TL82X/TL893/TL896 Automated Tape Library for DLT™ Cartridges

Software Interface Guide

EK-TL820-IG

Revision C01

EK-TL820-IG, Revision C01, April 24, 1997, Made in USA.

FCC STATEMENT

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications.

Any changes or modifications made to this equipment may void the user's authority to operate this equipment.

Operation of this equipment in a residential area may cause interference in which case the user at his own expense will be required to take whatever measures may be required to correct the interference.

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

INDUSTRY CANADA (DIGITAL APPARATUS)
Interference-Causing Equipment Standard
ICES-003 Issue 2

This Class A digital apparatus meets all requirements of the Canadian Interference-Causing Equipment Regulations.

Cer apparcil numerique de la classe A respecte toutes les exigences du Reglement sur le materiel brouilleur du Canada.

CISPR-22 WARNING!

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

ACHTUNG!

Dieses ist ein Gerät der Funkstörgrenzwertklasse A. In Wohnbereichen können bei Betrieb dieses Gerätes Rundfunkstörungen auftreten, in welchen Fällen der Benutzer für entsprechende Gegenmassnahmen verantwortlich ist.

ATTENTION!

Ceci est un produit de classe A. Dans un environment domestique, ce produit peat causer des interférences radio lectriques. Il appartienl alors a l'utilisateur de prendre les mesures appropriées.

NOTICE FOR USA AND CANADA ONLY

If shipped to USA, use the UL LISTED power cord specified below for 100-120 V operation. If shipped to CANADA, use the CSA CERTIFIED power cord specified below for 100-120V operation.

Plug Cap	Parallel blade with ground pin (NEMA 5-15P Configuration)
Cord	Type: SJT, three 16 or 18 AWG wires
Length	Maximum 15 feet
Rating	Minimum 10 A, 125 V

ATTENTION

LIRE LA REMARQUE DANS LE MODE D'EMPLOI

REMARQUE

CETTE REMARQUE NE CONCERNE QUE LES ÉTATS-UNIS ET LE CANADA.

En cas d'envoi aux États-Unis, utiliser le cordon d'alimentation certifié UL et convenant pour 100-120 V.

En cas d'envoi au CANADA, utiliser le cordon d'alimentation CERTIFIÉ CSA et convenant pour 100-120 V.

Fiche	Broches paralléus avec une broche de mise à la terre (configuration NEMA 5-15P)
Cordon	Type: SJT, trifilaire 16 ou 18 AWG
Longeur	Maximum 15 pieds
Capacité	Minimum 10 A, 125 V

ZU IHRER SICHERHEIT

Vorsicht

Um Feuergefahr und die Gefahr eines elektrischen Schlages zu vermeiden. darf das Gerät weder Regen noch Feuchtigkeit ausgesetzt werden.

Um einen elektrischen Schlag zu vormeiden, darf das Gehäuse nicht geöffnet werden. Überlassen Sie Wartungsarbeiten stets nur einem Fachmann.

Achtung

Da der interne Laserstrahl in lhre Augen eindringen und Verletzungen verursachen kann, darf das Gehäuse nicht selbst geöffnet werden. Überlassen Sie Wartungearbeiten stets nur einem Fachmann.

Die Verwendung von Brillen, Kontaktlinsen usw.vergrössert die Gefahr.

Zur besonderen Beachtung

Zur Sicherheit

Sollte ein fester Gegenstand oder Flüssigkeit in das Geräteinnere gelangen, trennen Sie das Gerät von der Wandsteckdose ab und lassen Sie es von einem Fachmann überprufen, bevor Sie es weiter verwenden.

Zum Abziehen des Kabels fassen Sie stets am Stecker und niemals am Kabel selbst an.

Zur Aufstellung

Stellen Sie das Gerät weder auf einer weichen Unterlage (z. B. Decke, Teppich) noch in der Nahe von Vorhangen, Tapeten usw, auf, da hierdurch die Ventilationsöffnungen blockiert werden können.

Zur Reiningung

Verwenden Sie zur Reiningung des Gehäuses, des Bedienungspultes und der Bedienungselemente ein trockenes, weiches Tuch oder ein weiches, leicht mit mildem Haushaltsreiniger angefeuchtetes Tuch. Lösemittel wie Alkohol oder Benzin dürfen nicht verwendet werden, da diese die Gehäuseoberfläche ungreifen.

LASER STATEMENT

CLASS 1 LASER PRODUCT

CAUTION - This product contains a Class II laser. Laser light - DO NOT stare into beam. Avoid Exposure - Laser Light is emitted from the barcode scanner.

CAUTION - Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous exposure.

LASER KLASSE 1

VORSICHT : Dieses Produkt Enthdlt Einen Laser Der Kategorie II. Laserstrahlen - Der Strichcode-scanner Gibt Laserstrahlen aus. VERMEIDEN SIE jeden Blickkontakt und direkten kvrperlichen Kontakt mit diesen Strahlen.

VORSICHT : Ein nicht ordnungsgemd_er (siehe hier enthaltene Anweisungen) Einsatz bzw. Dnderungen der Betriebsleistung kvnnen einen gesundheitsgefdhrdenden Kontakt zur Folge haben.

APPAREIL À LASER DE CLASSE 1

ATTENTION : ce produit relhve de la classe laser II. Rayonnement laser - NE PAS fixer des yeux le rayon. Eviter les expositions - Le rayonnement laser est imis' partir du lecteur optique de code barre.

ATTENTION : L'utilisation de contrtles ou d'ajustements de performance des procidures autres que ceux indiquis ici peut entranner une exposition dangereuse.

PRODUCTO LÁSER DE CLASE 1

¡ATENCIÓN! Este producto contiene laser de clase II. Luz de laser - NO mire el rayo. Evite el contacto con la luz: la luz de laser se emite desde el explorador de código de barras.

¡ATENCIÓN! El uso de los controles o ajustes para realizar procedimientos que no son especificados puede provocar una situación peligrosa.

LUOKAN 1 LASERLAITE

ATTENZIONE: questo prodotto emette una luce laser di Classe II. NON guardare il facsio di luce ed evitare di esporsi alla fonte del laser. Il fascio di luce laser h emesso dal dispositivo di scansione del codice a barre.

ATTENZIONE: l'uso di comandi o regolazioni per eseguire le procedure che non siano quelli specificati in questa documentazione pur causare rischi all 'incolumit' delle persone.

Table of Contents

Software Interfaces

x

List of Figures

List of Tables

Introduction 1

Purpose

The TL82X/TL893/TL896 is an automated tape library subsystem which brings the benefits of Archival Automation™ to distributed processing and network servers. The TL82X/TL893/TL896 uses either a SCSI-2 or an EIA/TIA-574 interface combined with industry-standard command protocols. This allows existing optical jukebox device drivers to be easily modified for use with the TL82X/TL893/TL896 libraries.

The TL82X/TL893/TL896 product family consists of the following tape libraries: TL820, TL822, TL826, TL893, and TL896. The model number for each library is printed on the product label located on the rear of the unit. Table 1 identifies the configuration differences between these tape libraries. Table 2 describes the specifications of the different tape drive models.

Table 1: Library Configurations

Library	No. of Tape Drives	Max. No. of Cartridges	Tape Drive Model	Default No. of SCSI Busses
TL820	3	264	TZ87	2
TL822	3	264	TZ88	3
TL826	6	176	TZ88	6
TL893	3	264	TZ89	3
TL896	6	176	TZ89	6

Table 2: Tape Drive Specifications

Model Number	Native Mode		With 2:1 Compression	
	Transfer Rate	Capacity	Transfer Rate	Capacity
TZ87	1.25 Mbytes/s	10 Gbytes	2.5 Mbytes/s	20 Gbytes
TZ88	1.5 Mbytes/s	20 Gbytes	3.0 Mbytes/s	40 Gbytes
TZ89	5 Mbytes/s	35 Gbytes	10 Mbytes/s	70 Gbytes

The information in this guide is intended for software engineers who are developing application and hierarchical mass storage software to access the TL82X/TL893/TL896 libraries. This guide describes the SCSI-2 and EIA/TIA-574 software interfaces, performance issues, and error handling. It also contains a list of error codes and possible solutions.

This guide is divided into the following sections:

- Chapter 1, "Introduction," describes the purpose of this manual and provides an explanation of its contents as well as a list of related documentation.

- Chapter 2, "Theory of Operation," provides a general overview of library events, operating sequences, and configuration procedures.

- Chapter 3, "Software Interfaces," describes the commands, messages, and implementation of the SCSI-2 and the EIA/TIA-574 interfaces.

- Appendices provide sense data values and control panel and system states.

Conventions Used in this Guide

The following conventions are used in this guide:

- All binary numbers are followed by **"b."**
- All hexadecimal numbers are followed by "**h.**"
- Error or attention conditions are represented in parenthesis, which translate as follows:
  (SK=S ASC=AA ASCQ=QQ)

where:

S = hexadecimal sense key value.

AA = hexadecimal sense additional sense code.

QQ = hexadecimal additional sense code qualifier.

A definition of these values can be found in Appendix A.

References

Documentation and Contacts

To obtain further information and/or copies of documentation on this product, contact:

U.S. Software Supply Business
Digital Equipment Corporation
10 Cotton Road
Nashua, New Hampshire 03063-1260

The part number of each document will be required at the time of order. Table 3 on page 1-6 is a list of documentation related to the TL82X/TL893/TL896 libraries.

On-Line Documentation

On-line documentation for the TL82X/TL893/TL896 libraries is available from the Digital Equipment Corporation, Shrewsbury MA world wide web site, in portable document format (.pdf) at:

http://www.shr.dec.com

SCSI-2 Specification

This Small Computer System Interface-2 (SCSI-2)communications specification is the proposed American National Standard for information systems, dated March 9, 1990. Copies may be obtained from:

Global Engineering Documents
2805 McGaw
Irvine, California 92714
(800) 854-7179 or (714) 261-1455

Table 3: Related
Documentation

Document Number	Document Title	Document Description
EK-TL820-OP	TL82X/TL893/TL896 Operator's Guide	This guide defines the control functions, operational procedures and end user maintenance procedures for TL82X/TL893/TL896 libraries.
EK-TL820-PG	TL82X/TL893/TL896 Facilities Planning and Installation Guide	This guide describes facilities requirements and installation procedures for TL82X/TL893/TL896 libraries.
EK-TL820-SV	TL82X/TL893/TL896 Field Service Manual	This manual contains fault isolation, removal and replacement, and periodic maintenance procedures for TL82X/TL893/TL896 libraries.
EK-TL820-SM	TL82X/TL893/TL896 Diagnostic Software User's Manual	This manual describes how to install and use the TL82X/TL893/TL896 Diagnostic Software Package.
6207125	TL82X/TL893/TL896 IOD Installation Instructions	This document explains how to install the import/outport device (IOD).
6207126	TL82X/TL893/TL896 MUC Installation Instructions	This document explains how to install the multi-unit controller (MUC).
6207127	TL82X/TL893/TL896 Cabinet-to-Cabinet Mounting Instructions	This document explains how to install a multi-unit library system.
EK-OTZ87-OM	TZ87 Series Cartridge Tape Subsystem Owner's Manual	This document describes the TZ87 Tape Drive and provides operating instructions and troubleshooting procedures.
EK-TZ88X-OM	TZ88 Series Cartridge Tape Subsystem Owner's Manual	This document describes the TZ88 Tape Drive and provides operating instructions and troubleshooting procedures.
EK-TZ89N-UG	TZ89 DLT™ Series Tape Drive User's Guide	This document describes the TZ89 Tape Drive and provides operating instructions and troubleshooting procedures.

Theory of Operation **2**

Introduction

The TL82X/TL893/TL896 is the storage and retrieval component of an automated tape library system. A single TL82X/TL893/TL896 tape library unit houses three to six TZ87, TZ88, or TZ89 tape drives and has fully functional media changer capability, as defined by the SCSI-2 specification.

The tape library robotics control is directed by the host computer. A serial or SCSI interface control line is used as the standard control interface for the single unit configuration.

The SCSI interface enables the robotics to be driven by the same SCSI bus as the tape drives. The multi-unit controller (MUC) allows the host to control multiple tape library units from one host interface (serial or SCSI). By providing a standard control interface and supporting standard tape drives, the TL82X/TL893/TL896 enables host software developers to adapt their software to drive the library.

The library supports a serial EIA/TIA-574 interface (RS-232 for 9-pin connectors) or a SCSI-2 interface. Only one interface is supported per tape library. With either interface, each tape library supports only one initiator and input/output (I/O) operation at a time.

The TL82X/TL893/TL896 has a minimal connection to any installed tape drives. The tape library knows the number of drives installed, but does not know the SCSI addresses for the tape drives. The tape library also does not know if the drives are on the same SCSI bus. This information is only relevant to the host computer.

Implementation Philosophy

Using the SCSI-2 standard, the host computer can adapt to changes in the tape library configuration, such as changes in the number of tape libraries or the number of tape drives.

The tape library uses the SCSI-2 medium-changer command set. This command set includes all primitive (elemental) commands required by a host to carry out library operations.

Note   *No attempt has been made to add complex commands to the command set.*

Even though the library depends on the host for direction (in the form of command sequences), the library has been designed to be forgiving of any system integration errors the host might make. The library continuously monitors the status of all mechanisms and will refuse to execute any operation which could result in damage to library components.

Medium Changer Elements

The TL82X/TL893/TL896 library system consists of one or more cabinets logically configured using one of the following two modes: multi-unit multi-LUN (MUML) or multi-unit single-LUN (MUSL). The mode you select determines how elements associated with each library unit are identified and utilized. For more information about these modes, see "Multi-Unit Operation" on page 2-15.

Note   *"Element" is a SCSI-2 term used throughout this document to refer to a discrete physical entity within a library cabinet or that connects two or more library cabinets together.*

Each cabinet consists of a combination of the following medium changer elements:

- Medium transport elements
- Storage elements
- Import/export elements
- Data transfer elements

Within a library cabinet, each medium changer element has a unique, 16-bit address. In a multi-cabinet library system, the use of MUML or MUSL mode affects how element addresses are assigned. (Compare Figure 2 on page 2-16 with Figure 3 on page 2-21.)

For example, in MUML mode, each cabinet is a considered a separate unit; corresponding element addresses repeat from cabinet to cabinet, differentiated only by the logical unit number (LUN) of the cabinet in which they physically reside. Import/export elements, which are shared by all associated cabinets, have addresses which are unique throughout the entire tape library system.

In MUSL mode, however, all cabinets form a single logical unit. Each element within the library system has a unique address and the same logical unit number (always 0).

Note   *The Mode Sense command can be used to determine a library unit's configuration. The first address and number of elements for each type (medium transport, storage, import/export, or data transfer) can also be determined using this command.*

Medium Transport Element

Each library cabinet has a transport mechanism. This mechanism consists of the vertical axis, extension axis, and gripper.

Note   *In MUSL mode, the Pass Through Mechanism (PTM) used to move cartridges from one cabinet to the next is also considered a transport element. For more information about the PTM, see "Import/Export Elements" later in this chapter.*

The transport mechanism can hold a single tape cartridge using the gripper, and thus is considered one medium transport element. The transport mechanism is used to move media between other elements within the library unit.

Storage Elements

Each library cabinet contains a maximum of 176 (TL826 and TL896) or 264 (TL820, TL822, and TL893) storage elements, which correspond to the bins in the tape cartridge carousel. One storage element exists per bin. Issuing a Move Medium command with a storage element as the source or destination address causes the carousel to automatically rotate as required to access the bin with the transport mechanism.

Import/Export Elements

Inport/export elements vary depending on MUML or MUSL mode.

MUML Mode

In MUML mode, the import/export mechanism consists of a PTM with or without an inport/outport device (IOD).

The PTM is a conveyor which moves the cartridge to a registration position when importing, or out of the system when exporting. The PTM is also used to pass cartridges between tape libraries. The PTM has a single element address used by the host to move cartridges to and from the PTM registration position.

The IOD is a single-cartridge import (inport) and 12-cartridge export (outport) device. The IOD has a one-element address for importing and a one-element address for exporting.

Within the tape library, each import/export element is uniquely addressed. The three most significant bits of the high-order address byte represents the library unit in which the element physically resides. The low-order byte of the address determines the type of import/export element as follows (see Figure 2 on page 2-16):

- **40h** left (latch side) inport
- **41h** left (hinge side) outport
- **42h** PTM

The Mode Sense Data's start element address and number of elements identify the import/export configuration for each library unit. For example, a start address of 4040h and number of elements 3 indicates logical unit 2 with a PTM and a left-hand IOD. This is because the upper 3 bits of the address are 010 and there are 3 import/export elements: 4040h, 4041h, and 4042h.

MUSL Mode

In MUSL mode, the import/export mechanism consists of one or more IODs.

The IOD is functionally the same as with MUML mode. It consists of a single-cartridge import (inport) and 12-cartridge export (outport) device and has a one-element address for importing and a one-element address for exporting.

Within the tape library, each import/export element is uniquely addressed as follows (see Figure 3 on page 2-21):

- **40h** (leftmost) inport
- **41h** outport

Data Transfer Elements

A data transfer element is associated with each of the library's tape drives. The medium transfer mechanism of the element loads and unloads tape cartridges from each tape drive.

Events

Events are system conditions created by system failures or operator actions such as opening the door or pressing the STOP button. Some of these events appear as states on the control panel. For a list of event states, see Appendix B. Note that the control status panel does not queue these states.

Figure 1: Control Status Panel
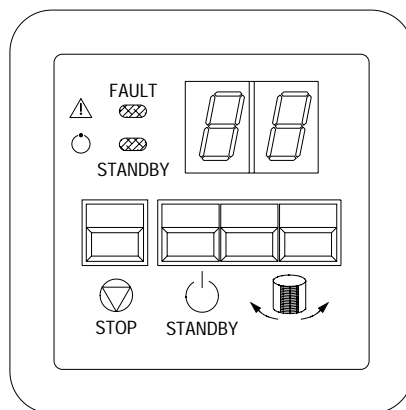
Events are recorded in sense data. Depending on the interface, the host can obtain the sense data either in response to a Request Sense command or as an Unsolicited Message.

For hosts using the SCSI-2 interface, the tape library does not support asynchronous event notification. This simplifies the host/tape library interface and is acceptable since events happen infrequently and do not require an immediate host response. The SCSI host can check for library unit events by issuing the Request Sense command. (The event sense data is transmitted in response to this command.) A tape library using the SCSI interface queues event conditions for each library unit. The host can repeatedly issue the Request Sense command to obtain each queued condition.

For hosts using the EIA/TIA-574 interface, the tape library transmits an unsolicited message when the event occurs (see "Unsolicited Message (EFh)" on page 3-90). This unsolicited message contains the event sense data.

The following sections describe significant library events.

Power Cycle

When the library unit is turned on, it generates a "Power On/Reset Occurred" event (SK=6 ASC=29 ASCQ=00).

Library Unit Off-line/Standby

When a library unit is placed into the off-line/standby state, it generates a "Logical Unit Standby Button Was Pressed" event (SK=6 ASC=80 ASCQ=09).

Library Unit On-line Initialization Failure

When a library unit is placed into the on-line state and the on-line initialization fails, the library unit generates an event for the specific error condition which caused the failure as indicated on the control panel. See Appendix B for more information.

Library Unit Door Opened

When the door of a library unit is opened, the library unit disables all actuators and generates a "Door Was Opened" event (SK=6 ASC=80 ASCQ=00).

Library Unit Stopped

When the library unit is stopped by pressing the STOP button on the control panel, the library unit disables all actuators and generates a "System Stop Button Was Pressed" event (SK=6 ASC=80 ASCQ=07).

Cartridge in Inport

When a cartridge is placed in the inport of the IOD and the inport door is closed, the library unit generates an "Import or Export Element Accessed" event (SK=6 ASC=28 ASCQ=01).

Maximum Temperature Exceeded

The library unit monitors the ambient temperature within the system. If the temperature exceeds 91 F (32.7 C), the library generates a "Warning Safe Temperature Exceeded" event (SK=6 ASC=88 ASCQ=00) and continues operation. If the temperature exceeds 111 F (43.8 C) the library disables all actuators until the temperature decreases and generates a "Maximum Temperature Exceeded" event (SK=6 ASC=88 ASCQ=01).

Library Operating Sequences

Library operating sequences are listed in order of precedence. For example, if the door is opened and the STOP button pressed, the door open sequence overrides the system stop sequence until it is completed.

The power-on sequence occurs first. After the system is turned on, the other sequences occur when specific conditions are met.

Power-On Sequence

The following actions occur when the tape library is turned on:

- The local controller for each tape library resets and initializes all tape library hardware.
- The control panel shows "2C" to indicate the unit is powering on.
- During this time, the tape library responds to Inquiry, Request Sense, Log Sense, Mode Select, and Mode Sense commands. A Check Condition is set for all other commands and the "Logical Unit is Not Ready" condition (SK=2 ASC=04 ASCQ=00) is set in sense data.
- After the library is turned on, a "Power On/Reset Occurred" event (SK=6 ASC=29 ASCQ=00) is generated.

Door Open Sequence

Note   *Before opening the tape library, it must be taken off-line. After completing the off-line sequence, you can press the STOP button and open the door. While the door is opened, the tape library is not operational.*

The following actions occur when the door is opened:

- The control panel changes to "2b" to indicate the door is opened.
- The tape library generates a "Door Was Opened" event (SK=6 ASC=80 ASCQ=00).
- If the door is opened without performing the off-line sequence, the system halts all tape library motion. Any motion command currently in progress is aborted and a Check Condition is returned to the host. The "Door is Opened" condition (SK=2 ASC=80 ASCQ=00) is set in the sense data.
- While the door is opened, the tape library responds to Inquiry, Request Sense, Log Sense, Mode Select, and Mode Sense commands. A Check Condition is set for all other commands issued during this time and the "Door is Opened" condition (SK=2 ASC=80 ASCQ=00) is set in sense data.

System Stopped Sequence

The STOP button allows the operator to stop all power to the actuators. The following actions occur when the system is stopped:

- The control panel changes to "2A" to indicate that the system is stopped.
- The library unit generates a "System Stop Button Was Pressed" event (SK=6 ASC=80 ASCQ=07).
- The system stops all library actions. Any action currently in progress is aborted and Check Condition status is returned to the host. The "System is Stopped" condition (SK=2 ASC=80 ASCQ=07) is set in sense data.
- While the system is stopped, the library responds to Inquiry, Request Sense, Log Sense, Mode Select, and Mode Sense commands. Check Condition status is set for all other commands issued during this time and the "System is Stopped" condition (SK=2 ASC=80 ASCQ=07) is set in sense data.

On-line Initialization Sequence

The STANDBY/ON-LINE button allows the library unit to be placed on-line. The on-line initialization sequence occurs only when the doors are shut, the library is placed on-line, and the STOP button has not been pressed. (Refer to the *TL82X/TL893/TL896 Operator's Guide* to determine how the system is placed on-line and off-line). The following actions occur during the on-line initialization sequence:

- The control panel changes to "2d" to indicate that the unit is performing the on-line initialization sequence.
- The local controller for the library unit performs a test to check the operation of the library mechanisms.
- The mechanisms are then homed.
- During this time, the library unit responds to Inquiry, Request Sense, Log Sense, Mode Select, and Mode Sense commands. Check Condition status is set for all other commands and the "Logical Unit in Process of Becoming Ready" condition (SK=2 ASC=04 ASCQ=01) is set in sense data.
- When the mechanisms are tested and homed, the library unit performs an inventory of its elements. See "Library Unit Inventory Sequence" on page 2-12 for more information.
- After initialization is successful, the control panel changes to "00" and the library unit is fully operational. See "Library Unit On-line Initialization Failure" on page 2-9 for information on initialization failures.

Library Unit Inventory Sequence

The library unit performs an inventory of its storage elements at start-up, upon receipt of an Initialize Element Status command, or after the door is closed and the library unit is placed on-line.

- The local controller for the library unit checks the state of the medium transport element. If it contains a tape cartridge and a PTM is available, the cartridge is placed on the PTM before the inventory begins.

  If a PTM is not available and a cartridge is in the medium transport element, the inventory cannot be performed. If the inventory is host-generated, then a Check Condition is set and the "Transfer Full" condition (SK=5 ASC=80 ASCQ=01) is set in sense data. If it is not host-generated, the library generates a "Transfer Full" (SK=5 ASC=80 ASCQ=01) on-line initialization failure event (see "Library Unit On-line Initialization Failure" on page 2-9).

- If the library unit contains tape drives, an attempt is made to inventory them. The controller first scans for a valid bar code and, if none is found, then checks the status of the drive.

  If no cartridge is on-line in the drive, the drive handle is opened and the gripper extended to check for the presence of a cartridge.

- The controller uses the PTM sensors to determine whether a cartridge is present. If there is a cartridge on the PTM, it is centered and the controller scans it for a valid bar code.

- If this is the first inventory since start-up or if this inventory was generated using the Initialize Element Status command, each face of the carousel is inventoried. If the inventory is initiated by the opening and closing of a door, only the faces exposed while the door was opened are inventoried.

  First, the face is scanned for bar codes. If the library unit has bin pack sensors, then the area containing bin packs is the only area scanned. If the library unit does not have bin pack sensors, the entire face is scanned; if the library unit determines that a bin pack contains all invalid bar codes, it uses the gripper to sense whether a bin pack is present. After the face is scanned, any bins (in a present bin pack) with invalid bar codes are revisited and the gripper is extended to sense whether a cartridge is in the bin.

Inventory time varies depending on the number of storage units and the number of cartridges with valid bar codes. A fully populated storage unit with valid bar codes takes much less time than a partially populated storage unit. Removing empty bin packs also helps to improve inventory time.

Use the Read Element Status command to get inventory results.

Off-line Sequence

The STANDBY button allows the library unit to be taken off-line. The off-line sequence can only occur when the doors are shut, the library unit is placed off-line, and the STOP button has not been pressed. (Refer to the *TL82X/TL893/TL896 Operator's Guide* to determine how the system is placed on-line or off-line).

The following actions occur during the off-line sequence:

- The local controller for the library unit completes any currently processing command.
- When all commands are complete, the control panel changes to "01" to indicate the unit is off-line.
- The library unit generates a "Logical Unit Standby Button Was Pressed" event (SK=6 ASC=80 ASCQ=09).
- While the library unit is off-line, it responds to the Inquiry, Request Sense, Log Sense, Mode Select and Mode Sense commands. A Check Condition is set for all other commands issued during this time and the "Logical Unit is Off-line" (SK=2 ASC=04 ASCQ=01) condition is set in sense data.
- The carousel can be moved by buttons on the control panel when the door is closed and the library unit is off-line.
- Field-engineer-level diagnostic commands can be executed using the diagnostic port. For more information, see "Off-line Diagnostics via Field Engineer Port" on page 2-27.

The library unit remains off-line until one of the other operating sequences occur.

Load Retry Sequence

When the host issues a command to load a tape, the following sequence occurs:

- The host issues a Mode Select command (Vendor Unique Page) with the DLR (Drive Load Retry) bit set to 1.
- The host issues a Move Medium command (with the tape drive as the destination element).
- The robotics picks the cartridge from the bin, places it in the drive, and then waits at the drive bezel with its pusher retracted. If the cartridge ejects from the drive, the robotics senses the cartridge, pushes it back into the drive, and waits again.
- If the cartridge cannot be placed into the drive after five attempts, the command completes with a "Load Retry Failure" (SK=B ASC=80 ASCQ=10) condition. If the cartridge is not sensed after four seconds, the command finishes without error.

Multi-Unit Operation

Multi-Unit Multi-LUN

In a multi-unit multi-LUN (MUML) configuration, there may be up to five library units. In order to pass cartridges from one library unit to another, at least one library unit must be configured with a Multi-Unit Controller (MUC), and all library units must have Pass Through Mechanisms (PTMs).

Note *The location of the unit housing the MUC is not critical and can be based on proximity to the host computer.*

See Figure 2 on page 2-16 for a logical representation of a multi-unit multi-LUN, five-unit configuration. For actual MUML cabling, see the *TL82X/TL893/TL896 Facilities Planning and Installation Guide.*

Note *Element addresses are hexadecimal and are provided for reference only. Although the addresses are accurate at the time of this publication, they are subject to change. It is recommended that mode sense data be used to determine the address configuration of each library unit.*

A single Move Medium command can be used to transport a cartridge between any import/export element within the tape library and any other element in the tape library. However, two Move Medium commands are required to move a cartridge between two non-import/export elements that reside within different library units (e.g., a move from a bin in one library to a drive in a different library).

After importing a tape cartridge to the PTM, a storage cell, or a drive, the library unit automatically scans the bar code. (The bar code is not scanned by library units which are only passing the cartridge to the next unit.) The bar code information can be obtained using the Read Element Status command.

Figure 2: MUML Expansion
Diagram
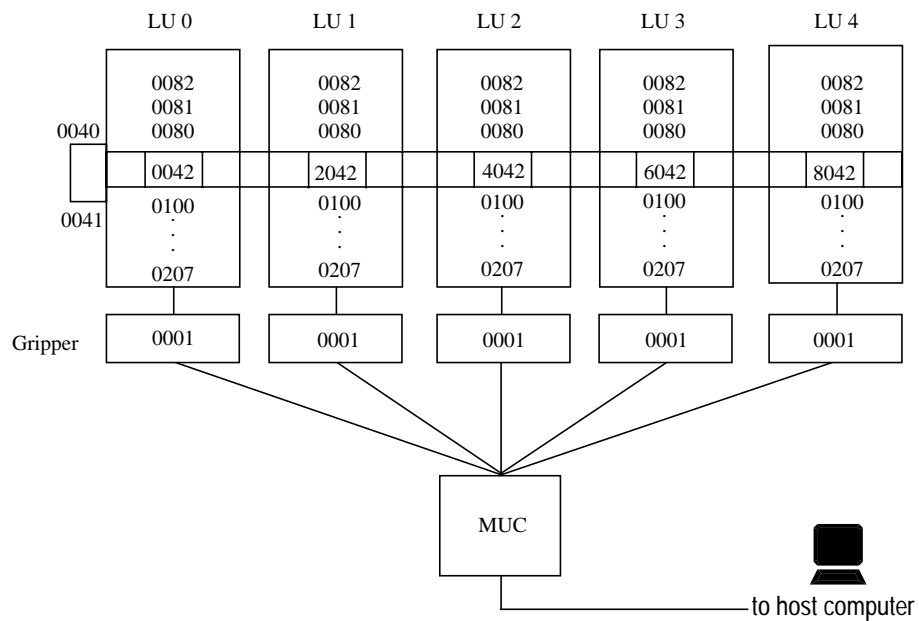
Importing a Cartridge

To import a cartridge from the inport/outport device (address 0040h) to a storage element (address 0123h) in library unit 3 (LU3):

1. The host sends a Ready Inport command with an element address of 0040h.

2. LU0 unlocks the inport door and turns the "ready" light on.

3. The operator opens the inport door, places a cartridge into the inport device, and then closes the door.

4. LU0 generates an Import or Export Accessed Event (SK=6 ASC=28 ASCQ=01).

5. The host sends a Move Medium command to the MUC with a source element address of 0040h (the inport) and a destination element address of 0123h. The LU field in the Move Medium command contains a "3."

6. The cartridge is passed from PTM to PTM.

   The MUC reserves the LU3 PTM for importing from left to right and the LU2, LU1, and LU0 PTMs for transporting from left to right.

   LU0, LU1, and LU2 send a completion notice to the MUC when the cartridge is passed to the adjacent system. (PTM motors are shut down when the cartridge is passed.)

   LU3 registers the cartridge against the lift gate, inventories the PTM, and sends a completion notice to the MUC.

   The MUC sends a Move Medium command to LU3 with a source element address of 6042h (PTM) and a destination element address of 0123h (storage element).

   LU3 moves the cartridge from the PTM to the storage element and sends a completion notice to the MUC.

7. The MUC sends command complete status to the host.

Exporting a Cartridge

To export a cartridge from a storage element (0209h) in LU2 to an inport/outport device (8044h) adjacent to LU4:

1. The host sends a Move Medium command to the MUC with a source element address of 0209h (the logical unit field contains a "2") and a destination element address of 8044h (the outport).

2. The cartridge is sent from PTM to PTM.

   The MUC reserves the LU4 PTM for transferring left to right and the LU3 PTM for transporting from left to right.

   The MUC sends a Move Medium command to LU2 with a source element address of 0209h and a destination element address of export right (internal address). LU2 reserves its PTM, moves the cartridge from bin location 0209h to the PTM, and starts the PTM.

   LU2 and LU3 send a completion notice to the MUC when the cartridge is passed to the adjacent systems (LU3 and LU4, respectively).

   LU4 sends a completion notice to the MUC when the cartridge is passed out to the IOD.

3. The MUC sends command complete status to the host.

Moving a Cartridge

To move a cartridge from bin location 01CBh in LU1 to drive address 0081h in LU3:

1. The host sends a Move Medium command to the MUC with a source element address of 01CBh (the logical unit field contains a 1) and a destination element address of 6042h (import address of LU3).

   The MUC reserves the LU3 PTM for importing left to right and the LU2 PTM for transporting from left to right.

2. The MUC sends a Move Medium command to LU1 with a source element address of 01CBh and a destination element address of the right export (internal address).

3. LU1 reserves its PTM, moves the cartridge from bin location 01CBh to the PTM, and starts the PTM.

4. The cartridge is passed from PTM to PTM. LU1 and LU2 send a completion notice to the MUC when the cartridge is passed to the adjacent systems (LU2 and LU3, respectively). LU3 registers the cartridge in the PTM and sends a completion notice to the MUC.

5. The MUC sends a command complete status to the host.

6. The host sends a Move Medium command to the MUC with a source element address of PTM 6042h (the logical unit field contains a 3) and a destination element address of drive 0081h.

7. LU3 moves the cartridge to the drive and sends a command complete status to the host.

Multi-Unit Single LUN

The physical setup of a multi-unit single LUN (MUSL) library set is identical to that of the MUML, requiring alignment of the PTM and correct cabling of the multi-unit controller ports at the rear of the units. The logical setup is also similar, requiring that the LUN for all units reflect its physical position in the set and agree with the MUC cabling.

In addition to these requirements, a field engineer must issue a command to enable the MUSL operation. This command (Config. MUSL Enable) is issued to the diagnostic port of any unit in the set to inform the MUC to record the number of units in the MUSL set and the element configuration of the units.

Note   *All units in the set must be configured and operational when this command is issued.*

See Figure 3 on page 2-21 for a logical representation of an MUSL five-library configuration. For actual MUSL cabling, see the *TL82X/TL893/TL896 Facilities Planning and Installation Guide.*

For MUSL operation, the MUC makes a set of units appear to be a single library. For the SCSI interface to provide consistent information to a host, the library set must not report ready unless all the units are ready. After the library set is auto-configured, the MUC presumes all units are ready and available for use.

To complete auto-configuration, the host identifies the MUSL set, configures the mode parameters of all participating library cabinets to the values of the first cabinet encountered, and assigns a unique starting element address to each library element as shown in Figure 3 on page 2-21.

Note   *The addresses for each element type (gripper, storage bins, etc.) are consecutive from the first library unit to the last.*

When a host sends a command to the MUSL library set, the MUC reformats the command and issues it to all applicable units. If a unit is unable to respond, the MUC formats the error response and returns the error message to the host. The MUC does not presume this unit is unavailable for future use and will contact the unit to complete subsequent host commands.

Figure 3: MUSL
Expansion Diagram
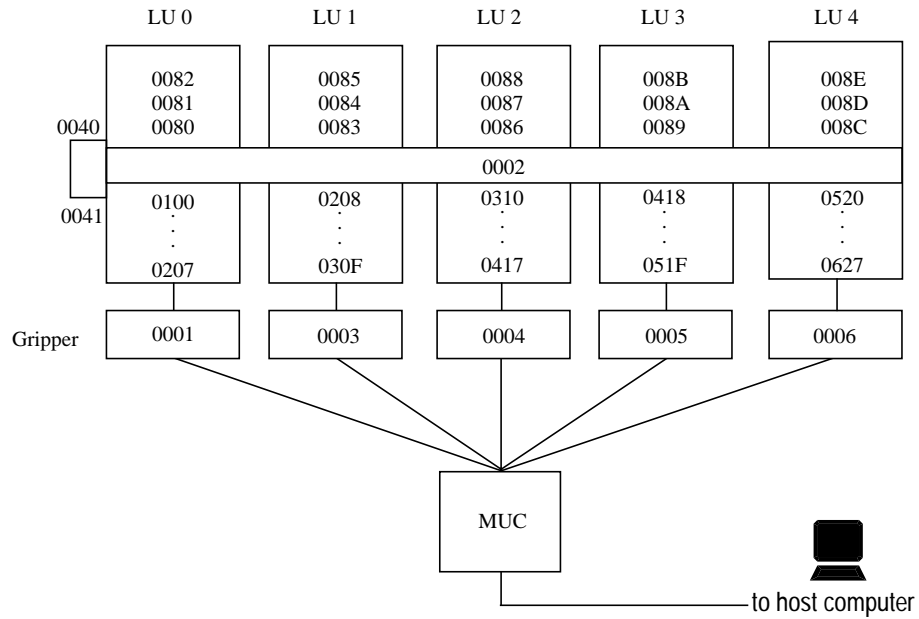
Note *The storage element addressing shown above applies to TL820, TL822, and TL893 (3-drive) models only. The addressing for a library system with a mixture of 3-drive and 6-drive models is similar.*

Configuration Procedures

Diagnostic Port Configurable Items

A library unit can be configured using the EIA/TIA-574 diagnostic port interface. The following can be reconfigured:

- Vertical and extension positions of the data transfer elements
- Vertical and extension positions of the data storage elements
- Vertical and extension positions of the PTM
- Model type
- Logical unit number of the library unit
- Number of bins and drives
- IOD and PTM configuration
- Recovery modes
- Clean Tape enable/disable/report
- User Op IOD enable/disable/report
- Multi-unit single LUN enable/disable/report

Note   *Refer to the TL82X/TL893/TL896 Diagnostic Software User's Manual for instructions on how to configure these options for your library.*

Setting SCSI Addresses

The MUC is switch-configurable and supports any host SCSI address. Refer to the *TL82X MUC Installation Instructions* or the *TL82X/TL893/TL896 Facilities Planning and Installation Guide* for instructions on how to configure the MUC.

Tape Drive Addresses

The SCSI address of each tape drive is set using the instructions provided by the tape drive manufacturer.

The tape library does not require the tape drive's address. The SCSI option to report tape drive addresses as part of the medium changer's configuration information is not supported by the tape library.

Error Recovery Procedures

Internal Error Recovery

If a failure occurs during a movement command, the library software attempts to recover. The following are some of the retries and recovery attempted by the library:

- If an actuator is not in a valid starting position at the start of any movement command, the software attempts to home the actuator before starting the command. If the home is successful the command is continued. (SK=B ASC=81 ASCQ=10, SK=B ASC=83 ASCQ=10, SK=B ASC=84 ASCQ=10, SK=B ASC=86 ASCQ=10)

- If an actuator movement fails because of a current feedback, actuator timeout, or mechanical position error, the actuator move is retried. If the retry is successful, the command is continued. (SK=B ASC=81 ASCQ=00-05, SK=B ASC=83 ASCQ=01-03, SK=B ASC=84 ASCQ=01, SK=B ASC=84 ASCQ=03, SK=B ASC=86 ASCQ=01, SK=B ASC=86 ASCQ=03, SK=B ASC=86 ASCQ=07)

- If a drive does not eject the cartridge far enough for it to be fully gripped, the software makes several attempts to pull the cartridge out of the drive. It closes the gripper on the cartridge, pulls it out slightly, and then attempts again to pull the cartridge out of the drive. (SK=B ASC=81 ASCQ=51)

- If a cartridge is picked from a bin, but is not fully seated in the gripper, the cartridge is placed back in the bin and picked one more time before the error is reported. (SK=B ASC=80 ASCQ=0D)

- If the pick portion of a move command fails and the cartridge appears to be in the gripper, the command is continued and the place completed if possible. If the place fails as well, only the original pick error code is returned.

- If a place into a drive fails because of an extension axis current feedback error, the extension axis is retracted and the place is attempted one additional time before the error is reported. (SK=B ASC=83 ASCQ=02)

- During inventory, if the initial scan of a face does not read a bar code in a bin slot, the cartridge is rescanned before extending the gripper to sense if the cartridge is present.

Host-Support Error Recovery

General suggestions for preventing failures (or recovering from failures) include the following:

- Before moving a cartridge from a tape drive, check the status of the tape drive to verify the cartridge has been unloaded.
- Sometimes a tape drive ejects a cartridge immediately after it is loaded. The host can determine this by monitoring drive status. If the move to the tape drive was successful, but drive status indicates the tape is not loaded, move the cartridge from the drive to the transport element. If this move is successful, move the cartridge back to the drive.
- If a Move Medium command fails, do a Read Element Status for the elements involved in the move to locate the cartridge and then continue the move from the point of failure. For example, if the move was from drive element 0080h to storage element 0200h, and the Read Element Status shows both elements as empty and the transport element contains the cartridge, move the cartridge from the transport element to storage element 0200h.
- Retry any other commands which fail.

Operator Recovery

See the *TL82X/TL893/TL896 Operator's Guide* for suggested operator recovery procedures.

System Performance

Key Performance Issues

Actuator move times are key performance issues. Internal software attempts to improve a unit's performance by allowing actuators to move simultaneously and by shortening the distance actuators have to move.

Many actuators can work simultaneously. For example, the vertical axis and carousel move to the appropriate position at the same time when approaching a storage element. Also, the extension and gripper actuators return to a ready position after the completion of a move to prepare for the next move.

The host can also improve performance by shortening the distance the actuators move. One way to do this is to use the time when tape drives are busy or when no commands are being issued to sort storage elements to better suit the application.

Another example of this occurs during an inventory. Internal software leaves the extension axis as far out as possible without obstructing the bar code scanner. This allows the extension axis to be closer to the bins. If a bar code is missing, the extension axis will take less time to go out and sense it.

Typical Application Enhancements

The host can check for an attention or error condition by issuing a Request Sense command. To check for queued conditions, keep issuing the Request Sense command until no message returns.

The SCSI interface allows the host to enable the "disconnect from bus" option. This allows the target to disconnect from the bus while processing a command from the host application and reconnect when the command is complete. Disconnecting allows access to the drives or other logical units while the command is being performed.

Internal software does not support command queueing on an individual logical unit. It is up to the host application to queue commands to a unit. It may also be advantageous for the application to group queued commands to require the least amount of actuator motion.

The Position To Element command allows the application to move the robotics to a more advantageous position while the tape drives are busy. For example, if a cartridge is about to be ejected from the drive, the carousel can be moved to the face where the cartridge will be placed and the robotics can be positioned in front of a drive to pick up the cartridge when ejected.

The application can also sort the most-used cartridges and keep them on one face. If the sequence of cartridges is known, the application can move the other required cartridges to the same face close to the top of the carousel while the first tape is in the drive.

Operator Performance Enhancements

Operator performance enhancements are described in the *TL82X/TL893/TL896 Operator's Guide*.

System Diagnostic Support

The library unit has a layered self-diagnostic capability. Each layer addresses a specific type of diagnostic need. The layers provide a basic go ⁄ no-go capability as well as a complete fault-isolation capability.

Host Interface Diagnostic Error Codes

The least sophisticated diagnostic capabilities are made available to the host computer by the host interface. This lowest layer consists of the tests which are performed when the library unit is placed on-line. These tests are designed to catch all major system failures and to give the host computer a high degree of confidence that the library unit is operational. This layer has been kept as simple as possible to reduce the amount of support software required by the host.

The next layer isolates faults which occur during operation. Error definitions and recovery procedures, provided in Appendix A, are designed to be descriptive enough to quickly test failed operations and to correct any conditions that would have resulted in an unnecessary service call.

Off-line Diagnostics via Field Engineer Port

The top level of diagnostic commands is available using an EIA ⁄ TIA-574 diagnostic port found on each library unit. This level is designed for field service technicians with specialized test equipment as a part of the fault isolation procedures described in the *TL82X/TL893/TL896 Field Service Manual*. They are not intended for use by an untrained operator.

Software Interfaces 3

Introduction

This chapter describes the Small Computer System Interface (SCSI) and EIA/TIA-574 interfaces in relation to the TL82X/TL893/TL896. SCSI-2 and EIA/TIA-574 specific terminology are listed below with their TL82X/TL893/TL896 equivalents:

- *Logical unit* is the library unit.
- *Initiator* is the host computer.
- *Data transfer element* is the tape drive.
- *Medium transport element* is the gripper/carriage.
- *Storage element* is the bin in the carousel.

SCSI Interface

The TL82X/TL893/TL896 is a SCSI-2 medium change device. The host computer serves as the SCSI initiator and issues commands to the tape library and tape drives which act as SCSI targets.

The tape library provides only SCSI target support. It does not perform any of the initiator functions. The tape library has its own SCSI address separate from any other SCSI devices including the tape drives.

Each tape library is operated independently. SCSI queuing is not supported. Each tape library supports just one initiator and input/output (I/O) operation at a time.

The tape library does not support linked commands. All element addresses must be specified absolutely; no relative addressing is permitted.

The amount of data transferred between the host and the tape library is minimal. For this reason, the tape library does not support either synchronous or wide-data transfers.

The tape library is intended for use with SCSI-2 initiators. It cannot be used with a SCSI-1 initiator.

The tape library does not support the Change Definition command, Asynchronous Event Notification, or extended contingent allegiance.

Note   *The message ("Supported Messages" on page 3-5) and command ("Supported Operational Commands" on page 3-8) sections assume that you have a working knowledge of the SCSI-2 specification.*

Reset Sequence

The tape library supports the SCSI-2 soft reset option. When a SCSI bus reset occurs, the tape library clears the SCSI bus as described in the SCSI-2 standard.

Supported Messages

This section describes the required messages and supported optional messages and their use in coordinating the host (a SCSI initiator) and the tape library (a SCSI target). The following items are described:

- Host messages sent to the tape library
- Tape library responses to host messages
- Tape library messages sent to the host

These descriptions are not meant as a supplement to the information provided in the SCSI-2 Standard. These descriptions are intended to document how these messages have been adapted for use with the TL82X/TL893/TL896 tape library.

The tape library supports all messages indicated as mandatory for target support by the SCSI-2 specification. The mandatory messages are:

- Abort
- Bus Device Reset
- Command Complete
- Identify (initiator to target)
- Initiator Detected Error
- Message Parity Error
- Message Reject
- No Operation

The tape library also supports several messages indicated as optional for SCSI targets by the SCSI-2 specification. Most of the tape library operations are slow in relation to the other operations being controlled using the SCSI bus. By using these optional messages, the tape library can make the bus available for other operations while completing a tape library operation. These messages are:

- Disconnect (Direction is from target to initiator)
- Identify
- Save Data Pointer

Abort

The Abort message allows the host to clear the current operation on a specified tape library. Abort can be used as follows with the tape library:

- The host that initiates an operation can abort the process at any time by sending an Abort message to the appropriate tape library. Since only one operation at a time is supported per tape library, this message effectively stops all processing for that library unit.
- If any other host sends an Abort message, the tape library receives the message but does not abort its operation.

Bus Device Reset

The Bus Device Reset message allows a host to initiate a SCSI hard reset. The tape library responds to this message by clearing all I/O processes including those in other associated libraries (multi-unit configurations). The Unit Attention condition is set for all hosts (one per library unit is possible) to indicate that the operation they initiated has been aborted.

Command Complete

The tape library sends this message to the host after the library unit has completed the command operation and sent valid status information to the host. This message does not indicate that the operation was completed successfully. Successful completion must be determined by examining the status information.

After sending this message, the library unit is ready to accept another command.

Disconnect (From Target to Initiator)

The Identify message from the host indicates whether the tape library can disconnect during the execution of an operation. When the tape library receives a command that it cannot complete immediately and a disconnect has been allowed, then the tape library disconnects from the host while performing the operation. This frees the SCSI bus for other uses while the operation is in progress.

The tape library disconnects from the host by sending the host the Save Data Pointer message (if necessary) just before the Disconnect message.

Given the nature of the host and tape library interface, it is not expected that a data pointer will be used by the host. Only data transfers which are broken into multiple connections will end each successful connection with a Save Data Pointer and Disconnect message sequence. This conforms to SCSI-2 Standard (section 5.6.6).

The SCSI-2 Standard also allows an optional host-to-target disconnect message. The tape library does not support this option and responds with a Message Reject if a Disconnect message is received.

Identify (Initiator to Target)

The host sends the Identify message to authenticate the tape library to which a command is being sent. This message also indicates whether the tape library can disconnect during command execution.

The Identify message from the host overrides the unit number in the command descriptor block. If an Identify message is not received, the tape library uses the unit number in the command descriptor block. The tape library **cannot** disconnect during an operation under these circumstances.

Identify (Target to Initiator)

When the tape library uses the Disconnect message to disconnect from the host, the tape library sends an Identify message to the host after completing the operation and reselecting the host. The tape library number in this Identify message is the same as that used in the Identify message sent to the tape library at the start of the operation.

The tape library supports one initiator at a time per library unit and does not support any target routines.

The host does an implied Resume Pointers when the Identify message is received from the tape library.

Save Data Pointer

Whenever data transfers are broken into multiple connections, the tape library sends the Save Data Pointer message to the host just before disconnection using the Disconnect message.

Supported Operational Commands

The tape library supports all commands required by the SCSI-2 specification for all devices:

- Inquiry
- Request Sense
- Test Unit Ready

The tape library also supports all commands required by the SCSI-2 specification for media changer devices:

- Move Medium
- Send Diagnostic

In addition, the tape library supports the following optional commands:

- Initialize Element Status
- Log Sense
- Mode Select
- Mode Sense
- Position to Element
- Read Element Status
- Release
- Request Volume Element Status
- Reserve
- Rezero Unit
- Send Volume Tag
- Start/Stop Unit

Finally, the tape library supports the following vendor-specific commands:

- Initialize Element Status with Range
- Ready Inport

Note *This section describes operational commands and their command and data formats. Although, for the most part, these formats are taken directly from the SCSI-2 specification, only the fields and values supported by the TL82X/TL893/TL896 library are described in this guide.*

The commands and their operation code, type, and page reference are shown in Table 4 on page 3-9.

Table 4: Supported
Operational Commands

Command Name	Operation Code	Type[a]	Page
Initialize Element Status	07h	O	3-10
Initialize Element Status with Range	E7h	V	3-11
Inquiry	12h	M	3-13
Log Sense	4Dh	O	3-17
Mode Select	15h	O	3-21
Mode Sense	1Ah	O	3-28
Move Medium	A5h	M	3-38
Position to Element	2Bh	O	3-41
Read Element Status	B8h	O	3-43
Ready Inport	DEh	V	3-59
Release	17h	O	3-59
Request Sense	03h	M	3-61
Request Volume Element Status	B5h	O	3-64
Reserve	16h	O	3-78
Rezero Unit	01h	O	3-81
Send Diagnostic	1Dh	O	3-82
Send Volume Tag	B6h	O	3-83
Start/Stop Unit	1Bh	O	3-85
Test Unit Ready	00h	M	3-86

a. Type designations are as follows:

   M = SCSI-2 command implementation is mandatory.

   O = SCSI-2 command implementation is optional.

   V = SCSI-2 command implementation is vendor-specific.

Initialize Element Status (07h)

The Initialize Element Status command allows the host to request an inventory of the tape cartridges stored in a library unit. The library unit conducts an inventory by determining the location of tape cartridges within the library and then reading the bar code of each tape cartridge encountered.

Inventory information is returned to the host only if requested using the Read Element Status command. The library unit will not accept any other commands from the host during the inventory process.

As with other commands, the host can abort the inventory during execution. If another Initialize Element Status command is then issued, the inventory process starts from the beginning.

If the gripper contains a tape cartridge, it is placed on the pass-through, if available; otherwise, the inventory procedure cannot be conducted. In this case, a Transfer Full error (SK=5 ASC=80 ASCQ=01) is returned. The cartridge should be moved to an available bin and the command retried.

The format for this command data block is shown in Table 5.

Table 5: Initialize Element Status Command

Bit/Byte	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	Reserved (00h)							

Logical Unit Number   The Logical Unit Number can range from 0–4. This field indicates which logical unit the command should be sent to.

Initialize Element Status with Range (E7h)

The Initialize Element Status with Range command allows the host to request an inventory of tape cartridges within a specified range of library elements. During the inventory, the library locates tape cartridges within the specified range and reads the bar code of each cartridge (unless commanded not to). If bar codes are not read, the library uses sensors to determine whether each element contains a cartridge.

Inventory information is returned to the host only if requested using the Read Element Status command.The library will not accept any other commands from the host during the inventory process.

As with other commands, the host can abort the inventory during execution. If another Initialize Element Status command is then issued, the inventory process starts from the beginning.

If the gripper contains a tape cartridge, the inventory procedure cannot be conducted. In this case, a Transfer Full error (SK=5 ASC=80 ASCQ=01) is returned. The cartridge should be moved to an available bin before reissuing the command.

The format for this command data block is shown in Table 6.

Table 6: Initialize
Element Status with
Range Command

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

Logical Unit Number   The Logical Unit Number can range from 0–4. This field indicates
                             which logical unit the command should be sent to.

Range   A Range field of 1 specifies performing the inventory over the range
                             specified by the Starting Element Address and Number of Elements
                             fields. A value of 0 specifies performing the inventory on all ele-
                             ments in the library, ignoring the Starting Element Address and
                             Number of Elements fields.

Starting Element   These fields are used to select the range of elements for inventory
Address and Number of   and are only valid when the Range field is set to 1. The inventory
Elements   range begins with the first element with an address greater than or
                             equal to the Starting Element Address and includes all defined ele-
                             ments until the indicated number of elements have been invento-
                             ried or the last element has been reached.

Inquiry (12h)

The host uses the Inquiry command to identify the devices attached to
the SCSI bus. Using this command, the host can request a description
of each device. This description provides the device type,
manufacturer, and the nature of the supported SCSI interface.

The format for this command data block is shown in Table 7.

Table 7: Inquiry
Command

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

Only the standard Inquiry data format is supported.

Logical Unit Number The Logical Unit Number can range from 0–4. This field indicates
which logical unit the command should be sent to.

EVPD The Enable Vital Product Data (EVPD) bit should always be 0. An
EVPD bit of 0 specifies that the target returns the standard Inquiry
data.

Allocation Length This field contains the maximum amount of data which may be
returned. Anything greater than 36 returns the full 36 bytes of data.

Page Code This field specifies which page of the Vital Product Data
information the target will return. The library returns only the
standard Inquiry data. This field is not used and must be set to 0.

The format for the standard Inquiry data block returned by the library
unit to the initiator is shown in Table 8.

Table 8: Standard Inquiry
Data

Bit/Byte	7	6	5	4	3	2	1	0
0	Peripheral Qualifier			Peripheral Device Type				
1	RMB (1)	Device-Type Modifier (00h)						
2	ISO Version (0)		ECMA Version (0)			ANSI-Approved Version (2)		
3	AENC (0)	TrmIOP (0)	Reserved (0)		Response Data Format (02h)			
4	Additional Length (1Fh)							
5	Reserved (0000h)							
6								
7	RelAdr (0)	WBus32 (0)	WBus16 (0)	Sync (0)	Linked (0)	Reserved (0)	CmdQue (0)	SftRes (0)
8–15	(MSB) Vendor ID (LSB)							
16–31	(MSB) Product ID (LSB)							
32–35	(MSB) Product Revision Level (LSB)							

Peripheral Qualifier	0	indicates the specified library unit is currently connected.
	1	indicates the specified library unit can be supported but is not connected.
	3	indicates the specified library unit cannot be supported.
Peripheral Device Type	08h	indicates medium changer device.
	1Fh	indicates unknown or no device type used in conjunction with Peripheral Qualifier 3.

RMB A removable medium (RMB) bit of 1 indicates the medium is removable.

Device-Type Modifier This field is not supported and should return a value of 0.

ISO Version and ECMA Version A 0 code value in this field indicates that the target does not claim compliance to the ISO version of SCSI (ISO IS 9316) or the ECMA version of SCSI (ECMA-111).

ANSI-Approved Version A return of 2 indicates the device complies with the SCSI-2 standard.

AENC The asynchronous event notification capability bit of 0 indicates that the device does not support the asynchronous event notification capability.

TrmIOP A terminate I/O process value of 0 indicates that the device does not support the TERMINATE I/O PROCESS message.

Response Data Format A value of 2 indicates that the data must be in the format specified in the SCSI-2 standard.

Additional Length This field indicates the length (in bytes) of additional inquiry data available.

RelAdr A Relative Address of 0 indicates the device does not support relative addressing for this library unit.

WBus32 and WBus16 A bit of 0 in these two fields indicates that the device supports 8-bit, wide-data transfers.

Sync A synchronous transfer value of 0 indicates the device does not support synchronous data transfer.

Linked A linked command value of 0 indicates the device does not support linked commands for this library unit.

CMDQue A command queuing value of 0 indicates the device does not support tagged command queuing for this library unit.

SftRes A soft reset bit of 1 indicates that the device responds to the soft RESET alternative condition. As shown in Table 9, none of the TL82X/TL893/TL896 libraries respond to the RESET condition.

Vendor ID This field contains the string "DEC" as shown in Table 9. If communicating via a MUC and the specified library unit is not supported (Logical Units 5, 6, and 7) or not connected, then this field will be left blank.

Product ID This field contains the product model number as indicated in Table 9. If communicating via a MUC and the specified library unit is not supported (Logical Units 5, 6, and 7) or not connected, then this field will contain "MUC" followed by blanks.

Product Revision Level This field contains both the MUC and the library unit firmware revision levels. The first 2 characters represent the MUC and the last two represent the library. (For example, "1C3H" is MUC revision 1C and library revision 3H.) If the revision information is not available (that is, there is no MUC or the indicated library unit is not supported or connected), then the revision is left blank.

Table 9: Library
Attributes

DEC Part No.	Model No.	Max # of Drives	Max # of Bins	Inquiry Data			Auto Clean	EDU Auto Clean
				Vendor	Product ID	SftRes		
TL820	6200203	3	264	"DEC"	"TL820 (C) DEC"	0		
TL822	6200208	3	264	"DEC"	"TL822 (C) DEC"	0		
TL893	6200210	3	264	"DEC"	"TL893 (C) DEC"	0		
TL893	6200211	3	264	"DEC"	"TL893 (C) DEC"	0	X	X
TL822	6200212	3	264	"DEC"	"TL822 (C) DEC"	0	X	X
TL820	6200213	3	264	"DEC"	"TL820 (C) DEC"	0	X	
TL820	6200214	3	264	"DEC"	"TL820 (C) DEC"	0	X	X
TL893	6200215	3	264	"DEC"	"TL893 (C) DEC"	0	X	
TL822	6200218	3	264	"DEC"	"TL822 (C) DEC"	0	X	
TL896	6200223	6	176	"DEC"	"TL820 (C) DEC"	0	X	X
TL896	6200225	6	176	"DEC"	"TL896 (C) DEC"	0	X	X
TL826	6200228	6	176	"DEC"	"TL826 (C) DEC"	0	X	X

Log Sense Command (4Dh)

The Log Sense command (Table 10) provides a means to retrieve statistical information maintained by the logical unit. Data is returned from the logical unit in the Medium Changer Statistics page (see Table 12 on page 3-19).

Table 10: Log Sense
Command

Bit/Byte	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 (0000h)							
4								
5	(MSB)							
6	Parameter Pointer							(LSB)
7	(MSB)							
8	Allocation Length							(LSB)
9	Reserved (00h)							

Logical Unit Number   The Logical Unit Number can range from 0–4. This field indicates which logical unit the command should be sent to.

PPC   The parameter pointer control field is not supported and must be set to 0.

SP   The save parameters field is not supported and must be set to 0.

PC   The page control field defines the type of parameter values to be selected. Only cumulative values are supported, so this field must be set to 1.

Page Codes   Currently, there are only three supported page codes:

00h   Supported Log Page (see Table 11 on page 3-18).

30h   Medium Changer Statistic Page (see Table 12 on page 3-19).

3Fh   Return all supported pages.

Parameter Pointer   This field allows the host to request parameter data beginning from a specific parameter code to the maximum allocation length or the maximum parameter code supported by the target, whichever is less. See Table 14 on page 3-21 for supported parameter codes.

Allocation Length: This field specifies how much memory the host has set aside to store the log sense information returned by the library unit.

Supported Log Page   The supported log page (Table 11) returns the list of log pages supported.

Table 11: Supported Log Pages

Bit/Byte	7	6	5	4	3	2	1	0
0	Reserved (0)		Page Code (00h)					
1	Reserved (00h)							
2	(MSB)		Page Length (0003h)					
3								(LSB)
	Supported Page List							
4	(00h)							
5	(30h)							
6	(3Fh)							

Page Length   This field specifies the length in bytes of the following supported page list.

Supported Page List   The supported page list field contains a list of all log page codes supported. Currently, there are only three pages supported. This page (00h), the Medium Changer Statistics Page (30h), and all log pages (3Fh).

Medium Changer Statistics Page   This page provides a means for returning medium changer statistical data.

Table 12: Medium
Changer Statistics Page

Bit/Byte	7	6	5	4	3	2	1	0
0	Reserved (0)		Page Code (30h)					
1	Reserved (00h)							
2	(MSB)							
3			Page Length					(LSB)
	Log Parameter List							
4 –11	Log Parameter (First)							
	. .							
x-7–x	Log Parameter (Last)							

Page Length   This field specifies the length in bytes of the list of log parameters shown in Table 13.

Log Parameter   Each log parameter begins with a four-byte parameter header followed by four bytes of parameter value data. See Table 13 for the Log Parameter format.

Table 13: Log Parameter

Bit/Byte	7	6	5	4	3	2	1	0
0	(MSB)							
1				Parameter Code				(LSB)
2	DU (0)	DS (0)	TSD (0)	ETC (0)	TMC (0)		Rsv (0)	LP (0)
3				Parameter Length (04h)				
4–7	(MSB)			Parameter Value				(LSB)

Parameter Code   The parameter code field identifies which log parameter is being transferred for that log page. See Table 14 on page 3-21 for parameter codes supported.

DU, DS, TSD, ETC,   These parameters are not supported and must be set to 0.
TMC, and LP

Parameter Length   All log parameter values supported in the Medium Changer Statistics page have a length of four bytes.

Parameter Value   The cumulative count of parameter as described in Table 14 on page 3-21.

Table 14: Supported Log
Parameter Codes

Parameter Code	Description	Size (bytes)
8000	Number of seconds system has been powered on	4
8001	Number of seconds spent processing commands	4
8010	Number of attempted moves from a bin	4
8011	Number of attempted moves to a bin	4
8012	Number of attempted moves from a drive	4
8013	Number of attempted moves to a drive	4
8014	Number of attempted moves from the PTM	4
8015	Number of attempted moves to the PTM	4
8020	Number of individual carousel moves[a]	4
8021	Number of individual vertical moves[a]	4
8022	Number of individual extension moves[a]	4
8023	Number of individual gripper moves[a]	4
8024	Number of individual pusher extends[a]	4
8030	Number of carousel retries	4
8031	Number of vertical retries	4
8032	Number of extension retries	4
8033	Number of gripper retries	4
8040	Number of place into drive retries	4
8041	Number of pick from drive retries	4
8042	Number of partially gripped cartridge retries	4
8043	Number of drive load retries	4

a. These counts are based on the individual moves of the axis. For example, to move the carousel from its current position to any other face takes 3 individual moves: one large move close to the carousel flag, one small move to sense the edge of the flag, and another small move to reach the center of the carousel flag. The following table shows the nominal number of moves required for other pick and place operations:

	Moves to PICK from			Moves to PLACE to		
COMPONENT	Bin	Drive	PTM	Bin	Drive	PTM
Extension axis	3	4	5	5	5	5
Gripper	2	—	—	3	4	5
Vertical axis	1	—	2	1	2	5

Mode Select Command (15h)

The Mode Select command provides a means for the host to specify parameters for the library unit. The library unit supports changes to:

- Vendor Unique Page 0
- Vendor Unique Page 20
- Element Address Assignment Page

These pages support enabling or disabling of the drive load retries parameter.

Table 15: Mode Select
Command

Bit/Byte	7	6	5	4	3	2	1	0
0	Operation Code (15h)							
1	Logical Unit Number			PF (1)	Reserved (0)			SP
2	Reserved (0000h)							
3								
4	Parameter List Length (04h)							
5	Reserved (00h)							

Logical Unit Number The Logical Unit Number can range from 0–4. This field indicates which logical unit the command should be sent to.

SP - Save Page When set to 0, Mode Select is performed without saving. When set to 1, Mode Select is performed and saved in non-volatile memory.

PF - Page Format When set to 1, this field indicates that Mode Select parameters are formatted as specified in the SCSI-2 Standard.

Parameter List Length This indicates the length of the following parameter list. The only page supported by the Mode Select command is the four-byte Vendor Unique Page shown in Table 17. This field must be set to 4.

The parameter data returned for each Mode Select command can be preceded by a Mode Parameter Header Block. The header block is then followed by the requested parameter pages or all pages if the Return All Pages page code was used.

The format for the Mode Parameter Header Block is shown in Table 21.

Table 16: Mode Parameter Header Block

Bit/Byte	7	6	5	4	3	2	1	0
0	Mode Data Length							
1	Medium Type (00h)							
2	Device-Specific Parameter (00h)							
3	Block Descriptor Length (00h)							

Mode Data Length This field is set to the amount of data following the Data Length field in bytes. This includes the last three bytes in the Header Block as well as all bytes in the parameter page or pages.

Medium Type Code This field is reserved for medium changer devices.

Device-Specific Parameter This field is reserved for medium changer devices.

Block Descriptor Length This field is reserved for medium changer devices.

The format for the Mode Select Vendor Unique Page is shown in Table 17.

Table 17: Mode Select Data - Vendor Unique Page (20h)

Bit/Byte	7	6	5	4	3	2	1	0
0	PS (0)	Reserved (0)	Page Code (20h)					
1	Page Length (02h)							
2	Reserved (00h)							DLR
3	MUSL	MUSL NumLUNS			User Op IOD	Reserved		

PS - **Parameters Savable**   This bit is only used with the Mode Sense command (See Table 25 on page 3-36). This bit is reserved for Mode Select command and should be set to 0.

DLR-**Drive Load Retry**   When this bit is set to 1, a retry is performed if the drive port area becomes occupied by a cartridge within four seconds after placing a cartridge into a drive. The load will attempt a maximum of five times. When this bit is set to 0, retries will not be performed.

MUSL   Setting this bit to 1 places the library in MUSL mode. Setting the bit to 0 places the library in MUML (default).

MUSL NumLUNS   When the MUSL bit is set to 1, this field indicates the total number of cabinets in the MUSL configuration. A value of 1–5 can be set.

Note   *MUSL and MUSL NumLUNS may only be changed if the SP bit in the CDB is set to 1. If an attempt is made to change these values when SP is set to 0, the command will fail with a sense of 5-26-00, "Invalid Field in Parameter List."*

User Op IOD   When this bit is set to 1, the Inport Ready lamp stays on, allowing tapes to be loaded at any time. When this bit is set to 0, the Inport Ready lamp stays off until a host computer issues a command, causing the lamp to light for one minute.

Note   *Keeping the Inport Ready lamp on may cause the lamp to burn out prematurely. To run User Op IOD replace the 14-volt lamp with a 28-volt lamp (PN 0385015). The 28-volt lamp is dimmer but will last at least two years in continuous operation.*

The format for Mode Select Vendor Unique Page 00h is shown in Table 18.

Table 18: Mode Select
Data - Vendor Unique
Page (00h)

Bit/Byte	7	6	5	4	3	2	1	0
0	PS (0)	Reserved (0)	Page Code (00h)					
1	Page Length (3Eh)							
2	AInit	UInit (0)	Parity (0)	NBL	Rsrvd (0)	NRDC (0)	MDC (0)	
3	Maximum Parity Retries (00h)							
4–63	Display Messages (00h)							

PS - **Parameters Savable**   This bit is only used with the Mode Sense command (see Table 20 on page 3-28). This bit is reserved for the Mode Select command and should be set to 0.

AInit   When this value is set to 1, the library performs an inventory of all elements before going on-line. If set to 0, the library only performs an inventory when it receives an Init Element Status or Init Element Status with Range command.

UInit   Not supported.

Parity   Not supported.

NBL - **No Bar Code Label**   This field is valid only if the AInit field value is set to 1. If the NBL field is 1, bar codes are not scanned and the primary volume tags are set to empty. If the NBL field is set to 0, bar codes are scanned and their value placed in the corresponding primary volume tag.

NRDC -**Not Ready Display Control**   Not supported.

MDC - **Message Display Control**   Not supported.

Maximum Parity Retries   Not supported.

Display Message   Not supported.

The format for the Element Address Assignment Page is shown in Table 17.

Table 19: Mode Select
Data - Element Address
Assignment Page

Bit/Byte	7	6	5	4	3	2	1	0
0	PS (0)	Reserved (0)	Page Code (1Dh)					
1	Parameter Length (12h)							
2	(MSB)							
3	First Medium Transport Element Address							(LSB)
4	(MSB)							
5	Number of Medium Transport Elements (0001h)							(LSB)
6	(MSB)							
7	First Storage Element Address							(LSB)
8	(MSB)							
9	Number of Storage Elements							(LSB)
10	(MSB)							
11	First Import/Export Element Address							(LSB)
12	(MSB)							
13	Number of Import/Export Elements							(LSB)
14	(MSB)							
15	First Data Transport Element Address							(LSB)
16	(MSB)							
17	Number of Data Transport Elements							(LSB)
18	Reserved (0000h)							
19								

PS - **Parameter Savable**   This bit is used with the Mode Sense command only (see Table 20 on page 3-28). This bit is reserved for the Mode Select command and should be set to 0.

First Medium Transport Element Address   This field specifies the first medium transport element contained in the medium changer (other than the default medium transport address of 0).

Number of Medium Transport Elements   This field defines the total number of medium transport elements contained in the medium changer.

First Storage Element Address   This field specifies the first storage element contained in the medium changer.

Number of Storage Elements   This field defines the total number of storage elements contained in the medium changer.

First Import/Export Element Address   This field specifies the first import/export element contained in the medium changer.

Number of Import/Export Elements   This field defines the total number of import/export elements contained in the medium changer.

First Data Transport Element Address   This field specifies the first data transfer element contained in the medium changer.

Number of Data Transport Elements   This field defines the total number of data transfer elements contained within the medium changer and accessible to the medium transport elements.

Mode Sense (1Ah)

The SCSI Mode Sense command provides a general method for a host to obtain the current parameter settings for a target device. The host selects the set parameters to be returned by setting the Page Code field in the command block. This code selects the page of parameter information to be returned by the target.

The TL82X/TL893/TL896 tape library supports the following three medium changer device parameter pages (defined in the SCSI-2 Standard) and two vendor unique pages:

- Element Address Assignment Page
- Transport Geometry Parameters Page
- Device Capabilities Page
- Vendor Unique Page 0
- Vendor Unique Page 20

The host can request all pages with a single command using the Return All Pages page code as described in the SCSI-2 Standard.

The format for the Mode Sense Command block is shown in Table 20.

Table 20: Mode Sense
Command

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

Logical Unit Number   The Logical Unit Number can range from 0–4. This field indicates which logical unit the command should be sent to.

DBD   The disable block descriptors (DBD) field can be 1 or 0. A bit of 0
indicates that the target may return zero or more block descriptors
in the returned Mode Sense data at the target's discretion. A DBD
bit of 1 specifies that the target does not return any block
descriptors in the returned Mode Sense data.

PC   The page control (PC) field defines the type of parameter values to
be returned.

0   requests the current parameter values for the specified
page code for the library unit. The current values returned
are the default values.

1   requests the target to return the changeable parameter
mask for the page code specified. The page requested is
returned containing information that indicates which
parameters are changeable.

2   requests the target return the default values for the page
code specified.

3   requests the target return savable values for the page code
specified. Only the Vendor Unique Page has
changeable/savable parameters. Otherwise, the current
setting for each parameter is always the same as when the
library unit was turned on. The library unit responds with
a Check Condition status if the page control (PC) field is
Saved Values, for any page codes other than 20h and 3Fh.

Page Codes   The valid page codes are:

00h   Vendor Unique Page 00h

1Dh   Element Address Assignment Page

1Eh   Transport Geometry Parameters Page

1Fh   Device Capabilities Page

20h   Vendor Unique Page 20h

3Fh   Return All Pages

Allocation Length   This should be set according to the number of bytes in the page that has been requested:

44h	Vendor Unique Page 00h
18h	Element Address Assignment Page
08h	Transport Geometry Parameters Page
18h	Device Capabilities Page
08h	Vendor Unique Page 20h
84h	Return All Pages

The parameter data returned for each Mode Sense command is preceded by a Mode Parameter Header Block. The header block is then followed by either the requested parameter page or all pages if the Return All Pages page code was used.

The format for the Mode Parameter Header Block is shown in Table 21.

Table 21: Mode Parameter Header Block

Bit/Byte	7	6	5	4	3	2	1	0
0	Mode Data Length							
1	Medium Type (00h)							
2	Device-Specific Parameter (00h)							
3	Block Descriptor Length (00h)							

Mode Data Length   This field is set to the amount of data following the Data Length field in bytes. This includes the last three bytes in the Header Block as well as all bytes in the parameter page or pages.

Medium Type Code   This field is reserved for medium changer devices.

Device-Specific Parameter   This field is reserved for medium changer devices.

Block Descriptor Length   This field is reserved for medium changer devices.

The format for the Element Address Assignment Page is shown in Table 22.

Table 22: Mode Sense
Data - Element Address
Assignment Page

Bit/Byte	7	6	5	4	3	2	1	0
0	PS (0)	Reserved (0)	Page Code (1Dh)					
1	Parameter Length (12h)							
2	(MSB) First Medium Transport Element Address							
3								(LSB)
4	(MSB) Number of Medium Transport Elements							
5								(LSB)
6	(MSB) First Storage Element Address							
7								(LSB)
8	(MSB) Number of Storage Elements							
9								(LSB)
10	(MSB) First Import Export Element Address							
11								(LSB)
12	(MSB) Number of Import Export Elements							
13								(LSB)
14	(MSB) First Data Transport Element Address							
15								(LSB)
16	(MSB) Number of Data Transport Elements							
17								(LSB)
18	Reserved (0000h)							
19								

First Medium Transport Element Address This field identifies the first medium transport element contained in the medium changer (other than the default medium transport address of 0).

Number of Medium Transport Elements This field defines the total number of medium transport elements contained in the medium changer.

First Storage Element Address This field identifies the first medium storage element contained in the medium changer.

Number of Storage Elements This field defines the total number of medium storage elements contained in the medium changer.

First Import/Export Element Address This field identifies the first import/export element contained in the medium changer.

Number of Import/Export Elements This field defines the total number of import/export elements contained in the medium changer.

First Data Transport Element Address The first data transfer element address field identifies the first data transfer element contained in the medium changer.

Number of Data Transport Elements This field defines the total number of data transfer elements contained within the medium changer and accessible to the medium transport elements.

The format for the Transport Geometry Parameters Page is shown in Table 23.

Table 23: Mode Sense Data - Transport Geometry Parameters Page

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

PS	When set to 0, this indicates the target is not capable of saving the page in a non-volatile vendor-specific location.
Parameter Length	There are two bytes of parameter information.
Transport Geometry Descriptor	A rotate bit of 0 indicates that the medium transport element does not support media rotation.
Member Number In Transport Element Set	The first element in a set has a member number of 0.

The format for the Device Capabilities Page is shown in Table 24.

Table 24: Mode Sense
Data - Device Capabilities
Page

Bit/Byte	7	6	5	4	3	2	1	0
0	PS (0)	Reserved (0)	Page Code (1Fh)					
1	Parameter Length (12h)							
2	Reserved (0h)				StorDT (0)	StorI/E (1)	StorST (1)	StorMT (1)
3	Reserved (0h)							
4	Reserved (0h)				MT->DT (1)	MT->I/E (0)	MT->ST (1)	MT->MT (0)
5	Reserved (0h)				ST->DT (1)	ST->I/E (0)	ST->ST (1)	ST->MT (1)
6	Reserved (0h)				I/E->DT (0)	I/E->I/E (0)	I/E->ST (0)	I/E->MT (0)
7	Reserved (0h)				DT->DT (1)	DT->I/E (0)	DT->ST (1)	DT->MT (1)
8–11	Reserved (00000000h)							
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)

DT = Data Transfer Element (tape drive)

IE = Import/Export Element (load/unload mechanism)

ST = Storage Element (storage bin)

MT = Medium Transfer (transfer mechanism)

The StorDT, StorIE, StorST, and StorMT fields indicate whether an element of the indicated type (DT, IE, ST, or MT) is capable of storing a tape cartridge.

Even though a tape drive can physically store a tape cartridge, the StorDT bit indicates otherwise in this parameter page. The library unit has no control over the tape drive. For example, performing an inventory of the contents of the tape drives (data transfer elements) is not possible by the library unit unless the cartridge has been properly ejected. This requires coordination of the tape drives and the library unit that can only be performed by the host.

The XX->YY fields indicate whether a transfer from an element of type XX is possible to an element of type YY. A value of 1 in any of these fields indicates that all Move Medium commands where the source element is type XX and destination element is type YY are supported. A value of 0 in any of these fields indicates the move may not be valid depending on the particular element requested. Moves to and from the IE type depend on the whether the particular element is an inport, outport, or PTM. Moves from the outport or to the inport are not valid. All other IE combinations are supported.

The tape library does not support the Exchange Medium command. Bytes 12 through 15 in this parameter page contain the individual fields specifying the library unit exchange capabilities. Since the library unit has no exchange capability, these fields must be 0.

The format of the Vendor Unique Page is shown in Table 25.

Table 25: Mode Sense
Data - Vendor Unique
Page 20h

Bit/Byte	7	6	5	4	3	2	1	0
0	PS	Reserved	Page Code (20h)					
1	Page Length (02h)							
2	Reserved						AC	DLR
3	MUSL	MUSL NumLUNS			User Op IOD	Reserved		

PS-Parameters Savable   This bit is always set to 1, indicating this page can be saved to nonvolatile RAM.

Page Code   The value of 20h indicates a vendor unique page in page format.

Page Length   The page length is fixed at 2 bytes.

AC - Auto Clean   When this bit is set to 1, the automatic drive cleaning feature is enabled. When the bit is set to 0, the feature is disabled.

DLR-Drive Load Retry   When this bit is set to 1, retries as described in the Mode Select Page 20h section will be performed. When this bit is set to 0, retries are not performed.

MUSL   Setting this bit to 1 places the library in MUSL mode. Setting the bit to 0 places the library in MUML (default).

MUSL NumLUNS   When the MUSL bit is set to 1, this field indicates the total number of cabinets in the MUSL configuration. A value of 1–5 can be set.

User Op IOD   When this bit is set to 1, the Inport Ready lamp stays on, allowing tapes to be loaded at any time. When this bit is set to 0, the Inport Ready lamp stays off until a host computer issues a command, causing the lamp to light for one minute.

Note   *Keeping the Inport Ready lamp on for an extended period of time may cause the lamp to burn out prematurely. To run User Op IOD for an extended period of time, replace the 14-volt lamp with a 28-volt replacement lamp (PN 0385015). The 28-volt lamp is slightly dimmer but will last at least two years in continuous operation.*

Table 26: Mode Sense
Data - Vendor Unique
Page 00h

Bit/Byte	7	6	5	4	3	2	1	0
0	PS (1)	Reserved (0)	Page Code (00h)					
1	Page Length (3Eh)							
2	AInit	UInit (0)	Parity (0)	NBL	Rsrvd (0)	NRDC (0)	MDC (0)	
3	Maximum Parity Retries (00h)							
4 - 63	Display Messages (00h)							

PS-Parameters Savable   This bit is always set to one indicating that this page can be saved to nonvolatile memory.

AInit   Not supported

UInit   Not supported.

Parity   Not supported.

NBL - No Bar Code Labels   Not supported

NRDC - Not Ready Display Control   Not supported

MDC - Message Display Control   Not supported

Maximum Parity Retries   Not supported

Display Message   Not supported

Move Medium (A5h)

The host uses the Move Medium command to move a tape cartridge between library units and from one element to another within a library unit. The host specifies the source element and the destination element in the command block. The library unit then moves the tape cartridge contained in the source element to the empty destination element.

The source and destination elements can be of any type: storage, medium transport, import/export, or data transport. The valid combinations of source element type and destination element type are summarized in the Mode Sense Device Capabilities Parameter Page. The library unit returns a Check Condition status and sets the sense key to Illegal Request if an invalid combination is requested.

Although specifying valid source and destination element types constitutes a valid command, the operation may still not be possible. In this case, as with the invalid command, the library unit returns Check Condition status and sets the sense key to Illegal Request.

The Additional Sense Code and Additional Sense Code Qualifier is set to indicate why the operation cannot be carried out. For example, this might occur if a source or destination element is specified which does not contain a tape cartridge. See Appendix A, "Sense Data Values" for a summary of conditions, sense keys, and additional sense encoding.

The format for the Move Medium Command block is shown in Table 27.

Table 27: Move Medium Command

Bit/Byte	7	6	5	4	3	2	1	0
0	Operation Code (A5h)							
1	Logical Unit Number			Reserved (00h)				
2	(MSB)							
3	Transport Element Address (0000h)							(LSB)
4	(MSB)							
5	Source Element Address							(LSB)
6	(MSB)							
7	Destination Element Address							(LSB)
8	Reserved							
9	(0000h)							
10	Reserved (00h)							Invert (0)
11	Reserved (00h)							

Logical Unit Number The Logical Unit Number can range from 0–4. This field indicates which logical unit the command should be sent to.

Transport Element Address The default medium transport element address of 0 or the medium transport element address specified by the Mode Sense Data can be used.

Source Element Address The source element address specifies the location from which the medium is taken.

Destination Element Address The destination address specifies the location to which the medium is moved.

Invert   The medium changer does not support medium rotation for
                                    handling double sided media. The invert bit is set to 0.

Position to Element (2Bh)

The Position To Element command moves the medium transport element in front of the destination element within a library unit.

The destination element can be one of the following types: storage or data transfer. If the address is in error, the library unit returns Check Condition status and sets the sense key to Illegal Request.

The format of the Position To Element Command block is shown Table 28.

Table 28: Position To Element Command

Bit/Byte	7	6	5	4	3	2	1	0
0	Operation Code (2Bh)							
1	Logical Unit Number			Reserved (00h)				
2	(MSB) Transport Element Address							
3	(0000h)							(LSB)
4	(MSB) Destination Element Address							
5								(LSB)
6	Reserved							
7	(00h)							
8	Reserved (00h)							Invert (0)
9	Reserved (00h)							

Logical Unit Number   The Logical Unit Number can range from 0–4. This field indicates which logical unit the command should be sent to.

Transport Element Address   The default medium transport element address of 0 or the medium transport element address specified by the mode sense data can be used.

Destination Element Address   The destination address specifies the location to which the medium transport element is moved.

Invert   The medium changer does not support medium rotation for handling double sided media. The invert bit is set to 0.

Read Element Status (B8h)

The host can determine the status of any library element by issuing a Read Element Status command. The type of element (medium transfer, storage, import/export, or data transfer) can be specified in the command as well as the starting address and the number of elements to be included in the status check.

The library unit begins storing status information after its initial unit inventory. After that, the information is automatically updated with each move or status change. When the host sends a Read Element Status command, the library returns current information about the requested elements.

In MUML configuration, each cabinet can only return status information about its own elements. To obtain status for an entire MUML system, a Read Element Status command must be issued to each library unit.

For MUSL systems, a single Read Element Status command can be issued to obtain the status for the entire library system.

The format for the Read Element Status Command block is shown in Table 29.

Table 29: Read Element
Status Command

Bit/Byte	7	6	5	4	3	2	1	0
0	Operation Code (B8h)							
1	Logical Unit Number			VolTag	Element Type Code			
2	(MSB)							
3	Starting Element Address							(LSB)
4	(MSB)							
5	Number of Elements							(LSB)
6	Reserved (00h)							
7	(MSB)							
8	Allocation Length							
9								(LSB)
10	Reserved (00h)							
11	Reserved (00h)							

Logical Unit Number   The Logical Unit Number can range from 0–4. This field indicates which logical unit the command should be sent to.

VolTag   The Volume Tag field (VolTag) indicates whether the volume tag information associated with each tape cartridge should be returned as part of the status information. The volume tag (or bar code) is updated for each tape cartridge whenever it is moved with a Move Medium command. The volume tag information for all tape cartridges can also be updated using the Initialize Element Status command. Since tape cartridges are a single sided media, only a single volume tag is supported per tape cartridge.

Element Type Code   This field is used to indicate which type of element (medium transport, storage, import/export, data transfer, or all) is to be reported by this command.

     0   indicates all element types reported.

     1   indicates medium transport element.

     2   indicates storage element.

     3   indicates import/export element.

     4   indicates data transfer elements.

Starting Element Address and Number of Elements   These fields are used to select the range of elements. Beginning with the first element with an address greater than or equal to the Starting Element Address, all matching elements are reported until the specified number of elements is reached. Only elements matching the specified type are reported.

Allocation Length   This field specifies how much memory the host must set aside to store the status information returned by the library unit. This field should be set to a value large enough to store the status information for the requested number of elements. If this field is not large enough, the library unit only reports the status of the elements whose information fits within the allocated memory.

The returned Read Element Status Data has the general structure shown in Figure 4.

Figure 4: Read Element
Status Data General
Structure

Read Element Status Data
Read Element Status Data Header
Element Status Data Page (first or only)
Element Status Data Page Header
Element Descriptor (first or only)
Other Element Descriptors (if any)
Other Status Data Pages (if any)
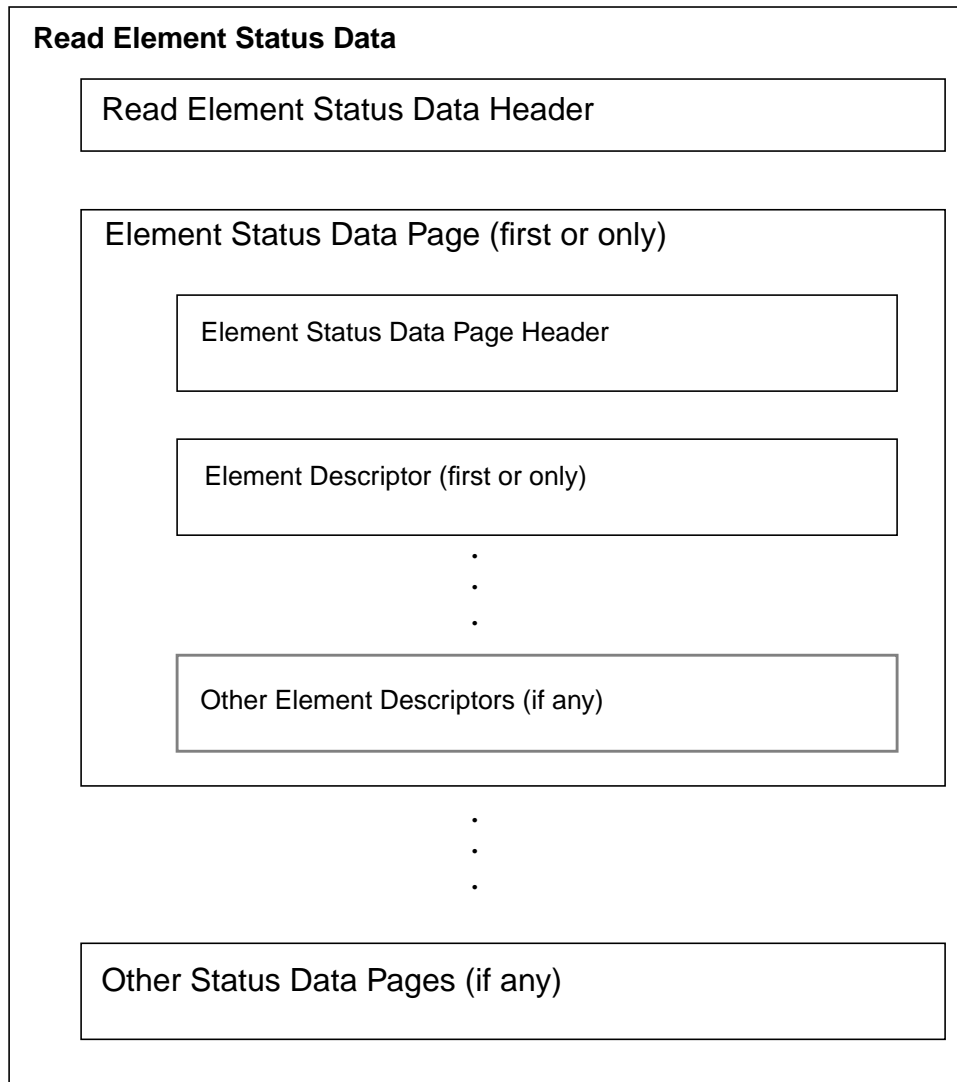
Element Status Data

A single Read Element Status Data Header is returned along with one or more element status pages. The Read Element Status Data Header indicates the address of the first element reported, the number of elements reported, and the size of the report (in bytes) for all requested data.

The size of a report is equal to the total number of bytes for all requested data minus seven. The Read Element Status command can be given with an allocation length of eight to determine how much space must be allocated to transfer all of the status data requested by the command.

The format for Read Element Status Data is shown in Table 30.

Table 30: Read Element
Status Data

Bit/Byte	7	6	5	4	3	2	1	0
0	(MSB)							
1		First Element Address Reported						(LSB)
2	(MSB)							
3		Number of Elements Reported						(LSB)
4	Reserved (00h)							
5	(MSB)							
6		Byte Count of Report Available						
7								(LSB)
8–X	One or More Element Status Page(s)							

First Element Address Reported This field indicates the element address of the element with the smallest element address found to meet the command description block request.

Number of Elements Reported This field indicates the number of elements meeting the request in the command descriptor block. The status for these elements is returned if sufficient allocation length was specified.

Byte Count of Report Available   This field indicates the number of bytes of element status page data available for all elements meeting the request in the command descriptor block.

From one to four Element Status Pages can be returned. One page is returned for each element type with status information. Each page contains a header and one or more element descriptors. Each element descriptor reports the status for a single library unit element.

The page header (bytes 0-7) defines the contents of each element descriptor. The format for a status page is shown in Table 31.

Table 31: Element Status
Page

Bit/Byte	7	6	5	4	3	2	1	0
0	Element Type Code							
1	PVolTag	AVolTag (0)	Reserved (00h)					
2	(MSB)							
3	Element Descriptor Length							(LSB)
4	Reserved (00h)							
5	(MSB)							
6	Byte Count of Descriptor Data Available							
7								(LSB)
8–X	One or More Element Descriptors							

PVolTag

A primary volume tag field value of 1 indicates that the primary volume tag information field is present in each of the following element descriptor blocks. A value of 0 indicates that these bytes are omitted from the element descriptors that follow.

AVolTag

The alternate volume tag is not supported. This field is set to 0.

Element Descriptor Length   This field indicates the number of bytes in each element descriptor.

Byte Count of Descriptor Data Available

The Byte Count of Descriptor Data Available indicates the number of bytes (minus seven) of descriptor data (excluding this header) that would be returned for the descriptors of the specified type if an adequate allocation length had been specified.

There are four different types of element descriptor blocks, one for each type of element. As indicated in the tables that follow, these element descriptors share some fields in common.

Medium Transport Element Descriptor

The format for the medium transport element descriptor is shown in Table 32.

Table 32: Medium Transport Element Descriptor

Bit/Byte	7	6	5	4	3	2	1	0
0	(MSB)							
1	Element Address							(LSB)
2	Reserved (00h)					Except	Rsvd (0)	Full
3	Reserved (00h)							
4	Additional Sense Code							
5	Additional Sense Code Qualifier							
6	Reserved (000000h)							
7								
8								
9	SValid (0)	Invert (0)	Reserved (00h)					
10	Source Storage Element Address (0000h)							
11								
12–47	Primary Volume Tag Information (if present)							
48–51	Reserved (00000000h)							
52	Vendor Unique (0000h)							
53								

Element Address   This field indicates the address of the element being reported by that element descriptor.

Except   The Exception field is set to 1 when that element is in an abnormal state. When the element is in a normal state, it is set to 0. Further information on the abnormal state is available in the Additional Sense Code and Additional Sense Code Qualifier fields.

Full   The Full field is set to 1 whenever the element contains a tape cartridge. It is set to 0 otherwise.

Additional Sense Code and Additional Sense Code Qualifier   These fields are only valid if the Exception field is set to 1. Currently the only valid values for these fields indicate the Element Contents Unknown condition (ASC=80 ASCQ=22). For more information, see Appendix A.

SValid, Invert, and Source Storage Element Address   The value of 0 indicates these fields are not valid.

Primary Volume Tag Information   If Volume Tag information is requested in the command block, the Primary Volume Tag Information field will be included in the element descriptor. This field contains the information read from the bar code affixed to each tape cartridge; its format is shown in Table 33.

Table 33: Primary
Volume Tag Information
Format

Bit/Byte	7	6	5	4	3	2	1	0
12–43	Volume Identification Field							
44	Reserved (0000h)							
45								
46	Volume Sequence Number (0000h)							
47								

Volume Identification Field This field is a left-justified sequence of ASCII characters representing the bar code scanned from the cartridge followed by blanks.

Volume Sequence Number This field is reserved; it should be set to 0.

Storage Element Descriptor

The format for a storage element descriptor is shown in Table 34.

Table 34: Storage
Element Descriptor

Bit/Byte	7	6	5	4	3	2	1	0
0	(MSB)							
1				Element Address				(LSB)
2	Reserved (0h)				Access (1)	Except	Reserved (0)	Full
3	Reserved (00h)							
4	Additional Sense Code							
5	Additional Sense Code Qualifier							
6	Reserved (000000h)							
7								
8								
9	SValid	Invert (0)	Reserved (00h)					
10	Source Storage Element Address							
11								
12–47	Primary Volume Tag Information (if present)							
48–51	Reserved (00000000h)							
52	Vendor Unique (0000h)							
53								

Element Address   This field indicates the address of the element being reported by that element descriptor.

Access   An access bit value of 1 indicates access to the element by a medium transport element is allowed.

Except   The Exception field is set to 1 when that element is in an abnormal state. When the element is in a normal state, it is set to 0. Further information on the abnormal state is available in the Additional Sense Code and Additional Sense Code Qualifier fields in that element descriptor. See the Request Sense Command for the meaning of the codes contained in the two Sense Code fields.

Full   The Full field is set to 1 whenever the element contains a tape cartridge. It is set to 0 otherwise.

Additional Sense Code and Additional Sense Code Qualifier   These fields are only valid if the Exception field is set to 1. Currently, the only valid values for these fields indicate either the Element Contents Unknown condition (ASC=80 ASCQ=22) or Twelve Pac Missing (ASC=80 ASCQ=02).

SValid   The SValid bit is set to 1 if the information in the Source Storage Element Address field is valid. If the information is unknown (due to a door open or power on condition) the SValid bit is set to 0.

Invert   The invert field is not supported and is set to 0.

Source Storage Element Address   The Source Storage Element Address represents the address of the last storage element which held the cartridge. The SValid field indicates whether this information is valid.

Primary Volume Tag Information   If the Volume Tag information was requested in the command block, the Primary Volume Tag Information field will be included in the element descriptor. See Table 33 for formatting.

Import/Export Element Descriptor

The format for an import/export element descriptor is shown in Table 35.

Table 35: Import Export
Element Descriptor

Bit/Byte	7	6	5	4	3	2	1	0
0	(MSB)							
1		Element Address						(LSB)
2	Reserved (0)		Import Enable	Export Enable	Access	Except	Import Export	Full
3	Reserved (00h)							
4	Additional Sense Code							
5	Additional Sense Code Qualifier							
6	Reserved (000000h)							
7								
8								
9	SValid	Invert (0)	Reserved (00h)					
10	Source Storage Element Address							
11								
12–47	Primary Volume Tag Information (if present)							
48–51	Reserved (00000000h)							
52	Vendor Unique (0000h)							
53								

Element Address This field indicates the address of the element being reported by the import/export element descriptor.

Import Enable	The Import Enable field determines whether the element can import a tape cartridge into the library unit. If imports are possible through that element, the field is set to 1; if not, it is set to 0. This field is always set to 1 for the inport and pass-through elements and 0 for outport elements.
Export Enable	The Export Enable field determines whether the element can export a tape cartridge from the library unit. If exports are possible through that element, the field is set to 1; if not, it is set to 0. This field is always set to 1 for outport and pass-through elements and 0 for inport elements.
Access	An access bit value of 1 allows access to the element by a medium transport element. This field is 0 for inport and outport elements and 1 for pass-through elements.
Except	The Exception field is set to 1 when that element is in an abnormal state. When the element is in a normal state, it is set to 0. Further information on the abnormal state is available in the Additional Sense Code and Additional Sense Code Qualifier fields in that element descriptor. See Appendix A for the meaning of the codes contained in the two Sense Code fields.
Import Export	The Import Export field of 1 indicates the unit of media in the element was placed there by an operator. It is set to 0 if the tape cartridge in the element was placed there by the transfer mechanism. This field is only set to 1 for inport elements which contain a cartridge. Otherwise, it is set to 0.
Full	The Full field is set to 1 whenever the element does not contain a tape cartridge or whenever an outport element is not full. Otherwise, it is set to 0.
Additional Sense Code and Additional Sense Code Qualifier	These fields are only valid if the Exception field is set to 1. Currently the only valid values for these fields indicate the Element Contents Unknown condition (ASC=80 ASCQ=22).
SValid	The SValid bit is set to 1 if the information in the Source Storage Element Address field is valid. If the information is unknown the SValid bit is set to 0.
Invert	The invert field is not supported and is set to 0.
Source Storage Element Address	The Source Storage Element Address represents the address of the last storage element which held the cartridge. The SValid field indicates whether this information is valid.

Data Transfer Element Descriptor

The format of a data transfer element descriptor is shown in Table 36.

Table 36: Data Transfer
Element Descriptor

Bit/Byte	7	6	5	4	3	2	1	0
0	(MSB)							
1				Element Address				(LSB)
2	Reserved (0h)				Access (1)	Except	Rsvd (0)	Full
3	Reserved (00h)							
4	Additional Sense Code							
5	Additional Sense Code Qualifier							
6	Reserved (000000h)							
7								
8								
9	SValid	Invert (0)	Reserved (00h)					
10	Source Storage Element Address							
11								
12–47	Primary Volume Tag Information (if present)							
48–51	Reserved (00000000h)							
52	Vendor Unique (0000h)							
53								

Element Address　　This field indicates the address of the element being reported by that element descriptor.

Access　　An access bit value of 1 allows access to the element by a medium transport element.

Except   The Exception field is set to 1 when that element is in an abnormal
                                    state. When the element is in a normal state, it is set to 0. Further
                                    information on the abnormal state is available in the Additional
                                    Sense Code and Additional Sense Code Qualifier fields in that
                                    element descriptor. See the Request Sense Command for the
                                    meaning of the codes contained in the two Sense Code fields.

Full   The Full field is set to 1 whenever the element contains a tape
                                    cartridge. It is set to 0 otherwise.

Additional Sense Code and   These fields are only valid if the Exception field is set to 1. Currently
Additional Sense Code   the only valid values for these fields indicate the Element Contents
Qualifier   Unknown condition (ASC=80 ASCQ=22). For more information,
                                    Table A-1:, "Sense Data Values (Hexadecimal)," on page A-2

SValid   The SValid bit is set to 1 if the information in the Source Storage
                                    Element Address field is valid. If the information is unknown (due
                                    to a door open or power on condition) the SValid bit is set to 0.

Invert   The invert field is not supported and is set to 0.

Source Storage Element   The Source Storage Element Address represents the address of the
Address   last storage element which held the cartridge. The SValid field indi-
                                    cates whether this information is valid.

Primary Volume Tag   If the Volume Tag information was requested in the command
Information   block, the Primary Volume Tag Information field is included in the
                                    element descriptor. See Table 33 for formatting.

Ready Inport (DEh)

The vendor-specific Ready Inport command allows the host to unlock the IOD inport door so a tape cartridge can be placed inside. After this command has been issued, the inport door light goes on for one minute, indicating the operator has access. The operator can then open the IOD inport door and place a cartridge inside. When the operator closes the inport door, the library unit generates a Unit Attention Import or Export Element Accessed (SK=6 ASC=28 ASCQ=01). If the operator does not place a cartridge in the inport within the one-minute time period, the IOD light goes out and another Ready Inport is required to unlock the inport door again. See Table 37 for formatting.

Table 37: Ready Inport
Command

Bit/Byte	7	6	5	4	3	2	1	0
0	Operation Code (DEh)							
1	Logical Unit Number			Reserved (00h)				
2	(MSB)							
3				Element Address				(LSB)
4	Reserved (00h)							
5	Reserved (00h)							

Logical Unit Number   The Logical Unit Number can range from 0–4. This field indicates which logical unit the command should be sent to.

Element Address   Address of inport to ready.

Release (17h)

The Release command releases the library or a library element that matches specified parameters. See Table 38 for formatting.

Note   ***Attempting to release the library or a library element not currently reserved by the requesting initiator will not generate an error message. However, if the library or element is reserved by another initiator, it will not respond to the Release command.***

Table 38: Release
Command

Bit/Byte	7	6	5	4	3	2	1	0
0	Operation Code (17h)							
1	Logical Unit Number			3rdPty	3rd Party ID			Element
2	Reservation ID							
3	Reserved (00h)							
4	Reserved (00h)							
5	Unused		Reserved (00h)				Flag	Link

Logical Unit Number   The Logical Unit Number can range from 0–4. This field indicates which logical unit the command should be sent to.

3rdPty and 3rd Party ID   This option allows an initiator to release a unit or element previously reserved with the third-party reservation option. If the third-party bit is 0, then this release option is not requested and the command will only release a unit or element that was reserved without third-party reservation. If the third-party bit is 1, the unit or element to be released was originally reserved by the same initiator using the third-party reservation option and the third-party device ID value matches the ID value used to make the reservation.

Element and Reservation ID The Element field specifies whether this command is an element or unit release. If the value is 1, the command releases all elements with the specified Reservation ID. If the value is 0, the command releases the specified unit.

In either cases, all third-party release requirements must be met to secure the release.

Request Sense (03h)

The Request Sense command allows the host to receive sense data from the tape library.

The tape library supports the reporting of current and deferred errors only. A current error (error code 70h) is returned when the error was generated during the execution of the command indicating a Check Condition. A deferred error (error code 71h) is returned when the error was generated prior to the execution of the command indicating a Check Condition.

The tape library supports unit attention condition queuing as described in Section 6.9 in the SCSI-2 Standard.

Other details of processing for this command are consistent with those described in Section 7.2.14 of the SCSI-2 Standard.

The format of the Request Sense command is shown in Table 39.

Table 39: Request Sense
Command

Bit/Byte	7	6	5	4	3	2	1	0
0	Operation Code (03h)							
1	Logical Unit Number			Reserved (00h)				
2	Reserved (0000h)							
3								
4	Allocation Length							
5	Reserved (00h)							

Logical Unit Number   The Logical Unit Number can range from 0–4. This field indicates which logical unit the command should be sent to.

Allocation Length   This field contains the maximum amount of data which may be returned to the host. Anything greater than 15 returns the full 15 bytes of data.

The format of the Request Sense data is shown in Table 40.

Table 40: Request Sense
Data

Bit/Byte	7	6	5	4	3	2	1	0
0	Valid (0)	Error Code (70h or 71h)						
1	Segment Number (00h)							
2	Filemark (0)	EOM (0)	ILI (0)	Reserved (0)	Sense Key			
3	(MSB)							
4		Information (00000000h)						
5								
6								(LSB)
7	Additional Sense Length (07h)							
8	(MSB)							
9		Command-Specific Information (00000000h)						
10								
11								(LSB)
12	Additional Sense Code							
13	Additional Sense Code Qualifier							
14	Field Replaceable Unit Code (00h)							

Valid This field is set to 0 indicating the information field is not being used. For library units containing firmware revisions prior to Release 3H or MUC Release 1C, this field is set to 1.

Segment Number, Filemark, These fields are not supported and should be set to 0.
EOM, and ILI

Error Code   The following error values are supported:

70h   current error

71h   deferred error

Sense Key   The following sense key values are supported:

0h   NO SENSE

1h   RECOVERED ERROR

2h   NOT READY

4h   HARDWARE ERROR

5h   ILLEGAL REQUEST

6h   UNIT ATTENTION

9h   VENDOR SPECIFIC

Bh   ABORTED COMMAND

Information   This field is not supported and should be set to 0.

Additional Sense Length,   See Table A-1:, "Sense Data Values (Hexadecimal)," on page A-2 for
Additional Sense Code,   a list of possible sense information returned from the tape library.
and Additional Sense Code
Qualifier

Command-Specific   These fields are not supported and should be set to 0.
Information and
Field Replaceable Unit Code

Request Volume Element Address (B5h)

The Request Volume Element Address command reports the element descriptors found by a Send Volume Tag command. The type of element (medium transfer, storage, import/export, or data transfer) can be specified in the command as well as the starting address and number of elements for which status information is to be returned.

The format of the Request Volume Element Address command is shown in Table 51.

Table 41: Request
Volume Element Address
Command

Bit/Byte	7	6	5	4	3	2	1	0
0	Operation Code (B5h)							
1	Logical Unit Number			VolTag		Element Type Code		
2	(MSB) Starting Element Address							
3								(LSB)
4	(MSB) Number of Elements							
5								(LSB)
6	Reserved (00h)							
7	(MSB) Allocation Length							
8								
9								(LSB)
10	Reserved (00h)							
11	Reserved (00h)							

Logical Unit Number   The Logical Unit Number can range from 0–4. This field indicates which logical unit the command should be sent to.

VolTag

The Volume Tag field (VolTag) indicates whether the bar code (volume tag) information should be returned as part of the status information for a tape cartridge. The volume tag (or bar code) is updated for each tape cartridge whenever it is moved with a Move Medium command. The volume tag information for all tape cartridges can also be updated using the Initialize Element Status command. Since tape cartridges are a single-sided media, only one volume tag is supported per tape cartridge.

Element Type Code

This field is used to indicate which type of element (medium transport, storage, import/export, data transfer, or all) is to be reported by this command.

0   indicates all element types reported.

1   indicates medium transport element.

2   indicates storage element.

3   indicates import/export element.

4   indicates data transfer elements.

Starting Element Address and Number of Elements

These fields are used to select the range of elements for reporting purposes. Beginning with the first defined element with an address greater than or equal to the Starting Element Address, all matching elements will be reported until reports for the indicated number of elements have been returned. Within this range, no status information will be reported for an undefined element address. Only elements matching the indicated type will be returned.

Allocation Length

This field specifies the amount of memory the host has set aside to store the status information returned by the library. This field should be set to a number which is large enough to store the status information for the requested number of elements. If it is not, the library only reports the number of elements whose status information fits within the allocated space.

The returned Request Volume Element Address Data has the general structure as depicted in Figure 5.

Figure 5: Request
Volume Element Address
Data General Structure
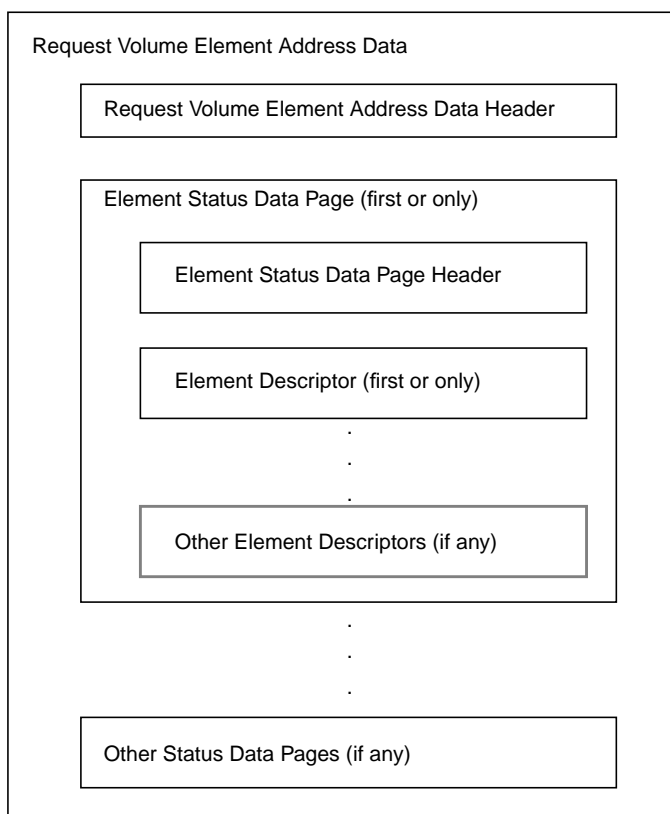
A single Volume Element Address Header is returned along with one or more element status pages. The Volume Element Address indicates the address of the first element reported, the number of elements reported, the action code of the reported Send Volume Tag command, and the size of the report for all requested data.

The size of the report is given in bytes. The size is the total number of bytes that would be contained in the report for all requested data minus seven bytes. The Request Volume Element Address command can be given with an Allocation Length of eight to determine how much space must be allocated to transfer all of the status data requested by the command.

The format for the Volume Element Address Header is shown in Table 42.

Table 42: Volume
Element Address Header

Bit/Byte	7	6	5	4	3	2	1	0
0	(MSB)							
1			First Element Address Reported					(LSB)
2	(MSB)							
3			Number of Elements Reported					(LSB)
4	Reserved (00h)				Send Action Code (05h)			
5	(MSB)							
6				Byte Count of Report Available				
7								(LSB)
8 - X	One or More Element Status Page(s)							

First Element Address Reported This field indicates the smallest element address found to meet the command description block request.

Number of Elements Reported This field indicates the number of elements that meet the request in the command descriptor block. The status for these elements is returned if sufficient allocation length was specified.

Send Action Code Send Action Code from the Send Volume Tag that issued the command. The library only supports Action code 05h.

Byte Count of Report Available This field indicates the number of bytes of element status page data available for all elements meeting the request in the command descriptor block.

From zero to four Element Status Pages can be returned. One page is returned for each type of element with status information. Each page contains a header and one or more element descriptors. Each element descriptor reports the status for a single library element.

The page header (bytes 0-7) contains information that defines the contents of the element descriptors for the elements of that type. The format of a status page is shown in Table 43.

Table 43: Element Status
Page

Bit/Byte	7	6	5	4	3	2	1	0
0	Element Type Code							
1	PVolTag	AVolTag (0)	Reserved (00h)					
2	(MSB)		Element Descriptor Length					
3								(LSB)
4	Reserved (00h)							
5	(MSB)							
6			Byte Count of Descriptor Data Available					
7								(LSB)
8–X	One or More Element Descriptors							

PVolTag

A primary volume tag field value of 1 indicates that the primary volume tag information field is present in each of the following element descriptor blocks. A value of 0 indicates that these bytes are omitted from the element descriptors that follow.

AVolTag

The Alternate Volume Tag is not supported. This field is set to 0.

Element Descriptor Length This field indicates the number of bytes in each element descriptor.

Byte Count of Descriptor Data Available

The Byte Count of Descriptor Data Available indicates the number of bytes (minus seven) of descriptor data (excluding this header) that would be returned for the descriptors of the specified type if an adequate allocation length had been specified.

There are four different types of element descriptor blocks, one for each type of element. There are several fields which are found in more than one type of element descriptor as well as fields which are unique to an element descriptor.

The format for a medium transport element descriptor is shown in Table 44.

Table 44: Medium
Transport Element
Descriptor

Bit/Byte	7	6	5	4	3	2	1	0
0	(MSB)							
1			Element Address					(LSB)
2	Reserved (00h)					Except	Rsvd (0)	Full
3	Reserved (00h)							
4	Additional Sense Code							
5	Additional Sense Code Qualifier							
6	Reserved (000000h)							
7								
8								
9	SValid (0)	Invert (0)	Reserved (00h)					
10	Source Storage Element Address (0000h)							
11								
12 - 47	Primary Volume Tag Information (if present)							
48–51	Reserved (00000000h)							
52	Vendor Unique (0000h)							
53								

Element Address   This field indicates the address of the element being reported by that element descriptor.

Except   The Exception field is set to 1 when that element is in an abnormal state. When the element is in a normal state, it is set to 0. Further information on the abnormal state is available in the Additional Sense Code and Additional Sense Code Qualifier fields.

Full	The Full field is set to 1 whenever the element contains a tape cartridge. It is set to 0 otherwise.
Additional Sense Code and Additional Sense Code Qualifier	These fields are only valid if the Exception field is set to 1.
SValid, Invert, and Source Storage Element Address	The source valid, source storage element address field and the invert bit information value of 0 indicates these fields are not valid.
Primary Volume Tag Information	If the Volume Tag information is requested in the command block, the Primary Volume Tag Information field will be included in the element descriptor. This field contains the information read from the bar code affixed to each tape cartridge; its format is shown in Table 45.

Table 45: Primary
Volume Tag Information

Bit/Byte	7	6	5	4	3	2	1	0
12–43	Volume Identification Field							
44	Reserved (0000h)							
45								
46	Volume Sequence Number (0000h)							
47								

Volume Identification Field

This is a left-justified sequence of ASCII characters representing the bar code scanned from the cartridge followed by 20h (blanks).

Volume Sequence Number This field is reserved and set to 0.

The format of an element descriptor for an element of the storage element type is shown in Table 46.

Table 46: Storage
Element Descriptor

Bit/Byte	7	6	5	4	3	2	1	0
0	(MSB)	Element Address						
1								(LSB)
2	Reserved (0h)				Access	Except	Reserved (0)	Full
3	Reserved (00h)							
4	Additional Sense Code							
5	Additional Sense Code Qualifier							
6	Reserved (000000h)							
7								
8								
9	SValid	Invert (0)	Reserved (00h)					
10	Source Storage Element Address							
11								
12–47	Primary Volume Tag Information (if present)							
48–51	Reserved (00000000h)							
52	Vendor Unique (0000h)							
53								

Element Address   This field indicates the address of the element being reported by that element descriptor.

Access   An access bit value of 1 indicates that access to the element by a medium transport element is allowed.

Except   The Exception field is set to 1 when that element is in an abnormal state. When the element is in a normal state, it is set to 0. Further information on the abnormal state is available in the Additional Sense Code and Additional Sense Code Qualifier fields in that element descriptor. See the Request Sense Command for the meaning of the codes contained in the two Sense Code fields.

Full	The Full field is set to 1 whenever the element contains a tape cartridge. It is set to 0 otherwise.
Additional Sense Code and Additional Sense Code Qualifier	These fields are only valid if the Exception field is set to 1. Currently, the only valid values for these fields indicate either the Element Contents Unknown condition (ASC=80 ASCQ=22), Cleaning Cartridge Installed (ASC=30 ASCQ=03) or Operation Medium Removal Requested (ASC=5A ASCQ=01).
SValid	The SValid bit is set to 1 if the information in the Source Storage Element Address field is valid. If the information is unknown (due to a door open or power on condition) the SValid bit is set to 0.
Invert	The invert field is not supported and is set to 0.
Source Storage Element Address	The Source Storage Element Address represents the address of the last storage element which held the cartridge. The SValid field indicates whether this information is valid.
Primary Volume Tag Information	If the Volume Tag information was requested in the command block, the Primary Volume Tag Information field will be included in the element descriptor. See Table 45 for formatting.

The layout of an element descriptor for an element of the Import∕Export element type is illustrated in Table 47.

Table 47: Import/Export
Element Descriptor

Bit/Byte	7	6	5	4	3	2	1	0
0	(MSB)							
1	Element Address							(LSB)
2	Reserved (0)		Import Enable	Export Enable	Access	Except	Import Export	Full
3	Reserved (00h)							
4	Additional Sense Code							
5	Additional Sense Code Qualifier							
6	Reserved (000000h)							
7								
8								
9	SValid	Invert (0)	Reserved (00h)					
10	Source Storage Element Address							
11								
12–47	Primary Volume Tag Information (if present)							
48–51	Reserved (00000000h)							
52	Vendor Unique (0000h)							
53								

Import Element

The Import Enable field indicates whether the element can import a tape cartridge into the library. A setting of 1 indicates that imports are possible through the element. This field should always be set to 1.

Export Enable

The Export Enable field indicates whether the element can export a tape cartridge from the library. It is set to 1 (01h).

Access   An access bit value of 1 indicates access to the element by a
                                    medium transport element is allowed. This is set to 0 (0h) if the
                                    load port door is open.

Except   The Exception field is set to 1 when that element is in an abnormal
                                    state. When the element is in a normal state, it is set to 0. Further
                                    information on the abnormal state is available in the Additional
                                    Sense Code and Additional Sense Code Qualifier fields in that
                                    element descriptor. See Appendix A for the meaning of the codes
                                    contained in the two Sense Code fields.

Import/Export   The Import/Export field is set to 0 if the tape cartridge contained
                                    in the element was placed there by the transfer mechanism. It is set
                                    to 1 if the tape was placed there by an operator or if its source is
                                    unknown (e.g., after power cycle).

Full   The Full field is set to 1 whenever the element contains a tape
                                    cartridge. It is set to 0 when the element contains no tape or the
                                    Load Port door is open.

Additional Sense Code and   These fields are only valid if the Exception field is set to 1.
Additional Sense Code   Currently, the only valid values for these fields indicate the
Qualifier   Element Contents Unknown condition (ASC=80 ASCQ=22),
                                    Cleaning Cartridge Installed (ASC=30 ASCQ=03) and Operator
                                    Medium Removal Request (ASC=5A ASCQ=01).

SValid   The SValid bit is set to 1 if the information in the Source Storage
                                    Element Address field is valid. If the information is unknown the
                                    SValid bit is set to 0.

Invert   The invert field is not supported and is set to 0.

Source Storage Element   The Source Storage Element Address represents the address of the
Address   last storage element which held the cartridge. The SValid field indi-
                                    cates whether this information is valid.

Primary Volume Tag   If the Volume Tag information is requested in the command block,
Information   the Primary Volume Tag Information field will be included in the
                                    element descriptor. See Table 33 for formatting.

                                    The format of an element descriptor for an element of the data transfer
                                    element type is shown in Table 48.

Table 48: Data Transfer
Element Descriptor

Bit/Byte	7	6	5	4	3	2	1	0
0	(MSB)	Element Address						
1								(LSB)
2	Reserved (0h)				Access	Except	Rsvd (0)	Full
3	Reserved (00)							
4	Additional Sense Code							
5	Additional Sense Code Qualifier							
6	Not Bus	Rsvd	ID Valid	LU Valid	Rsvd	Logical Unit Number		
7	SCSI Bus Address							
8	Reserved (00h)							
9	SValid	Invert (0)	Reserved (00h)					
10	Source Storage Element Address							
11								
12–47	Primary Volume Tag Information (if present)							
48–51	Reserved (00000000h)							
52	Vendor Unique (0000h)							
53								

Element Address   This field indicates the address of the element being reported by that element descriptor.

Access   An access bit value of 1 indicates access to the element by a medium transport element is allowed.

Except   The Exception field is set to 1 when that element is in an abnormal state. When the element is in a normal state, it is set to 0. Further information on the abnormal state is available in the Additional Sense Code and Additional Sense Code Qualifier fields in that element descriptor. See the Request Sense Command for the meaning of the codes contained in the two Sense Code fields.

Full   The Full field is set to 1 whenever the element contains a tape cartridge. It is set to 0 otherwise.

Additional Sense Code and   These fields are only valid if the Exception field is set to 1. Current-
Additional Sense Code   ly, the only valid values for these fields indicate the Element Con-
Qualifier   tents Unknown condition (ASC=80 ASCQ=22), Cleaning Cartridge Installed (ASC=30 ASCQ=03) or any DLT™ drive error (ASC=8D or ASC=F3).

SValid   The SValid bit is set to 1 if the information in the Source Storage Element Address field is valid. If the information is unknown (due to a door open or power on condition) the SValid bit is set to 0.

Invert   The invert field is not supported and is set to 0.

Source Storage Element   The Source Storage Element Address represents the address of the
Address   last storage element which held the cartridge. The SValid field indi-cates whether this information is valid.

Primary Volume Tag   If the Volume Tag information was requested in the command
Information   block, the Primary Volume Tag Information field is included in the element descriptor. See Table 45 for format.

Reserve (16h)

This command reserves the specified library or elements for exclusive use by the requesting initiator or the another specified SCSI device. The reservation remains in effect until one of the following conditions is met:

- The initiator that made the reservation sends a valid Reserve command capable of overriding the reservation. Element reservations will replace all previous element reservations with the same Reservation ID from the same initiator, and cannot override Unit reservations. Unit reservation can override any previous reservation from the same initiator, regardless of Reservation ID.
- The library or element is released by a valid Release command from the same initiator.
- A Bus Device Reset message is received from any initiator.
- A hard reset occurs.

The occurrence of the last two conditions is indicated by the library returning a Check Condition status with a sense key of Unit Attention on the next command following the condition. It is not an error to issue Reserve Unit to a library that is currently reserved to the requesting initiator.

If a Unit Reserve is attempted on a unit that has previously been reserved by another initiator or contains any element previously reserved by another initiator, the target returns a Reservation Conflict status. If an Element Reserve is attempted on an element previously reserved from another initiator or contained by a unit previously reserved by any initiator or previously element reserved with a different Reservation ID, the target returns a Reservation Conflict status.

If, after honoring a Unit Reservation, any other initiator attempts to perform any command except Inquiry, Request Sense, or Release, the command is rejected with a Reservation Conflict status. A Release command issued by another initiator is ignored by the reserved unit. If, after honoring an Element Reservation, any other initiator issues a command other than Release to that element, the command is rejected with a Reservation Conflict status. A Release command issued by another initiator is ignored by the reserved element.

Table 49: Reserve
Command

Bit/Byte	7	6	5	4	3	2	1	0
0	Operation Code (16h)							
1	Logical Unit Number			3rdPty	3rd Party ID			Element
2	Reservation ID							
3	(MSB)							
4	Element List Length							(LSB)
5	Unused		Reserved (00h)				Flag	Link

Logical Unit Number   The Logical Unit Number can range from 0–4. This field indicates which logical unit the command should be sent to.

3rdPty and 3rd Party ID   The third-party reservation option for RESERVE UNIT allows an initiator to reserve a logical unit for another SCSI device. This option is intended for systems that use COPY, and is implemented by the library.

If the third-party bit is 0, then the third-party reservation option is not requested. If the 3rdPty bit is 1, Reserve Unit reserves the logical unit for the SCSI device specified in the Third-Party Device ID field. The library preserves the reservation until any one of the four conditions mentioned earlier occurs. The library ignores any attempt made by any other initiator to release the reservation and returns a Good status.

An initiator that holds a current reservation may modify that reservation (for example, to switch third-parties) by issuing another Reserve Unit to the library.

Element and Reservation ID The Element field specifies whether this command is an Element or Unit Release. If the value is 1, the command will Release all elements reserved by the requesting initiator, that were reserved with the same Reservation ID value as this release attempt and that meet third-party release requirements. If the value is 0, the command will release a reservation placed on this unit by the requesting initiator that meets third-party release requirements, if applicable.

Element List Length   This field is only valid if the Element field is 1, otherwise this field is reserved and must contain 0 (0000h). This field specifies the Length of Element List Descriptors that follow. This value must be a whole multiple of the length of a single Element List Descriptor (6).

Table 50: Element List Descriptor

Bit/Byte	7	6	5	4	3	2	1	0
0								
1				Reserved (0000h)				
2	(MSB)							
3				Number of Elements				(LSB)
3	(MSB)							
4				Starting Element Address				(LSB)

Starting Element Address and Number of Elements   These fields are used to select the range of elements to be reserved. The reservation begins with the first element with an address greater than or equal to the Starting Element Address, and includes all defined elements until the indicated number of elements have been reserved or the last element is reached. All the specified elements must be able to be reserved or no reservation can take place at all.

Rezero Unit (01h)

The Rezero Unit command allows the host to home all library unit mechanisms. The format of the Rezero Unit command is shown in Table 51.

Table 51: Rezero Unit Command

Bit/Byte	7	6	5	4	3	2	1	0
0	Operation Code (01h)							
1	Logical Unit Number			Reserved (00h)				
2	Reserved (000000h)							
3								
4								
5	Reserved (00h)							

Logical Unit Number   The Logical Unit Number can range from 0–4. This field indicates which logical unit the command should be sent to.

Send Diagnostic (1Dh)

The library unit includes a built-in self-test. This test is automatically performed when the library unit is turned on. It can also be performed by issuing the Send Diagnostic command to the library unit. This test verifies all major library unit subsystems are working.

The format of the Send Diagnostic command is shown in Table 52.

Table 52: Send
Diagnostic Command

Bit/Byte	7	6	5	4	3	2	1	0
0	Operation Code (1Dh)							
1	Logical Unit Number			PF (1)	Reserved (0)	Self Test (1)	Dev-OfL (0)	Unit-OfL (0)
2	Reserved (00h)							
3	(MSB) Parameter List Length (00)							
4								(LSB)
5	Reserved (00h)							

Logical Unit Number The Logical Unit Number can range form 0–4. This field indicates which logical unit the command should be sent to.

PF A page format bit of 1 specifies that the Send Diagnostic parameters conform to the page structure as specified in the SCSI-2 Standard. This bit must be set to 1.

Self Test A self-test bit of 1 directs the target to complete its default self-test. If the self-test passes, a Good status is returned. If the self-test fails, a Check Condition status is returned and the sense key is set to Hardware Error. The Additional Sense fields identify the type of failure. The description of the Request Sense command tells how to get the Sense data from the tape library and how to interpret the Sense data fields.

DevOfL and UnitOfL These bits are not used and must be set to 0.

Parameter List Length A parameter length of 0 indicates that no data is transferred.

Send Volume Tag (B6h)

The Send Volume Tag command evaluates the element descriptors found by a Send Volume Tag command. The type of element (medium transfer, storage, import/export or data transfer) can be specified in the command as well as the starting address for evaluation.

The format of the Send Volume Tag command is shown in Table 53.

Table 53: Send Volume
Tag Command

Bit/Byte	7	6	5	4	3	2	1	0
0	Operation Code (B6h)							
1	Logical Unit Number			Rsvd	Element Type Code			
2	(MSB)							
3	Starting Element Address							(LSB)
4	Reserved (00h)							
5	Reserved (0h)			Send Action Code (05h)				
6	Reserved (0000h)							
7								
8	(MSB)							
9	Parameter List Length (0028h)							(LSB)
10	Reserved (00h)							
11	Reserved (00h)							

Logical Unit Number   The Logical Unit Number can range from 0–4. This field indicates which logical unit the command should be sent to.

Element Type Code   This field is used to indicate which type of element is to be acted on by this command.

0   indicates all element types reported.

1   indicates medium transport element.

2   indicates storage element.

3   indicates import/export element.

4   indicates data transfer elements.

Starting Element Address   The Starting Element Address field specifies the starting point of the Volume Tag evaluation. Beginning with the first defined element with an address greater than or equal to the Starting Element Address, all matching elements will be tagged until the last element of the specified type.

Send Action Code   The Send Action Code field specifies the test to be evaluated. The library only implements the "Translate - search primary tags - ignore sequence numbers" (05h) action.

Parameter List Length   This field specifies the number of bytes in the Send Volume Tag Parameters. This value should always be 28h.

The format of the Send Volume Tag Parameters is shown in Table 54.

Table 54: Send Volume
Tag Parameters

Bit/Byte	7	6	5	4	3	2	1	0
0-	(MSB)							
31			Volume Identification Template Field					(LSB)
32								
33			Reserved (0000h)					
34	(MSB)							
35			Minimum Volume Sequence Number (0000h)					(LSB)
36								
37			Reserved (0000h)					
38	(MSB)							
39			Maximum Volume Sequence Number (0000h)					(LSB)

Volume Identification Template Field   The search template to be evaluated by the translate function. This may contain the '?' and '*' wildcards, where '?' matches any single character and '*' matches any number of characters. Any characters that follow the '*' wildcard are ignored.

Minimum and Maximum Volume Sequence Numbers   Sequence numbers are not supported. These two fields must be set to 0.

Start/Stop Unit Command (1Bh)

The host can enable a library unit to accept medium access commands (or disable this function) by sending the Start/Stop Unit command. The format for the Start/Stop Unit Command Descriptor Block is shown in Table 52.

Table 55: Start/Stop Unit Command

Bit/Byte	7	6	5	4	3	2	1	0
0	Operation Code (1Bh)							
1	Logical Unit Number			Reserved (00h)				
2	Reserved (0000h)							
3								
4	Reserved (00h)							Start
5	Reserved (00h)							

Logical Unit Number   The Logical Unit Number can range from 0–4. This field indicates which logical unit the command should be sent to.

Start   A start bit of 1 enables the library unit; 0 disables the library unit.

Test Unit Ready (00h)

The host uses the Test Unit Ready command to determine if a library unit is ready. The library unit responds in one of the following ways, depending upon the state of the library unit:

- Returns a Good status.
- Returns a Check Condition status.

Whenever the library unit is ready to accept a Medium Access command without returning a Check Condition status, it returns this status in response to a Test Unit Ready command.

When the library unit receives a Test Unit Ready command but is not ready to accept a medium access command, it sets the Additional Sense fields and returns this status. The meaning of the values in the Additional Sense fields are described along with the Request Sense command.

The format for the Test Unit Ready Command Descriptor Block is shown in Table 55.

Table 56: Test Unit Ready Command

Bit/Byte	7	6	5	4	3	2	1	0
0	Operation Code (00h)							
1	Logical Unit Number			Reserved (00h)				
2	Reserved (000000h)							
3								
4								
5	Reserved (00h)							

Logical Unit Number   The Logical Unit Number can range from 0–4. This field indicates which logical unit the message should be sent to.

EIA/TIA-574 Interface

The tape library can support either the EIA/TIA-574 or SCSI interface. Because of the strict guidelines of the SCSI interface, the EIA/TIA-574 interface for the tape library has been designed to support the SCSI command set and format. In addition to the command set, a set of message commands have been added to emulate SCSI messages.

Note *Only the messages which pertain to an EIA/TIA-574 interface are emulated. Messages such as Disconnect, which have no meaning with this interface, are not included.*

Another layer has also been added to the command set to support a "wrapper" around all transmitted data and software handshaking. The wrapper consists of a header and trailer which keep track of the start and end of data as well as the length and checksum of the transmission packet. The software handshaking involves acknowledging transmitted data packets (negatively, if an error is detected by the wrapper or the hardware).

Messages

The tape library supports all SCSI interface operating commands. In addition, the tape library supports operating message commands, which emulate SCSI messages.

These messages are listed in Table 57.

Table 57: Supported Messages

Message Name	Operation Code	Sender	Page
Abort	F6h	Host	3-88
Command Complete	F0h	LU	3-89
Unsolicited Message	EFh	LU	3-90

Abort (F6h)

The host uses the Abort command to abort a command currently being executed by the logical unit. This message emulates the SCSI Abort message described in "Abort" on page 3-6.

The format for the Abort message is shown in Table 58.

Table 58: Abort Message

Bit/Byte	7	6	5	4	3	2	1	0
0	Operation Code (F6h)							
1	Logical Unit Number			Reserved (00h)				
2	Reserved (00h)							
3	Reserved (00h)							

Logical Unit Number   The Logical Unit Number can range from 0–4. This field indicates which logical unit the message should be sent to.

Command Complete (F0h)

The tape library sends the Command Complete message to the host when a library unit has completed a command. This command emulates the SCSI STATUS phase and the Command complete message seen in the previous chapter. In addition, when an error condition is detected, the sense data is included as part of this message (a SCSI host must issue a separate Request Sense command to obtain this data).

The format for the Command Complete message is shown in Table 59.

Table 59: Command
Complete Message

Bit/Byte	7	6	5	4	3	2	1	0
0	Operation Code (F0h)							
1	Logical Unit Number			Reserved (00h)				
2	Completed Command Operation Code							
3	Status							
4–18	Sense Data (if Status is 02h) only							

Logical Unit Number   The Logical Unit Number can range from 0–4. This field indicates which logical unit the message should be sent to.

Status   The following are valid for the Status field:

00 Good command completed successfully.

02 Check Condition command encountered a warning or error.

04 Busy command rejected because the library unit is busy.

Sense Data   The Sense data field is only present if the status is a Check Condition. This field is the format of the Request Sense Data as described in "Request Sense (03h)" on page 3-61. This differs from the SCSI philosophy of returning Sense Data only upon request.

Unsolicited Message (EFh)

The tape library sends this message to the host when an unsolicited event occurs. The format for the Unsolicted Message is shown in Table 60.

Table 60: Unsolicited Message

Bit/Byte	7	6	5	4	3	2	1	0
0	Operation Code (EFh)							
1	Logical Unit Number			Reserved (00h)				
2	Status (02h-CHECK CONDITION)							
	SENSE DATA							
3	Valid (0)	Error Code (70h or 71h)						
4	Segment Number (00h)							
5	Filemark (0)	EOM (0)	ILI (0)	Reserved (0)	Sense Key			
6	(MSB)							
7				Information				
8				(00000000h)				
9								(LSB)
10	Additional Sense Length (07h)							
11	(MSB)							
12								
13				Command-Specific Information				
				(00000000h)				
14								(LSB)
15	Additional Sense Code							
16	Additional Sense Code Qualifier							
17	Field Replaceable Unit Code (00h)							

Logical Unit Number   The Logical Unit Number can range from 0–4. This field indicates which logical unit the message should be sent to.

Status   This is always 02h for Check Condition.

Valid   This field is set to 0 indicating the information field is not being used.

Segment Number, Filemark, EOM, and ILI   These fields are not supported and should be set to 0.

Error Code   The following error values are supported:

70h   current error

71h   deferred error

Sense Key   The following Sense Key values are supported:

0h   NO SENSE

1h   RECOVERED ERROR

2h   NOT READY

4h   HARDWARE ERROR

5h   ILLEGAL REQUEST

6h   UNIT ATTENTION

9h   VENDOR SPECIFIC

Bh   ABORTED COMMAND

Information   This field is not supported and should be set to 0.

Additional Sense Length, Additional Sense Code, and Additional Sense Code Qualifier   See Appendix A for a list of possible sense information returned from the tape library.

Command-Specific Information and Field Replaceable Unit Code   These fields are not supported and should be set to 0.

Supported Operational Commands

The tape library supports all SCSI interface operational commands. These commands are listed in Table 61. The format for these commands is described in "SCSI Interface" on page 3-4.

Table 61: Supported
Operational Commands

Message/Command Name	Operation Code	Sender	Page
Initialize Element Status	07h	Host	3-10
Initialize Element Status with Range	E7h	Host	3-11
Inquiry	12h	Host	3-13
Log Sense	4Dh	Host	3-17
Mode Select	15h	Host	3-21, 3-94
Mode Sense	1Ah	Host	3-28
Move Medium	A5h	Host	3-38
Position To Element	2Bh	Host	3-41
Read Element Status	B8h	Host	3-43
Ready Inport	DEh	Host	3-59
Release	17h	Host	3-60
Request Sense	03h	Host	3-61
Request Volume Element Status	B5h	Host	3-64
Reserve	16h	Host	3-78
Rezero Unit	01h	Host	3-81
Send Diagnostic	1Dh	Host	3-82
Send Volume Tag	B6h	Host	3-83
Start/Stop Unit	1Bh	Host	3-85
Test Unit Ready	00h	Host	3-86

The EIA/TIA-574 command and response data differ from the SCSI Interface commands in the following ways:

- All data is sent to the host with an Intermediate Data Header (see "Intermediate Data Header (FFh)" on page 3-93).
- All data from the host is appended to the end of the command (see "EIA/TIA-574 Mode Select Command Format (15h)" on page 3-94).

Intermediate Data Header (FFh)

The data sent to the host in response to a command is formatted as shown in Table 62.

Table 62: Intermediate
Data Header

Bit/Byte	7	6	5	4	3	2	1	0
0	Intermediate Data Operation Code (FFh)							
1	Logical Unit Number			Reserved (00h)				
2	Command Operation Code							
3	Reserved (00h)							
4 - x	Data							

Logical Unit Number   The Logical Unit Number can range from 0–4. This field indicates which logical unit the command should be sent to.

Command Operator Code   This field indicates which data type is being returned.

03h	Request Sense Data.
12h	Inquiry Data.
1Ah	Mode Sense Data.
4Dh	Log Sense Data.
B8h	Read Element Status Data.

Data   This field contains data corresponding with the specified Command Operator Code.

The format for this data is defined as follows.

Request Sense Data	Table 40.
Inquiry Data	Table 8.
Mode Sense Data	Table 21-Table 25.
Log Sense Data	Table 11-Table 14.
Read Element Status Data	Table 30-Table 36.

EIA/TIA-574 Mode Select Command Format (15h)

Currently, the only data sent from the host is with the Mode Select command.

The EIA ⁄ TIA-574 interface combines the Mode Select command Table 15 on page 3-22 and the Mode Select Vendor specific page into one data block as shown in Table 63.

Table 63: EIA/TIA Mode
Select Command Format

Bit/Byte	7	6	5	4	3	2	1	0
0	Operation Code (15h)							
1	Logical Unit Number			PF (1)	Reserved (0)			SP
2	Reserved (0000h)							
3								
4	Parameter List Length (04h)							
5	Reserved (00h)							
6	PS (0)	Reserved (0)	Page Code (20h)					
7	Page Length (02h)							
8	Reserved (00h)							DLR
9	Reserved (00h)							

Logical Unit Number The Logical Unit Number can range from 0–4. This field indicates which logical unit the command should be sent to.

SP - Save Page When set to 0, Mode Select operates without saving. When set to 1, Mode Select operates and is saved in non-volatile memory.

PF When set to 1, the page format field indicates that the Mode Select Parameters are formatted as specified in the SCSI-2 standard.

Parameter List Length   This field indicates the length of the following parameter list. The only page supported by the Mode Select command is the four-byte Vendor Unique Page shown in Table 17 on page 3-24. This field must be set to 4.

PS - **Parameters Savable**   This bit is only used with the Mode Sense command (See Table 25 on page 3-36). This bit is reserved for Mode Select command and should be set to 0.

DLR-**Drive Load Retry**   When this bit is set to 1, retries will be performed. When this bit is set to 0, retry will not be performed.

Command/Message/Status Packaging

All commands, messages, and status data supported by this EIA/TIA-574 interface are repackaged into packets to ensure accurate transmission. Each packet can transmit 128 bytes of data, so each command or message is transmitted as a single packet. If status data exceeds 128 bytes (e.g., Read Element Status data), it is broken up into multiple packets. Each packet consists of a header, data, and a trailer, where data is either a command, message, or status data.

For all fields listed below which have more than one byte, the first byte is the most significant byte. The format for the packet is shown in Table 64.

Table 64: EIA/TIA-574
Interface Packet

Byte	Description	Values
0	Start of Packet character (delimiter)	"["
1	Packet Type	'a' - Acknowledge Packet 'n' - Negative Acknowledge Packet 'd' - Data Packet
2-3	Message Number. Incremental counter updated after transmission of all packets in a message.	0h - valid for NAKs only 1h-FFFFh
4	Packet Number. Number of current packet within message.	0h - valid for NAKs only 1h-FFh - should not exceed total number of packets.
5	Total Number of Packets. X of N packets within message.	0h - valid for NAKs only 1h-FFh
6	Data Length. (n) Number of byte of data in packet.	0h - valid for ACK/NAKs only 1h-FFFFh
7		
8	Start of Data character (delimiter)	"<"
- n+8	Data	This field does not exist if n is 0.
n+9	End of Data character (delimiter)	">"

Byte	Description	Values
n+10	Checksum	Sum of all packet bytes up to and including End of Data character
n+11		
n+12	End of Packet character (delimiter)	0Ah

The Packet Type field determines whether a message is data or protocol (ACK/NAK). Protocol messages (ACKs and NAKs) do not contain data and always have a data length of 0. Their message and packet number fields indicate which packet is being acknowledged. A NAK message only fills in these fields if they can be determined from the received packet.

For data type messages, the message, packet, and total packet number fields are generated by the transmitter. The format of the data is the same as described in previous sections of this manual, except that the data can be divided into multiple packets.

Software Handshaking

Three types of packets can be transmitted over the EIA/TIA-574 interface. One is used to transmit data and the other two are protocol packets which are used for software handshaking. These protocol packets (ACK and NAK) are transmitted by a receiver to acknowledge that a data packet was received.

If the transmitter receives an ACK message, then the data message transmitted without error and the transmitter can send the next data packet. If a NAK message is received (or if nothing is received), then the transmitter should retransmit the packet. The number of retries is driver-dependent.

Notes on Creating a Device Driver

The data is transmitted as binary, not ASCII. The driver must be written with this in mind. The device driver should not assume that every character which matches a delimiter is a delimiter. The delimiters should be used only to verify that it is parsing the packet correctly. Data length, delimiters, checksums and time-outs can be used to verify that packets are received correctly.

This protocol allows multiple packets to be sent before waiting for an acknowledgment. The transmitting driver does not have to use this, but the receiving portion of the driver must support it.

All data packets must be acknowledged within 400 ms or the library will resend the data packet.

If communicating directly to a library unit (not via a MUC), the library unit queues unsolicited messages until they have been acknowledged.

Note   *If an unsolicited message is not acknowledged within 400 ms (after several retries), the library unit queues the message. The library unit will not resend the message until a command is received from the host. Note that commands will not be processed by the library unit until the unsolicited messages have been acknowledged.*

Configuration

The EIA/TIA-574 serial communications interface is configured as follows:

- BAUD Rate   9600
- Data Bits   8
- Parity   None
- Stop Bits   1

Appendix *A*

Sense Data Values

Table A-1 lists message information that can be sent from the TL82X/TL893/TL896 library unit to the host computer. In addition to definition, recovery suggestions, and the identification of the host interface receiving the message, the table lists the following information.

* Sense Key, Additional Sense Code (ASC),
* Additional Sense Code Qualifier (ASCQ), and
* Additional Sense Length (ASL) fields of the sense data block.

Valid host interfaces are listed below. If the interface is abbreviated in the table, the abbreviation is shown in parentheses.

* SCSI
* EIA/TIA-574 (TIA/EIA)
* Diagnostic (Diag)
* All

The messages and recovery/explanations use the following abbreviations:

LU	Logical Unit/Library Unit
REQ'D	Required
DEV	Device
Diag	Diagnostics
NVRAM	Nonvolatile RAM
A/D	Analog to Digital

Table is sorted by data in the ASC column

Table A-1: Sense Data
Values (Hexadecimal)

Sense Key	ASC	ASCQ	ASL	Description Recovery/Explanation	Host Interface
0	00	00	00	NO ADDITIONAL SENSE INFORMATION No recovery necessary.	All
B	00	00	00	SCSI ABORT Command was aborted because the host sent a SCSI abort message.	SCSI
2	04	00	07	LU IS NOT READY, CAUSE NOT REPORTABLE Check library unit power. Retry command.	All
2	04	01	07	LOGICAL UNIT IN PROCESS OF BECOMING READY Wait for library unit to complete initialization.	All
2	04	02	07	NOT READY, INITIALIZATION REQUIRED The status of some element(s) required by the operation are unknown. Issue an Init Element Status command (07h) to recover.	
2	04	03	07	LU IS NOT READY, MANUAL INTERVENTION REQ'D Initialization failed. Determine failure type by checking any previous error code returned to host. Correct the cause of the failure and toggle ONLINE/STANDBY switch.	All
B	08	00	07	LOGICAL UNIT COMMUNICATION FAILURE Check cables. Ensure library unit is turned on. Retry command.	SCSI
B	08	01	07	LOGICAL UNIT COMMUNICATION TIME-OUT Check cables. Ensure library unit is turned on. Retry command.	SCSI EIA/TIA
5	1A	00	07	PARAMETER LIST LENGTH ERROR Invalid parameter list length specified by Mode Select command.	SCSI EIA/TIA
5	20	00	07	INVALID COMMAND OPERATION CODE Verify host command format using the *TL82X/TL893/TL896 Software Interface Guide.*	SCSI TIA/ EIA

Table is sorted by data in the ASC column

Sense Key	ASC	ASCQ	ASL	Description Recovery/Explanation	Host Interface
5	21	01	07	INVALID ELEMENT ADDRESS Check Mode Sense data for correct element addresses.	SCSI TIA/ EIA
5	24	00	07	INVALID FIELD IN COMMAND DATA BLOCK Ensure all reserve fields are set to 0.	SCSI EIA/TIA
5	25	00	07	LOGICAL UNIT IS NOT SUPPORTED Verify the logical unit field specified in the command contains a legitimate logical unit number. Check cabling to logical unit(s).	SCSI TIA/ EIA
5	26	00	07	INVALID FIELD IN PARAMETER LIST Verify Mode Select page fields. Verify that fields comply with the command format described in the *TL82X/TL893/TL896 Software Interface Guide.*	SCSI EIA/TIA
5	26	01	07	PARAMETER NOT SUPPORTED An unsupported Mode Page was selected. Verify Mode Select page fields. Verify that fields comply with the command format described in the *TL82X/TL893/TL896 Software Interface Guide.*	SCSI EIA/TIA
5	26	02	07	PARAMETER VALUE INVALID Verify Mode Select page fields. Verify that fields comply with the command format described in this guide.	All
6	28	01	07	IMPORT OR EXPORT ELEMENT ACCESSED IOD door has been closed.	All
6	29	00	07	POWER-ON, RESET OR BUS DEV. RESET OCCURRED Informational message. No action is necessary.	All
6	2A	01	07	MODE PARAMETERS CHANGED Mode parameters may have changed due to a change in the MUSL/MUML mode.	SCSI
-none-	30	03	07	CLEANING CARTRIDGE INSTALLED Indicates that the element contains a cleaning cartridge that is not "used up." This is returned with the element status data, which has no sense key.	SCSI EIA/TIA

Table is sorted by data in the ASC column

Sense Key	ASC	ASCQ	ASL	Description Recovery/Explanation	Host Interface
5	30	03	07	CLEANING CARTRIDGE INSTALLED Indicates any one of the following: • A cleaning cartridge cannot be removed from a drive because it is being used in a cleaning operation. • A cartridge cannot be placed into the drive because the drive is being cleaned. • A cartridge cannot be placed into an empty storage element because it is reserved for a cleaning cartridge currently in use in a drive-cleaning operation.	All
5	39	00	07	SAVING PARAMETERS NOT SUPPORTED Verify Save Parameter field in the Mode Sense command complies with the command format described in the *TL82X/TL893/TL896 Software Interface Guide.*	SCSI TIA/EIA
5	3A	00	07	MEDIUM NOT PRESENT The inventory indicates that a cartridge is in the bin (drive) but no cartridge is sensed by the gripper when it attempts to pick it.	All
5	3B	0D	07	MEDIUM DESTINATION ELEMENT FULL Destination element address already contains a cartridge. Issue a Read Element Status command and retry move command. If the problem repeats, issue an Initialize Element Status command followed by a Read Element Status command and retry move command.	All
5	3B	0E	07	MEDIUM SOURCE ELEMENT EMPTY Source element address does not contain a cartridge. Issue a Read Element Status command and retry move command. If problem repeats issue an Initialize Element Status command followed by a Read Element Status command and retry the move command.	All
B	43	00	07	SCSI MESSAGE ERROR Detected a message error in message processing on the SCSI bus.	SCSI
2	44	00	07	LU INTERNAL FAILURE An unspecified error occurred. Notify DEC.	SCSI

Table is sorted by data in the ASC column

Sense Key	ASC	ASCQ	ASL	Description Recovery/Explanation	Host Interface
B	45	00	07	SELECT OR RE-SELECT FAILURE TL82X/TL893/TL896 timed out trying to reselect host. Make sure host is running.	SCSI
B	47	00	07	SCSI PARITY ERROR Check cable connections and cable length.	SCSI
B	48	00	07	INITIATOR DETECTED ERROR Initiator Detected Error Message was received from host.	SCSI
2	4C	00	07	LU CONFIG FAILED The unit was unable to configure properly during start-up or after a change in MUSL mode. Check cabling. Then check unit MUSL configuration using the diagnostic port.	SCSI EIA/TIA
5	4E	00	07	OVERLAPPED COMMANDS ATTEMPTED Second command was sent to logical unit while the previous command was executing.	EIA/TIA
5	53	02	07	MEDIUM REMOVAL PREVENTED Prevent Medium Removal command was executed and command was received to export cartridge. Execute Allow Medium Removal command and retry move medium command.	SCSI EIA/TIA
6	54	00	07	SCSI TO HOST SYSTEM INTERFACE FAILURE Possible SCSI bus time-out or premature disconnect. Check cable connections and cable length.	SCSI
2	5A	01	07	OPERATOR MEDIUM REMOVAL REQUEST Indicates one of the following: • The element contains a cleaning cartridge that is "used up" and the system is unable to export the cleaning cartridge. Manually unload the tape. • The load port door is open, so import/export elements could not be accessed.	All
2	80	00	07	DOOR IS OPENED INVENTORY MAY HAVE BEEN CORRUPTED Close door and retry command. If the system is ON-LINE, it executes its initialization procedure.	All

Table is sorted by data in the ASC column

Sense Key	ASC	ASCQ	ASL	Description Recovery/Explanation	Host Interface
6	80	00	07	DOOR WAS OPENED INVENTORY MAY HAVE BEEN CORRUPTED Close door and retry command.	All
	80	01	07	DLT™ DRIVE REQUIRES CLEANING. DLT™ tape drive indicates that drive needs cleaning. Clean the DLT™ tape drive. This is returned with status data, which has no sense key.	
5	80	01	07	TRANSFER FULL - COMMAND CAN NOT BE EXECUTED Gripper has cartridge in it. Move cartridge to empty storage element using Move Medium command. Retry command.	All
5	80	02	07	BIN PACK MISSING If the bin pack is missing, install the bin pack. If the bin pack is present check the bin pack present sensor.	All
5	80	06	07	TRANSFER EMPTY - COMMAND CANNOT BE EXECUTED Gripper does not contain cartridge at beginning of place portion of Move Medium command.	All
B	80	06	07	TRANSFER EMPTY - COMMAND ABORTED Gripper does not contain cartridge at end of pick portion of Move Medium command.	All
2	80	07	07	SYSTEM IS EMERGENCY STOPPED (BUTTON IS CURRENTLY PUSHED) The STOP button on the status panel is in the on position. Press the STOP button to the off position.	All
6	80	07	07	SYSTEM STOP BUTTON WAS PRESSED (MAY CURRENTLY BE PRESSED) Check the STOP button. Retry command.	All
6	80	08	07	LOGICAL UNIT TURNED ON-LINE The ONLINE/STANDBY button on the status panel is in the ONLINE position. Press the ONLINE/STANDBY button to the STANDBY position.	Diag

Table is sorted by data in the ASC column

Sense Key	ASC	ASCQ	ASL	Description Recovery/Explanation	Host Interface
2	80	09	07	LOGICAL UNIT IS TURNED OFFLINE The ONLINE/STANDBY button on the status panel is in the STANDBY position. Press the ONLINE/STANDBY button to the ONLINE position.	SCSI TIA/EIA
6	80	09	07	LOGICAL UNIT STANDBY BUTTON WAS PRESSED Retry command.	SCSI TIA/EIA
6	80	0A	07	NVRAM CHECKSUM FAILURE Nonvolatile RAM contents are corrupted. Ensure nonvolatile RAM ICs are seated correctly. Use the Diagnostic host to initialize nonvolatile RAM and calibrate system.	All
B	80	0B	07	COMMAND ABORTED BY USER Informational message. No action is necessary.	All
5	80	0C	07	UNIT DISABLED Issue Start Unit command.	SCSI TIA/EIA
B	80	0D	07	CARTRIDGE IS ONLY PARTIALLY GRIPPED (ONLY SEEN IN THE FRONT SENSOR). Issue a Move Medium command to move the cartridge from the transfer element to an empty storage element.	All
4	80	0F	07	LOW POWER ERROR Check power connections.	All
B	80	10	07	LOAD RETRY FAILED TL82X/TL893/TL896 was unable to successfully load the drive, even after retries. Check drive alignment. If problem continues, drive may need servicing	All
B	80	21	07	INVENTORY TIMEOUT Scanning of a carousel face using the barcode scanner did not complete within acceptable time limits. Issue an Initialize Element Status command.	All

Table is sorted by data in the ASC column

Sense Key	ASC	ASCQ	ASL	Description Recovery/Explanation	Host Interface
5	80	22	07	ELEMENT CONTENTS UNKNOWN The contents of an element address are unknown. Issue a Read Element Status for the element address. If contents are still unknown, issue an Initialize Element Status command.	All
B	80	23	07	BARCODE DECODER COMMUNICATION FAILURE Unable to initialize decoder. Verify that the decoder is powered on. Cycle power and/or check cable connections.	All
B	80	80	07	LIGHT CURTAIN BLOCKED Visually inspect system for obstructions. If obstruction exists, remove source of obstruction. If obstruction does not exist, check light curtain sensor.	All
B	80	81	07	LIGHT CURTAIN TEST FAILURE Start initialization again, and verify extension axis is moving out far enough to break the light curtain. If it is, then the Field Engineer should inspect the light curtain sensors.	SCSI TIA/ EIA
B	81	00	07	GRIPPER FAILURE Gripper not on sensors at end of move. Issue a Rezero Unit command.	All
B	81	01	07	GRIPPER TIMEOUT Gripper did not reach desired position. Issue a Rezero Unit command.	All
B	81	02	07	GRIPPER EXTEND PUSHER FAILURE Gripper did not reach pusher extended position. Issue a Rezero Unit command.	All
B	81	03	07	GRIPPER OPEN FAILED ON EXTEND PUSHER Gripper did not reach open position. Issue a Rezero Unit command.	All
B	81	04	07	GRIPPER OPEN FAILURE Gripper did not reach open position. Issue a Rezero Unit command.	All
B	81	05	07	GRIPPER CLOSE FAILURE Gripper did not reach close position. Issue a Rezero Unit command.	All

Table is sorted by data in the ASC column

Sense Key	ASC	ASCQ	ASL	Description Recovery/Explanation	Host Interface
B	81	10	07	GRIPPER INVALID STARTING POSITION Gripper position is unknown. Issue a Rezero Unit command.	All
4	81	20	07	GRIPPER SENSORS TEST FAILED Cartridge-in-Gripper sensors were not blocked by pusher during gripper self-test. Use Diagnostic interface to test pusher and Cartridge-in-Gripper sensors.	All
4	81	50	07	REAR CASSETTE IN GRIPPER SENSOR IS BLOCKED, BUT FRONT SENSOR IS CLEAR. Either the pusher is extended and blocking the sensor or possibly a cartridge is in the gripper, but the front sensor is not working. Issue a Rezero Unit command. If condition repeats, check for a cartridge in the gripper and issue a Move Medium to an empty storage element.	All
B	81	51	07	UNABLE TO PICK CARTRIDGE Cartridge was sensed in front gripper sensor, but was unable to seat cartridge in the rear gripper sensor. Check that gripper sensors are working and/or that tape was ejected far enough.	All
B	83	01	07	EXTENSION TIMEOUT Extension axis did not reach desired position. Retry command. If failure repeats use Diagnostic host to run extension self-test.	All
4	83	02	07	EXTENSION CURRENT FEEDBACK FAILURE Extension axis collided with obstruction. Determine cause of obstruction. Align and calibrate the system.	All
B	83	03	07	EXTENSION MECHANICAL POSITION ERROR Extension axis was unable to move to commanded position. Retry command. If failure repeats, use the Diagnostic host to run extension self-test.	All
B	83	10	07	EXTENSION INVALID ACTUATOR START POSITION Extension axis position is unknown. Issue a Rezero Unit command.	All

Table is sorted by data in the ASC column

Sense Key	ASC	ASCQ	ASL	Description Recovery/Explanation	Host Interface
4	83	21	07	EXTENSION ACTUATOR CURRENT FEEDBACK TEST FAILURE Unable to detect current feedback during self-test. Restart unit. If failure repeats, use Diagnostic host to run extension self-test.	All
4	83	22	07	EXTENSION ACTUATOR ENCODER (OR MOTOR) TEST FAILURE The value of the extension encoder did not change during self-test. Restart unit. If failure repeats, use Diagnostic host to run extension self-test.	All
4	83	81	07	EXTENSION A/D SELF-TEST FAILURE The analog to digital converter failed during self-test. Restart unit. If failure repeats, use Diagnostic host to run extension self-test.	All
4	83	83	07	EXTENSION DIGITAL SELF-TEST FAILURE Unable to toggle test bit during self-test. Restart unit. If failure repeats, use Diagnostic host to run extension self-test.	All
B	84	01	07	VERTICAL TIMEOUT Vertical axis did not reach desired position within the time limits. Retry command. If failure repeats, use the Diagnostic host to run vertical self-test.	All
B	84	02	07	VERTICAL CURRENT FEEDBACK FAILURE Vertical axis collided with obstruction. Determine and remove the cause of obstruction.	All
B	84	03	07	VERTICAL MECHANICAL POSITION ERROR Vertical axis did not reach desired position. Retry command. If failure repeats, use the Diagnostic host to run vertical self-test.	All
B	84	10	07	VERTICAL INVALID ACTUATOR START POSITION Position of vertical axis is unknown. Issue a Rezero Unit command.	All
4	84	21	07	VERTICAL ACTUATOR CURRENT FEEDBACK TEST FAILURE Unable to detect current feedback during self-test. Restart unit. If failure repeats, use Diagnostic host to run vertical self-test.	All

Table is sorted by data in the ASC column

Sense Key	ASC	ASCQ	ASL	Description Recovery/Explanation	Host Interface
4	84	22	07	VERTICAL ACTUATOR ENCODER (OR MOTOR) TEST FAILURE The value of the vertical encoder did not change during self-test. Restart unit. If failure repeats use Diagnostic host to run a vertical self-test.	All
4	84	24	07	VERTICAL HARDWARE ERROR Vertical actuator or sensor has failed (Vertical Home∕Limit).	All
B	86	01	07	CAROUSEL TIMEOUT Carousel axis did not reach desired position. Retry command. If failure repeats use the Diagnostic host to run a carousel self-test.	All
B	86	02	07	CAROUSEL NOT ON FACE FLAG At the end of a carousel move, the carousel was not on a face flag. Issue a Rezero Unit command.	All
B	86	03	07	CAROUSEL MECHANICAL POSITION ERROR Carousel axis did not reach desired position. Retry command. If failure repeats, use the Diagnostic host to run a carousel self-test.	All
B	86	04	07	CAROUSEL UNDEFINED POSITION Position of carousel axis is unknown. Issue a Rezero Unit command.	All
4	86	05	07	CAROUSEL IS MISSING FACE OR HOME FLAG Did not detect eight face flags during carousel homing or unable to find home flag.	All
B	86	06	07	CAROUSEL CORRECTION FAILURE Size of correction exceeded maximum correction size. Issue a Rezero Unit command.	All
B	86	07	07	CAROUSEL CURRENT FEEDBACK FAILURE Carousel axis collided with obstruction. Determine and remove the cause of the obstruction.	All
B	86	08	07	CAROUSEL NOT ON HOME FLAG At the end of carousel homing, the carousel did not position itself on the home flag. Issue a Rezero Unit command.	All

Table is sorted by data in the ASC column

Sense Key	ASC	ASCQ	ASL	Description Recovery/Explanation	Host Interface
B	86	10	07	CAROUSEL INVALID ACTUATOR START POSITION Position of carousel axis is unknown. Issue a Rezero Unit command.	All
4	86	21	07	CAROUSEL ACTUATOR CURRENT FEEDBACK TEST FAILURE Unable to detect current feedback during self-test. Restart unit. If failure repeats, use the Diagnostic host to run carousel self-test.	All
4	86	22	07	CAROUSEL ACTUATOR ENCODER (OR MOTOR) TEST FAILURE The value of the carousel encoder (gear box) did not change during self-test. Restart unit. If failure repeats, use the Diagnostic host to run carousel self-test.	All
4	86	23	07	CAROUSEL MOTOR ENCODER TEST FAILED The value of the carousel encoder (motor) did not change during self-test. Restart unit. If failure repeats, use the Diagnostic host to run carousel self-test.	All
4	86	24	07	CAROUSEL HARDWARE ERROR One of the carousel sensors has failed (Home/Flag).	All
4	86	81	07	CAROUSEL A/D SELF-TEST FAILURE The analog-to-digital converter failed during self-test. Restart unit. If failure repeats, use Diagnostic host to run carousel self-test.	All
4	86	83	07	CAROUSEL DIGITIAL SELF-TEST FAILURE Unable to toggle test bit during self-test. Restart unit. If failure repeats, use the Diagnostic host to run carousel self-test.	All
6	88	00	07	WARNING SAFE TEMPERATURE EXCEEDED This is only a warning that the temperature in the system exceeds the normal operational temperature (91ºF). This feature is not available on those units whose top assembly number is 6101280.	All

Table is sorted by data in the ASC column

Sense Key	ASC	ASCQ	ASL	Description Recovery/Explanation	Host Interface
6	88	01	07	MAXIMUM TEMPERATURE EXCEEDED System will shutdown until temperature falls to an acceptable level (below 111ºF). This feature is not available on those units whose top assembly number is 6101280.	All
B	8A	00	07	MISSING CALIBRATION TOOL Calibration was started without the calibration tool inserted in the gripper. Insert calibration tool in gripper.	Diag
B	8A	01	07	MISSING CALIBRATION FLAG A calibration flag was not detected during calibration. Insert all required calibration cartridges.	Diag
5	8A	02	07	UNCALIBRATED POSITION System requires calibration.	All
5	8A	03	07	INVALID CALIBRATION PARAMETER A parameter entered during calibration was incorrect.	All
B	8B	00	07	PASS THROUGH BUSY An attempt was made to use a pass through that was already in use. Wait for busy pass through to complete. Retry command.	All
B	8B	01	07	PASS THROUGH TIMEOUT The pass through failed to move the cartridge to the desired location within a time-out period.	All
B	8B	02	07	PASS THROUGH GATE FAILURE Unable to raise pass through gate.	All
B	8B	03	07	PASS THROUGH FULL An attempt was made to use a pass through that is occupied. Move cartridge from pass through and retry command.	All
B	8B	04	07	PASS THROUGH EMPTY An attempt was made to move a cartridge from an empty pass through. Place the desired cartridge on the pass through. Retry command.	All

Table is sorted by data in the ASC column

Sense Key	ASC	ASCQ	ASL	Description Recovery/Explanation	Host Interface
B	8B	05	07	PASS THROUGH CURRENT FEEDBACK FAILURE The pass through is jammed. Determine and remove the cause of obstruction.	All
B	8B	07	07	NO CARTRIDGE ON PASS THROUGH No cartridge was detected on pass through during self-test. Place a cartridge on the pass through. Retry command.	Diag
B	8B	08	07	CALIBRATE PASS THROUGH SENSORS The registration sensor on the pass through did not detect the cartridge correctly.	All
B	8B	30	07	PASS THROUGH MOTOR OR SENSOR FAILURE During PTM self-test (via diagnostic port only), a cartridge is passed between sensors on the PTM. This error is returned if any of the PTM sensors do not transition. This could occur due to a faulty sensor or motor.	Diag
B	8B	80	07	MUML MOVE, OTHER UNIT DOOR OPEN The door is open on one of the non-commanded units involved in a MUML operation. Close the door.	SCSI EIA/TIA
B	8B	81	07	MUML NON-COMMANDED UNIT—STOPPED The STOP button is pressed on a non-commanded unit.involved in a MUML operation. Release the STOP button.	SCSI EIA/TIA
B	8B	82	07	MUML NON-COMMANDED UNIT—LIGHT CURTAIN BROKEN The light curtain is disrupted in a non-commanded unit involved in an MUML operation. Verify that all cartridges are properly seated in their bin packs and that all bin packs are fully secured in the carousels.	SCSI EIA/TIA
B	8B	83	07	MUML NON-COMMANDED UNIT—OFF-LINE A non-commanded unit involved in the MUML operation is off-line. Press the STANDBY button to place the unit on-line.	SCSI EIA/TIA
B	8B	84	07	MUML NON-COMMANDED UNIT—OVER TEMP The temperature in a non-commanded unit has exceeded safe operating temperature. This is a serious condition which must be attended to before continuing with library operation.	SCSI EIA/TIA

Table is sorted by data in the ASC column

Sense Key	ASC	ASCQ	ASL	Description Recovery/Explanation	Host Interface
B	8B	85	07	MUML NON-COMMANDED UNIT—ERROR OCCURRED Some other error occurred to a non-commanded unit involved in the MUML operation. Perform a diagnostic to all pertinent non-commanded units. If performing concurrent moves, the failure of one move (for example, within a single cabinet) can result in the failure of the MUML operation.	SCSI EIA/TIA
B	8C	01	07	IOD TIMEOUT The Inport/Outport Device failed to move the cartridge from the INPORT within a time-out period.	All
B	8C	02	07	IOD OUTPORT FULL The cartridge OUTPORT is full. Open the outport door and remove the cartridges. Retry the command.	All
B	8C	03	07	IOD INPORT FULL A cartridge is present in the INPORT at self-test start-up. Remove the cartridge. Retry the command.	Diag
B	8C	04	07	IOD INPORT EMPTY An attempt was made to move a cartridge from an empty INPORT. Place the desired cartridge in the INPORT. Retry the command.	All
B	8C	05	07	IOD CURRENT FEEDBACK FAILURE The IOD INPORT is jammed. Determine and remove the cause of the obstruction.	All
B	8C	06	07	IOD INPORT DOOR IS OPEN The INPORT door on the IOD is open. Close INPORT door. Retry the command.	All
B	8C	07	07	IOD INPORT REGISTRATION A cartridge is detected in the INPORT but it is improperly registered. Reseat the cartridge. Retry the command.	All
B	8C	30	07	IOD MOTOR OR SENSOR FAILED Check for obstructions and reload the cartridge.	All
B	8D	01	07	STEPPER MOTOR TPU TIMEOUT CPU failure. Retry command. If failure repeats, power cycle unit. Use diagnostic host to self-test stepper.	All

Table is sorted by data in the ASC column

Sense Key	ASC	ASCQ	ASL	Description Recovery/Explanation	Host Interface
B	8D	02	07	STEPPER MOTOR MOVE TIMEOUT CPU failure. Retry command. If failure repeats, power cycle unit. Use diagnostic host to self-test stepper.	All
4	8D	03	07	STEPPER MOTOR TPU RAM ERROR CPU failure. Retry command. If failure repeats, power cycle unit. Use diagnostic host to self-test stepper.	All
4	8D	04	07	STEPPER MOTOR TPU REGISTER ERROR CPU failure. Retry command. If failure repeats, power cycle unit. Use diagnostic host to self-test stepper.	All
4	8D	05	07	STEPPER MOTOR HARDWARE ERROR Stepper was unable to reach destination (open or close). Retry command. If failure repeats use diagnostic host to self-test stepper.	All
4	8D	06	07	STEPPER MOTOR CURRENT FEEDBACK TEST FAILURE Unable to sense current feedback from stepper motor controller. Use diagnostic host to self-test stepper.	All
4	8E	01	07	FLASH MEMORY UNABLE TO IDENTIFY Replace flash memory on CPU.	Diag
4	8E	02	07	FLASH MEMORY UNABLE TO ERASE Replace flash memory on CPU.	Diag
4	8E	03	07	FLASH MEMORY UNABLE TO PROGRAM Replace flash memory on CPU.	Diag
B	8F	00	07	LIBRARY UNIT COMMAND TIMED OUT Verify communications to Library Unit still exist by issuing another command	SCSI EIA/TIA
9	CO	00	07	ENGINEERING USE TEST FAIL Reserved for testing by manufacturer.	Diag
5	F0	01	07	RESERVATION CONFLICT A command has been issued for a unit or element that is reserved by another host. For more information, refer to "Reserve (16h)" on page 3-78.	SCSI EIA/TIA

Appendix B

Control Panel and System States

The control panel communicates error and status information using display codes. The display codes and their descriptions are listed in Table B-1.

Table B-1: Front Control
Panel Status Codes

Code	Code Description
00	System on-line and ready to accept host commands.
01	System off-line and ready to accept diagnostic commands.
2A	STOP button depressed.
2b	Door open (front or back).
2C	System performing power-up sequence.
2d	System is initializing actuators and taking inventory.
2F	Low Power Error
3A	Error occurred during initialization of actuator prior to coming online.
3b	Error occurred during actuator self-test prior to coming online.
3C	Inventory failed.
4A	Extension home failed.
4b	Extension test failed.
4C	Carriage A/D failed.

Code	Code Description
4d	Carriage diagnostic test failed.
5A	Vertical home failed.
5b	Vertical test failed.
6A	Carousel home failed.
6b	Carousel test failed.
6C	Carousel A/D test failed.
6d	Carousel digital test failed.
7A	Gripper home failed.
7b	Gripper test failed.
8b	Light curtain test failed.
8C	Light curtain broken.
d0-dF	Downloading (one-digit increments every sixteen S-Records received).
E0	Downloader ready.
E1	Downloader complete.
EA	Can't identify flash memory.
Eb	Can't erase flash memory.
EC	Can't program flash memory.
F0-F7	Carousel is on face indicated (0-7).
FF	MPU firmware at location U3 & U4 is missing or defective. Or the 5V power supply is adjusted too low.

Glossary

actuator	Refers to one of the four motor-powered assemblies in the TL82X/TL893/TL896: gripper, extension, vertical, and carousel.
alignment	In the context of this manual, alignment refers to the mechanical adjustments required for successful operation of the TL82X/TL893/TL896 library.
alignment cartridge	An alignment aid in the general form of a DLT™ cartridge. There are two types of alignment cartridges: a tape drive alignment cartridge which has flanges to keep it from being stuck in a drive, and a bin pack alignment cartridge which fits into a bin pack.
alignment tool	An alignment aid which seats in the gripper and is used in conjunction with the alignment cartridges.
asynchronous event notification	Optional, unsolicited event protocol specified in SCSI-2 standard.
Automated Cartridge Library	A robotic storage and retrieval system for tape cartridges.
bar code	In the context of this manual, the machine-readable label on DLT™ cartridges.
carousel	The eight-sided rotating cylinder in the center of the library unit which holds bin packs with DLT™ cartridges.
carousel face	One side of the eight-sided carousel.
control panel	The panel containing the display, fault light, and control buttons on the front door of the TL82X/TL893/TL896 library.
data transfer element	The tape drive installed in a library unit.
DLT™	Digital linear tape (cartridge)
EIA/TIA-574	Serial communications cabling and protocol standard for 9-pin connectors, sometimes called RS-232.
element	An addressable physical component of the TL82X/TL893/TL896 library that can serve as the location of a unit of media.

host	See host computer.
host computer	The computer which issues high-level pick and place commands to control the TL82X/TL893/TL896 library.
import export element	Refers to the PTM, the inport or the outport of the library.
initiator	In this manual, SCSI-2 terminology for the host computer.
inport	Refers to the portion of the IOD which allows operator to import cartridge into tape library.
IOD	Inport/outport device.
LED	Light-emitting diode.
library unit	A single TL82X/TL893/TL896 cabinet and the robotics therein.
logical unit	The number used to reference an individual library unit.
LUN	Logical unit number
medium changer device	SCSI terminology referring to devices which mechanize the movement of media to and from primary devices (such as tape drives).
medium transport element	A component of the TL82X/TL893/TL896 that is used to move units of media. Also known as the transport mechanism.
MUC - multi-unit controller	A component of an library which permits the library to communicate to a host computer using a SCSI interface and which directs the control signals from the host computer to each of the units in the library.
MUSL	Multi-unit single-LUN. A software-selected feature to externally interface up to five mid-range libraries units as a single logical unit.
NVRAM	Nonvolatile RAM
on-line	Ready for communication with a host computer.
operation	Refers to entire SCSI operation from initiation by host to completion of command by target.
outport	Refers to the portion of the IOD which holds cartridges which are exported from the tape library.
pick	The act of removing a cartridge from one location in preparation for placing it in another location.
place	The act of placing a cartridge in a location after it has been picked from another location.

PTM	Pass-through mechanism
SCSI	Small computer system interface. A communications standard for attaching peripheral equipment to computers. In the context of this manual it always refers to the SCSI-2 standard.
storage elements	Elements correspond to the bins in the tape cartridge carousel. One storage element exists per bin.
tape drive	The mechanism which reads and writes data to and from a tape.
target	In this manual, SCSI-2 terminology for the TL82X/TL893/TL896 device.
TL820 library	An automated tape library used for storing and handling DLT™ cartridges. The TL820 uses three TZ87 tape drives and has a maximum capacity of 264 DLT™ cartridges.
TL822 library	An automated tape library used for storing and handling DLT™ cartridges. The TL822 uses three TZ88 tape drives and has a maximum capacity of 264 DLT™ cartridges.
TL826 library	An automated tape library used for storing and handling DLT™ cartridges. The TL826 uses three to six TZ88 tape drives and has a maximum capacity of 176 DLT™ cartridges.
TL893 library	An automated tape library used for storing and handling DLT™ cartridges. The TL893 uses three TZ89 tape drives and has a maximum capacity of 264 DLT™ cartridges.
TL896 library	An automated tape library used for storing and handling DLT™ cartridges. The TL896 uses three to six TZ89 tape drives and has a maximum capacity of 176 DLT™ cartridges.
TL82X/TL893/TL896	Term used throughout this manual to describe any one of the five libraries listed above.
transport mechanism	This mechanism consists of the vertical and extension axes and the gripper. It is used to move media between any of the storage and/or data transfer elements.

Index

A

Abort message 3-6, 3-88
actuator move times 2-25
Additional Sense Code (ASC) A-1
Additional Sense Code Qualifier (ASCQ) A-1
Additional Sense Length (ASL) A-1
application enhancements 2-25

B

Bus Device Reset message 3-6

C

cartridge
    exporting 2-18
    importing 2-17
    moving 2-19
Command Complete message 3-6, 3-89
commands
    Release/Reserve Unit 3-60
    Rezero Unit 3-64
configurations
    diagnostic port configurable items 2-22
    SCSI addresses 2-22
    tape drive addresses 2-22
control panel 2-8, B-1
conventions, documentation 1-4

D

data packaging 3-96–3-97
Data Transfer Element descriptor 3-57–3-58
data transfer elements 2-7, 3-3
descriptors
    Data Transfer Element 3-57–3-58
    Import/Export Element 3-55–3-56
    Medium Transport Element 3-50–3-52
    Storage Element 3-53–3-54
device driver, creating 3-98
diagnostic port configurable items 2-22
diagnostic support 2-27
Disconnect (from target to initiator) 3-6

disconnect from bus option 2-25
documentation
    conventions 1-4
    related 1-5
door opened event 2-9
door opened sequence 2-10

E

EIA/TIA-574
    configuration 3-98
    data packaging 3-96–3-97
    device driver, creating 3-98
    interface 1-3, 2-3, 3-87–3-98
    Intermediate Data Header 3-93
    messages
        Abort 3-88
        Command Complete 3-89
        Unsolicited Message 3-90–3-91
    Mode Select 3-94–3-95
    operational commands 3-92
    serial communication 3-98
    software handshaking 3-98
Element Status Data 3-47–3-58
elements
    data transfer 2-7
    import/export 2-6
    medium changer 2-5–2-7
    storage 2-6
error recovery procedures
    host support 2-24
    internal 2-23
    operator 2-24
events
    cartridge in inport 2-9
    defined 2-8
    door opened 2-9
    library off-line 2-9
    library off-line 2-9
    library stopped 2-9
    maximum temperature exceeded 2-9
    off-line/standby 2-9
    on-line initialization failure 2-9
    power cycle 2-9