tr>
<tr><td>9</td><td colspan="4">Connection Info</td><td colspan="4">Ethernet Mode (0h)</td></tr>
<tr><td>10</td><td colspan="4">Reserved (0h)</td><td colspan="4">DHCP Info (0h)</td></tr>
<tr><td>11</td><td colspan="8">Reserved (00h)</td></tr>
<tr><td>12 to 15</td><td colspan="8">(MSB)
Internet Protocol (IP) Address
(LSB)</td></tr>
<tr><td>16 to 19</td><td colspan="8">(MSB)
IP Net Mask
(LSB)</td></tr>
<tr><td>20 to 23</td><td colspan="8">(MSB)
IP Gateway
(LSB)</td></tr>
<tr><td>24 to 31</td><td colspan="8">(MSB)
Reserved (00h)
(LSB)</td></tr>
</table>

- **PS** (Page Savable)
  This bit must be 0 for the “Mode Select” command.
- **Page Code**
  A 2Eh identifies the Network Configuration page.
- **Parameter Length**
  This field indicates the length (1Eh) of the Network Configuration page.
- **SNMP Support**
  This bit indicates whether the library supports the Simple Network Management Protocol (SNMP). This bit is valid only for the “Mode Sense” command and is not checked in the “Mode Select” command.
- **HTTP Support**
  This bit indicates whether the library supports the HyperText Transfer Protocol. This bit is valid only for the “Mode Sense” command and is not checked in the “Mode Select” command.
- **IP Information Valid**
  This bit indicates whether the Internet Protocol (IP) information is valid. This bit is valid only for the “Mode Sense” command and is not checked in the “Mode Select” command.
- **DHCP Information Valid**
  This bit indicates whether the Dynamic Host Configuration Protocol (DHCP) information is valid. This bit is valid only for the “Mode Sense” command and is not checked in the “Mode Select” command.
- **Ethernet Information Valid**
  This bit indicates whether the Ethernet information is valid. This bit is valid only for the “Mode Sense” command and is not checked in the “Mode Select” command.
- **Connection Information Valid**
  This bit indicates whether the connection information is valid. This bit is valid only for the “Mode Sense” command and is not checked in the “Mode Select” command.
- **MAC (Ethernet) Information Valid**
  This bit indicates whether the Media Access Control (Ethernet) address information is valid. This bit is valid only for the “Mode Sense” command and is not checked in the “Mode Select” command.
- **MAC (Ethernet) Address**
  This field provides the library’s unique Ethernet (Media Access Control) address. This field is valid only for the “Mode Sense” command and is not checked in the “Mode Select” command.
- **Connection Information**
  This field provides information about the library’s network connection. This field is valid only for the “Mode Sense” command and is not checked in the “Mode Select” command.

- **Ethernet Mode**
  The value in this field indicates the mode of the library's Ethernet connection. This field is valid only for the "Mode Sense" command and is not checked in the "Mode Select" command.

- **DHCP Information**
  This field provides information about the library's Dynamic Host Configuration Protocol. This field is valid only for the "Mode Sense" command and is not checked in the "Mode Select" command.

- **IP Address**
  This field sets the library's IP address.

- **IP Net Mask**
  This field sets the library's network mask address.

- **IP Gateway**
  This field sets the library's network gateway address.

Mode Select (Fibre)

The "Mode Select" command (15) enables an initiator to specify certain operating parameters for the library (Table 6-28). The library uses the saved or default versions of these parameters to configure itself:

- During power-on
- Following a reset on the interface
- Upon receiving a Bus Device Reset message

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" 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 6-28. Mode Select Command (Fibre)

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

- **PF**
  The library supports the SCSI-2 page format (PF) 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**
  This field indicates the length of the entire parameter list:

  00h No data is transferred.

10h The Mode Parameter Header and the TapeAlert Mode Page are transferred, in that order.

0Ch The Mode Parameter Header and the Fibre Channel Logical Unit Control Page are transferred, in that order.

18h The Mode Parameter Header and the Element Address Assignment Page are transferred, in that order.

24h The Mode Parameter Header and the Network Configuration page are transferred, in that order.

A value of 00h is not considered an error. Any other value is considered an error.

Mode Select Data

The initiator must provide mode parameter data in a parameter list that includes:

- A 4-byte Mode Parameter Header and
- A 20-byte Element Address Assignment Page or
- A 12-byte TapeAlert Mode Select Page
- An 8-byte Fibre Channel Logical Unit Control Page (Fibre Channel implementation only)
- An 8-byte Fibre Channel Port Control Page (Fibre Channel implementation only)

In Fibre Channel, the "Mode Select" command supports the Element Address Assignment Page, the TapeAlert Mode Select Page, the Fibre Channel Logical Unit Control Page, and the Fibre Channel Control Port Control Page. 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 Parameter Header (Fibre)

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

Table 6-29. Mode Select Parameter Header (Fibre)

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

- **Mode Parameter Header Field Definitions**
  For the library, all fields must be 00h (Table 6-30).

Fibre Channel Logical Unit Control Page (Fibre only)

The following table shows the format of the Fibre Channel Logical Unit Control page.

Table 6-30. Fibre Channel Logical Unit Control Page (18h)

Byte	Bit							
	7	6	5	4	3	2	1	0
0	PS	Reserved	Page Code (18h)					
1	Page Length (06h)							
2	Reserved							
3	Reserved							EPDC
4	Reserved							
5	Reserved							
6	Reserved							
7	Reserved							

- **PS**
  Parameters Savable bit (must be 0)

  0 Not supported

- **EPDC**
  Enable Precise Delivery Checking (must be 0)

0 Not supported

Note: When the library supports command queuing, this bit will be supported.

Fibre Channel Port Control Page (Fibre only)

The following table shows the format of the Fibre Channel Port Control page.

Table 6-31. Fibre Channel Port Control Page (19h)

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

- **PS**
  Parameters Savable bit (will always be 0)

  0 Not supported

- **DTFD**
  Disable Target Fabric Discovery (must be 0)

  0 Not supported

- **PLPB**
  Prevent Loop Port Bypass (must be 0)

  0 Not supported

- **DDIS**
  Disable Discovery (must be 0)

  0 Not supported

- **DLM**
  Disable Loop Master (must be 0)

  0 Not supported

- **DSA**
  Disable Soft Address (must be 0)

  0 Not supported

- **ALWI**
  Allow Login Without Loop Initialization (must be 0)

  0 Not supported

- **DTIPE**
  Disable Target Initiated Port Enable (must be 0)

  0 Not supported

- **DTOLI**
  Disable Target Originated Loop Initialization (must be 0)

  0 Not supported

- **RR_TOV units**
  (must be 100b)

  100b 10 second units

- **RR_TOV value**
  (must be 1Eh)

  1Eh 300 seconds

Element Address Assignment Mode Page Definition (Fibre)

Table 6-32 defines the Element Address Assignment Mode page.

Table 6-32. Element Address Assignment Mode Page (Fibre)

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

Table 6-32. Element Address Assignment Mode Page (Fibre) (Continued)

Byte	Bit							
	7	6	5	4	3	2	1	0
16 to 17	(MSB) Number of Data Transfer Elements (LSB)							
18	Reserved (00h)							
19	Reserved (00h)							

- **PS** (Page Savable)
  This bit must be 0 for a "Mode Select" command.
- **Page Code**
  A 1Dh identifies the Element Address Assignment mode page.
- **Parameter Length**
  This field 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**
  This field 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**
  This field 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**
  This field 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**
  This field 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**
  This field identifies the address of the first Import/Export element. On an L700 or L180, this address is the first CAP element 000Ah (10d). On an L700e, this address is the first PTP element 0008h(8d).
- **Number of Import/Export Elements**
  This field identifies the number of Import/Export storage locations. This value is obtained by 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**
  This field identifies the address of the first tape drive; the default setting address is 1F4h (500d).

- **Number of Data Transfer Elements**
  This field identifies the total number of tape drives installed in the library. The number of Data Transfer Elements varies depending on 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 (Fibre)

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.

The maximum allowable element number that can be configured using a “Mode Select” command is 251Bh (9499d). An attempt to configure an element number greater than this will result in the “Mode Select” command being rejected with a Check Condition status.

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
- Following a reset on the interface
- Upon receiving a Bus Device Reset message

TapeAlert Page (Fibre)

Table 6-33 defines the Mode Select TapeAlert page.

Table 6-33. Mode Select TapeAlert Page (Fibre)

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

- **Perf**
  The performance bit must be 0, which indicates acceptance of informational exception operations that cause delays.
- **DExcpt**
  The exception bit must be 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 target does not generate any false/test informational exception conditions.

  1 The target generates false/test informational exception conditions.
- **LogErr**
  The log information exception conditions must be 0, which indicates that the logging of informational exception conditions is vendor-specific.
- **MRIE**
  This field indicates the method that the target uses to report informational exception

conditions. The value must be 3h, which indicates that the target reports any informational exception conditions by returning Check Condition status.

- **Interval Timer**
  Bytes 4 through 7 must be 00h. The target 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, and Bytes 8 through 11 must be set to 00h. This indicates there is no limit to the number of times the target will report the informational exception condition. This value is returned with Mode Sense.

  - When the Flag bit is 1, this field is the test flag number.

  Two test mode options are supported in the current tape alert implementation:

  - Test modes are in the snapshot of all bits supported, or
  - Test modes for individual bits.

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.

See "TapeAlert Flags" on page 6-32 for supported TapeAlert flags.

Network Configuration Page

The following table defines the Network Configuration Page (2Eh), a vendor-specific page for the Sun StorageTek L700, L700e and L180 libraries.

CAUTION:
***Library reset required*: This Mode Select page is intended for use only during library installation. You must reset (re-IPL) the library after you have used this Mode Select page to update the network data.**

Table 6-34. Network Configuration Page

Byte	Bit							
	7	6	5	4	3	2	1	0
0	PS (0)	Reserved (0)	Page Code (2Eh)					
1	Parameter Length (1Eh)							
2	Reserved (0)	SNMP Supp (0)	HTTP Supp (1)	IP Info Valid	DHCP Info Valid	Enet Info Valid (0)	Conn Info Valid	Mac Info Valid
3 to 8	MAC Address (Ethernet)							
9	Connection Info				Ethernet Mode (0h)			
10	Reserved (0h)				DHCP Info (0h)			
11	Reserved (00h)							
12 to 15	(MSB) Internet Protocol (IP) Address (LSB)							
16 to 19	(MSB) IP Net Mask (LSB)							
20 to 23	(MSB) IP Gateway (LSB)							
24 to 31	(MSB) Reserved (00h) (LSB)							

- **PS** (Page Savable)
  This bit must be 0 for the “Mode Select” command.
- **Page Code**
  A 2Eh identifies the Network Configuration page.
- **Parameter Length**
  This field indicates the length (1Eh) of the Network Configuration page.
- **SNMP Support**
  This bit indicates whether the library supports the Simple Network Management Protocol (SNMP). This bit is valid only for the “Mode Sense” command and is not checked in the “Mode Select” command.
- **HTTP Support**
  This bit indicates whether the library supports the HyperText Transfer Protocol. This bit is valid only for the “Mode Sense” command and is not checked in the “Mode Select” command.
- **IP Information Valid**
  This bit indicates whether the Internet Protocol (IP) information is valid. This bit is valid only for the “Mode Sense” command and is not checked in the “Mode Select” command.
- **DHCP Information Valid**
  This bit indicates whether the Dynamic Host Configuration Protocol (DHCP) information is valid. This bit is valid only for the “Mode Sense” command and is not checked in the “Mode Select” command.
- **Ethernet Information Valid**
  This bit indicates whether the Ethernet information is valid. This bit is valid only for the “Mode Sense” command and is not checked in the “Mode Select” command.
- **Connection Information Valid**
  This bit indicates whether the connection information is valid.This bit is valid only for the “Mode Sense” command and is not checked in the “Mode Select” command.
- **MAC (Ethernet) Information Valid**
  This bit indicates whether the Media Access Control (Ethernet) address information is valid. This bit is valid only for the “Mode Sense” command and is not checked in the “Mode Select” command.
- **MAC (Ethernet) Address**
  This field provides the library’s unique Ethernet (Media Access Control) address. This field is valid only for the “Mode Sense” command and is not checked in the “Mode Select” command.
- **Connection Information**
  This field provides information about the library’s network connection. This field is valid only for the “Mode Sense” command and is not checked in the “Mode Select” command.

- **Ethernet Mode**
  The value in this field indicates the mode of the library's Ethernet connection. This field is valid only for the "Mode Sense" command and is not checked in the "Mode Select" command.

- **DHCP Information**
  This field provides information about the library's Dynamic Host Configuration Protocol. This field is valid only for the "Mode Sense" command and is not checked in the "Mode Select" command.

- **IP Address**
  This field sets the library's IP address.

- **IP Net Mask**
  This field sets the library's network mask address.

- **IP Gateway**
  This field sets the library's network gateway address.

Mode Sense (SCSI)

The “Mode Sense” command (1A) enables the library to report its operating mode parameters to the initiator (Table 6-35). The initiator can request one page or all pages of the mode parameters.

Note: The initiator can use the “Mode Select” command to change the values of certain mode parameters.

Table 6-35. Mode Sense Command (SCSI)

Byte	Bit							
	7	6	5	4	3	2	1	0
0	Operation Code (1Ah)							
1	Logical Unit Number			Reserved (0)	DBD (1)	Reserved (0)		
2	Page Control		Page Code					
3	Reserved (00h)							
4	Allocation Length							
5	Control Byte (00h)							

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 what the supported length of each page is.

- **DBD** (Disable Block Descriptors)
  This bit should be set to 1 to indicate that the block descriptor should not be returned.

- **Page Control**
  These two bits define the type of parameters to be returned for the “Mode Sense” command, and includes values 0h (00b), 1h (01b), 2h (10b), or 3h (11b):

  00 **Current Values:** The library returns the current parameter values, including:

  - The parameters set in the last successful “Mode Select” command.
  - The default values if saved values are unavailable or invalid.
  - The saved values if a MODE command has not been executed since the last power-on, an interface reset condition, or Bus Device Reset message.

01 **Changeable Values**: The library returns the changeable parameter masks. The requested pages are returned, and 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 by the initiator are set to 0.

10 **Default Values**: The library returns the default values. The requested pages are returned with each supported parameter set to its default value. Parameters not supported by the library are set to 0. The default values for the Element Address Assignment page are based on the configuration of the library.

11 **Saved Values**: The library returns the saved values. Requested pages are returned with each supported parameter 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**
  This field specifies which pages the library returns, including:

  1Ch TapeAlert page

  1Dh Element Address Assignment page

  1Eh Transport Geometry page

  1Fh Device Capabilities page

  2Eh Network Configuration page

  3Fh All pages (in the above order)

- **Allocation Length**
  This field specifies the length of the parameter list the library returns. The maximum length is 3Ch (60d) bytes. The length varies based on the Page Code selected:
  - 4 bytes for the parameter list header (always present)
  - 12 additional bytes for the 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
  - 32 additional bytes for the Network Configuration page (vendor-specific)

  The library transfers the number of bytes specified by the Allocation Length or the available Mode Sense data, whichever is less.

Mode Sense Data (SCSI)

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 on page 6-62. The mode pages available are those defined for medium changers in the SCSI-2 standard, and include a Tape Alert page, an Element Address Assignment page, a Transport Geometry page, and a Device Capabilities page.

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

Mode Parameter Header Definition (SCSI)

Table 6-36 defines the Mode Parameter Header page.

Table 6-36. Mode Parameter Header (SCSI)

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

- **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 and returns a value of 00h.

TapeAlert Page (SCSI)

Table 6-37 defines the Mode Sense TapeAlert page.

Table 6-37. Mode Sense TapeAlert Page (SCSI)

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

- **Perf**
  The performance bit is 0, which indicates acceptance of informational exception operations that cause delays.
- **DExcpt**
  The exception bit is 1, which indicates that the target 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 target 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 target will only report the informational exception condition one time.

- **Report Count**
  Bytes 8 through 11 are set to 00h, which indicates that there is no limit to the number of times the informational exception condition can be reported. For Mode Sense, the report counter is returned.

Element Address Assignment Page Definition (SCSI)

Table 6-38 defines the Element Address Assignment page of the “Mode Sense” command.

Table 6-38. Element Address Assignment Page (SCSI)

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	PS (1)	Reserved (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)							

Table 6-38. Element Address Assignment Page (SCSI) (Continued)

Byte	Bit							
	7	6	5	4	3	2	1	0
16 to 17	(MSB) Number of Data Transfer Elements (LSB)							
18	Reserved (00h)							
19	Reserved (00h)							

- **PS (Page Savable)**
  This bit specifies that the library can save this page to non-volatile memory; the library returns a value of 1.
- **Page Code**
  This field identifies the Element Address Assignment mode page; the library returns a value of 1Dh.
- **Parameter Length**
  This field indicates the amount of element address data following this byte and returns a value of 12h (18d).
- **First Medium Transport Element Address**
  This field identifies the address of the hand in the library. The library has only one hand, so the default address is 0h (0d).
- **Number of Medium Transport Elements**
  This field identifies the number of hands within the library. The library has only one hand, so the value is 0001h (1d).
- **First Storage Element Address**
  This field identifies the starting address of the cartridge tape storage cells. The default starting address is 03E8h (1000d).
- **Number of Storage Elements**
  This field 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 equipped and configured.
- **First Import/Export Element Address**
  This field identifies the address of the first Import/Export element. On an L700 or L180 this address is the first CAP element 000Ah (10d). On an L700e this address is the first PTP element 0008h(8d).
- **Number of Import/Export Elements**
  This field identifies the total number of CAP cells.

- **First Data Transfer Element Address**
  This field identifies the address of the first tape transport installed in the library. The default address is 1F4h (500d).

- **Number of Data Transfer Elements**
  This field identifies the number of tape drives in the library, and the library returns the configured count.

Transport Geometry Mode Page Definition (SCSI)

Table 6-39 gives the Mode Sense Transport Geometry Mode page definition.

Table 6-39. Transport Geometry Mode Page (SCSI)

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

- **PS**
  The value is 0, which indicates that the library cannot save this page to non-volatile memory.
- **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 bytes 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.

  Note: 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 (SCSI)

Table 6-40 defines the Device Capabilities page of the “Mode Sense” command.

Table 6-40. Device Capabilities Page (SCSI)

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

Table 6-40. Device Capabilities Page (SCSI) (Continued)

Byte	Bit							
	7	6	5	4	3	2	1	0
Notes: 1. DT - Data Transfer Element (tape drive) 1. I/E = Import/Export Element (cartridge access port cell and the PTP cells in an L700e) 1. ST = Storage Element (cartridge tape storage cell) 1. MT= Medium Transport (hand)								

- **PS**
  This field indicates the library cannot save this page to non-volatile memory; the library returns a value of 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.
- **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.

Network Configuration Page

The following table defines the Network Configuration Page (2Eh), a vendor-specific page for the Sun StorageTek L700, L700e and L180 libraries.

Table 6-41. Network Configuration Page

<table>
<tr><th rowspan="2">Byte</th><th colspan="8">Bit</th></tr>
<tr><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>0</td><td>PS (0)</td><td>Reserved (0)</td><td colspan="6">Page Code (2Eh)</td></tr>
<tr><td>1</td><td colspan="8">Parameter Length (1Eh)</td></tr>
<tr><td>2</td><td>Reserved (0)</td><td>SNMP Supp (0)</td><td>HTTP Supp (1)</td><td>IP Info Valid</td><td>DHCP Info Valid (1)</td><td>Enet Info Valid (0)</td><td>Conn Info Valid</td><td>Mac Info Valid (1)</td></tr>
<tr><td>3 to 8</td><td colspan="8">MAC Address (Ethernet)</td></tr>
<tr><td>9</td><td colspan="4">Connection Info (2h)</td><td colspan="4">Ethernet Mode (0h)</td></tr>
<tr><td>10</td><td colspan="4">Reserved (0h)</td><td colspan="4">DHCP Info (0h)</td></tr>
<tr><td>11</td><td colspan="8">Reserved (00h)</td></tr>
<tr><td>12 to 15</td><td colspan="8">(MSB)
Internet Protocol (IP) Address
(LSB)</td></tr>
<tr><td>16 to 19</td><td colspan="8">(MSB)
IP Net Mask
(LSB)</td></tr>
<tr><td>20 to 23</td><td colspan="8">(MSB)
IP Gateway
(LSB)</td></tr>
<tr><td>24 to 31</td><td colspan="8">(MSB)
Reserved (00h)
(LSB)</td></tr>
</table>

- **PS** (Page Savable)
  This field indicates the library cannot save this page to non-volatile memory; the library returns a value of 0.

- **Page Code**
  A 2Eh identifies the Network Configuration page.

- **Parameter Length**
  This field indicates the length (1Eh) of the Network Configuration page.
- **SNMP Support**
  This bit indicates whether the library supports the Simple Network Management Protocol (SNMP). Currently, the library does not support SNMP, so the library returns a value of 0.
- **HTTP Support**
  This bit indicates whether the library supports the HyperText Transfer Protocol. The library returns a value of 1 to indicate that the library supports HTTP.
- **IP Information Valid**
  This bit indicates whether the Internet Protocol (IP) information is valid.

  0 The information is *not* valid.

  1 The information is valid.
- **DHCP Information Valid**
  This bit indicates whether the Dynamic Host Configuration Protocol (DHCP) information is valid. Currently, the library does not support DHCP, so the library returns a value of 0.
- **Ethernet Information Valid**
  This bit indicates whether the Ethernet information is valid. Because the library currently does not detect a connection to an Ethernet network, the library returns a value of 0.
- **Connection Information Valid**
  This bit indicates whether the connection information is valid.

  0 The information is *not* valid.

  1 The information is valid.
- **MAC (Ethernet) Information Valid**
  This bit indicates whether the Media Access Control (Ethernet) address information is valid. Because the library's Ethernet address is unique, the library returns a value of 1 to indicate that the information is valid.
- **MAC (Ethernet) Address**
  This field provides the library's unique Ethernet (Media Access Control) address.
- **Connection Information**
  This field provides information about the library's network connection. The library returns a value of 2h to indicate that the library is connected to a 10Base-T network.
- **Ethernet Mode**
  The value in this field indicates the mode of the library's Ethernet connection. Because the library currently does not detect a connection to an Ethernet network, the library returns a value of 0.

- **DHCP Information**
  This field provides information about the library's Dynamic Host Configuration Protocol. Because the library does not currently support DHCP, the library returns a value of 0h.
- **IP Address**
  This field identifies the library's IP address.
- **IP Net Mask**
  This field identifies the library's network mask address.
- **IP Gateway**
  This field identifies the library's network gateway address.

Mode Sense (Fibre)

The “Mode Sense” command (1A) enables the library to report its operating mode parameters to the initiator (Table 6-42). The initiator can request one page or all pages of the mode parameters.

Note: The initiator can use the “Mode Select” command to change the values of certain mode parameters.

Table 6-42. Mode Sense Command (Fibre)

<table>
<tr><th rowspan="2">Byte</th><th colspan="8">Bit</th></tr>
<tr><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>0</td><td colspan="8">Operation Code (1Ah)</td></tr>
<tr><td>1</td><td colspan="3">Logical Unit Number</td><td>Reserved (0)</td><td>DBD (1)</td><td colspan="3">Reserved (0)</td></tr>
<tr><td>2</td><td colspan="2">Page Control</td><td colspan="6">Page Code</td></tr>
<tr><td>3</td><td colspan="8">Reserved (00h)</td></tr>
<tr><td>4</td><td colspan="8">Allocation Length</td></tr>
<tr><td>5</td><td colspan="8">Control Byte (00h)</td></tr>
</table>

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 what the supported length of each page is.

- **DBD** (Disable Block Descriptors)
  This bit should be set to 1 to indicate that the block descriptor should not be returned.

- **Page Control**
  These two bits define the type of parameters to be returned for the “Mode Sense” command, and includes values 0h (00b), 1h (01b), 2h (10b), or 3h (11b):

  00 **Current Values:** The library returns the current parameter values, including:

  - The parameters set in the last successful “Mode Select” command.
  - The default values if saved values are unavailable or invalid.
  - The saved values if a MODE command has not been executed since the last power-on, an interface reset condition, or Bus Device Reset message.

01 **Changeable Values**: The library returns the changeable parameter masks. The requested pages are returned, and 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 by the initiator are set to 0.

10 **Default Values**: The library returns the default values. The requested pages are returned with each supported parameter set to its default value. Parameters not supported by the library are set to 0. The default values for the Element Address Assignment page are based on the configuration of the library.

11 **Saved Values**: The library returns the saved values. Requested pages are returned with each supported parameter 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**
  This field specifies which pages the library returns, including:

  18h Fibre Channel Logical Unit Control page

  19h Fibre Channel Port Control page

  1Ch TapeAlert page

  1Dh Element Address Assignment page

  1Eh Transport Geometry page

  1Fh Device Capabilities page

  2E Network Configuration page

  3Fh All pages (in the above order)

- **Allocation Length**
  This field specifies the length of the parameter list the library returns. The maximum length is 4Ch (76d) bytes. The length varies based on the Page Code selected:

  - 4 bytes for the parameter list header (always present)
  - 8 additional bytes for the Fibre Channel Logical Unit Control page
  - 8 additional bytes for the Fibre Channel Port Control page
  - 12 additional bytes for the 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
  - 32 additional bytes for the Network Configuration page (vendor-specific)

  The library transfers the number of bytes specified by the Allocation Length or the available Mode Sense data, whichever is less.

Mode Sense Data (Fibre)

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 on in the Page Code list (see page 6-79). The mode pages available are those defined for medium changers in the Fibre Channel standard, and include a Fibre Channel Logical Unit Control page, a Fibre Channel Port Control page, a Tape Alert page, an Element Address Assignment page, a Transport Geometry page, and a Device Capabilities page.

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

Mode Parameter Header Definition (Fibre)

Table 6-43 defines the Mode Parameter Header page.

Table 6-43. Mode Parameter Header (Fibre)

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

- **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 and returns a value of 00h.

Fibre Channel Logical Unit Control Page (Fibre only)

The following table shows the format of the Fibre Channel Logical Unit Control page.

Table 6-44. Fibre Channel Logical Unit Control Page (18h)

Byte	Bit							
	7	6	5	4	3	2	1	0
0	PS (0)	Reserved	Page Code (18h)					
1	Page Length (06h)							
2	Reserved							
3	Reserved							EPDC (0)
4	Reserved							
5	Reserved							
6	Reserved							
7	Reserved							

- **PS**
  Parameters Savable bit (will always be 0)

  0 Not supported

- **EPDC**
  Enable Precise Delivery Checking (will always be 0)

  0 Not supported

Note: When the library supports command queuing, this bit will be supported.

Fibre Channel Port Control Page (Fibre only)

The following table shows the format of the Fibre Channel Port Control page.

Table 6-45. Fibre Channel Port Control Page (19h)

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

- **PS**
  Parameters Savable bit (will always be 0)

  0 Not supported

- **DTFD**

  0 Public Loop behavior supported

  1 Private Loop only behavior supported

- **PLPB**
  Prevent Loop Port Bypass (will always be 0)

  0 Not supported

- **DDIS**
  Disable Discovery (will always be 0)

  0 Not supported

- **DLM**
  Disable Loop Master (will always be 0)

  0 Not supported

- **DSA**
  Disable Soft Address (will always be 0)

  0 Not supported

- **ALWI**
  Allow Login Without Loop Initialization (will always be 0)

  0 Not supported

- **DTIPE**
  Disable Target Initiated Port Enable (will always be 0)

  0 Not supported

- **DTOLI**
  Disable Target Originated Loop Initialization (will always be 0)

  0 Not supported

- **RR_TOV units**
  (will always be 100b)

  100b 10 second units

- **RR_TOV value**
  (will always be 1Eh)

  1Eh 300 seconds

TapeAlert Page (Fibre)

Table 6-46 defines the Mode Sense TapeAlert page.

Table 6-46. Mode Sense TapeAlert Page (Fibre)

<table>
<tr><th rowspan="2">Byte</th><th colspan="8">Bit</th></tr>
<tr><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>0</td><td colspan="8">Page Code (1Ch)</td></tr>
<tr><td>1</td><td colspan="8">Page Length (0Ah)</td></tr>
<tr><td>2</td><td>Perf (0)</td><td colspan="3">Reserved (0)</td><td>DExcpt (1)</td><td>Test (0)</td><td>Reserved (0)</td><td>LogErr (0)</td></tr>
<tr><td>3</td><td colspan="4">Reserved (0h)</td><td colspan="4">MRIE (3h)</td></tr>
<tr><td>4 to 7</td><td colspan="8">(MSB)
Interval Timer
(LSB)</td></tr>
<tr><td>8 to 11</td><td colspan="8">(MSB)
Report Counter/Test Flag Number
(LSB)</td></tr>
</table>

- **Perf**
  The performance bit is 0, which indicates acceptance of informational exception operations that cause delays.

- **DExcpt**
  The exception bit is 1, which indicates that the target 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 target 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 target will only report the informational exception condition one time.
- **Report Count**
  Bytes 8 through 11 are set to 00h, which indicates that there is no limit to the number of times the informational exception condition can be reported. For Mode Sense, the report counter is returned.

Element Address Assignment Page Definition (Fibre)

Table 6-47 defines the Element Address Assignment page of the “Mode Sense” command.

Table 6-47. Element Address Assignment Page (Fibre)

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

Table 6-47. Element Address Assignment Page (Fibre) (Continued)

Byte	Bit							
	7	6	5	4	3	2	1	0
16 to 17	(MSB) Number of Data Transfer Elements (LSB)							
18	Reserved (00h)							
19	Reserved (00h)							

- **PS (Page Savable)**
  This bit specifies that the library can save this page to non-volatile memory; the library returns a value of 1.
- **Page Code**
  This field identifies the Element Address Assignment mode page; the library returns a value of 1Dh.
- **Parameter Length**
  This field indicates the amount of element address data following this byte and returns a value of 12h (18d).
- **First Medium Transport Element Address**
  This field identifies the address of the hand in the library. The library has only one hand, so the default address is 0h (0d).
- **Number of Medium Transport Elements**
  This field identifies the number of hands within the library. The library has only one hand, so the value is 0001h (1d).
- **First Storage Element Address**
  This field identifies the starting address of the cartridge tape storage cells. The default starting address is 03E8h (1000d).
- **Number of Storage Elements**
  This field 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 equipped and configured.
- **First Import/Export Element Address**
  This field identifies the address of the first Import/Export element. On an L700 or L180 library, this address is the first CAP element 000Ah (10d). On an L700e library, this address is the first PTP element 0008h(8d).
- **Number of Import/Export Elements**
  This field identifies the total number of CAP cells.

- **First Data Transfer Element Address**
  This field identifies the address of the first tape transport installed in the library. The default address is 1F4h (500d).

- **Number of Data Transfer Elements**
  This field identifies the number of tape drives in the library, and the library returns the configured count.

Transport Geometry Mode Page Definition (Fibre)

Table 6-48 gives the Mode Sense Transport Geometry Mode page definition.

Table 6-48. Transport Geometry Mode Page (Fibre)

<table>
<tr><th rowspan="2">Byte</th><th colspan="8">Bit</th></tr>
<tr><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>0</td><td>PS (0)</td><td>Reserved (0)</td><td colspan="6">Page Code (1Eh)</td></tr>
<tr><td>1</td><td colspan="8">Parameter Length (02h)</td></tr>
<tr><td>2</td><td colspan="7">Reserved (00h)</td><td>Rotate (0)</td></tr>
<tr><td>3</td><td colspan="8">Member Number in Transport Element Set (00h)</td></tr>
</table>

- **PS**
  The value is 0, which indicates that the library cannot save this page to non-volatile memory.

- **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 bytes 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.

  Note: 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 (Fibre)

Table 6-49 defines the Device Capabilities page of the "Mode Sense" command.

Table 6-49. Device Capabilities Page (Fibre)

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

Table 6-49. Device Capabilities Page (Fibre) (Continued)

Byte	Bit							
	7	6	5	4	3	2	1	0
Notes: 1. DT - Data Transfer Element (tape drive) 2. I/E = Import/Export Element (cartridge access port cell and the PTP cells in an L700e)) 3. ST = Storage Element (cartridge tape storage cell) 4. MT= Medium Transport (hand)								

- **PS**
  This field indicates the library cannot save this page to non-volatile memory; the library returns a value of 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.
- **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.

Network Configuration Page

The following table defines the Network Configuration Page (2Eh), a vendor-specific page for the Sun StorageTek L700, L700e and L180 libraries.

Table 6-50. Network Configuration Page

<table>
<tr><th rowspan="2">Byte</th><th colspan="8">Bit</th></tr>
<tr><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>0</td><td>PS (0)</td><td>Reserved (0)</td><td colspan="6">Page Code (2Eh)</td></tr>
<tr><td>1</td><td colspan="8">Parameter Length (1Eh)</td></tr>
<tr><td>2</td><td>Reserved (0)</td><td>SNMP Supp (0)</td><td>HTTP Supp (1)</td><td>IP Info Valid</td><td>DHCP Info Valid (1)</td><td>Enet Info Valid (0)</td><td>Conn Info Valid</td><td>Mac Info Valid (1)</td></tr>
<tr><td>3 to 8</td><td colspan="8">MAC Address (Ethernet)</td></tr>
<tr><td>9</td><td colspan="4">Connection Info (2h)</td><td colspan="4">Ethernet Mode (0h)</td></tr>
<tr><td>10</td><td colspan="4">Reserved (0h)</td><td colspan="4">DHCP Info (0h)</td></tr>
<tr><td>11</td><td colspan="8">Reserved (00h)</td></tr>
<tr><td>12 to 15</td><td colspan="8">(MSB)
Internet Protocol (IP) Address
(LSB)</td></tr>
<tr><td>16 to 19</td><td colspan="8">(MSB)
IP Net Mask
(LSB)</td></tr>
<tr><td>20 to 23</td><td colspan="8">(MSB)
IP Gateway
(LSB)</td></tr>
<tr><td>24 to 31</td><td colspan="8">(MSB)
Reserved (00h)
(LSB)</td></tr>
</table>

- **PS** (Page Savable)
  This field indicates the library cannot save this page to non-volatile memory; the library returns a value of 0.
- **Page Code**
  A 2Eh identifies the Network Configuration page.

- **Parameter Length**
  This field indicates the length (1Eh) of the Network Configuration page.

- **SNMP Support**
  This bit indicates whether the library supports the Simple Network Management Protocol (SNMP). Currently, the library does not support SNMP, so the library returns a value of 0.

- **HTTP Support**
  This bit indicates whether the library supports the HyperText Transfer Protocol. The library returns a value of 1 to indicate that the library supports HTTP.

- **IP Information Valid**
  This bit indicates whether the Internet Protocol (IP) information is valid.

  0 The information is *not* valid.

  1 The information is valid.

- **DHCP Information Valid**
  This bit indicates whether the Dynamic Host Configuration Protocol (DHCP) information is valid. Currently, the library does not support DHCP, so the library returns a value of 0.

- **Ethernet Information Valid**
  This bit indicates whether the Ethernet information is valid. Because the library currently does not detect a connection to an Ethernet network, the library returns a value of 0.

- **Connection Information Valid**
  This bit indicates whether the connection information is valid.

  0 The information is *not* valid.

  1 The information is valid.

- **MAC (Ethernet) Information Valid**
  This bit indicates whether the Media Access Control (Ethernet) address information is valid. Because the library's Ethernet address is unique, the library returns a value of 1 to indicate that the information is valid.

- **MAC (Ethernet) Address**
  This field provides the library's unique Ethernet (Media Access Control) address.

- **Connection Information**
  This field provides information about the library's network connection. The library returns a value of 2h to indicate that the library is connected to a 10Base-T network.

- **Ethernet Mode**
  The value in this field indicates the mode of the library's Ethernet connection. Because the library currently does not detect a connection to an Ethernet network, the library returns a value of 0.

- **DHCP Information**
  This field provides information about the library's Dynamic Host Configuration Protocol. Since the library does not currently support DHCP, the library returns a value of 0h.

- **IP Address**
  This field identifies the library's IP address.

- **IP Net Mask**
  This field identifies the library's network mask address.

- **IP Gateway**
  This field identifies the library's network gateway address.

Move Medium

The “Move Medium” command (A5) moves a cartridge tape from one specific element location to another specific element location (Table 6-51).

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.

If one audits the playground (see “Reserved Cells” on page A-5 and “PlyGrnd” on page 6-114) and there is a cartridge in the top cell (also known as the swap cell), the user can retrieve this cartridge through normal use of the “Move Medium” command (A5). The element address of this cell is 10,000 (2710h) and it may only be used as a source address—not a destination address.

Table 6-51. Mode Move Medium Command

Byte	Bit							
	7	6	5	4	3	2	1	0
0	Operation Code (A5h)							
1	Logical Unit Number			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)					

- **Transport Element Address**
  This field defines the hand element to use and should contain the element address of the hand or 00h. A value of 00h indicates use of the default hand.

- **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.

Note: 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.

Note: 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” (5E) and “Persistent Reserve Out” (5F) commands resolve contention among multiple initiators and multiple-port targets within the system.

Note: Do not use these commands with either the “Reserve” command or the “Release” command.

The library uses the “Persistent Reserve In” command to identify which initiators are holding conflicting or invalid persistent reservations. The command’s format appears in Table 6-52.

Table 6-52. Persistent Reserve In Command

Byte	Bit							
	7	6	5	4	3	2	1	0
0	Operation Code (5Eh)							
1	Reserved			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)							

- **Service Action**
  This field defines the type of request that is being made to the initiator. Valid values are 00h and 01h. Values 02h through 1Fh are reserved.

  00h The initiator reads all registered reservation keys

  01h The initiator reads all current persistent reservations

- **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 initiator return a list of all the current Reservation keys it has registered. Refer to Table 6-53 for the format of the parameter data returned in response to a "Persistent Reserve In" command with the Read Keys service action.

Table 6-53. Read Keys Parameter Data

Byte	Bit							
	7	6	5	4	3	2	1	0
0 to 3	(MSB) Generation (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)							

- **Generation**
  This value is a 32-bit counter that is incremented every time a "Persistent Reserve Out" command requests a Register, a Clear, a Preempt, or a Preempt and Abort operation. It allows the library to verify that its configuration of initiators has not been illegally modified.

- **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 initiator return a description of all current Reservation keys it has registered. Refer to Table 6-54 for the format of the parameter data returned in response to a "Persistent Reserve In" command with the Read Reservations service action.

Table 6-54. Read Reservations Parameter Data

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

- **Generation**
  This value is a 32-bit counter that is incremented every time a "Persistent Reserve Out" command requests a Register, a Clear, a Preempt, or a Preempt and Abort operation. It allows the library to verify that its configuration of initiators has not been illegally modified.
- **Additional Length**
  This field indicates the number of bytes in the list of reservation descriptors.
- **Reservation Descriptors**
  Each persistent reservation for a logical unit has one reservation descriptor that has the format shown in Table 6-55 on page 6-103.

Table 6-55. Reservation Descriptors Format

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

- **Reservation Key**
  This value indicates the reservation key for the descriptor data that follows.
- **Scope-specific Address**
  If the scope is an Element Reservation, the Scope-specific Address field will contain the element address. The address will be zero-filled in the most significant bytes to fit the field.
- **Scope**
  The value in the Scope field indicates whether a persistent reservation applies to an entire logical unit or to an element. Valid values are 0h and 2h.

0h The persistent reservation applies to the logical unit

2h The persistent reservation applies to the element

- **Type**
  This value specifies the characteristics of the persistent reservation. Valid values are 3h and 6h.

3h **Exclusive Access:** This value indicates that the initiator holding the persistent reservation has exclusive read and write access. If any other initiator requests a data transfer to or from the target, the result will be a reservation conflict.

6h **Exclusive Access, Registrants Only:** This value indicates that any currently registered initiator has exclusive read and write access. If any non-registered initiator requests a data transfer to or from the target, the result will be a reservation conflict.

Persistent Reserve Out

The “Persistent Reserve Out” (5F) command reserves a target for the exclusive or shared use of an initiator. The command’s format appears in Table 6-56.

Table 6-56. Persistent Reserve Out Command

Byte	Bit							
	7	6	5	4	3	2	1	0
0	Operation Code (5Fh)							
1	Reserved (000)			Service Action				
2	Scope				Type			
3	Reserved (00h)							
4	Reserved (00h)							
5	Reserved (00h)							
6	Reserved (00h)							
7 to 8	(MSB) Parameter List Length (18h) (LSB)							
9	Control (00h)							

- **Service Action**
  This value indicates the action that will result from the “Persistent Reservation” command:

  00h **Register**: Register a reservation key with the device server 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.

  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 device server.

- **Scope**
  The value in the Scope field indicates whether a persistent reservation applies to an entire logical unit or to an element. Valid values are 0h and 2h.

  0h The persistent reservation applies to the logical unit

  2h The persistent reservation applies to the element

- **Type**
  This value specifies the characteristics of the persistent reservation. Valid values are 3h and 6h.

  3h **Exclusive Access:** This value indicates that the initiator holding the persistent reservation has exclusive read and write access. If any other initiator requests a data transfer to or from the target, the result will be a reservation conflict.

  6h **Exclusive Access, Registrants Only:** This value indicates that any registered initiator has read and write access. If any non-registered initiator requests a data transfer to or from the target, the result will be a reservation conflict.

- **Parameter List Length**
  This value should always specify a field length of 18h (24d) bytes. The parameter data for the "Persistent Reserve Out" command includes all fields, even when a field is not required for the specified service action.

- **Parameter List**
  The parameter list for the "Persistent Reserve Out" command has the format shown in Table 6-57 on page 6-107.

Table 6-57. 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) Scope-specific Address (LSB)							
20	Reserved (00h)							APTPL
21	Reserved (00h)							
22 to 23	Obsolete (00h)							

- **Reservation Key**
  This field contains an eight-byte value that identifies the initiator.

- **Service Action Reservation Key**
  This field contains information needed for three service actions: Register, Preempt, and Preempt and Abort. Refer to Table 6-58 for definitions of these actions.

Table 6-58. Service Action Reservation Key Information

If the service action[1] is...	Then the information in this field is...
Register	the new reservation key to be registered
Preempt	the reservation key of the persistent reservation being preempted
Preempt and Abort	the reservation key of the persistent reservation being preempted

1. For a list of service action values, see 6-105.

- **Scope-specific Address**
  If the scope is an Element Reservation, the Scope-specific Address field will contain the element address. The address will be zero-filled in the most significant bytes to fit

the field. If the service action is Register or Clear or if the scope is a Logical Unit reservation, the Scope-specific Address field will be set to 0.

- **APTPL (Activate Persist Through Power Loss)**
  This bit is valid only for the Register service action:

0	The loss of power in the target releases all persistent reservations and sets all reservation keys to their default value of 0.
1	The loss of power in the target causes the target to store all persistent reservations and all reservation keys for all initiators.

Position to Element

The “Position to Element” command (2B) moves the hand to the specified element (Table 6-59).

Table 6-59. Position to Element Command

Byte	Bit							
	7	6	5	4	3	2	1	0
0	Operation Code (2Bh)							
1	Logical Unit Number			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	Count Byte (00h)							

- **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 (1E) requests that the library enable or disable operator panel access to the cartridge access port (CAP). Refer to Table 6-60 for the command's format.

- 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.

On an L700e, the "Prevent/Allow Medium Removal" command has no effect on the Pass-Thru-Port; it can only be used to affect access to the CAPs.

Table 6-60. Prevent/Allow Medium Removal Command

Byte	Bit							
	7	6	5	4	3	2	1	0
0	Operation Code (1Eh)							
1	Logical Unit Number			Reserved (00h)				
2	Reserved (00h)							
3	Reserved (00h)							
4	Reserved (00h)							Prevent
5	CAP B	CAP A	Control Byte (00h)					

- **Prevent Bit**
  The prevent values are:

  0 The library allows operator panel access to unlock and open the indicated CAP.

  1 The library prevents access to the indicated CAP.

- **CAP B and CAP A Bits**
  The value of these bits indicates how the library should apply the prevent/allow data. The values are:

  00 The library applies the prevent/allow action to both CAPs.

01 The library applies the prevent/allow action to CAP B but not to CAP A.

10 The library applies the prevent/allow action to CAP A but not to CAP B.

11 The library applies the prevent/allow action to *neither* CAP.

Note: If the library contains only one CAP, the values in these fields should be 0. This applies to L700 and L700e libraries with a single CAP and to all L180 libraries.

Read Element Status

The “Read Element Status” command (B8) requests that the library return the status of the elements in the library (Table 6-61).

Table 6-61. Read Element Status Command

<table>
<tr><th rowspan="2">Byte</th><th colspan="8">Bit</th></tr>
<tr><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>0</td><td colspan="8">Operation Code (B8h)</td></tr>
<tr><td>1</td><td colspan="3">Logical Unit Number</td><td>VolTag</td><td colspan="4">Element Type Code</td></tr>
<tr><td>2
to
3</td><td colspan="8">(MSB)
Starting Element Address
(LSB)</td></tr>
<tr><td>4
to
5</td><td colspan="8">(MSB)
Number of Elements
(LSB)</td></tr>
<tr><td>6</td><td colspan="6">Reserved (00h)</td><td>CurData</td><td>DvcID</td></tr>
<tr><td>7
to
9</td><td colspan="8">(MSB)
Allocation Length
(LSB)</td></tr>
<tr><td>10</td><td colspan="8">Reserved (00h)</td></tr>
<tr><td>11</td><td>PlyGrnd</td><td colspan="7">Control Byte (00h)</td></tr>
</table>

- **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 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**
  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 (see note below)

  Note: Current databit is 1. The library will still audit the CAP and PTP if the CAP has just been closed or the PTP is unknown.

- **DvcID**
  The device identification bit indicates whether the return data will contain device identification information.

  0 The target will not return device identification information.

  1 The target 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.

• **PlyGrnd**
This bit indicates whether to report the playground cells. In order to have the playground reported you must set this bit and, in addition, you must set the Element Type Code to 0 (all element types). If the element type code is not 0 and this bit is set, a Check Condition will be returned. Also since this is a vendor-unique extension, it operates a little differently than the normal "Read Element Status" command. If the user wants the playground reported, the Allocation length must be large enough to fit all the data. Thus, if you request the playground, you get all the cells reported or none.

• **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 6-62).

Table 6-62. Element Status Data 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 (00h)							
5 to 7	(MSB) Byte Count of Report Available (all pages, n-7) (LSB)							
8 to n	Element Status page(s)							

- **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 6-63).

Table 6-63. Element Status Page Header

Byte	Bit							
	7	6	5	4	3	2	1	0
0	Element Type Code							
1	PVolTag	AVolTag (0)	Reserved (0)					
2 to 3	(MSB) Element Descriptor Length (LSB)							
4	Reserved (00h)							
5 to 7	(MSB) Byte Count of Report Available (all pages, n-7) (LSB)							
8 to n	Element Descriptor(s)							

- **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 and PTP cells)

  04h Data Transfer Element (tape drive)

  FFh Playground Elements (cleaning and diagnostic storage cells)

- **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

The medium transport element is the hand. The library contains one hand. The Medium Transport Element Descriptor defines the hand's characteristics (Table 6-64).

Table 6-64. 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	Reserved (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)					
10 to 11	(MSB) Source Storage Element Address (LSB)							
12 to 47	Primary Volume Tag Information (Field omitted if PVolTag=0)							
48 to 51	Reserved (00h, 00h, 00h, 00h) (Field moved up if Primary Volume Tag Information omitted.)							
52	Media Domain (Field moved up if Primary Volume Tag Information omitted.)							
53	Media Type (Field moved up if Primary Volume Tag Information omitted.)							

Table 6-64. Medium Transport Element Descriptor (Continued)

Byte	Bit							
	7	6	5	4	3	2	1	0
54 to 55	Reserved (00h, 00h) (Field moved up if Primary Volume Tag Information omitted.)							

- **Element Address**
  This field contains the element address of the hand.
- **Except**
  This bit indicates the current operational state of the hand:

  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.

- **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.

- **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:

00h	The element contains a 9x40 half-inch form factor cartridge.
01h or 53h	The element contains a DLT/SDLT form factor cartridge (53h is 'S').
43h	The element contains an LTO, T10000 (or future) cleaning form factor cartridge (43h 'C').
4Ch	The element contains an LTO form factor cartridge (4Ch is 'L').
54h	The element contains a T10000 form factor cartridge (54h is 'T').
FFh	The media domain cannot be determined.

  Note: 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 00h, the value reported for the Media Type field conforms to the ANSI standard for media characters on 9x40 half-inch form factor cartridges:

R	The element contains a standard 9840 cartridge.
U	The element contains a 9840 cleaning cartridge.
P	The element contains a standard 9940 cartridge (L700 only).
W	The element contains a 9940 cleaning cartridge (L700 only).

Y The element contains a 9840D cleaning cartridge.

FFh The media type cannot be determined.

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

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

C The element contains a DLT CompacTape III cartridge or a DLT cleaning cartridge.

D The element contains a DLT CompacTape IV cartridge.

E The element contains a DLT CompacTape III XT cartridge.

S The element contains an SDLT cartridge.

2 The element contains an SDLT II cartridge or cleaning cartridge.

4 The element contains a DLTtape S4 cartridge or cleaning cartridge.

FFh The media type cannot be determined.

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

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.

T The element contains a T10000 cleaning cartridge.

FFh The media type cannot be determined.

Note: 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 a 800 GB Generation 4 LTO cartridge.

A The element contains a 50 GB Generation 1 LTO cartridge.

B The element contains a 35 GB Generation 1 LTO cartridge.

C The element contains a 10 GB Generation 1 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.

FFh The media type cannot be determined.

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

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 element cannot be determined.

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

If the Media Domain field is 54h (54h is 'T'), the value reported for the Media Type field identifies in ASCII the type of T10000 cartridge:

1 The element contains a standard T10000 cartridge.

S The element contains a Sport T10000 cartridge.

FFh The element cannot be determined.

Note: 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 6-65).

Table 6-65. 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	Reserved (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)					
10 to 11	(MSB) Source Storage Element Address (LSB)							
12 to 47	Primary Volume Tag Information (Field omitted if PVolTag=0)							
48 to 51	Reserved (00h, 00h, 00h, 00h) (Field moved up if Primary Volume Tag Information omitted.)							
52	Media Domain (Field moved up if Primary Volume Tag Information omitted.)							
53	Media Type (Field moved up if Primary Volume Tag Information omitted.)							

Table 6-65. Storage Element Descriptor (Continued)

Byte	Bit							
	7	6	5	4	3	2	1	0
54 to 55	Reserved (00h, 00h) (Field moved up if Primary Volume Tag Information omitted.)							

- **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.

- **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.

- **Media Domain**
  The Media Domain field, along with the Media Type field, provide a hierarchy of information that indicates the type of media in the element:

00h	The element contains a 9x40 half-inch form factor cartridge.
01h or 53h	The element contains a DLT/SDLT form factor cartridge (53h is ‘S’).
43h	The element contains an LTO, T10000 (or future) cleaning form factor cartridge (43h ‘C’).
4Ch	The element contains an LTO form factor cartridge (4Ch is ‘L’).
54h	The element contains a T10000 form factor cartridge (54h is ‘T’).
FFh	The media domain cannot be determined.

  Note: 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 00h, the value reported for the Media Type field conforms to the ANSI standard for media characters on 9x40 half-inch form factor cartridges:

R	The element contains a standard 9840 cartridge.
U	The element contains a 9840 cleaning cartridge.
P	The element contains a standard 9940 cartridge (L700 only).

W	The element contains a 9940 cleaning cartridge (L700 only).
Y	The element contains a 9840D cleaning cartridge.
FFh	The media type cannot be determined.

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

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

C	The element contains a DLT CompacTape III cartridge or a DLT cleaning cartridge.
D	The element contains a DLT CompacTape IV cartridge.
E	The element contains a DLT CompacTape III XT cartridge.
S	The element contains an SDLT I cartridge or cleaning cartridge.
2	The element contains an SDLT II cartridge or cleaning cartridge.
4	The element contains a DLTtape S4 cartridge or cleaning cartridge.
FFh	The media type cannot be determined.

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

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.
T	The element contains a T10000 cleaning cartridge.
FFh	The media type cannot be determined.

Note: 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 a 800 GB Generation 4 LTO cartridge.
A	The element contains a 50 GB Generation 1 LTO cartridge.

B The element contains a 35 GB Generation 1 LTO cartridge.

C The element contains a 10 GB Generation 1 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.

FFh The media type cannot be determined.

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

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.

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

If the Media Domain field is 54h (54h is 'T'), the value reported for the Media Type field identifies in ASCII the type of T10000 cartridge:

1 The element contains a standard T10000 cartridge.

S The element contains a Sport T10000 cartridge.

FFh The media type cannot be determined.

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

Import/Export Element Descriptor Definitions

Import/Export elements are the CAP cells of the library. The Import/Export Element Descriptor describes a CAP cell (Table 6-66).

Table 6-66. Import/Export Element Descriptor

Byte	Bit							
	7	6	5	4	3	2	1	0
0 to 1	(MSB) Element Address (LSB)							
2	Reserved (00)	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)					
10 to 11	(MSB) Source Storage Element Address (LSB)							
12 to 47	Primary Volume Tag Information (Field omitted if PVolTag=0)							
48 to 51	Reserved (00h, 00h, 00h, 00h) (Field moved up if Primary Volume Tag Information omitted.)							
52	Media Domain (Field moved up if Primary Volume Tag Information omitted.)							
53	Media Type (Field moved up if Primary Volume Tag Information omitted.)							

Table 6-66. Import/Export Element Descriptor (Continued)

Byte	Bit							
	7	6	5	4	3	2	1	0
54 to 55	Reserved (00h, 00h) (Field moved up if Primary Volume Tag Information omitted.)							

- **Element Address**
  This field contains the element address of the import/export element reported.
- **CMC**
  This bit indicates if the import/export element is a PTP or a CAP. When the bit is set the import/export element is a PTP. When the bit is not set the import/export element is a CAP. A connected media changer (CMC) bit of one indicates that exports are to a connected media changer's domain and imports are from a connected media changer's domain. A CMC bit of zero indicates that exports are to the operator's domain and imports are from the operator's domain.

  If the CMC bit is zero, media shall not leave the domain of the media changer when prevented by the "PREVENT ALLOW MEDIA REMOVAL" command (see SPC). If the CMC bit is one, the "PREVENT ALLOW MEDIA REMOVAL" command shall not prevent export operations to a connected media changer.
- **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 access is allowed to the import/export 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.

  Note: 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.
- **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.

- **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:

00h	The element contains a 9x40 half-inch form factor cartridge.
01h or 53h	The element contains a DLT/SDLT form factor cartridge (53h is 'S').
43h	The element contains an LTO, T10000, (or future) cleaning form factor cartridge (43h 'C').
4Ch	The element contains an LTO form factor cartridge (4Ch is 'L').
54h	The element contains a T10000 form factor cartridge (54h is 'T').
FFh	The media domain cannot be determined.

Note: 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 00h, the value reported for the Media Type field conforms to the ANSI standard for media characters on 9x40 half-inch form factor cartridges:

R	The element contains a standard 9840 cartridge.
U	The element contains a 9840 cleaning cartridge.
P	The element contains a standard 9940 cartridge (L700 only).
W	The element contains a 9940 cleaning cartridge (L700 only).
Y	The element contains a 9840D cleaning cartridge.
FFh	The media type cannot be determined.

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

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

C	The element contains a DLT CompacTape III cartridge or a DLT cleaning cartridge.
D	The element contains a DLT CompacTape IV cartridge.
E	The element contains a DLT CompacTape III XT cartridge.
S	The element contains an SDLT I cartridge or cleaning cartridge.
2	The element contains an SDLT II cartridge or cleaning cartridge.
4	The element contains a DLTtape S4 cartridge or cleaning cartridge.
FFh	The media type cannot be determined.

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

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.
T	The element contains a T10000 cleaning cartridge.
FFh	The media type cannot be determined.

Note: 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.
A	The element contains a 50 GB Generation 1 LTO cartridge.
B	The element contains a 35 GB Generation 1 LTO cartridge.
C	The element contains a 10 GB Generation 1 LTO cartridge.
T	The element contains a 400 GB Generation 3 LTO WORM cartridge.
U	The element contains a 800 GB Generation 4 LTO WORM cartridge.

FFh The media type cannot be determined.

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

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.

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

If the Media Domain field is 54h (54h is 'T'), the value reported for the Media Type field identifies in ASCII the type of T10000 cartridge:

1 The element contains a standard T10000 cartridge.

S The element contains a Sport T10000 cartridge.

FFh The media type cannot be determined.

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

Data Transfer Element Descriptor Definitions (DvcID = 0)

Data transfer elements are the tape drives in the library. The Data Transfer Element Descriptor Definitions page describes a tape drive. Table 6-67 shows the data returned when the DvcID bit in the command is set to 0.

Table 6-67. Data Transfer Element Descriptor (DvcID = 0)

<table>
<tr><th rowspan="2">Byte</th><th colspan="8">Bit</th></tr>
<tr><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>0 to 1</td><td colspan="8">(MSB)
Element Address
(LSB)</td></tr>
<tr><td>2</td><td colspan="4">Reserved (0h)</td><td>Access</td><td>Except</td><td>Reserved (0)</td><td>Full</td></tr>
<tr><td>3</td><td colspan="8">Reserved (00h)</td></tr>
<tr><td>4</td><td colspan="8">Additional Sense Code</td></tr>
<tr><td>5</td><td colspan="8">Additional Sense Code Qualifier</td></tr>
<tr><td>6</td><td>NotBus</td><td>Reserved (0)</td><td>ID Vld</td><td>LU Vld (0)</td><td>Reserved (0)</td><td colspan="3">LUN (0)</td></tr>
<tr><td>7</td><td colspan="8">SCSI Bus Address</td></tr>
<tr><td>8</td><td colspan="8">Reserved (00h)</td></tr>
<tr><td>9</td><td>SValid</td><td>Invert (0)</td><td colspan="6">Reserved (00h)</td></tr>
<tr><td>10 to 11</td><td colspan="8">(MSB)
Source Storage Element Address
(LSB)</td></tr>
<tr><td>12 to 47</td><td colspan="8">Primary Volume Tag Information
(Field omitted if PVolTag = 0)</td></tr>
<tr><td>48 to 51</td><td colspan="8">Reserved (00h, 00h, 00h, 00h)
(Field moved up if Primary Volume Tag information omitted.)</td></tr>
<tr><td>52</td><td colspan="8">Media Domain
(Field moved up if Primary Volume Tag information omitted.)</td></tr>
<tr><td>53</td><td colspan="8">Media Type
(Field moved up if Primary Volume Tag information omitted.)</td></tr>
</table>

Table 6-67. Data Transfer Element Descriptor (DvcID = 0) (Continued)

Byte	Bit							
	7	6	5	4	3	2	1	0
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)							

- **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.

- **Not Bus**
  This bit will only be valid if the ID is valid. A value of 1 indicates that the SCSI bus address and LUN reported for this tape drive are not on the same SCSI bus as the medium changer device. This value is set when the drive information is set during configuration.

- **ID Valid**
  If this bit is 1h, the SCSI Bus Address field is valid.

- **LU Valid**
  The library does not support this bit and returns a value of 0.

- **Logical Unit Number**
  The library does not support this field and returns a value of 0.

- **SCSI Bus Address**
  The user configures the SCSI Bus Address field. The library returns the SCSI bus address of the data transfer element.

- **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.

- **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.

- **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:

00h	The element contains a 9x40 half-inch form factor cartridge.
01h or 53h	The element contains a DLT/SDLT form factor cartridge (53h is 'S').
43h	The element contains an LTO, T10000 (or future) cleaning form factor cartridge (43h 'C').
4Ch	The element contains an LTO form factor cartridge (4Ch is 'L').
54h	The element contains a T10000 form factor cartridge (54h is 'T').
FFh	The media domain cannot be determined.

  Note: 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 00h, the value reported for the Media Type field conforms to the ANSI standard for media characters on 9x40 half-inch form factor cartridges:

R	The element contains a standard 9840 cartridge.
U	The element contains a 9840 cleaning cartridge.
P	The element contains a standard 9940 cartridge (L700 only).
W	The element contains a 9940 cleaning cartridge (L700 only).
Y	The element contains a 9840D cleaning cartridge.
FFh	The media type cannot be determined.

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

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

C	The element contains a DLT CompacTape III cartridge or a DLT cleaning cartridge.
D	The element contains a DLT CompacTape IV cartridge.
E	The element contains a DLT CompacTape III XT cartridge.
S	The element contains an SDLT I cartridge or cleaning cartridge.
2	The element contains an SDLT II cartridge or cleaning cartridge.

4 The element contains a DLTtape S4 cartridge.

FFh The media type cannot be determined.

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

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.

T The element contains a T10000 cleaning cartridge.

FFh The media type cannot be determined.

Note: 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.

A The element contains 50 GB Generation 1 LTO cartridge.

B The element contains a 35 GB Generation 1 LTO cartridge.

C The element contains a 10 GB Generation 1 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.

FFh The media type cannot be determined.

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

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.

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

If the Media Domain field is 54h (54h is 'T'), the value reported for the Media Type field identifies in ASCII the type of T10000 cartridge:

1 The element contains a standard T10000 cartridge.

S The element contains a Sport T10000 cartridge.

FFh The media type cannot be determined.

Note: 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:

  00h The transport supports 9x40 half-inch form factor cartridges.

  01h The transport supports DLT/SDLT form factor cartridges.

  4Ch The transport supports LTO form factor cartridges (4Ch is 'L').

  54h The transport supports T10000 form factor cartridges (54h is 'T').

  FFh The transport domain cannot be determined.

- **Transport Type**
  The Transport Type field with the Transport Domain field provide a hierarchy of information that indicates the type of data transfer element installed.

  If the Transport Domain field is 00h, the value in the Transport Type field indicates that the drive installed is:

  01h A Sun StorageTek 9840B drive

  02h A Sun StorageTek 9840 drive

  05h A Sun StorageTek 9940 drive (L700 only)

  09h A Sun StorageTek 9940B drive (L700 only)

  0Bh A Sun StorageTek 9840C drive

  0Ch A Sun StorageTek 9840C (3590 emulation) drive

  12h A Sun StorageTek 9840D (3490 emulation) drive

  13h A Sun StorageTek 9840D (3590 emulation) drive

  14h A Sun StorageTek 9840D Encryption (3490 emulation) drive

15h A Sun StorageTek 9840D Encryption (3590 emulation) drive

FFh The type cannot be determined.

If the Transport Domain field is 01h, the value reported for the Transport Type field identifies the type of DLT/SDLT drive installed is:

04h A Quantum DLT 7000 drive

07h A Quantum DLT 8000 drive

14h A Quantum SDLT 220 drive

15h A Quantum SDLT 320 drive

17h A Quantum SDLT 600 drive

18h A Quantum DLTtape 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 LTO drive installed is:

30h An HP Generation 1 LTO drive

31h An IBM Generation 1 LTO drive

32h A Quantum Generation 1 LTO drive

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 driv.

38h A Quantum Generation 3 LTO drive

39h An HP Generation 4 LTO drive

3Ah An IBM Generation 4 LTO drive

FFh The type cannot be determined.

If the Transport Domain field is 54h (54h is 'T'), the value in the Transport Type field indicates that the T1000 drive installed is:

0Dh A T10000 (3490 emulation) drive

0Eh A T10000 (3592 emulation) drive

18h A T10000 Encryption (3490 emulation) drive

19h A T10000 Encryption (3592 emulation) drive

1Ah A T10000B (3490 emulation) drive

1Bh A T10000B (3592 emulation) drive

1Ch A T10000B Encryption (3490 emulation) drive

1Dh A T10000B Encryption (3592 emulation) 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.

  Note: Left justification in this 32-byte field provides space for serial numbers of varying lengths.

Data Transfer Element Descriptor Definitions (DvcID = 1)

Data transfer elements are the tape drives in the library. The Data Transfer Element Descriptor Definitions page describes a tape drive. The following table (Table 6-68) shows the data returned when the DvcID bit in the command is set to 1.

Table 6-68. Data Transfer Element Descriptor (DvcID = 1)

Byte	Bit							
	7	6	5	4	3	2	1	0
0 to 1	(MSB) Element Address (LSB)							
2	Reserved (0)				Access	Except	Reserved (0)	Full
3	Reserved (00h)							
4	Additional Sense Code							
5	Additional Sense Code Qualifier							
6	NotBus	Reserved (0)	ID Vld	LU Vld (0)	Reserved 0)	LUN (0)		
7	SCSI Bus Address							
8	Reserved (00h)							
9	SValid	Invert (0)	Reserved (00h)					
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			
49	Reserved (0h)				Identifier Type			
50	Reserved (00h)							
51	Identifier Length (x)							
52 to 52+x-1 (x bytes)	Identifier							

Table 6-68. Data Transfer Element Descriptor (DvcID = 1) (Continued)

Byte	Bit							
	7	6	5	4	3	2	1	0
32-x bytes	Identifier Pad							
84	Media Domain							
85	Media Type							
86	Transport Domain							
87	Transport Type							

- **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.

- **Not Bus**
  This bit will only be valid if the ID is valid. A value of 1 indicates that the SCSI bus address and LUN reported for this tape drive are not on the same SCSI bus as the medium changer device. This value is set when the drive information is set during configuration.
- **ID Valid**
  If this bit is 1h, the SCSI Bus Address field is valid.
- **LU Valid**
  The library does not support this bit and returns a value of 0.
- **Logical Unit Number**
  The library does not support this field and returns a value of 0.
- **SCSI Bus Address**
  The user configures the SCSI Bus Address field. The library returns the SCSI bus address of the data transfer element.
- **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.
- **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:

0h	Reserved.

1h	The identifier contains binary values.
2h	The identifier field contains ASCII graphic codes (that is, 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.
2h	The identifier field contains a Canonical form IEEE Extended Unique identifier, 64-bit (EUI-64). In this case, the identifier length field is set to 8. Note that the IEEE guidelines for EUI-64 specify a method for unambiguously encapsulating an IEEE 48-bit identifier within an EUI-64.

- **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 device identification of the type indicated in the Identifier Type field and in the format specified in the Code Set field.
- **Identifier Pad**
  This field contains binary zeros if the identifier is binary. This field contains ASCII blanks if the identifier is ASCII. The number of zeros or 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:

00h	The element contains a 9x40 half-inch form factor cartridge.
01h or 53h	The element contains a DLT/SDLT form factor cartridge (53h is 'S').
43h	The element contains an LTO, T10000 (or future) cleaning form factor cartridge (43h 'C').
4Ch	The element contains an LTO form factor cartridge (4Ch is 'L').
54h	The element contains a T10000 form factor cartridge (54h is 'T').
FFh	The media domain cannot be determined.

Note: 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 00h, the value reported for the Media Type field conforms to the ANSI standard for media characters on 9x40 half-inch form factor cartridges:

R	The element contains a standard 9840 cartridge.
U	The element contains a 9840 cleaning cartridge.
P	The element contains a standard 9940 cartridge (L700 only).
W	The element contains a 9940 cleaning cartridge (L700 only).
Y	The element contains a 9840D cleaning cartridge.
FFh	The media type cannot be determined.

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

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

C	The element contains a DLT CompacTape III cartridge or a DLT cleaning cartridge.
D	The element contains a DLT CompacTape IV cartridge.
E	The element contains a DLT CompacTape III XT cartridge.
S	The element contains an SDLT I cartridge or cleaning cartridge.
2	The element contains an SDLT II cartridge or cleaning cartridge.
4	The element contains a DLTtape S4 cartridge or cleaning cartridge.
FFh	The media type cannot be determined.

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

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.
T	The element contains a T10000 cleaning cartridge.
FFh	The media type cannot be determined.

Note: 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.
A	The element contains a 50 GB Generation 1 LTO cartridge.
B	The element contains a 35 GB Generation 1 LTO cartridge.
C	The element contains a 10 GB Generation 1 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.
FFh	The media type cannot be determined.

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

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.

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

If the Media Domain field is 54h (54h is 'T'), the value reported for the Media Type field identifies in ASCII the type of T10000 cartridge:

1	The element contains a standard T10000 cartridge.
S	The element contains a Sport T10000 cartridge.
FFh	The media type cannot be determined.

Note: 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:

00h	The transport supports 9x40 half-inch form factor cartridges.
01h	The transport supports DLT form factor cartridges.
4Ch	The transport supports LTO form factor cartridges (4Ch is 'L').
54h	The transport supports T10000 form factor cartridges (54h is 'T')
FFh	The transport domain cannot be determined.

- **Transport Type**
  The Transport Type field with the Transport Domain field provide a hierarchy of information that indicates the type of data transfer element installed.

  If the Transport Domain field is 00h, the value in the Transport Type field indicates that the drive installed is:

01h	A Sun StorageTek 9840B drive
02h	A Sun StorageTek 9840 drive
05h	A Sun StorageTek 9940 drive (L700 only)
09h	A Sun StorageTek 9940B drive (L700 only)
0Bh	A Sun StorageTek 9840C drive
0Ch	A Sun StorageTek 9840C (3590 emulation) drive
12h	A Sun StorageTek 9840D (3490 emulation) drive
13h	A Sun StorageTek 9840D (3590 emulation) drive
14h	A Sun StorageTek 9840D Encryption (3490 emulation) drive
15h	A Sun StorageTek 9840D Encryption (3590 emulation) drive
FFh	The transport domain cannot be determined.

  If the Transport Domain field is 01h, the value reported for the Transport Type field identifies the type of DLT/SDLT drive installed:

04h	A Quantum DLT 7000 drive.
07h	A Quantum DLT 8000 drive.
14h	A Quantum SDLT 220 drive.
15h	A Quantum SDLT 320 drive
17h	A Quantum SDLT 600 drive
18h	A Quantum DLTtape 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 LTO drive installed is:

30h	An HP Generation 1 LTO drive
31h	An IBM Generation 1 LTO drive
32h	A Quantum Generation 1 LTO drive
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
FFh	The type cannot be determined.

If the Transport Domain field is 54h (54h is 'T'), the value in the Transport Type field indicates that the T10000 drive installed is:

0Dh	A T10000 (3490 emulation) drive
0Eh	A T10000 (3592 emulation) drive
18h	A T10000 Encryption (3490 emulation) drive
19h	A T10000 Encryption (3592 emulation) drive
1Ah	A T10000B (3490 emulation) drive
1Bh	A T10000B (3592 emulation) drive
1Ch	A T10000B Encryption (3490 emulation) drive
1Dh	A T10000B Encryption (3592 emulation) drive
FFh	The type cannot be determined.

Playground Element Descriptor Definition

The Playground Element Descriptor describes a playground cell. (Table 6-69).

Table 6-69. Playground Element Descriptor

Byte	Bit 7	6	5	4	3	2	1	0
0 to 1	(MSB) Element Address (LSB)							
2	Reserved (00h)				Access	Except (0)	Reserved (0)	Full
3	Reserved (00h)							
4	Additional Sense Code (0)							
5	Additional Sense Code Qualifier (0)							
6	Reserved (00h)							
7	Reserved (00h)							
8	Reserved (00h)							
9	SValid (0)	Invert (0)	Reserved (00h)					
10 to 11	(MSB) Source Storage Element Address (0) (LSB)							
12 to 47	Primary Volume Tag Information (Field omitted if PVolTag=0)							
48 to 51	Reserved (00h, 00h, 00h, 00h) (Field moved up if Primary Volume Tag Information omitted.)							

Table 6-69. Playground Element Descriptor (Continued)

Byte	Bit							
	7	6	5	4	3	2	1	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.)							

- **Element Address**
  This field contains the element address of the storage element reported.
- **Access**
  The library always returns a value of 0 for elements in the playground except the swap cell. The swap cell will allow access and set this bit to 1 if and only if it is full.
- **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.
- **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.
- **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:

00h	The element contains a 9x40 half-inch form factor cartridge.
01h or 53h	The element contains a DLT/SDLT form factor cartridge (53h is ‘S’).
43h	The element contains an LTO, T10000 (or future) cleaning form factor cartridge (43h ‘C’).
4Ch	The element contains an LTO form factor cartridge (4Ch is ‘L’).
54h	The element contains a T10000 form factor cartridge (54h is ‘T’).
FFh	The media domain cannot be determined.

Note: 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 00h, the value reported for the Media Type field conforms to the ANSI standard for media characters on 9x40 half-inch form factor cartridges:

R	The element contains a standard 9840 cartridge.
U	The element contains a 9840 cleaning cartridge.
P	The element contains a standard 9940 cartridge (L700 only).
W	The element contains a 9940 cleaning cartridge (L700 only).
Y	The element contains a 9840D cleaning cartridge.
FFh	The media type cannot be determined.

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

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

C	The element contains a DLT CompacTape III cartridge or a DLT cleaning cartridge.
D	The element contains a DLT CompacTape IV cartridge.
E	The element contains a DLT CompacTape III XT cartridge.
S	The element contains an SDLT I cartridge or cleaning cartridge.
2	The element contains an SDLT II cartridge or cleaning cartridge.
4	The element contains an DLTtape S4 cartridge or cleaning cartridge.
FFh	The media type cannot be determined.

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

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.
T	The element contains a T10000 cleaning cartridge.
FFh	The media type cannot be determined.

Note: 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.
A	The element contains a 50 GB Generation 1 LTO cartridge.
B	The element contains a 35 GB Generation 1 LTO cartridge.
C	The element contains a 10 GB Generation 1 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.
FFh	The media type cannot be determined.

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

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 an DLTtape S4 cartridge.
FFh	The media type cannot be determined.

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

If the Media Domain field is 54h (54h is ‘T’), the value reported for the Media Type field identifies in ASCII the type of T10000 cartridge:

1	The element contains a standard T10000 cartridge.
S	The element contains a Sport T10000 cartridge.
FFh	The media type cannot be determined.

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

Release

The "Release" command (17) enables the initiator to release unit or element reservations of the library (see Table 6-70) 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 6-70. Release Command

Byte	Bit							
	7	6	5	4	3	2	1	0
0	Operation Code (17h)							
1	Logical Unit Number			Reserved (0h)				Element
2	Reservation Identification							
3	Reserved (00h)							
4	Reserved (00h)							
5	Control Byte (00h)							

- **Element**
  This bit indicates if the release is an element release:

  1 The reserved elements associated with the Reservation Identification field from this initiator are to be released from reserved status.

  0 The library or any elements reserved by the initiator are to be released from reserved status.

- **Reservation Identification**
  This field is a value established by the initiator in a previous Reserve command. The field identifies the specific element reservation to be released. If an invalid Reservation Identification is specified, the library returns a Check Condition status. If the Element bit is 0, ignore this field.

Report LUNs

The “Report LUNs” command (A0) returns to the initiator the known LUNs to which the initiator can send commands. Only LUN 0 is supported in the library (Table 6-71).

Table 6-71. Report LUNs command

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

- **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 6-72).

Table 6-72. Report LUNs Data Definition

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0 to 3	(MSB) LUN list length (8) (LSB)							
4 to 7	Reserved (0)							
8 to 15	(MSB) LUN (0) (LSB)							

- **LUN list length**
  The library returns a LUN list length of 8h.Only LUN 0 is supported in the library.
- **LUN**
  The library returns a value of 0h for LUN zero.

Request Sense

The “Request Sense” command (03) requests the library to transfer sense data to the initiator (see Table 6-73).

Note: A reset or an abort message clears the contingent allegiance.

Table 6-73. Request Sense Command

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

- **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.
- **Request Sense Data**
  The library returns sense data in response to a “Request Sense” command.

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 previous command to the specified I_T_L nexus terminated with an unexpected bus free error. (Sense data might be available in this case, but not always.)
- 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.
  - An unrecoverable parity error is detected on the data bus.

  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 6-74 shows the Request Sense Data Definitions.

Table 6-74. Request Sense Data

<table>
<tr><th rowspan="2">Byte</th><th colspan="8">Bit</th></tr>
<tr><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>0</td><td>Valid (0)</td><td colspan="7">Error Code (70h)</td></tr>
<tr><td>1</td><td colspan="8">Segment Number (00h)</td></tr>
<tr><td>2</td><td colspan="4">Reserved (0)</td><td colspan="4">Sense Key</td></tr>
<tr><td>3 to 6</td><td colspan="8">(MSB)
Information (00h, 00h, 00h, 00h)
(LSB)</td></tr>
<tr><td>7</td><td colspan="8">Additional Sense Length (n-7)</td></tr>
<tr><td>8 to 11</td><td colspan="8">(MSB)
Command Specific Information (00h, 00h, 00h, 00h)
(LSB)</td></tr>
<tr><td>12</td><td colspan="8">Additional Sense Code</td></tr>
<tr><td>13</td><td colspan="8">Additional Sense Code Qualifier</td></tr>
<tr><td>14</td><td colspan="8">Field Replaceable Unit Code (00h)</td></tr>
<tr><td>15</td><td>SKSV</td><td>C/D</td><td colspan="2">Reserved (0)</td><td>BPV (0)</td><td colspan="3">Bit Pointer (0h)</td></tr>
<tr><td>16 to 17</td><td colspan="8">(MSB)
Field Pointer
(LSB)</td></tr>
<tr><td>18</td><td colspan="8">CAP Condition</td></tr>
<tr><td>19</td><td colspan="8">Reserved (00h)</td></tr>
</table>

- **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 and Field pointer 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)**
  The library does not support the Bit Pointer Valid (BPV) field and returns a value of 0.
- **Bit Pointer**
  The library does not support this field and returns a value of 0h.
- **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.

- **CAP Condition**
  This field indicates the condition of the CAP relative to the most recent audit. The field set to a value other than 00h only when the Unit Attention 6h, ASC 28h, ASCQ 01h (CAP Element Accessed) has occurred. Under those circumstances one of these values appears:

  40h CAP A (or the only CAP in a single-CAP library) was closed

  80h CAP B was closed.

  C0h Both CAPs were closed

Sense Key

The Sense Key field provides basic information about an error. Table 6-75 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 "Additional Sense Codes and Qualifiers" for more information.

Table 6-75. Sense Key Code Descriptions

Code	Error	Description
0	No Sense	Indicates there is no specific sense key information to be reported. A sense key of 0 indicates a successful command.
2	Not Ready	Indicates the addressed logical unit is not ready for library motion commands (library is not initialized, device is not ready).
4	Hardware Error	Indicates the device detected an unrecoverable hardware failure while performing the command or during a self-test.
5	Illegal Request	Indicates an illegal parameter in the command descriptor block or in the parameter list data.
6	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.
B	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

Table 6-76. 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, Maintenance Mode	2h	04h	81h
Not Ready, Cartridge Access Port Open	2h	3Ah	02h
Not Ready, Cleaning Cartridge Installed	2h	30h	03h

If a command is sent when the library is not ready, it generates a Not Ready error code (see Table 6-76). The following codes describe the conditions of the library that can generate Not Ready codes.

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, Maintenance Mode

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

Not Ready, Cartridge Access Port Open

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

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 30 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.

Hardware Error Sense Key

Table 6-77. 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

The library generates a Hardware Error sense key (see Table 6-77) if a hardware or firmware error is detected during command execution. The following pages describe the conditions that generate hardware errors.

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.

Illegal Request Sense Key

Table 6-78. Illegal Request Sense Keys

Description	Sense Key	ASC	ASCQ	SKSV
Parameter Length Error	5h	1Ah	00h	Yes
Invalid Command	5h	20h	00h	Yes
Invalid Element	5h	21h	01h	No
Invalid Field in CDB	5h	24h	00h	Yes
Logical Unit Not Supported	5h	25h	00h	No
Invalid Field in Parameters	5h	26h	00h	Check SKSV
Invalid Release of Persistent Reservation	5h	26h	04h	No
Incompatible Medium	5h	30h	00h	No
Saving Parameters Not Supported	5h	39h	00h	Yes
Medium Not Present, Drive Not Unloaded	5h	3Ah	00h	No
Medium Magazine Removed	5h	3Bh	12h	No
Destination Element Full	5h	3Bh	0Dh	No
Source Element Empty	5h	3Bh	0Eh	No
Insufficient Reservation Resources	5h	55h	02h	No

Any illegal parameters in a command descriptor block (CDB) or parameter list for a particular command generate an Illegal Request sense key (see Table 6-78).

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 6-158 for more information.

Unit Attention Sense Key

Table 6-79. Unit Attention Sense Keys

Description	Sense Key	ASC	ASCQ
Power-On Occurred	6h	29h	01h
Not Ready-to-Ready Transition	6h	28h	00h
CAP Element Accessed	6h	28h	01h
Mode Parameters Changed	6h	2Ah	01h
Reservations Preempted	6h	2Ah	03h
Reservations Released	6h	2Ah	04h
Registrations Preempted	6h	2Ah	05h
Microcode Has Been Changed	6h	3Fh	01h
SCSI Bus Reset	6h	29h	02h
Bus Device Reset Message Occurred	6h	29h	03h

The library generates a Unit Attention sense key (see Table 6-79) 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.

Power On

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.

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.

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.

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.

SCSI Bus Reset

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

Bus Device Reset Message Occurred

The library generates this message to all initiators after the library is clear of all I/O processes following a hard reset.

Aborted Command Sense Key

Table 6-80. Aborted Command Sense Keys

Description	Sense Key	ASC	ASCQ
Mechanical Positioning Error	0Bh	15h	01h
SCSI Parity Error	0Bh	47h	00h
PTP error cartridge left in source	0B	15h	80h
PTP error cartridge moved to in-transit cell	0B	15h	81h
Initiator Detected Error	0Bh	48h	00h
Command Overlap	0Bh	4Eh	00h

The library generates an Aborted Command error code (see Table 6-80) 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.

Mechanical Positioning Error

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

SCSI Parity Error

The library detected a parity error during a data transfer operation, or the host rejected a Restore Pointers message.

PTP error cartridge left in source

An error was detected with the PTP on a Move Medium to/from a PTP element. The move could not be completed and the cartridge is in the source element.

PTP error cartridge moved to in-transit cell

A “Move Medium” command was in progress to/from a PTP element and could not be completed. The cartridge was placed in the in-transit cell.

Initiator Detected Error

The library receives an Initiator Detected Error message from the initiator, and the operation could not be completed.

Command Overlap

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

Request Volume Element Address

The “Request Volume Element Address” command (B5) requests that the library return the results of a previous “Send Volume Tag” command. See Table 6-81 for the format of the “Request Volume Element Address” command.

Table 6-81. Request Volume Element Address Command

Byte	Bit							
	7	6	5	4	3	2	1	0
0	Operation Code (B5h)							
1	Logical Unit Number			VolTag	Element type code			
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)							

- **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.

- **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 the Starting Element Address.

- **Starting Element Address**
  This field 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**
  This field represents the maximum number of element descriptors to be transferred.

- **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.
  - 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. See Table 6-82 for the header's format.

Table 6-82. 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							

- **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 6-112 for more information.

Reserve

The “Reserve” command (16) allows the initiator to perform unit reservations or element reservations. Unit reservations are reservations of the library as a whole. Element reservations are reservations of specific elements of the library. See Table 6-83 for the command’s format.

Table 6-83. Reserve Command

<table>
<tr><th rowspan="2">Byte</th><th colspan="8">Bit</th></tr>
<tr><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>0</td><td colspan="8">Operation Code (16h)</td></tr>
<tr><td>1</td><td colspan="3">Logical Unit Number</td><td colspan="4">Obsolete (0h)</td><td>Element</td></tr>
<tr><td>2</td><td colspan="8">Reservation Identification</td></tr>
<tr><td>3 to 4</td><td colspan="8">(MSB)
Element List Length
(LSB)</td></tr>
<tr><td>5</td><td colspan="8">Control Byte (00h)</td></tr>
</table>

- **Element**
  This bit indicates if the reserve is an element reserve. The library supports reservation at the element level:

  0 The entire library unit is reserved.

  1 A series of elements—identified by the Reservation Identification field and specified by the Element List Descriptor—is reserved.

- **Reservation Identification**
  This field is a value established by an initiator to identify a specific element reservation request. The library supports a maximum of 64 element reservations.

  Note: Ignore this field if the Element bit is not set.

- **Element List Length**
  This field indicates the length in bytes of the Element List that follows the command. The list may include a maximum of 16 Element List Descriptors, each of which is 6 bytes long. Valid values are 0, 6, and increments of 6 up to the maximum of 60h (96d).

  If the value is 0 and the Element bit is set, no elements are reserved.

  Note: Ignore this field if the Element bit is not set.

Element List Descriptor Definitions

An Element List is required if the Element bit is set. The list consists of 0 to 16 instances of the Element List Descriptor; see Table 6-84 for the descriptor's format.

Table 6-84. Element List Descriptor

Byte	Bit							
	7	6	5	4	3	2	1	0
0 to 1	Reserved (00h, 00h)							
2 to 3	(MSB) Number of Element (LSB)							
4 to 5	(MSB) Element Address (LSB)							

- **Number of Elements**
  This field indicates the number of elements of a specific type (cartridge tape storage cells, CAP cells, or tape drives) to be reserved. If the value of this field is 0, all elements starting at the Element Address through the last element address for that library are reserved.
- **Element Address**
  This field indicates the address of the element or the starting address of a series of elements to be reserved.

Other Commands and Reservations

Unit and element reservations are released or canceled by:

- A "Release" command from the same initiator
- Receipt of a Bus Device Reset message
- 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
- Release
- Request Sense

- Log Sense
- Read Element Status with the CurData bit set to 1

  Note: As of the publication date of this document, the CurData bit had not been fully implemented.

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

An element reservation may be used to modify or supersede a previous element reservation by the same initiator. If the superseding reservation does not result in any reservation conflicts or error conditions, the previous reservation is released, and the new reservations are completed. A unit reservation of the library supersedes any previous element reservations by the same initiator.

Rezero Unit

The “Rezero Unit” command (01h) performs no actions. The library accepts this command only for compatibility with existing host applications. Table 6-85 shows the command’s format.

The command descriptor block will be validated even though the command is not used.

Table 6-85. Rezero Unit Command

Byte	Bit							
	7	6	5	4	3	2	1	0
0	Operation Code (01h)							
1	Logical Unit Number			Reserved (0h)				
2	Reserved (00h)							
3	Reserved (00h)							
4	Reserved (00h)							
5	Control Byte (00h)							

Send Diagnostic

The “Send Diagnostic” command (1Dh) requests the library to perform a self-diagnostic test. The library supports the self-test option of this command and several extended tests. Table 6-86 shows the format of this command.

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 6-86. Send Diagnostic Command

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

- **PF**
  The library supports the page format (PF) specified by SCSI-2. The value of PF should be 1. However, the library accepts a 0 for self test.

- **SelfTest**
  This bit indicates whether the self-test function is requested.

  0 The self-test function is not requested.

  1 The self-test function is requested. The Parameter List Length also must be 0.

- **DevOfl**
  This feature is not supported by the library; the value must be 0.

- **UnitOfl**
  This feature is not supported by the library; the value must be 0.

- **Parameter List Length**
  For the self-test option, a value of 0h is required.

  For extended diagnostics, a value of 8h is required.

Send Diagnostic Data

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

- A page code
- Diagnostic parameters

Table 6-87 shows the parameter's format.

Table 6-87. Send Diagnostic Page Format

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)							

- **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 must be 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 through 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 (B6) 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 6-88 shows the format of the "Send Volume Tag" Command.

Table 6-88. Send Volume Tag Command

Byte	Bit							
	7	6	5	4	3	2	1	0
0	Operation Code (B6h)							
1	Logical Unit Number			Reserved (0)	Element Type Code			
2 to 3	(MSB) Starting Element Address (LSB)							
4	Reserved (00h)							
5	Reserved (0)			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)							

- **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

Note: 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 6-89 shows the command's format.

Table 6-89. 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 must be 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 (00) 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. Table 6-90 shows the command’s format.

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 6-90. Test Unit Ready Command

Byte	Bit							
	7	6	5	4	3	2	1	0
0	Operation Code (00h)							
1	Logical Unit Number			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. Table 6-91 shows the command’s format.

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’s 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 6-91. Write Buffer Command

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

- **Mode**
  This field indicates the type of download to be performed. The library supports four modes:

- **Download Microcode (100b)**
  This mode downloads code in a single transfer or multiple transfers. The library keeps track of the placement of data for multiple transfers. The data must be sent in sequential order. The library also detects when the download is complete. A change to this mode from any other mode is considered a new download request, and terminates any active download.

- **Download Microcode and Save (101b)**
  This mode downloads code in a single transfer only. Two consecutive "Write Buffer" commands with this mode are considered to be two complete and separate requests.

- **Download Microcode with Offsets (110b)**
  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. The last "Write Buffer" command uses the Download Microcode with Offsets and Save (111b) mode. This tells 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.

- **Download Microcode with Offsets and Save (111b)**
  This mode is used only once per download. It is used in conjunction with the Download Microcode with Offsets (110b) mode to indicate the last "Write Buffer" command of a download. A parameter list length of 0 is allowed for this mode. A change to this mode from any mode other than 110b 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 must be 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. The first command must contain a minimum of 32 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.

- **Write Buffer Command Data**
  The initiator must provide microcode only. This command is used only to download microcode.

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Glossary

This glossary defines terms and abbreviations in this publication.

Numbers

8B/10B A type of encoding and decoding algorithm for data bytes, invented and patented by IBM, to reduce transmission errors. This algorithm was adopted as part of the FC-PH-1 Standard in 1991.

A

abort An end to a process. To discard or ignore.

Abort Exchange (ABTX) In Fibre Channel, the Abort Exchange command can be used with Abort Sequence - Last Sequence (ABTS - LS) (SCSI-PLDA), by itself, or with ABTS Fibre Channel Link Encapsulation (FC-LE) protocol. The Abort Exchange Command is used in the Fibre Channel Extended Link Services, is prohibited when originated by the initiator, and is prohibited when originated by a library.

Abort Sequence (ABTS) The protocol that is invoked by devices supporting the Fibre Channel Protocol for SCSI to abort the exchange whenever a Sequence Error is detected. It comes in two protocols: Abort Sequence - Last Sequence (ABTS - LS) (SCSI-PLDA), by itself, or with ABTS Fibre Channel Link Encapsulation (FC-LE).

ABTS *See* Abort Sequence.

ABTX *See* Abort Exchange.

ACA Auto Contingent Alliance.

ACC Accept.

ACK Acknowledge. A signal driven by the initiator that indicates an acknowledgement for a data transfer handshake.

additional sense bytes The additional sense bytes contain data specific to the command and/or peripheral device. They further define the nature of the FCP_SNS_INFO feature of the FCP_RSP payload.

addressing scheme The order in which node and port names are presented to the recipient in a Fibre Channel transaction.

ADISC *See* Discover Address.

ADVC *See* Advise Credit.

Advise Credit (ADVC) In Fibre Channel, the Advise Credit Command uses Extended Link Services. It is prohibited when originated by the initiator, and prohibited when originated by a library.

AENC Asynchronous event notification capable.

algorithm An ordered set of well-defined rules used to govern an operation.

allowed A function in Fibre Channel that allows a feature or parameter to be used between an initiator and a target.

AL_PA *See* Arbitrated Loop Physical Address.

AL_PD Arbitrated Loop Physical Destination address.

AL_PS Arbitrated Loop Physical Source address.

AL_TIME Arbitrated loop timeout value.

American National Standards Institute (ANSI) A standards development organization that is not associated with the U.S. government, but that develops standards that can be used voluntarily by product vendors in the United States. The name of the organization was recently changed to the National Committee for Information Technology Standards (NCITS).

ANSI *See* American National Standards Institute.

arbitrate and win In an arbitrated loop topology in Fibre Channel, the process that a port performs to select another port to send data to or receive data.

arbitrated loop A topology in Fibre Channel that provides multiple connections for devices that share a single loop, over which only two devices can communicate at once. Similar to the SCSI protocol of the same name, it provides an "arbitrate and win" scenario between more than two devices when those devices negotiate to communicate on the bus. The sending device must arbitrate and win the connection with the receiving device before communication can begin.

arbitrated loop physical address A one-byte value that identifies a port in an arbitrated loop topology.

ASCII American Standard Code for Information Interchange.

ASC Additional Sense Code. A bit set in the Request Sense data format.

ASCQ Additional Sense Code Qualifier. A bit set in the Request Sense data format.

asynchronous A mode of data transfer that pertains to two or more processes that do not depend on specific events such as timing signals.

asynchronous event notification A form of communication used between processes to notify a process of an asynchronous action, such as an input/output activity or message transmission.

ATN Attention. A signal driven by the initiator that indicates an attention condition.

AVolTag Alternate VOLume TAG.

AWG American Wire Gauge.

B

b A symbol that designates binary notation (using bit values 0 and 1). Example: 001b.

B The abbreviation for byte.

BB_Credit *See* Buffer-to-Buffer Credit.

bit Unit of information, equal to a 0 or a 1.

BPV Bit pointer valid field.

BSY Busy. An OR-tied signal that indicates the SCSI bus is in use.

buffer size The amount of storage space allocated to the buffer, which is a storage space reserved temporarily for a given purpose. In Fibre Channel, this buffer is usually larger than a single frame, up to the size of an entire sequence.

Buffer-to-Buffer Credit (BB_Credit) In Fibre Channel, this value is managed by the R_RDY primitive signal on a link and is used by a transmitter to determine the permission to transmit frames. If permission is granted by the recipient, this value also tells the transmitter how many frames are permitted. The transmitter may transmit a frame when Available BB_Credit is greater than 0. This differs from End_to_End Credit.

buffer-to-buffer A method of transferring information in which neither the initiator nor receiver of the information knows the contents.

bus (1) A facility for transferring data between devices on a common connection. (2) An interface.

byte An eight-bit binary number.

C

CAP Cartridge Access Port.

cartridge exchange mechanism (CEM) A mechanism that allows a cartridge to pass from one library storage module (LSM) to another in a multiple LSM automated cartridge system. See also Pass-Thru-Port.

C/D Control and Data signals. These signals are driven by the target indicating the type of information on the SCSI bus.

CDB Command Descriptor Block.

cell Storage location for a tape cartridge.

channel An interface used for high-speed transfer of large amounts of data.

Class of Service The Fibre Channel method of defining a data transmission strategy between devices. There are three Fibre Channel Classes of Service currently specified in the FC-PH-1 and Sun StorageTek's implementation includes only one, Class 3.

Class 3 The Fibre Channel Class of Service in which the initiator sends a message to a receiving device without expecting or requiring an acknowledgement. It is analogous to the human communication method of sending an advertisement in hopes that the message is received.

CLS Close.

CMC Connected Media Changer.

CmdQue Command Queuing.

Command Descriptor Block The structure used to communicate commands from the initiator to the target.

CRC *See* Cyclic Redundancy Check.

CRN Command Reference Number.

Customer Services Engineer (CSE) A Sun StorageTek-trained representative who provides support and service for customer's products.

Cyclic Redundancy Check (CRC) A mechanism used for error detection that calculates a numeric value by using a special algorithm applied to a series of bytes that are generally appended to the data. If no error has occurred when the receiver executes the algorithm on the received data, the newly generated CRC value should be the same as the CRC value originally transmitted.

D

d Decimal number notation. Example: 9499d is equal to 251B in hexidecimal notation.

DB Data Bus. A SCSI bus signal.

DBD Disable Block Descriptors.

delimiter In Fibre Channel, a special transmission word that marks either the beginning, or ending, of a frame in a Fibre Channel transmission.

Destination ID In Fibre Channel, in the frame header of each frame transmitted, the destination address is a value that identifies the port in a node that is to receive the frame.

device (1) A host adapter or control unit attached to the SCSI bus. (2) In Fibre Channel, a node that has at least one N_Port or NL_Port.

DevOfl Device Offline.

DF_CTL The Data Field Control byte in a Fibre Channel frame header indicates optional headers in the frame.

differential A SCSI bus alternative with a maximum cable length or 25 m (82 ft).

DIFFSENS Differential sense. A SCSI bus signal.

disabled (1) Inactive. (2) Off.

Discover Address (ADISC) In Fibre Channel, the Discover Address command used in Extended Link Services. It is invokable when originated by the initiator, required as a response by the library, and prohibited when originated by a library.

Discover F_Port Parameters (FDISC) In Fibre Channel, the Discover F_Port Parameters command used in Extended Link Services. It is prohibited when originated by the initiator and prohibited when originated by a library.

Discover N_Port Parameters (PDISC) In Fibre Channel, the Discover N_Port Parameters command used in Extended Link Services. It is invokable when originated by the initiator, requires a response by the library, and is prohibited when originated by a library.

disparity In Fibre Channel, a form of error detection for frame transmission. Running disparity adds a second dimension to the transmission of characters that provides a balance of ones and zeros, helps protect transmission characters, and controls the heat output of the transmitter.

DLT Digital Linear Tape.

DS Disable save.

DT Data transfer element (the tape drive).

E

Echo In Fibre Channel, the Echo command used in Extended Link Services. It is prohibited when originated by the initiator, and is prohibited when originated by a library.

ECMA European Computer Manufacturers Association.

E_D_TOV *See* Error Detect Timeout value.

enabled (1) Active. (2) On.

encoding The process used to change the original form in which information is available into another form. An example of this is changing handwritten text into computer bytes.

End-of-Frame Delimiter (EOF) In Fibre Channel, a special transmission word in a frame used to mark the end of that frame.

EOF Delimiter *See* End-of-Frame Delimiter.

EOFa End Of Frame Abort.

EOFn End Of Frame normal.

EOFni End Of Frame normal invalid.

EOFt End Of Frame terminate.

Error_Detect Timeout Value In Fibre Channel, the minimum period of time that an L_Port can wait for the sequence to complete before initiating a recovery action.

Establish Streaming (ESTS) In Fibre Channel, the Establish Streaming command used in Extended Link Services. It is prohibited when originated by the initiator and prohibited when originated by a library.

ESTC Estimate Credit command

Estimate Credit (ESTC) In Fibre Channel, the Estimate Credit command used in Extended Link Services. It is prohibited when originated by the initiator and prohibited when originated by a library.

ESTS *See* Establish Streaming.

EVPD Enable Vital Product Data.

exchange In Fibre Channel, a set of one or more sequences, usually associated with an I/O operation, having the same Exchange Identifier. An exchange is established when an N_Port sends a sequence of at least one frame to another N_Port.

Exchange Identifier The field (OX_ID) in the frame header that identifies a process in the source during a transmission from one N_Port to another. An exchange is established between the N_Ports when the first frame of a new operation is accepted by the destination N_Port.

ExEnab Export element supports movement of tape cartridges.

F

Fault Symptom Code (FSC) Four-digit hexadecimal code generated in response to a subsystem error.

FCC Federal Communications Commission.

F_CTL Frame Control. A portion of the FC-2 Sequence Chaining feature that controls information within a frame.

F_Port A port in a fabric to which an N_Port or NL_Port may attach.

fabric The Fibre Channel topology that includes at least one fabric element. A fabric operates similarly to a telephone switch in that the initiator of a “call” to the receiving port simply provides the receiver with the port address, and the fabric routes the transmission to the proper port. A fabric differs from a point-to-point or arbitrated loop topology in that it provides for interconnections between ports without having a point-to-point connection. The fabric also serves as a media type converter.

FACT Fabric active alias_ID.

FAN Fabric Address Notification.

FC Fibre Channel.

FC_AL Fibre Channel Arbitrated Loop standard.

FC-PH-1 The Fibre Channel Physical and Signaling Interface defined in the ANSI X3.230-1994.

FC-PH-2 An extension of the Fibre Channel Physical and Signaling Interface defined in the ANSI X3.230-1994 that specifies several extra protocol levels.

FC-0 The level of the FC-PH-1 Standard that defines the physical level. FC-0 defines the media types and connectors, as well as the electrical and optical characteristics, necessary for connecting ports. This level can be found in the FC-PH-1 Standard, clauses 5 to 10, and 12 to 15.

FC-1 The level of the FC-PH-1 Standard that defines the transmission protocol. FC-1 includes the 8B/10B encoding/decoding scheme, word order transmission, and error detection. This level can be found in the FC-PH-1 Standard, clauses 11, 16, and 17.

FC-2 The level of the FC-PH-1 Standard that defines the framing and signaling protocol. FC-2 includes the frame layout, frame header content, and rules for use. This level can be found in the FC-PH-1 Standard, clauses 18 to 29.

FC-3 The level of the FC-PH-1 Standard that defines the common services level that may be available across multiple ports in a node. This level has no current standard in the FC-PH-1 Standard.

FC-4 The level of the FC-PH-1 Standard that defines the mapping of protocols between the lower levels of Fibre Channel and the command sets that use Fibre Channel. Separate standards exist for SCSI-3, IP, IPI-3, HIPPI, and others.

FCP *See* Fibre Channel Protocol.

FCP_DATA The action of delivering data.

FCP_DL The data length.

FCP_RSP SCSI-3 response such as Status.

FCP_XFER_RDY The request for date.

FDACT Fabric deactivate alias_ID

FDDI *See* Fiber Distributed Data Interface.

FDISC *See* Discover F_Port Parameters

fiber A wire or strand of optical cable.

Fiber Distributed Data Interface (FDDI) An NCITS standard for transmitting data at 100 megabaud over fiber optic cable.

fiber optic cable A jacketed cable of thin strands of glass that carry pulses of light that transmit data for high-speed transmissions over medium to long distances. The cable can be single mode, which carries a single signal from a laser or LED light source, or multi-mode, which carries multiple signals from either light source.

Fibre Channel The ANSI standard that defines an ultra high-speed, content-independent, multi-level data transmission interface that can support multiple protocols simultaneously, support connectivity to millions of devices over copper and/or fiber optic physical media, and provides the best characteristics of both networks and channels, over diverse topologies.

Fibre Channel Physical and Signaling Interface (FC-PH-1) *See* FC-PH-1.

Fibre Channel Protocol The mapping of SCSI-3 commands over a fibre channel interface.

field A group of one or more contiguous bits.

fill word In Fibre Channel, a word transmitted between frames containing no information essential to either frame. The fill words are defined by the topology. The Idle primitive signal is an example of a fill word.

FL_Port A special type of Fibre Channel fabric port used in an arbitrated loop to connect N_Ports and/or NL_Ports into a fabric, thus creating a public loop. Contrast this with a private loop.

FLOGI Fabric Login.

flow control In Fibre Channel, the process of limiting the number of single frames or groups of frames received by the receiving port. This is accomplished using a credit system. *See* Buffer-to-Buffer Credit (BB_Credit) and End-to-End Credit (EE_Credit).

frame In Fibre Channel, an indivisible, encapsulated data structure containing a beginning-of-frame (BOF) and end-of-frame (EOF) designator. A frame carries a payload of both control data and user data from one Fibre Channel port to another.

frame header In Fibre Channel, the first field in a frame that contains addressing information, as well as other control information, about the frame.

FRU Field Replaceable Unit.

FSC See Fault Symptom Code.

full duplex A communication protocol that allows signals to be transmitted and received simultaneously. The signal usually contains flow control.

G

GAID Get Alias_ID.

GBIC Giga-bit Interface Converter.

H

h A symbol designating hexadecimal notation (base 16 numbering system). Example: 10h

half duplex A communications protocol that permits a port to transmit or receive frames at any point in time, but not simultaneously, as in full duplex. The one exception to this is with link control frames, which are always allowed in full duplex.

host A processor, usually composed of a CPU and memory, that typically communicates with peripheral devices over channels and/or networks and performs I/O operations such as network control. It also provides end users with computation services and database access.

host bus adapter A device connecting between a host system and SCSI bus. The device usually performs the lower level layers of SCSI bus protocol operating as an initiator.

hub A piece of hardware, separate from the actual Fibre Channel interface on the backplane of a device, which houses the port bypass circuitry for configurations of 8 to 16 ports per hub. Hubs may be stacked to support larger configurations and can usually support a mix of both electrical and optical media ports.

HVD High Voltage Differential SCSI.

I

ID (1) Identifier; (2) Identification.

Idle A special type of fill word (no data or control information) sent from a transmitting port to a receiving port that communicates that the transmitting port has more frames to send. The Idle word is necessary because Fibre Channel needs a continuous flow of transmissions and receptions to remain operational.

I/E Import/Export element (the CAP).

IEC International Electrotechnical Commission.

IEEE Institute of Electrical and Electronics Engineers.

ImpExp Indication of how the cartridge tape was placed and in which element.

in. Inch.

InEnab This bit indicates that the import element supports movement of tape cartridges.

inbound fiber The fiber in a link that carries information into a receiving port.

Information Unit (IU) A unit of information defined by FC-4 mapping transferred as sequences.

invokable A function of Fibre Channel that allows a feature to be used between an initiator and a recipient (such as cartridge subsystem). Thus if a feature or parameter is invoked, the recipient must implement and respond to the feature or parameter.

initiator A SCSI device that requests an I/O process be performed by another SCSI device called a target.

I/O Input and output. A signal driven by the target controlling the flow of data. I/O pertains to the input, output, or both.

ISO International Standards Organization.

IU *See* Information Unit.

J

jitter The deviation of timing in an exchange.

L

L_Port In Fibre Channel, a multi-functional port, including an NL_Port, FL_Port, or GL_Port, which resides either in a fabric or arbitrated loop and which is capable of performing arbitrated loop functions and protocols.

laser A term meaning Light Amplification by Stimulated Emission of Radiation. Laser devices generate coherent radiation in the visible, ultraviolet, and infrared portions of the electromagnetic spectrum. In a Fibre Channel network, lasers can be transmitting either short waves or long waves, depending on the composition of the arbitrated loop or fabric.

library An automated device for storing tape cartridges.

link A two-fiber connection made between two Fibre Channel ports in which one fiber is transmitting and the other is receiving information.

linking In Fibre Channel, (1) The activity of connecting one inbound fiber and one outbound fiber to a port, or (2) The activity of linking commands, as identified in the INquiry data, where the Flag bit of the Command Descriptor Block is set to zero.

Link Service The set of commands used by Fibre Channel to manage functions such as port management, login/logout, and abort operations. Sun StorageTek libraries and tape drives support both Basic and Extended Link Services.

Link Services Command Reject (LS_RST) In Fibre Channel, the code returned by a recipient device (such as a cartridge subsystem) after it received a request for Extended Link Services that are unsupported. The recipient returns a reason code of "Command not supported."

LIP *See* Loop Initialization Primitive.

LILP Loop Initialization Loop Position.

LIRP Loop Initialization Report.

LISA Loop Initialization Soft Assigned address.

LISM Loop Initialization Select Master.

Logical Unit Number (LUN) A device address or ID on the SCSI bus.

login The Fibre Channel-required process used by any initiating N_Port or NL_Port in a Fibre Channel fabric to sign in with any other receiving N_Port or NL_Port port with which it plans to communicate. The signing in process provides the initiator with critical information about the attributes of the recipient port before it attempts to make a connection with it.

Login_BB_Credit On a Fibre Channel arbitrated loop, this signal is the value equal to the number of receive buffers that a recipient NL_Port guarantees to have available once a loop circuit is established. Login_BB_Credit is communicated via the FLOGI, PLOGI, or PDISC Extended Link Services.

logout In Fibre Channel, an Extended Link Services command that terminates all open Exchanges with the SCSI initiator and its target. LOGO is invokable when originated by the initiator, requires a response by the library, required when originated by the library, and requires a response by the initiator.

LOGO *See* Logout.

Loop Initialization Primitive (LIP) In Fibre Channel, the process that assigns up to a possible 127 addresses to different ports on the loop and builds a map of these addresses.

LPSM Loop Port State Machine.

LP List parameter.

LSB Least significant bit or byte.

LS_RJT *See* Link Services Command Reject.

LTO Linear Tape Open, an open specification for tape storage devices.

LUN *See* Logical Unit Number.

LVD Low-Voltage Differential SCSI.

M

m Meter.

mm Millimeter.

mA Milliampere.

Mb/s Abbreviation for megabits per second.

MB/s Megabytes per second.

Mode Select Command The command that specifies operational parameters and options for a logical unit.

MSB Most significant bit or byte.

MSG Message. A signal driven by the target during the message phase of the SCSI bus.

MT Medium transport (the hand).

N

NotBus "Not this bus" indication.

N_Port One of seven Fibre Channel port types. N_Ports attach to a node and are used with either the point-to-point or fabric topology. In point-to-point, a maximum of two N_Ports can communicate, with the initiator N_Port being linked directly to the recipient N_Port. In fabric, the number of N_Ports linked to other N_Ports or any other type Fibre Channel ports is only limited by the size of the fabric itself.

N_Port ID The identifier of an N_Port in a point-to-point or fabric Fibre Channel topology.

N_Port Login (PLOGI) The N_Port Login command used in Extended Link Services. It is required when originated by the initiator, requires a response by a library, and is prohibited when originated by a library.

Nanometers (nm) One billionth of a meter.

National Committee for Information Technology Standards (NCTIS) Formerly the American National Standards Institute (ANSI).

NCITS *See* National Committee for Information Technology Standards.

network An arrangement of nodes and branches that connect processing devices to one another via software and hardware links to facilitate information interchange.

NL_Port A port attached to a node for use in the point-to-point, arbitrated loop, and fabric topologies of Fibre Channel. The NL_Port can be configured as a private and/or a public port. *See* Private NL_Port and Public NL_Port.

nm Abbreviation for nanometers.

No Operation (NOP) In Fibre Channel, the No Operation command used in Basic Link Services. It is prohibited when originated by the initiator and prohibited when originated by a library.

node In Fibre Channel, a device that contains a minimum of one N_Port and/or NL_Port.

Node Name In Fibre Channel, a 64-bit concatenation of the Port Name, Company ID, and library serial number in an IEEE extended format.

NOP ***See* No Operation.**

ns Nanoseconds, one billionth of a second.

O

Operation Code Structure A component of the Command Descriptor Blocks that compose Byte 0.

OPN Open.

ordered set In Fibre Channel, special types of transmission words, either fill words or control words, that have special meanings in a transmission. Ordered sets include primitive signals, primitive sequences, and frame delimiters.

originated by library In Fibre Channel, an action taken by the recipient of either a Basic Link Service Command, or an Extended Link Service Command. These actions can be Allowable, Invokable, Prohibited, or Required.

originated by initiator In Fibre Channel, an action taken by the initiator of either a Basic Link Service Command or an Extended Link Service Command. These actions can be Allowable, Invokable, Prohibited, or Required.

OR-tied A SCSI bus condition that describes the logic of a signal. A condition indicating the operation is done when any one of the conditions are met.

outbound fiber The fiber in a link used to transmit information to a receiving port.

OX_ID Originator Exchange Identifier.

P

P Parity. A data transmission attribute used to ensure error-free transmission.

parallel transmission The transmission of bits over multiple fibers, either copper or glass, all at one time. Transmission is accomplished by dedicating each fiber to transmitting one bit at a time. This high-speed transmission method is good for short distances only. Contrast with serial transmission.

Pass-Thru-Port (PTP) A mechanism that enables a cartridge to pass through from one library storage module (LSM) to another in a multiple LSM automated cartridge system. See also cartridge exchange mechanism.

payload In Fibre Channel, the portion of the data field in a frame, not part of the optional header data, that contains the substantive information being transmitted between ports in Fibre Channel.

PC Page code or page control.

PDISC *See* Discover N_Port Parameters.

PF Page format.

PLOGI *See* N_Port Login.

point-to-point A topology in which exactly two ports communicate. In Fibre Channel, the two ports are N_Ports.

pointers A SCSI element that points to relative locations in memory.

port A specific end-point for communications within a host, or from a host to a peripheral device or vice versa. In Fibre Channel, it is an access point in a device where a link attaches. Examples of this port are N_Port, NL_Port, F_Port, and FL_Port.

Port Name In Fibre Channel, a 64-bit word consisting of the port number, Company ID, Tape library Number, and zeros.

PPC Parameter pointer control.

primitive sequence In Fibre Channel, a special type of ordered set transmission word sent repeatedly by a port until a proper response is received. The primitive sequence signals specific conditions such as online to offline, or link reset. *See* Ordered Set.

primitive signals In Fibre Channel, a type of ordered set that is transmitted by a port, outside the confines of a frame transmission, to do a specific function not associated with transmitting data per se. Examples are Idle and Receiver Ready (R_RDY). A receiving port recognizes a primitive signal when it is received as a single entity, not grouped with other signals.

private loop In Fibre Channel, an arbitrated loop that can connect up to 126 NL_Ports. In contrast with a public loop, a private loop does not attach to a fabric.

PRLI *See* Process Login.

PRLO *See* Process Logout.

Process Login (PRLI) In Fibre Channel, the Process Login command used in Extended Link Services. It is required when originated by the initiator, requires a response by a library, and is prohibited when originated by a library.

Process Logout (PRLO) In Fibre Channel, the Process Logout command used in Extended Link Services. It is invokable when originated by the initiator, requires a response by a library, is invokable when originated by a library, and requires a response by an initiator.

prohibited The state of a function, parameter, or operation in Fibre Channel not being allowed to be used between an initiator and a target.

public loop In Fibre Channel, an arbitrated loop that includes at least on FL_Port (attachment to fabric). A public loop can include up to 126 NL_Ports and one FL_Port.

PVolTag Primary volume tag.

Q

QoSR Quality of service request.

R

R_A_TOV *See* Resource Allocation Timeout.

R_CTL The Routing Control field in the frame header contains a routing bits sub-field, which has specific values indicating that FC-4 data will follow. It also contains an information category field, which indicates to the recipient the type of data that the frame contains.

R_RDY Receiver Ready.

R_T_TOV Receiver Transmitter Timeout value.

RCS Read connection status block.

Read Exchange Status Block (RES) In Fibre Channel, the Read Exchange Status Block command used in Extended Link Services. It is restricted when originated by the initiator, restricted when originated by a library, and invokable when originated by a library.

Read Link Error Status Block (RLS) In Fibre Channel, the Read Link Error Status Block command used in Extended Link Services. It is invokable when originated by the initiator, requires a response by the library, and is prohibited when originated by a library.

Read Sequence Status Block (RSS) In Fibre Channel, the Read Sequence Status Block command used in Extended Link Services. It is invokable when originated by the initiator, requires a response by the library, and is allowable when originated by a library.

REC Read Exchange Concise.

REC_TOV Read Exchange Concise Timeout.

Reinstate Recovery Qualifier (RRQ) In Fibre Channel, the Reinstate Recovery Qualifier Command used in Extended Link Services. It is invokable when originated by the initiator, requires a response by a library, and is prohibited when originated by a library.

RelAdr Relative address.

Remove Connection (RMC) The Remove Connection Command used in Basic Link Services. It is prohibited when originated by the initiator and is prohibited when originated by a library.

Report Node Capabilities Information (RNC) In Fibre Channel, the Report Node Capabilities Information Command used in Extended Link Services. It is invokable when originated by the initiator, requires a response by a library, and is prohibited when originated by a library.

Request Sequence Initiative (RSI) In Fibre Channel, the Request Sense Initiative Command used in Extended Link Services. It is invokable when originated by the initiator, allowable as a response by a library, is required when originated by a library, and requires a response by an initiator.

required The state of a function, parameter, or operation in Fibre Channel required to be implemented by both the initiator and target.

RES *See* Read Exchange Status Block.

Resource Allocation Timeout (R_A_TOV) The minimum amount of time that an L_Port waits before reinstating the Recovery Qualifier.

Resource Recovery Timeout (RR_TOV) The minimum amount of time a target waits for an ADISC or PDISC Extended Link Service following a LIP.

REQ Request. A signal driven by the target indicating a data request transfer handshake.

RLS *See* Read Link Error Status Block.

RMB Removable Medium Bit.

RMC *See* Remove Connection.

RNC *See* Report Node Capabilities Information.

RR_TOV *See* Resource Recovery timeout value.

RRQ *See* Reinstate Recovery Qualifier.

RSCN Registered state change notification.

RSI *See* Request Sequence Initiative.

RSS *See* Read Sequence Status Block.

RST Reset. An OR-tied signal indicating a reset condition.

Rsvd Reserved.

RTV Read Timeout Value.

RVCS Read VC Status.

RX_ID Responder Exchange Identifier.

S

SCSI Small computer system interface.

SCSI device A host adapter or control unit attached to the SCSI bus.

SCSI-3 The set of SCSI commands used for Fibre Channel. SCSI-3 comes in a Generic Packetized Protocol (SCSI-3 GPP) and Fibre Channel Protocol (SCSI-3 FCP).

SCN State change notification.

SEL Select. A signal used by the initiator to select a target.

SelfTestl Self test.

SEQ_CNT *See* Sequence Count.

SEQ_ID *See* Sequence Identifier.

sequence In Fibre Channel, a set of one or more frames identified as a unit within an interchange.

Sequence Count (SEQ_CNT) In Fibre Channel, a value in a frame header that helps the receiving port identify the order in which a set of frames was transmitted.

Sequence Identifier (SEQ_ID) In a transmission between a pair of terminal N_Ports in a Fibre Channel network, the field in the Sequence Content header portion of the Sequence Management frame that separates one sequence from another.

serial transmission A transmission in which bits are sent in a stream in a single fiber. Contrast this with a parallel transmission.

SftRe Soft reset.

single-ended A SCSI bus alternative with a maximum cable length of 6 m (25 ft).

SK Sense Key. A field in the Request Sense data format.

SKSV Sense Key Sense Valid.

SP Save Pages or Parameters.

SOF *See* Start of Frame Delimiter.

SOFi3 The abbreviation for Start of Frame Initiate Class 3 delimiter.

SOFn3 The abbreviation for Start of Frame Normal Class 3 delimiter.

Start-of-Frame Delimiter (SOF) In Fibre Channel, a delimiter used to mark the beginning of a frame, as well as specify the class of service used for the frame.

ST Storage element.

STK StorageTek. Storage Technology Corporation.

StorDT Store data transfer element (the tape drive).

StorI/E Store element (the CAP).

StorST Store storage cell location.

StorMT Store medium element (the hand).

SVaild Source elements are valid.

synchronous A mode of data transfer. *See* asynchronous.

T

TapeAlert A specification for tape and library diagnostics based on performance and interpretation of information.

target A SCSI device that performs an I/O operation requested by the initiator.

Task Management In Fibre Channel, defines when a task or group of tasks must be aborted or terminated.

TERMPWR Terminator power. A SCSI bus signal for device termination networks.

Third Party Process Logout (TPRLO) In Fibre Channel, the Third Party Process Logout Command used in Extended Link Services. It is invokable when originated by the initiator, requires a response by a library, is prohibited when originated by a library.

topology A method or scheme for connecting ports for communicating in Fibre Channel. Fibre Channel topologies include Point-to-Point, Arbitrated Loop, and Fabric.

TPRLO *See* Third Party Process Logout Command.

transmission character In Fibre Channel, the 10-bit encoded form of a byte or special code using the 8B/10B encoding algorithm.

transmission word In Fibre Channel, a set of four transmission characters that contains 32 bits of information, which is the smallest information unit transmitted on Fibre Channel.

TrmIOP Terminate I/O process.

TSD Target save disable.

U

ULP Upper level protocol.

ULP_TOV Upper Level Protocol timeout value.

Ultrium The single hub implementation of the LTO specification for tape storage devices.

UnitOfl Unit offline.

V

VDE Verband Deutscher Elektrotechniker.

vendor specific Something (a bit, field, code value) not defined by a specification unique to the manufacturer for reporting purposes.

virtual library A device that represents an emulation of a SCSI Media Changer and will behave differently from any specific instance of a real SMC device.

Virtual SCSI Media Changer See “virtual library.”

VolTag Volume tag.

X

X_ID In Fibre Channel, a Class 3 Service Parameter used for Recipient Control. It contains one word with 29 bits, and a value of 0.

XFER Transfer.

Z

zero A false or negative signal.

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Element Mapping

A

This appendix details how element numbers will be mapped into physical library locations using panel-row-column notation. These element numbers are returned to a SCSI host via the Mode Sense command.

Data Transfer (Drive) Element Mapping

The range of element addresses for drives in a library depends on the number of drives installed. (Note that drive type—DLT or 9840—affects the total number of drives that can be installed in each drive column.) The following two sections summarize the drive element addresses available on the L700, L700e and L180 and provide additional information about the configuration of drive types in the drive column.

Drive Element Mapping Rules

The following rules apply to drive element mapping:

- Drives may be placed in any of the 10 slots in a drive column, except that a 9840 drive may not be placed in the topmost slot.
- A DLT drive or an LTO Ultrium drive requires one slot.
- A 9840 drive requires one-and-a-half slots
- Auto configuration will map the L700 drive elements:
  - Counting from the top of Drive Column A (element 500d) to the bottom of Drive Column A (element 509d if 10 drives are installed), then
  - From the top of Drive Column B (element 510d) to the bottom of Drive Column B (element 519d if 10 drives are installed).
- Auto configuration will map the L180 drive elements, counting from the top of the drive column (element 500d) to the bottom of the drive column (element 509d if 10 drives are installed).

Drive Configuration Rules

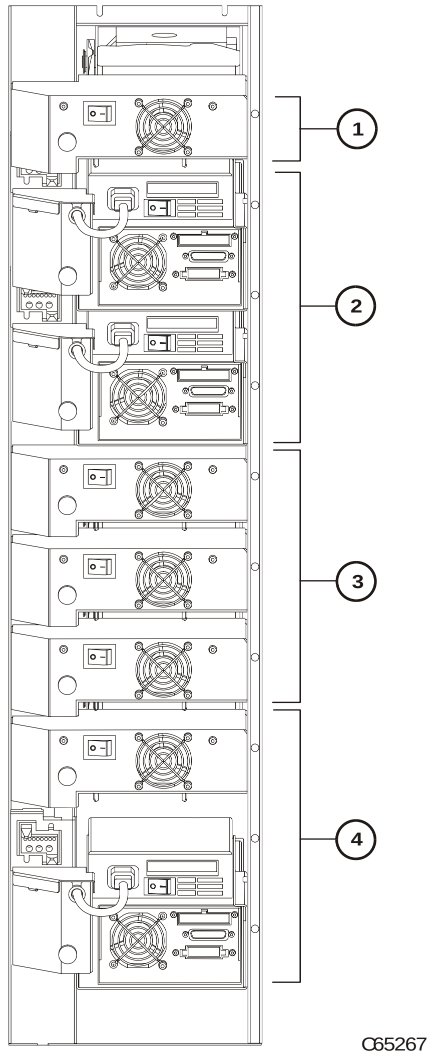
See Figure A-1 on page A-3 and Table A-1 on page A-2 for the configuration rules for installing drives:

1. The first section in Figure A-1 on page A-3 shows that the uppermost drive slot in the drive column may only be a DLT drive or an LTO Ultrium drive.
2. The second section depicts the size ratio of the 9840 drives to the DLT or Ultrium drives. In size, two 9840 drives fit in the same space as three DLT drives or three Ultrium drives. This space also accommodates one DLT or Ultrium drive and one 9840 drive.
3. The third section shows this ratio again: three DLT or Ultrium drives fit in the same space as two 9840 drives. This space also accommodates one DLT or Ultrium drive and one 9840 drive.
4. The fourth section depicts a mixture of 9840 and DLT or Ultrium drives.

Table A-1. Drive Combinations Permitted

Number of 9840 Drives	Number of DLT Drives or Ultrium Drives
0	10
1	8
2	7
3	5
4	4
5	2
6	1

Figure A-1. Drive Combination Rules



Drive Installation Rules (C65267)

1. DLT or Ultrium drive *only* in top-most slot
2. Two 9840 drives (shown), or three DLT drives, or three Ultrium drives or one 9840 and one DLT
3. Three DLT drives (shown), or three Ultrium drives, or two 9840 drives, or one 9840 and one DLT
4. Mixed 9840 and DLT drives (shown), or three DLT drives, or three Ultrium drives, or two 9840 drives

Import/Export (CAP) Element Mapping

The following rules apply to CAP element mapping on the L700:

- The bottom of CAP A is always the last CAP element (element 29d or 49d, depending on whether CAP B is installed).
- The top of CAP A is the first CAP element *if no optional CAP B is installed.*
- The top of CAP B is the first CAP element if the CAP B option is installed.
- The first CAP element is 10d.

The following rules apply to CAP element mapping on the L180:

- The bottom of the CAP is always the last CAP element (19d).
- The top of the CAP is always the first CAP element (10d).

Import/Export (PTP) Element Mapping

The following rules apply to PTP element mapping on the L700e:

- The bottom of the PTP is always the last PTP element (9d).
- The top of the PTP is always the first PTP element (8d).

Default Element Mapping

The following rules apply to the default element mapping values:

- 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 (cell) is element 1000d.

The following table shows these defaults and depicts how last element addresses are affected by variables in a library's configuration.

Table A-2. First and Last Element Addresses

Type of Element	First Element Address	Variables Affecting Last Element Address	Last Element Address
Hand	0d	None	0d
L700 or L700e CAP slots	10d	Only one CAP installed	29d
		Two CAPs installed	49d
L700e PTP slots	8d	None	9d
L180 CAP slots	10d	None	19d
Drives	500d	Only one drive column installed; 10-drive maximum reached	509d
		Two drive columns installed; 20-drive maximum reached (L700 only)	519d
Cells in L700, 1/3 capacity	1000d	Only one drive column installed	1215d
		Two drive columns installed	1155d
Cells in L700, 2/3 capacity	1000d	Only one drive column installed	1383d
		Two drive columns installed	1323d
Cells in L700, full capacity	1000d	Only one drive column installed	1677d
		Two drive columns installed	1617d
Cells in L180-80	1000d	None	1083d
Cells in L180-140	1000d	None	1139d
Cells in L180-180	1000d	None	1173d

Reserved Cells

The first short column of cells under the CAP (under CAP B on the L700) is reserved for cleaning and diagnostic cartridges.

Note: The top cell is reserved as a swap cell *and must be empty.*

L700/L700e Wall Elements

The following diagrams and tables describe the wall elements within the L700 and L700e libraries. Figure A-2 on page A-7 through Figure A-9 on page A-14 show the element numbers for various wall configurations of the library. The following tables list configuration/capacity information.

Table A-3. L700/L700e Configurations—Single Drive Column

Configuration	Number of Data Storage Cells[1] without PTP (L700)	Number of Data Storage Cells[1] with PTP[2] (L700e)	Panels Included
1/3	216	216	Panel 0, Panel 1, and Column 0 of Panel 2
2/3	384	378	Panel 0, Panel 1, Panel 2
Full	678	672	All

1. Data storage cells are also known as "customer-accessible cells."

2. Number listed is for each L700e.The total number of data storage cells in the L700e pair is two times the number listed.

Table A-4. L700/L700e Configurations—Two Drive Columns

Configuration	Number of Data Storage Cells[1] (L700)	Number of Data Storage Cells[1] with PTP[2] (L700e)	Panels Included
1/3	156	156	Panel 0, Panel 1, and Column 0 of Panel 2
2/3	324	318	Panel 0, Panel 1, Panel 2
Full	618	612	All

1. Data storage cells are also known as "customer-accessible cells."

2. Number listed is for each L700e.The total number of data storage cells in the L700e pair is two times the number listed.

Figure A-2. L700 Element Map—Single CAP, Single Drive Column

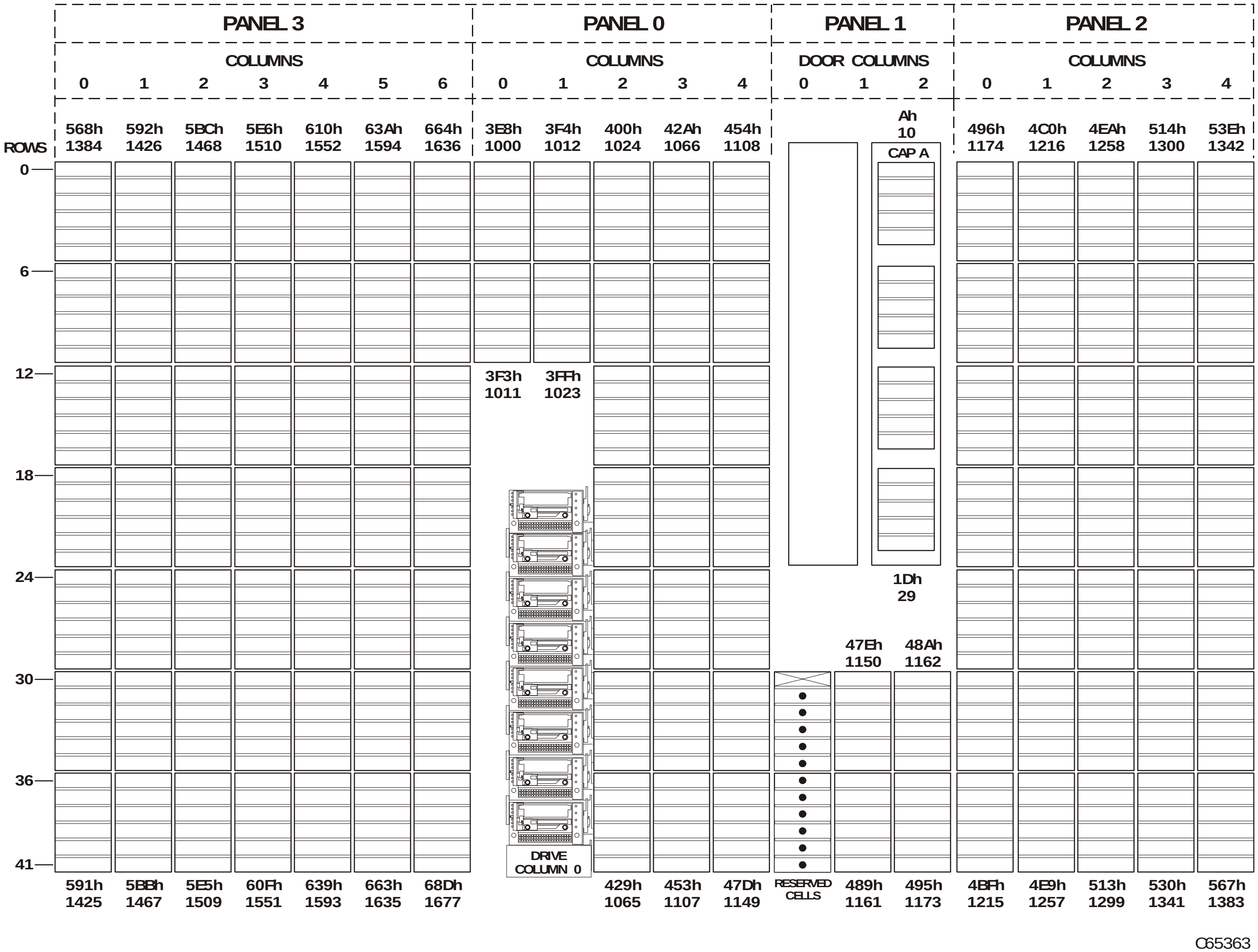
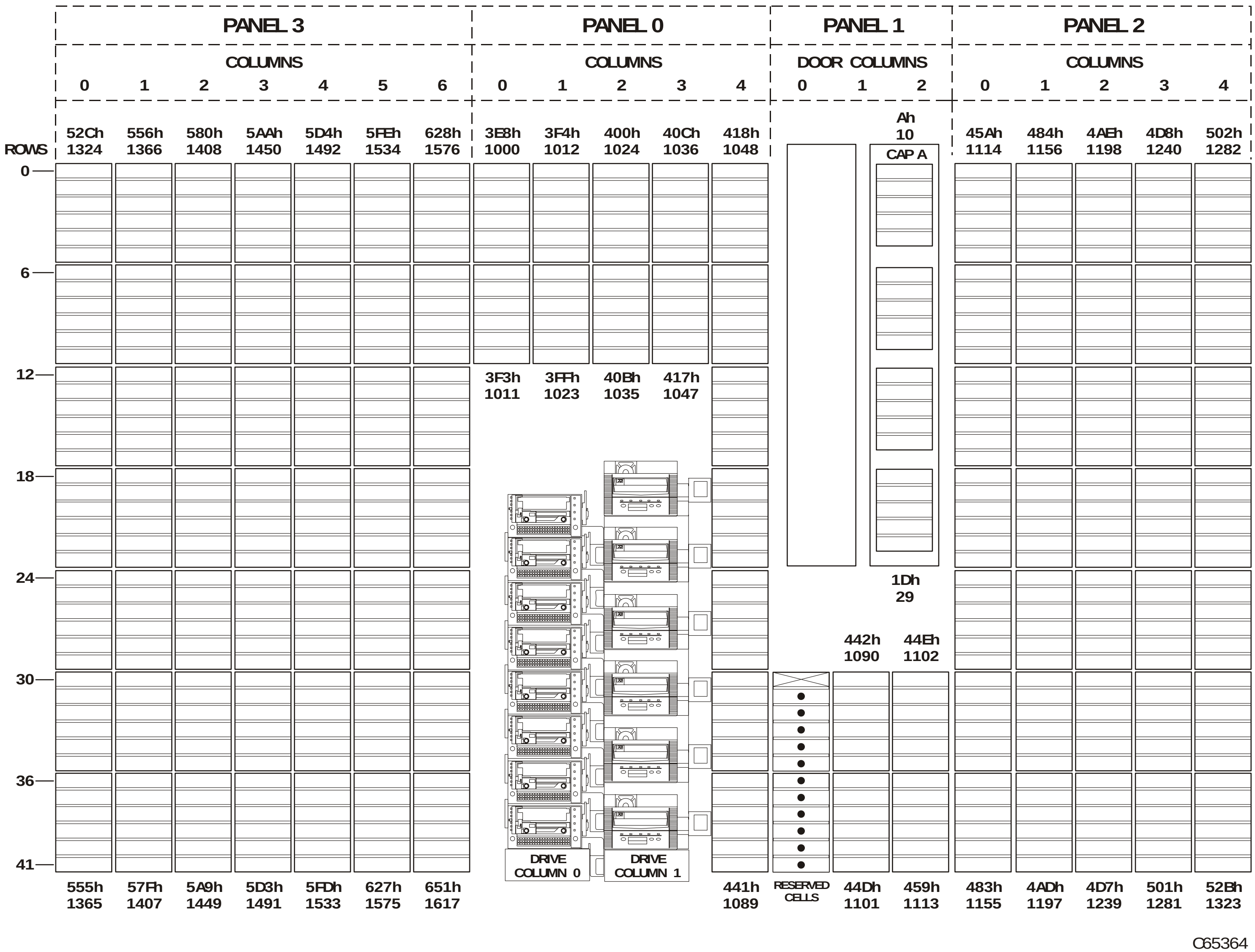


Figure A-3. L700 Element Map—Single CAP, Double Drive Columns



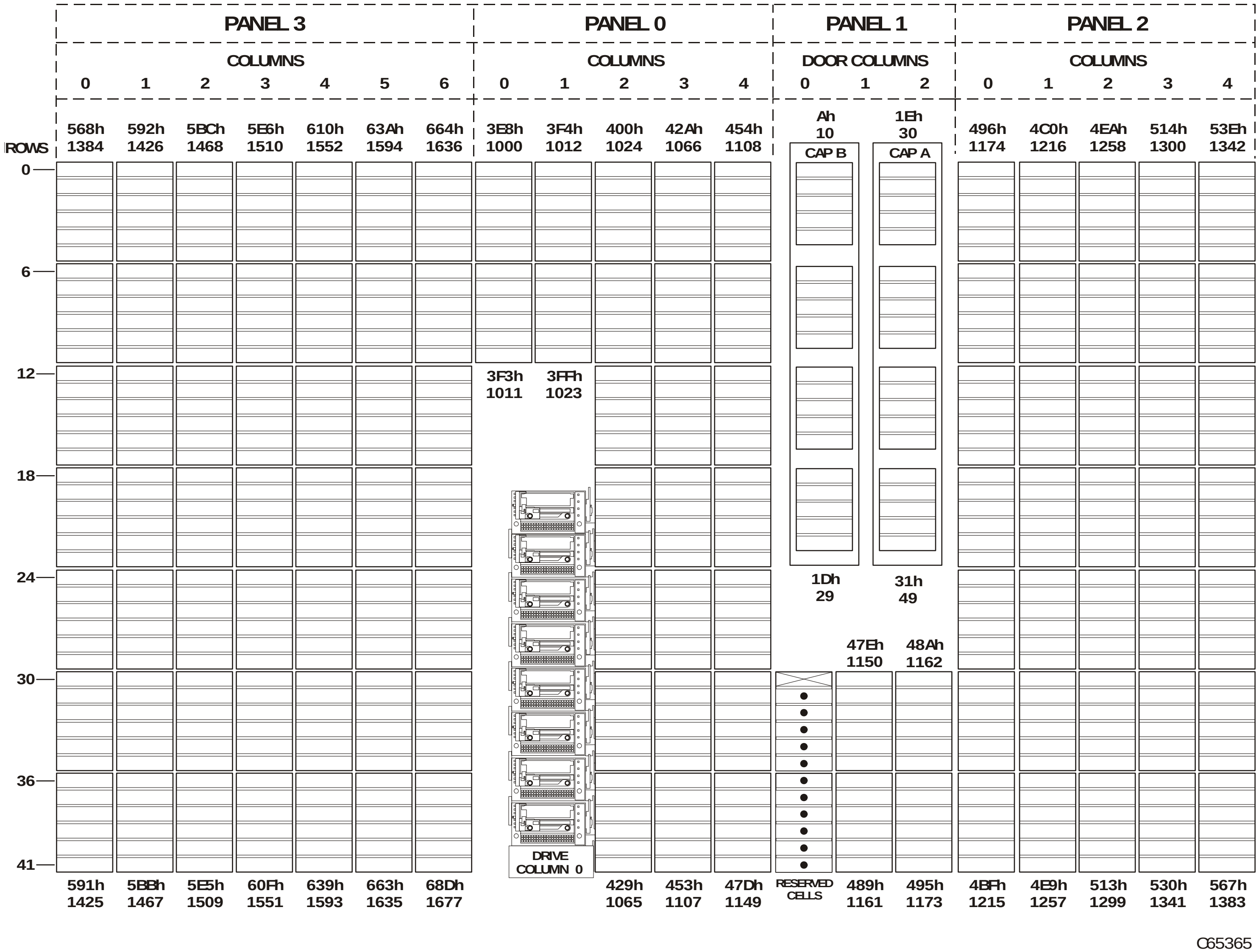


Figure A-4. L700 Element Map—Double CAP, Single Drive Column

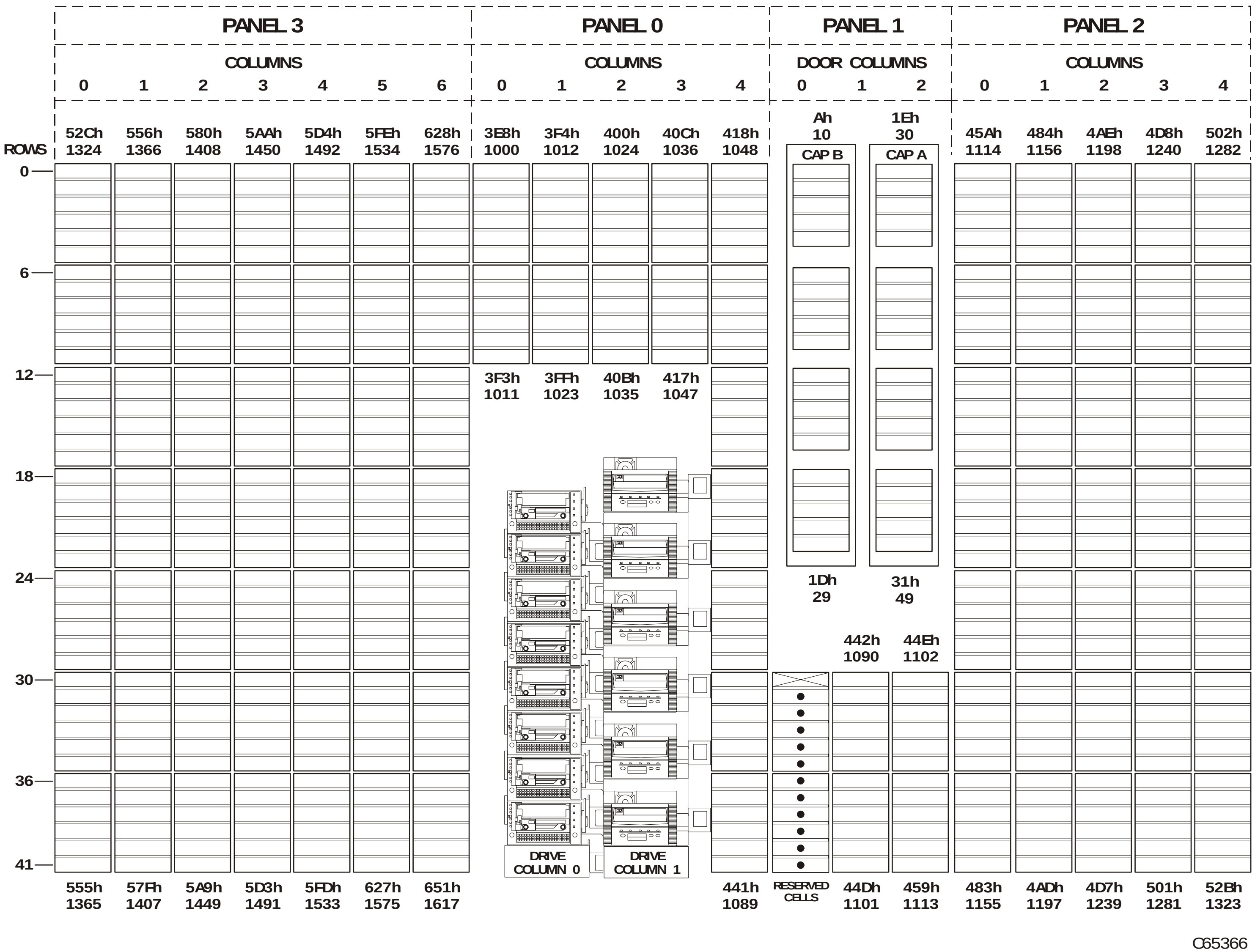


Figure A-5. L700 Element Map—Double CAP, Two Drive Columns

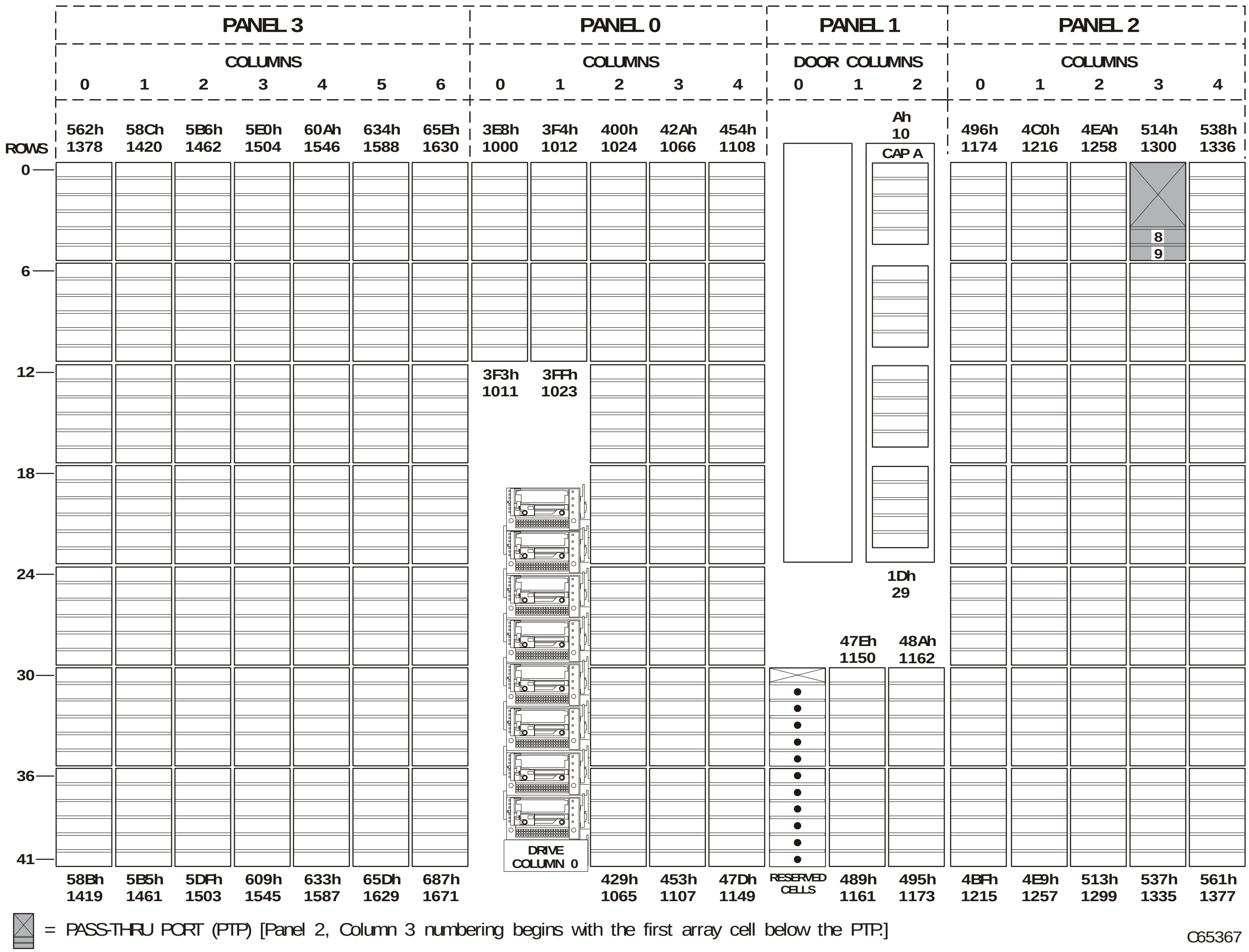


Figure A-6. L700e Element Map—Single CAP, Single Drive Column

Figure A-7. L700e Element Map—Single CAP, Double Drive Columns

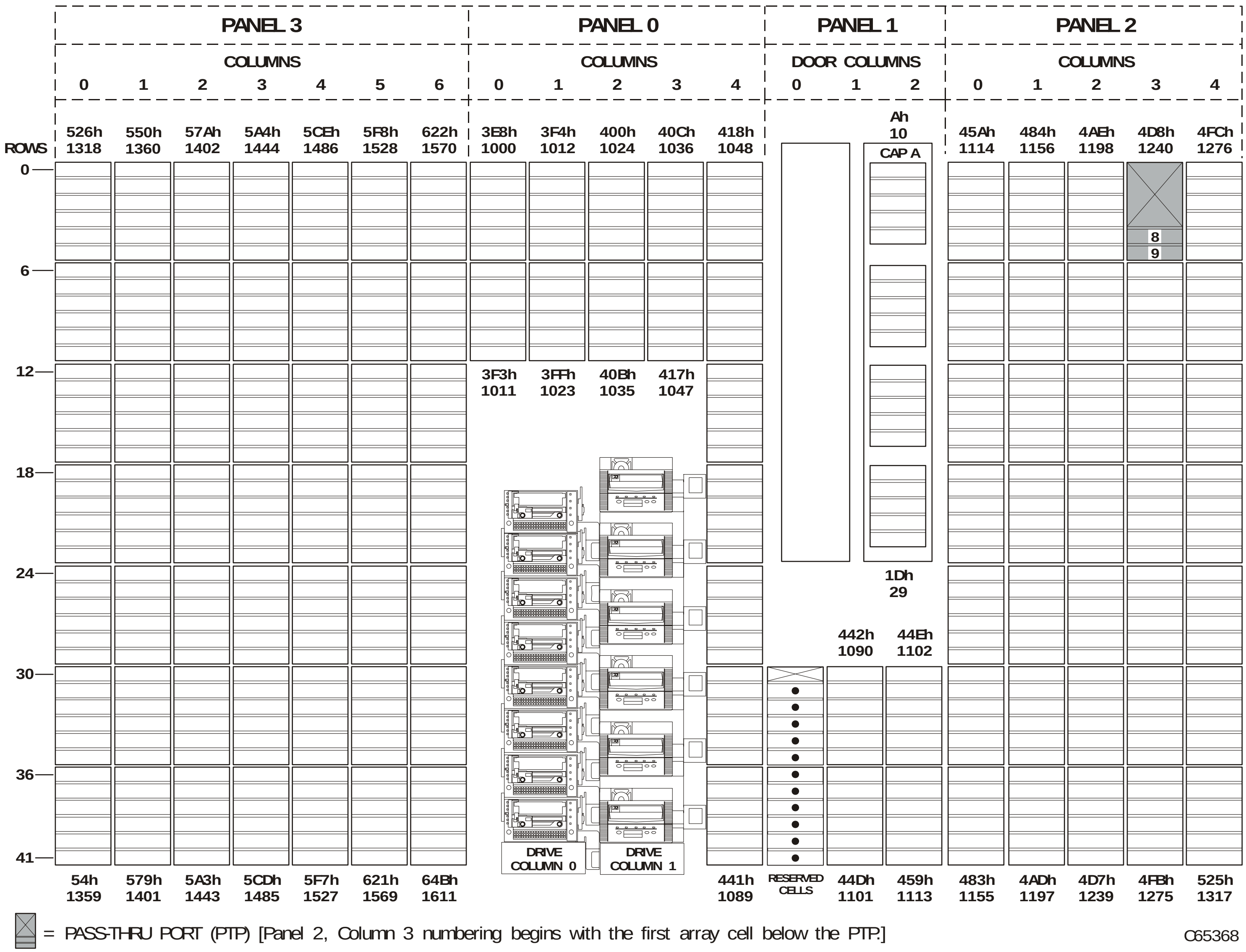


Figure A-8. L700e Element Map—Double CAP, Single Drive Column

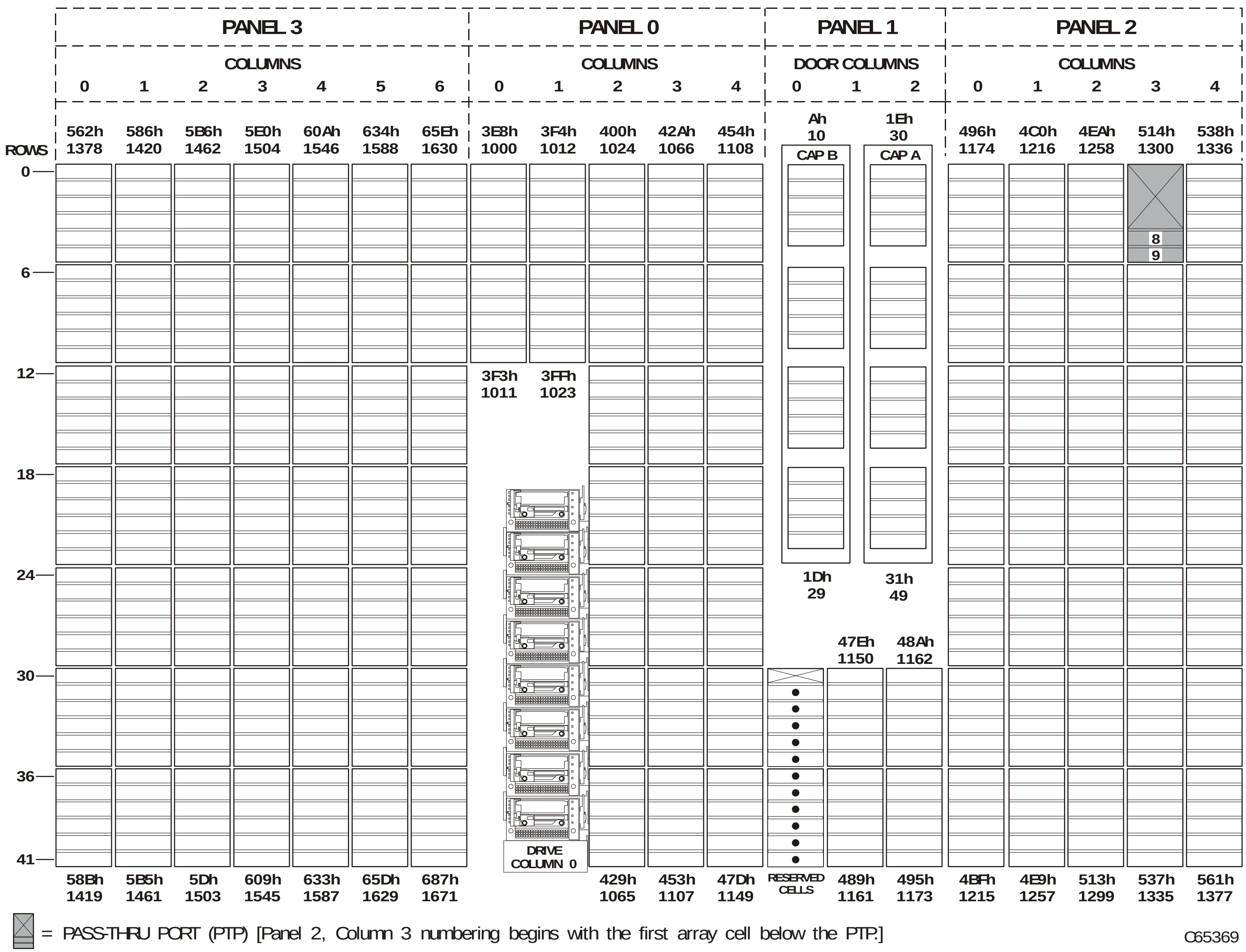
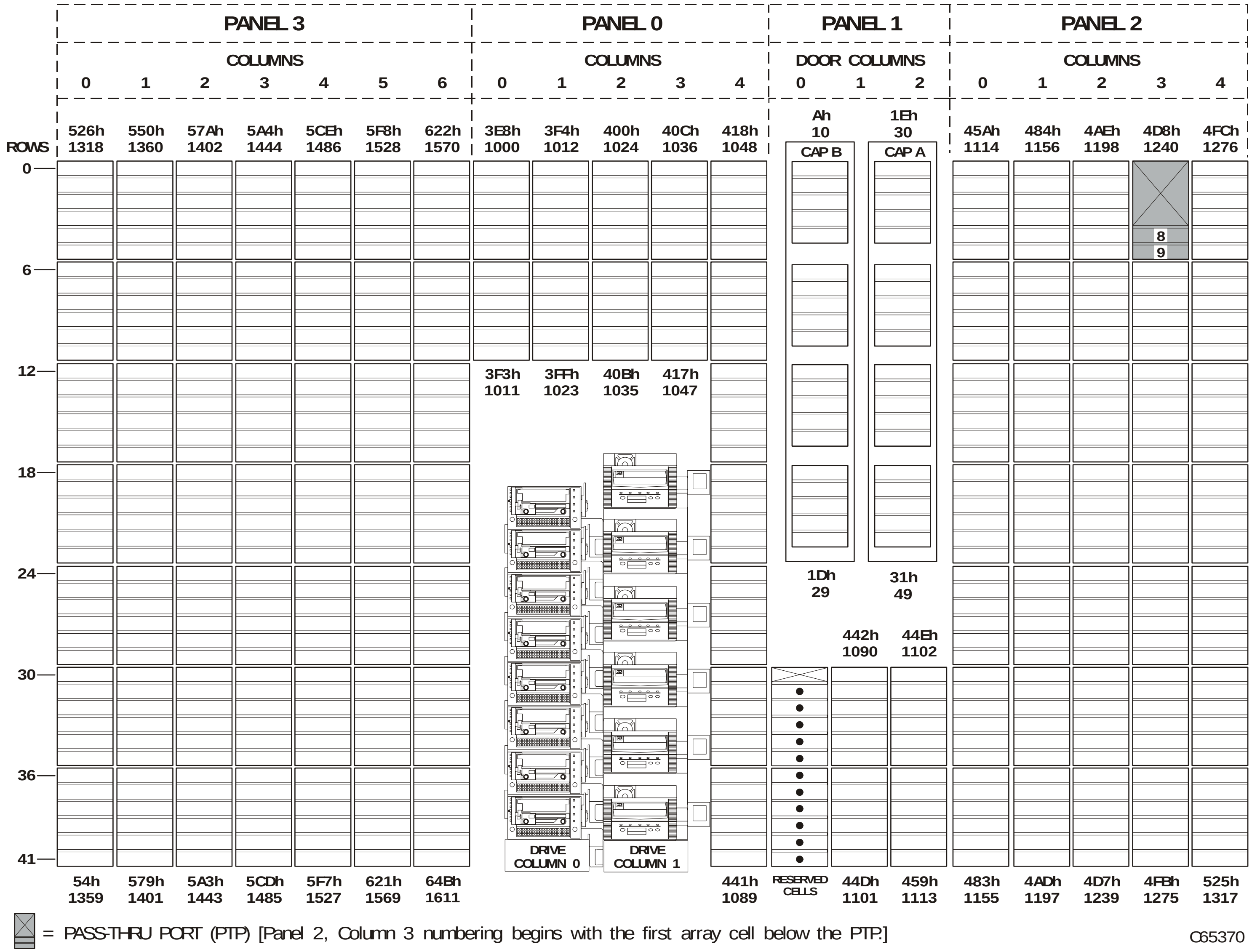


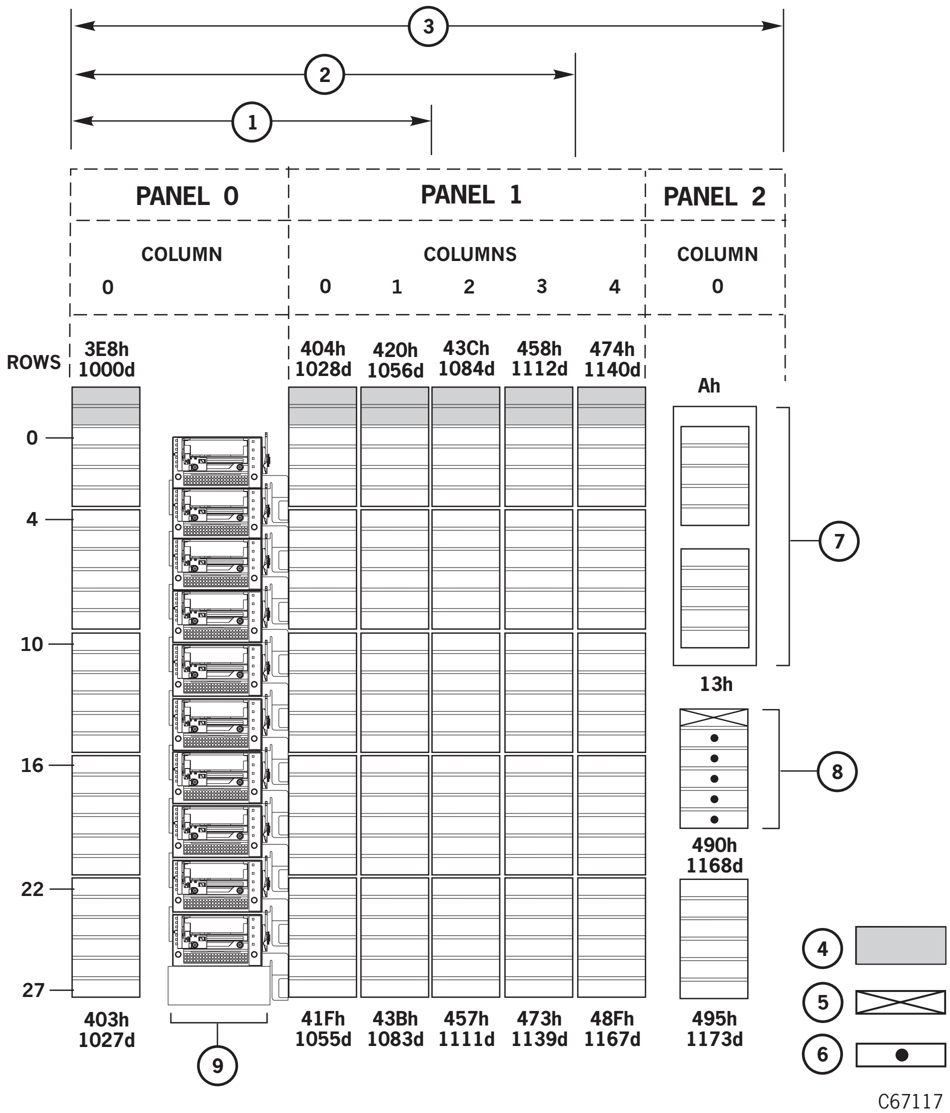
Figure A-9. L700e Element Map—Double CAP, Two Drive Columns



L180 Wall Elements

The following diagram shows the locations of wall elements within the L180 library. It also provides capacity information and cell addresses.

Figure A-10. L180 Wall Elements, Capacity, and Cell Addresses



L180 Wall Element Map (C67117)

1. Model L180-80 = 84 data storage cells
2. Model L180-140 = 140 data storage cells
3. Model L180-180 = 174 data storage cells
4. Blocked storage cells (no cartridges permitted)

Figure A-10. L180 Wall Elements, Capacity, and Cell Addresses (Continued)

5. Swap cell
6. Cells reserved for cleaning and diagnostic cartridges
7. CAP: logical address is Column 1, Panel 1
8. Reserved cell array: logical address is Column 0, Panel 1
9. Drive column: logical address is Column 0, Panel 0

Index

D

G

H

I

N

O

P

Q

R

T

U

V

W

X

Z

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