3581 Ultrium Tape Autoloader

SCSI Reference

WB1105-00

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Note!
Before using this information and the product it supports, read the information in “Notices” on page 67.

First Edition (October 2000)

This edition applies to the *IBM 3581 Ultrium Tape Autoloader SCSI Reference* and to all subsequent releases and modifications until otherwise indicated in new editions.

Contents

Preface

This guide describes how to program the IBM 3581 Ultrium Tape Autoloader. It contains the following chapters:

"Chapter 1. Introduction" on page 1 describes the 3581 Tape Autoloader, discusses requirements, and lists hardware specifications.

"Chapter 2. Autoloader SCSI Commands" on page 5 describes each of the SCSI commands that are supported by the 3581 Tape Autoloader.

"General SCSI Information" on page 61 gives an overview of the 3581 Tape Autoloader's SCSI bus operations, messages, and commands.

Store this guide with your server's manuals.

Related Publications

- *IBM 3581 Ultrium Tape Autoloader Quick Reference*, GX35-5056, illustrates how to configure and operate the 3581 Tape Autoloader.
- *IBM 3581 Ultrium Tape Autoloader Setup, Operator, and Service Guide*, GA32-0412, tells how to install and run the 3581 Tape Autoloader. The guide also describes how to administer basic service procedures.
- *IBM Ultrium Device Drivers Installation and User's Guide*, GA32-0430, provides instructions for attaching IBM-supported hardware to open-systems operating systems. It indicates what devices and levels of operating systems are supported, gives the requirements for adapter cards, and tells how to configure hosts to use the device driver with the Ultrium family of devices.
- *IBM Ultrium Device Drivers Programming Reference*, WB1304, supplies information to application owners who want to integrate their open-systems applications with IBM-supported Ultrium hardware. The reference contains information about the application programming interfaces (APIs) for each of the various supported operating-system environments.

Chapter 1. Introduction

The IBM 3581 Ultrium Tape Autoloader is a high-performance, high-capacity data-storage device that connects to and provides additional storage for supported hosts (see Figure 1). Available as a desktop or rack-mounted unit, the autoloader can contain up to seven tape cartridges. It offers a one-line, 10-character liquid crystal display (LCD) that provides operational information, as well as diagnostics and messages. Designed to perform unattended backups as well as to retrieve and archive files, the 3581 Tape Autoloader features:

- Native storage capacity of 100 GB per cartridge (200 GB at 2:1 compression)[1]
- Native sustained data transfer rate of 15 MB per second (30 MB at 2:1 compression)[2]
- Formatted capacity of 700 GB (1.4 TB at 2:1 compression)[3]

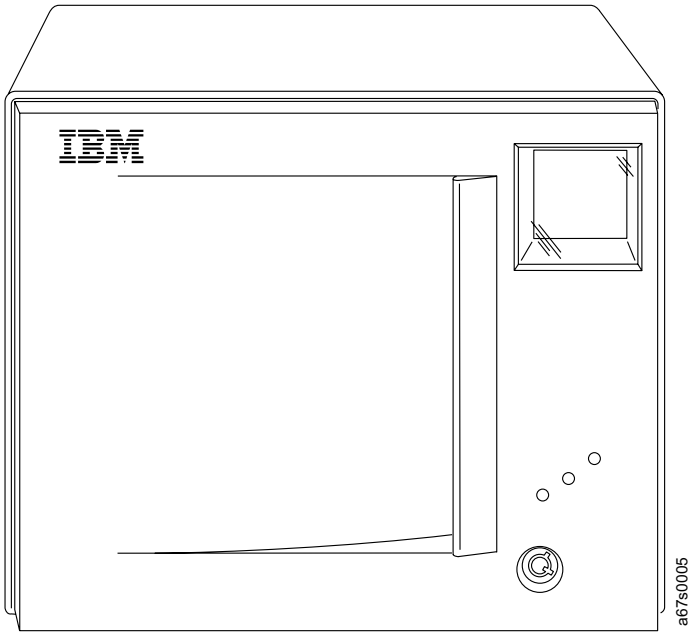

Figure 1. The IBM 3581 Tape Autoloader

The 3581 Tape Autoloader comes equipped with one IBM Ultrium Tape Drive and a robotics interface that moves tape cartridges to and from the drive and cartridge storage slots. Two models of the autoloader are available and vary according to the type of Small Computer Systems Interface (SCSI) each uses to communicate with the host:

- Model L17 uses the Ultra2, Low Voltage Differential/Single Ended (LVD/SE) interface
- Model H17 uses the Ultra SCSI, High Voltage Differential (HVD/DIFF) interface

The burst data transfer rate is 80 MB per second for the Model L17 autoloader and 40 MB per second for the Model H17 autoloader.

1. 1 GB = one gigabyte or 1 000 000 000 bytes
2. 1 MB = one megabyte or 1 000 000 bytes
3. 1 TB = one terabyte or 1 000 000 000 000 bytes

Computers that do not directly support a SCSI interface (like most personal computers) require a SCSI host adapter card to communicate with the autoloader. For a list of supported adapters, visit the Web at http://www.ibm.com/storage/lto.

The 3581 Tape Autoloader operates in both random access mode (in which the host's application software manages the cartridges) and sequential access mode (in which the autoloader's firmware manages the cartridges).

Supported Servers and Device Drivers

The 3581 Tape Autoloader is supported by a wide variety of servers (hosts) and operating systems, as well as adapters. These attachments can change throughout the product's life cycle. To determine the latest supported attachments, visit the Web at http://www.ibm.com/storage/lto.

Attachments to the 3581 Tape Autoloader include (but are not limited to) the following:

Server	Operating System
IBM AS/400®	IBM OS/400®
IBM RS/6000® and RS/6000 SP	IBM AIX®
HP	Hewlett-Packard HP-UX
Sun® SPARC™	Sun® Solaris®
Intel®-compatible servers	Microsoft® Windows NT® and Windows 2000®

Supported Device Drivers

IBM maintains the latest levels of device drivers and driver documentation for the 3581 Tape Autoloader on the Internet. You can access this material from your browser or via the IBM FTP site by doing the following:

- Using a browser, type one of the following:

  ftp://ftp.software.ibm.com/storage/devdrvr

  ftp://207.25.253.26/storage/devdrvr

- Using an IBM FTP site, enter the following specifications:

  FTP site: ftp.software.ibm.com

  IP Addr: 207.25.253.26

  Userid: anonymous

  Password: (use your current e-mail address)

  Directory: /storage/devdrvr

IBM provides PostScript- and PDF-formatted versions of its documentation in the /storage/devdrvr directory:

- IBM_ultrium_tape_IUG.pdf and IBM_ultrium_tape_IUG.ps contain the current version of the *IBM Ultrium Device Drivers Installation and User's Guide*.
- IBM_ultrium_tape_PROGREF.pdf and IBM_ultrium_tape_PROGREF.ps contain the current version of the *IBM Ultrium Device Drivers Programming Reference*.

Device drivers for each supported server are beneath /storage/devdrvr/ in the following directories (the device driver for the AS/400 is included in the OS/400 operating system).

- AIX/
- HPUX/
- Solaris/
- WinNT/
- Win2000/

For more information about device drivers, refer to any of the preceding device driver operating system directories.

Specifications

Table 1 gives the specifications for the 3581 Tape Autoloader.

Table 1. Specifications for the 3581 Tape Autoloader

Physical Specifications			
Width	21.9 cm (8.62 in.)		
Depth	58.1 cm (22.87 in.)		
Height	19.0 cm (7.48 in.)		
Weight	13.0 Kg (28.7 lb)		
Power Specifications			
AC line voltage	100 to 240 V ac		
Line frequency	50 to 60 Hz		
Line current at 100 V ac	1.3 A		
Line current at 240 V ac	0.7 A		
Maximum heat output	113 Cal/Hr (131 W)		
In-rush current	30 A at 208 V ac 25 A at 120 V ac		
Noise Specifications			
Maximum noise level	60 db (idling) 62 db (operating)		
Environmental Specifications			
Environmental Factor	**Operating**	**Storage**	**Shipping**
Temperature	10 to 38°C* (50 to 100°F)	−40 to 60°C (−40 to 140°F)	−40 to 60°C (−40 to 140°F)
Relative humidity (noncondensing)	20 to 80%	10 to 90%	10 to 90%
Wet bulb	26°C (79°F)	Noncondensing	Noncondensing

* The operating environment of the 3581 Tape Autoloader must not conflict with the media storage requirements (see the *IBM 3581 Ultrium Tape Autoloader Setup, Operator, and Service Guide*). While the autoloader may be capable of operating at elevated temperatures for an extended period of time, the temperature could shorten the useful life of media that is stored in the autoloader. If media is stored in the autoloader for more than 10 hours, the storage temperature requirements for media should be met. It should be assumed that media stored in the autoloader will be 2 degrees above ambient room temperature when the autoloader is powered on.

Chapter 2. Autoloader SCSI Commands

Table 2 shows the SCSI Medium Changer commands that are supported by the 3581 Tape Autoloader. The table includes all mandatory and some optional and vendor-specific commands for SCSI-2 Medium Changer devices. For detailed information about each command, see the indicated reference page in Table 2.

Table 2. SCSI Commands Supported by the 3581 Tape Autoloader

Command Name	Operation Code	Class*	See Page
INITIALIZE ELEMENT STATUS	07h	O	9
INITIALIZE ELEMENT STATUS WITH RANGE	E7h	Z	8
INQUIRY	12h	M	10
LOG SENSE	4Dh	O	18
MODE SENSE	1Ah	O	25
MOVE MEDIUM	A5h	M	35
POSITION TO ELEMENT	2Bh	O	36
PREVENT/ALLOW MEDIUM REMOVAL	1Eh	O	37
READ BUFFER	3Ch	Z	38
READ ELEMENT STATUS	B8h	O	40
RELEASE	17h	O	51
REQUEST SENSE	03h	M	52
RESERVE	16h	O	55
REZERO	01h	O	56
SEND DIAGNOSTIC	16h	M	56
TEST UNIT READY	00h	M	57
WRITE BUFFER	3Bh	O	58
*O=optional, M=mandatory, Z=vendor-specific			

The list of supported commands may change as the firmware for the autoloader is updated; however, you can get the exact list of supported commands for any version of the firmware from the Implemented SCSI-2 Commands Page and the Implemented Vendor-specific Commands Page of the Vital Product Data option of the INQUIRY command. For more information see “Vital Product Data” on page 13.

SCSI Command Format

A host communicates with the 3581 Tape Autoloader by sending it a Command Descriptor Block (CDB). All commands consist of 6-, 10-, or 12-byte CDBs. The CDB always has an operation code as its first byte and a control byte as its last byte.

Reserved bits, fields, bytes, and code values are set aside for future standardization. A reserved bit, field, or byte should be set to 0. If the autoloader receives a reserved bit, field, or byte that is not set to 0, the Sense Key is set to ILLEGAL REQUEST, the Additional Sense Code and Additional Sense Code Qualifier are set to INVALID FIELD IN CDB, and a Check Condition status is returned (for information about Sense Keys, Additional Sense Codes, and Additional Sense Code Qualifiers, see “REQUEST SENSE (03h) Command” on page 52).

Table 3 shows the format for a Command Descriptor Block.

Table 3. Format for Command Descriptor Block (CDB)

Bit Byte	7	6	5	4	3	2	1	0
0	Group Code			Command Code				
1	LUN			CDB-specific Fields				
2	CDB-specific Fields							
3	CDB-specific Fields							
4	CDB-specific Fields							
5	CDB-specific Fields or Control							
6	CDB-specific Fields							
7	CDB-specific Fields							
8	CDB-specific Fields							
9	CDB-specific Fields or Control							
10	CDB-specific Fields							
11	Control							

The Group Code field and a Command Code field comprise the operation code of the CDB (for example, E7h). The 3-bit Group Code field provides for eight groups of command codes. The group code definitions are shown in Table 4.

Table 4. CDB Group Codes

Operation Codes	Group Code	CDB Length
00h - 1Fh	0	6 bytes
20h - 3Fh	1	10 bytes
40h - 5Fh	2	10 bytes
60h - 7Fh	3	Reserved
80h - 9Fh	4	Reserved
A0h - BFh	5	12 bytes
C0h - DFh	6	Vendor-specific
E0h - FFh	7	Vendor-specific

The LUN field is contained in bits 5-7 of the second byte of every CDB. The LUN field of the CDB is supported strictly for compatibility with SCSI-1 devices; host software should specify the LUN in the IDENTIFY message because this field will be changed by the SCSI-3 specification.

The 3581 Tape Autoloader only supports a LUN value of 0. If the autoloader receives a LUN value other than zero, the Sense Key is set to ILLEGAL REQUEST, the Additional Sense Code and Additional Sense Code Qualifier are set to LUN NOT SUPPORTED, and a Check Condition status is returned.

The Control byte is the last byte of every CDB.

INITIALIZE ELEMENT STATUS WITH RANGE (E7h) Command

Table 5. CDB Format of the INITIALIZE ELEMENT STATUS WITH RANGE Command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (E7h)							
1	LUN			Reserved (0)				Range
2-3	(MSB) First Element Address (LSB)							
4	Reserved (0)							
5	Reserved (0)							
6-7	(MSB) Number of Elements (LSB)							
8	Reserved (0)							
9	NoScn	Control (0)						

When an INITIALIZE ELEMENT STATUS WITH RANGE command is received, the 3581 Tape Autoloader checks the picker, drive, and all slots within the specified range for the presence of a tape cartridge. It then sets the element status tables accordingly.

The Range field indicates which elements to check:

- 0 means the First Element Address and Number of Elements fields are ignored, and the command behaves identically to the INITIALIZE ELEMENT STATUS command (see “INITIALIZE ELEMENT STATUS (07h) Command” on page 9).
- 1 means the First Element Address must be valid.

The NoScn field is an autoloader-unique field. Its role is linked to the setting of the bar code’s enable option (described in “Standard INQUIRY Data” on page 11):

- When the bar code’s enable option is set to 0, the autoloader ignores the NoScn field.
- When the bar code’s enable option is set to 1, the setting of the NoScn field determines whether the autoloader will scan the media for bar codes:
  - If the NoScn field is set to 0, the autoloader scans the bar codes.
  - If the NoScn field is set to 1, the autoloader does not scan the bar codes.

  The contents of a successful scan are placed in the Primary Volume Tag field of an element’s status table.

INITIALIZE ELEMENT STATUS (07h) Command

Table 6. CDB Format of the INITIALIZE ELEMENT STATUS Command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (07h)							
1	LUN			Reserved (0)				
2	Reserved (0)							
3	Reserved (0)							
4	Reserved (0)							
5	NoScn	Control (0)						

When an INITIALIZE ELEMENT STATUS command is received, the 3581 Tape Autoloader checks the picker, all installed drives, and all slots for the presence of a tape cartridge. It then sets the element status tables accordingly.

The NoScn field is an autoloader-unique field. Its role is linked to the setting of the bar code's enable option (described in "Standard INQUIRY Data" on page 11):

- When the bar code's enable option is set to 0, the autoloader ignores the NoScn field.
- When the bar code's enable option is set to 1, the setting of NoScn field determines whether the autoloader will scan the media for bar codes:
  - If the NoScn field is set to 0, the autoloader scans the bar codes.
  - If the NoScn field is set to 1, the autoloader does not scan the bar codes.

  The contents of a successful scan are placed in the Primary Volume Tag field of an element's status table.

INQUIRY (12h) Command

Table 7. CDB Format of the INQUIRY Command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (12h)							
1	LUN			Reserved (0)				EVPD
2	Page Code							
3	Reserved (0)							
4	Allocation Length							
5	Control (0)							

The INQUIRY command causes the 3581 Tape Autoloader to send information about its parameters to the host.

The Enable Vital Product Data (EVPD) bit indicates which Vital Product Data Pages to report:

- 0 means the autoloader returns the standard INQUIRY data. In this case, if the Page Code field is not 0, the autoloader sets the Sense Key to ILLEGAL REQUEST, sets the Additional Sense Code and Additional Sense Code Qualifier to INVALID FIELD IN CDB, and returns a Check Condition status.
- 1 means the autoloader returns the Vital Product Data Page specified by the Page Code field.

The INQUIRY command returns Check Condition status only when the autoloader cannot return the requested data.

If an INQUIRY command is received with a pending Unit Attention condition from a host, the autoloader performs the INQUIRY command but does not clear the Unit Attention condition.

Standard INQUIRY Data

Table 8. Standard INQUIRY Data

Bit Byte	7	6	5	4	3	2	1	0
0	Periph. Qual.			Peripheral Device Type				
1	RMB (1)	Device Type Modifier (0)						
2	ISO Version (0)		ECMA Version (0)			ANSI Version (02h)		
3	AENC (0)	TrmIOP (0)	Reserved (0)		Response Data Format (2)			
4	Additional Length (n–4)							
5	Reserved (0)							
6	Reserved (0)							
7	RelAdr (0)	W32 (0)	W16 (0)	Sync (0)	Linked (0)	Rsv (0)	Que (0)	SftRe (0)
8-15	(MSB) Vendor Identification (“IBM ”) (LSB)							
16-31	(MSB) Product Identification (“ULT3581-TA”) (LSB)							
32-35	(MSB) Product Revision Level (LSB)							
36-55	(MSB) Vendor-specific 1 (0) BCEnb							
56-95	(MSB) Reserved (LSB)							
96-n	(MSB) Vendor-specific 2 (0) (LSB)							

For LUN 0, the 3581 Tape Autoloader sets the Peripheral Qualifier field to 0, which means that the specified peripheral device type is currently connected to this logical unit. The Peripheral Device Type field is set to 08h, which means a Medium Changer device. For all other LUNs, the autoloader sets the Peripheral Qualifier field to 0110 and the Peripheral Device Type field to 1Fh, to indicate that the LUN is not supported. For ***all*** LUNs, the remaining fields are set as follows:

- The autoloader indicates that the medium is removable by setting the Removable Medium Bit (RMB) to 1.
- The Device Type Modifier field is set to 0.
- The ISO Version and ECMA Version fields are set to 0. The ANSI Version field is set to 02h to indicate compliance with SCSI-2.

- The Asynchronous Event Notification Capability (AENC) bit is reserved for all SCSI devices other than processor devices, and is set to 0 by the autoloader.
- The Terminate I/O Process bit (TrmIOP) is set to 0 to indicate that the autoloader does not support the use of the Terminate I/O Process message.
- The Response Data Format field is set to 02h to indicate an INQUIRY data format that is compatible with SCSI-2.
- The Additional Length field provides the total number of remaining bytes available to be transferred. If the Allocation Length specified in the CDB is too small to transfer all of the data, the Additional Length field is not adjusted to reflect the truncation, but only the number of bytes specified in the CDB are transferred. If the Allocation Length specified in the CDB is larger than the number of bytes available, then only the total number of data bytes available are transferred. This is not considered an error condition.
- The Relative Addressing bit (RelAdr) is set to 0 to indicate that the autoloader does not support relative addressing.
- The Wide-32 and Wide-16 bits (W32 and W16) are set to 0 to indicate that the autoloader does not support 16- or 32-bit transfers.
- The Synchronous Transfer bit (Sync) is set to 0 to indicate that the autoloader does not support synchronous transfers.
- The Linked Commands bit (Linked) is set to 0 to indicate that the autoloader does not support linked commands.
- The Command Queuing bit (Que) is set to 0 to indicate that command queuing is not supported.
- The Soft Reset bit (SftRe) is set to 0 indicate that the autoloader responds to the RESET condition with the Hard Reset alternative.
- The Vendor Identification field contains 8 bytes of left-justified, space-padded ASCII data that identifies the vendor.
- The Product Identification field contains 16 bytes of left-justified, space-padded ASCII data that identifies the product.
- The Product Revision Level field contains 4 bytes of left-justified, space-padded ASCII data that identifies the product revision level.
- The Vendor-specific 1 field contains from 0 to 20 bytes of vendor-specified data. The least significant bit (LSB) of byte 55 is the bar code enable option:
  - 1 in the LSB field means that the bar code is enabled and bar code scanning is controlled by the NoScn field of the INITIALIZE ELEMENT STATUS or INITIALIZE ELEMENT STATUS WITH RANGE commands.
  - 0 in the LSB field means that the NoScn field of the INITIALIZE ELEMENT STATUS and INITIALIZE ELEMENT STATUS WITH RANGE commands are ignored.
- The Vendor-specific 2 field contains from 0 to 64 bytes of vendor-specified data. This field is only returned if it contains one or more bytes of data.

Vital Product Data

The Vital Product Data Pages of the INQUIRY command allow the host to request additional information about the 3581 Tape Autoloader. The autoloader supports the Vital Product Data Pages listed in Table 9.

Table 9. Supported Vital Product Data Pages

Description	Page Code
Supported Vital Product Data Pages Page	00h
Serial Number Page	80h
Firmware Revision Page	C0h
Vendor Unique Page	D0h
Implemented SCSI-2 Commands Page	E0h
Implemented Vendor-specific Commands Page	E1h

Supported Vital Product Data Pages Page

Table 10. Supported Vital Product Data Pages Page

Bit Byte	7	6	5	4	3	2	1	0
0	Peripheral Qualifier (0)			Peripheral Device Type (08h)				
1	Page Code (00h)							
2	Reserved (0)							
3	Page Length (05h)							
4	Supported Vital Product Data Pages Page Code (00h)							
5	Serial Number Page Code (80h)							
6	Firmware Revision Page Code (C0h)							
7	Implemented SCSI-2 Commands Page Code (E0h)							
8	Implemented Vendor-specific Commands Page Code (E1h)							

The Supported Vital Product Data Pages Page lists the page codes for all supported Vital Product Data Pages.

Because the number and codes of the supported Vital Product Data Pages may change when the autoloader's operating firmware is updated, this page should be examined to determine which other Vital Product Data Pages are supported by the current firmware.

Serial Number Page

Table 11. Serial Number Page

Bit Byte	7	6	5	4	3	2	1	0
0	Peripheral Qualifier (0)			Peripheral Device Type (08h)				
1	Page Code (80h)							
2	Reserved (0)							
3	Page Length (14)							
4-17	(MSB) Vendor Serial Number (LSB)							

The Serial Number Page provides the serial number of the 3581 Tape Autoloader.

The Vendor Serial Number field contains 14 bytes of left-justified ASCII data. The serial number is prefixed with the vendor identification (for example, IBM123456789AB).

Firmware Revision Page

Table 12. Firmware Revision Page

Bit Byte	7	6	5	4	3	2	1	0
0	Peripheral Qualifier (0)			Peripheral Device Type (08h)				
1	Page Code (C0h)							
2	Reserved (0)							
3	Page Length (39h)							
4-25	(MSB) Revision (LSB)							
26-46	(MSB) Build Date (LSB)							
47-60	(MSB) Checksum (LSB)							

The Firmware Revision Page identifies the current version of the operating firmware. The page is specific to the 3581 Tape Autoloader.

The Revision field contains 22 bytes of ASCII data in the form `"Firmware Revision=vvvv"`, where `vvvv` is identical to the data returned in the Product Revision Level field of the standard INQUIRY data.

The Build Date field contains 21 bytes of ASCII data in the form `"Build Date=yyyy-mm-dd"`, where `yyyy-mm-dd` is the date that the operating firmware was compiled.

The Checksum field contains 14 bytes of ASCII data in the form `"Checksum=ccccch"`, where `cccc` is the ASCII-hexadecimal representation of the 16-bit checksum value for the operating firmware.

Vendor Unique Page

The content of this page is not specified in this document.

Implemented SCSI-2 Commands Page

Table 13. Implemented SCSI-2 Commands Page

Bit Byte	7	6	5	4	3	2	1	0
0	Peripheral Qualifier (0)			Peripheral Device Type (08h)				
1	Page Code (E0h)							
2	Reserved (0)							
3	Page Length (11h)							
4	TEST UNIT READY Operation Code (00h)							
5	REZERO UNIT Operation Code (01h)							
6	REQUEST SENSE Operation Code (03h)							
7	INITIALIZE ELEMENT STATUS Operation Code (07h)							
8	INQUIRY Operation Code (12h)							
9	RESERVE Operation Code (16h)							
10	RELEASE Operation Code (17h)							
11	MODE SENSE Operation Code (1Ah)							
12	SEND DIAGNOSTIC Operation Code (1Dh)							
13	PREVENT/ALLOW MEDIUM REMOVAL Operation Code (1Eh)							
15	POSITION TO ELEMENT Operation Code (2Bh)							
16	WRITE BUFFER Operation Code (3Bh)							
17	READ BUFFER Operation Code (3Ch)							
18	LOG SENSE Operation Code (4Dh)							
19	MOVE MEDIUM Operation Code (A5h)							
20	READ ELEMENT STATUS Operation Code (B8h)							

The Implemented SCSI-2 Commands Page lists the command codes for all standard SCSI-2 commands that are supported by the 3581 Tape Autoloader. Because the number and codes of the supported SCSI-2 commands may change when the autoloader's operating firmware is updated, you should examine this page to determine which standard SCSI-2 commands are supported by the current firmware.

This page is specific to the 3581 Tape Autoloader.

Implemented Vendor-specific Commands Page

Table 14. Implemented Vendor-specific Commands Page

Bit Byte	7	6	5	4	3	2	1	0
0	Peripheral Qualifier (0)			Peripheral Device Type (08h)				
1	Page Code (E1h)							
2	Reserved (0)							
3	Page Length (01h)							
4	INITIALIZE ELEMENT STATUS WITH RANGE Operation Code (E7h)							

The Implemented Vendor-specific Commands Page lists the command codes for all SCSI commands that are unique to the 3581 Tape Autoloader. Use this page to determine which vendor-specific SCSI commands are implemented.

Because the number and codes of the supported vendor-specific SCSI commands may change when the autoloader's operating firmware is updated, you should examine this page to determine which standard vendor-specific SCSI commands are supported by the current firmware.

LOG SENSE (4Dh) Command

Table 15. CDB Format of the LOG SENSE Command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (4Dh)							
1	LUN (0)			Reserved (0)			PPC (0)	SP (0)
2	PC (01b)		Page Code					
3	Reserved (0)							
4	Reserved (0)							
5-6	(MSB) Parameter Pointer (LSB)							
7-8	(MSB) Allocation Length (LSB)							
9	Control (0)							

The LOG SENSE command provides a means for the 3581 Tape Autoloader to report statistical information to the host.

The Parameter Pointer Control (PPC) field controls the type of information returned by the autoloader. The autoloader only supports a value of 0 for the Parameter Pointer Control field.

The Save Parameters (SP) field indicates whether the autoloader saves all savable Log Parameters to vendor-specific, non-volatile memory locations upon execution of this command. Because the autoloader does not save Log Parameters, this value must be 0.

The Page Control (PC) field indicates the type of Log Parameter values to be returned. Because the autoloader does not support threshold values or default cumulative values, this field must be 01b to indicate that the autoloader returns the current cumulative values.

The Page Code field identifies which page of Log Parameters the autoloader returns. Only a single log page is returned. The autoloader supports the log pages in Table 16.

Table 16. Supported Log Pages

Description	**Page Code**
Supported Log Pages Page	00h
TapeAlert Log Page	2Eh
Counters Log Page	30h
Sensors Log Page	31h

The Parameter Pointer field allows the host to control the first Log Parameter to be returned. Data is returned starting with the specified Log Parameter code through

the maximum Log Parameter code for the specified page or the last complete Log Parameter that can be accommodated by the number of bytes specified in the Allocation Length field, whichever is less. A value of 0 indicates that all Log Parameters for the specified page are returned. If the Log Parameter code in the Parameter Pointer field is larger than the maximum Log Parameter code for the specified page, or if the Log Parameter code is not supported in the specified page, the autoloader sets the Sense Key to ILLEGAL REQUEST, sets the Additional Sense to INVALID FIELD IN CDB, and returns Check Condition status.

Note: When you request the Supported Log Pages Page, the Parameter Pointer field of the LOG SENSE CDB must be 0.

LOG SENSE Data

LOG SENSE data returned from the 3581 Tape Autoloader to the host contains a header, followed by more variable-length Log Parameters or no parameters.

Table 17. LOG SENSE Data

Item	**Byte**
Log Page Header	0 - 3
Log Parameter(s)	4 - n

Log Page Header

The Log Page Header consists of a 4-byte block that contains the following information:

Table 18. Log Page Header

Bit Byte	7	6	5	4	3	2	1	0
0	Page Code							
1	Reserved (0)							
2-3	(MSB) Page Length (LSB)							

The Page Code field identifies which log page is returned.

The Page Length field indicates the number of bytes of Log Parameter data that are available for all Log Parameters which meet the requirements of the command. This value is not truncated to match the value of the Allocation Length field of the LOG SENSE CDB.

Log Parameter

Except for Log Parameters in the Supported Log Pages Page, all Log Parameters consists of a 4-byte header followed by a variable number of bytes of Log Parameter data, as shown in Table 19.

Table 19. Log Parameter

Bit Byte	7	6	5	4	3	2	1	0
0-1	(MSB) Parameter Code (LSB)							
2	DU (0)	DS (1)	TSD (0)	ETC (0)	TMC (0)		Rsv (0)	LP
3	Parameter Length (n-3)							
4-n	(MSB) Parameter Data (LSB)							

The Parameter Code field identifies which Log Parameter is returned.

The Disable Update (DU) field indicates whether the 3581 Tape Autoloader returns cumulative values or updates the Log Parameter value only in response to a LOG SENSE command with the SAVE PARAMETERS (SP) field set to 1. Because the autoloader does not save Log Parameters, this value is 0.

The Disable Save (DS) field indicates whether the autoloader saves that Log Parameter value in response to a LOG SENSE command with the SAVE PARAMETERS (SP) field set to 1. Because the autoloader does not save Log Parameters, this value is 1.

The Target Save Disable (TSD) field indicates whether the autoloader provides an autoloader-defined method for saving log parameters. A TSD value of 0 indicates that the autoloader does provide a self-defined method for saving log parameters. The implicit saving operation is performed frequently enough to insure that the cumulative parameter values retain statistical significance (for example, across power cycles). A TSD value of 1 indicates that the autoloader does not provide an autoloader-defined method for saving log parameters, or it indicates that the host has disabled the autoloader-defined method. The autoloader does provide a self-defined method for saving log parameters, and always returns a value of 0 in this field.

The Enable Threshold Comparison (ETC) field indicates whether the autoloader performs a comparison to the threshold value whenever the cumulative value is updated. An ETC value of 1 indicates that the comparison is performed. An ETC value of 0 indicates that a comparison is not performed. The autoloader does not support threshold values, therefore this field is always 0.

The Threshold Met Criteria (TMC) field defines the basis for comparison of the cumulative and threshold values. The TMC field is valid only if the ETC field is 1. Because the ETC field is always 0, the TMC field is always 0.

The List Parameter (LP) field indicates the format of the log parameter. An LP value bit of 0 indicates that the parameter is a data counter. Data counters are associated

with one or more events. Whenever one of these events occurs, the autoloader updates the data counter by incrementing the counter value. An LP value of 1 indicates that the parameter is a list parameter. A list parameter is a string of ASCII graphic codes (for example, code values 20h through 7Eh).

The Parameter Length field specifies the length (in bytes) of the following parameter value. If the host sends a parameter length value that results in the truncation of a parameter value, the autoloader does not send that parameter.

For the Supported Log Pages Page, Log Parameters consist of a single byte which is the Page Code of a supported Log Parameter Page.

Note: When you request the Supported Log Pages Page, the Parameter Pointer field of the LOG SENSE CDB must be 0.

Log Pages

The Log Pages Page supports several Log Parameter pages. The pages are described in the sections that follow.

Supported Log Pages Page

Table 20. Supported Log Pages Page

Bit Byte	7	6	5	4	3	2	1	0
0	Page Code (00h)							
1	Reserved (0)							
2-3	(MSB) Page Length (0003h) (LSB)							
4	Supported Log Pages Page Code (00h)							
5	TapeAlert Log Page Code (2Eh)							
6	Counters Page Code (30h)							
7	Sensors Page Code (31h)							

TapeAlert Page

Table 21. TapeAlert Page

Bit Byte	7	6	5	4	3	2	1	0
0	Page Code (2Eh)							
1	Reserved (0)							
2-3	(MSB) Page Length (140h) (LSB)							
4-n	(MSB) TapeAlert Parameters (LSB)							

Table 22. TapeAlert Parameters

Bit Byte	7	6	5	4	3	2	1	0
0-1	Parameter Code							
2	DU (0)	DS (1)	TSD (0)	ETC (0)	TMC (0)		Rsv (0)	LP (0)
3	Parameter Length (1)							
4	Reserved							TA Flag

The 3581 Tape Autoloader supports the following TapeAlert flags:

- 1 (Hardware A)
- 2 (Hardware B)
- 4 (Hardware D)
- 21 (Library Offline)

TapeAlert flags 1 and 2 are both set whenever the autoloader is unable to receive data from the drive through the drive's serial port.

TapeAlert flags 2 and 4 are both set when the Error LED is on and the LCD displays the large E, except under the following conditions:

- EJECT PCKR was selected from the front panel and the picker was empty.
- SET AC ON (enable AUTOCLEAN) was selected from the front panel and slot 7 is full.
- SET AC OFF (disable AUTOCLEAN) was selected from the front panel and slot 7 is empty.
- SET AC OFF was selected from the front panel and slot 2 is full.
- A bar code reader is installed, but has been disabled through the front panel and RD BCODES was selected from the front panel.
- The autoloader is operating in sequential mode.

TapeAlert flag 21 is set whenever you press the MODE key to place the autoloader in offline mode.

The Parameter Code field is set to the currently reported TapeAlert flag.

The TA Flag field is set to 1 if the currently reported TapeAlert flag is set.

Counters Page

Table 23. Counters Page

Bit Byte	7	6	5	4	3	2	1	0
0	Page Code (30h)							
1	Reserved (0)							
2-3	(MSB) Page Length (n-4) (LSB)							
4-n	(MSB) Counter Parameters (LSB)							

Table 24. Counters Parameters

Bit Byte	7	6	5	4	3	2	1	0
0-1	Parameter Code							
2	DU (0)	DS (1)	TSD (0)	ETC (0)	TMC (0)		Rsv (0)	LP (0)
3	Parameter Length (03h)							
4-6	(MSB) Counter Value (LSB)							

Table 25. Counters

Parameter Code	Description
100	Pick from Front Slot
101	Pick from Rear Slot
102	Pick from Drive
103	Place in Front Slot
104	Place in Rear Slot
105	Place in Drive
200	Pick from Front Slot Retries
201	Pick from Rear Slot Retries
202	Pick from Drive Retries
203	Place in Front Slot Retries
204	Place in Rear Slot Retries
205	Place in Drive Retries
206	Drive Door Open Retries

Sensors Page

Table 26. Sensors Page

Bit Byte	7	6	5	4	3	2	1	0
0	Page Code (31h)							
1	Reserved (0)							
2-3	(MSB) Page Length (n-4) (LSB)							
4-n	(MSB) Sensor Parameters (LSB)							

Table 27. Sensors Parameters

Bit Byte	7	6	5	4	3	2	1	0
0-1	Parameter Code							
2	DU (0)	DS (1)	TSD (0)	ETC (0)	TMC (0)		Rsv (0)	LP (0)
3	Parameter Length (n-4)							
4-n	(MSB) Sensor Values (LSB)							

Table 28. Sensors

Parameter Code	Sensor	Parameter Length	Possible Values
01	Drive Door	1	0 or 1
03	Y-Home	1	0 or 1
100	Slots	7	0 or 1
200	Picker	3	0 or 1

The Drive Door and Y-Home sensors parameters are single-byte values that can be 0 or 1.

The Slots sensor parameter has 7 bytes; the first byte is for slot 1, the second for slot 2, and so forth.

The Picker sensors parameter has 3 bytes; the first is for the front tape sensor, the second for the rear tape sensor, and the third for the jaw sensor.

MODE SENSE (1Ah) Command

Table 29. CDB Format of the MODE SENSE Command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (1Ah)							
1	LUN (0)			Rsv (0)	DBD	Reserved (0)		
2	PC		Page Code					
3	Reserved (0)							
4	Allocation Length							
5	Control (0)							

The MODE SENSE command provides a means for the 3581 Tape Autoloader to report parameters to a host.

The Disable Block Descriptors (DBD) field controls whether the autoloader returns block descriptors to the host. A value of 1 indicates that the autoloader does not return block descriptors. A value of 0 indicates that the autoloader may, at its option, return block descriptors. When the value is 0, the autoloader returns a single block descriptor to the host.

The Page Control (PC) field defines the type of parameter values to be returned. The Page Control field values are defined in Table 30 on page 26.

Table 30. Values of the Page Control Field

Bit 7	Bit 6	Type of Parameter Values	Description
0	0	Current Values (00b)	A PC field value of 00b requests the autoloader to return the current parameter values for the specified Page Code.
0	1	Changeable Values (01b)	A PC field value of 01b requests the autoloader to return the changeable parameter mask for the Page Code that is specified. The page requested is returned and contains information that indicates which parameters are changeable. All bits of parameters that are changeable are set to 1. All bits of parameters that are not changeable by a host are set to 0.
1	0	Default Values (10b)	A PC field of 10b requests the autoloader to return the default values for the Page Code specified. The page requested is returned with each supported parameter set to its default value. Parameters not supported by the autoloader are set to 0.
1	1	Saved Values (11b)	A PC field of 11b requests the autoloader to return the saved values for the Page Code specified. Implementation of saved pages is optional. If saved values are not implemented, the command is terminated with Check Condition status, with the Sense Key set to ILLEGAL REQUEST and the Additional Sense Code set to SAVING PARAMETERS NOT SUPPORTED. The autoloader does not save parameter values and consequently does not support a Page Control field value of 11b.

The Page Code field specifies which Mode Page or pages the autoloader returns. Page Code usage is defined in Table 31.

Table 31. Page Code Usage

Page Code	Description
00h	Vendor-specific Page
1Ch	TapeAlert Page
1Dh	Element Address Assignment Page
1Eh	Transport Geometry Descriptor Page
1Fh	Device Capabilities Page
3Fh	All Supported Pages

A host may request any one or all of the supported pages of the autoloader. If a host attempts a MODE SENSE command with a Page Code value that is not implemented by the autoloader, the autoloader returns Check Condition status and sets the Sense Key to ILLEGAL REQUEST and the Additional Sense to INVALID FIELD IN CDB.

A Page Code field of 3Fh indicates that all pages implemented by the autoloader are returned to the host. The pages are returned in numeric order, with the exception of the Vendor-specific page which is returned last.

The Vendor-specific Page returns the same data when the Page Control field is set to Current, Changeable, or Default.

MODE SENSE Data

The MODE SENSE data that is returned from the 3581 Tape Autoloader to the host contains a header, followed by one or no block descriptor, followed by additional or no variable-length Mode Pages.

Table 32. Mode Sense Data

Bytes	Item in Bytes
0 - 3	Mode Parameter Header
4 - y*	Block Descriptor(s)
y + 1 - n**	Mode Page(s)
* y = the offset to the last byte of the returned block descriptor ** n = the offset to the last byte of the returned data	

Mode Parameter Header

The Mode Parameter Header consists of a 4-byte block that contains the data in Table 33.

Table 33. Mode Parameter Header

Bit Byte	7	6	5	4	3	2	1	0
0	Mode Data Length							
1	Medium Type (0)							
2	Device-specific Parameter (0)							
3	Block Descriptors Length							

The Mode Data Length field contains a length count of all data that is available for transfer, as specified in the Page Code field of the MODE SENSE CDB. This consists of a sum of the Mode Parameter Header length (excluding the Mode Data Length byte itself), the value in the Block Descriptors Length field, and the total lengths of all Mode Pages specified in the Page Code field.

The Medium Type and Device-specific Parameter fields are reserved for all Medium Changer devices and contain zeroes.

Depending on the setting of the DBD field of the MODE SENSE CDB, the Block Descriptors Length field contains the total length of all block descriptors that are available to be returned. If the DBD field is set to 1, the autoloader does not return any block descriptors and this field is set to 0. If the DBD field is set to 0, the autoloader returns a single block descriptor and this field is set to 8.

IBM strongly recommends that host software always check this value to determine the correct offset to the Mode Pages.

Block Descriptors

A Block Descriptor consists of an 8-byte block that contains the data in Table 34.

Table 34. Block Descriptor Fields

Bit Byte	7	6	5	4	3	2	1	0
0	Density Code (0)							
1-3	(MSB) Number of Blocks (0) (LSB)							
4	Reserved (0)							
5-7	(MSB) Block Length (0) (LSB)							

The Density Code field is reserved for all Medium Changer devices and is set to 0. All other fields are considered reserved by the autoloader and are set to 0.

Mode Pages

The 3581 Tape Autoloader is capable of returning several types of Mode Pages. These pages are described in the sections that follow.

Vendor-specific Page

Table 35. Vendor-specific Page

Bit Byte	7	6	5	4	3	2	1	0
0	PS (0)	Rsv (0)	Page Code (00h)					
1	Page Length (2Ch)							
2-33	(MSB) Copyright (LSB)							
34-43	(MSB) Firmware Build Date (LSB)							
44-45	(MSB) Checksum (LSB)							

The Vendor-specific Page provides vendor-specified information in a vendor-specified format, and is implemented to provide compatibility with the SCSI-1 MODE SENSE command.

The Copyright field contains 32 bytes of left-justified, space-padded ASCII data that displays the firmware's copyright notice.

The Firmware Build Date field contains 10 bytes of ASCII data in the form "`yyyy-mm-dd`", where `yyyy-mm-dd` is the date that the operating firmware was compiled.

The Checksum field contains the 16-bit checksum value of the operating firmware.

Tape Alert Page

Table 36. Tape Alert Page

Bit Byte	7	6	5	4	3	2	1	0
0-1	Page Code (1Ch) Page Length (0Ah)							
2	Perf (0)	Reserved			Dexcpt (1)	Test (0)	Reserved	LogErr (0)
3	Reserved				MRIE (0)			
4-7	Interval Timer (0)							
8-11	Report Count / Test Flag Number (0)							

The Tape Alert Page provides diagnostic information about the drive and the robotics.

The Dexcpt field indicates whether the 3581 Tape Autoloader uses the reporting method that is indicated by the MRIE field. This bit is set to 1, which indicates that the autoloader will disable all informational exception operations and ignore the MRIE field. The application software must poll the TapeAlert Log Page.

The LogErr field indicates whether the 3581 Tape Autoloader logs informational exception conditions. It is set to 0, which indicates that information about exception conditions is vendor specific.

The Perf field controls whether the 3581 Tape Autoloader performs informational exception operations that can cause delays. It is set to 0, which indicates that these operations can cause delays.

The Test field indicates whether the 3581 Tape Autoloader generates false or test informational exception conditions. It is set to 0 to indicate that these conditions will not be generated.

The MRIE field indicates that informational exception conditions are not reported. It is set to 0.

The Report Count / Test Flag Number field indicates that Report Count is not supported. It is set to 0.

Element Address Assignment Page

Table 37. Element Address Assignment Page

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

The Element Address Assignment Page reports the addresses assigned to the elements of the 3581 Tape Autoloader. This page also reports the number of each type of element that is present.

A PS bit of 1 indicates that an autoloader is capable of saving the page in a non-volatile, vendor-specific location. Because the autoloader does not save parameters, the PS bit value is 0.

The First Medium Transport Element Address field identifies the address of the first Medium Transport Element that is contained in the autoloader.

The Number of Medium Transport Elements field defines the total number of Medium Transport Elements that are contained in the autoloader.

The First Storage Element Address field identifies the first Medium Storage Element that is defined in the autoloader.

The Number of Storage Elements field defines the total number of Medium Storage Elements that are contained in the autoloader. This number represents the number of cartridge storage slots in the autoloader.

The First Import/Export Element Address field identifies the first medium portal that is accessible by both the medium transport devices and also by an operator from outside the Medium Changer.

The Number of Import/Export Elements field identifies the total number of Import/Export elements that are contained in the autoloader.

The First Data Transfer Element Address field identifies the first Data Transfer Element that is contained in the autoloader.

The Number of Data Transfer Elements field defines the total number of Data Transfer Elements for which the autoloader is currently configured.

Transport Geometry Descriptor Page

Table 38. Transport Geometry Descriptor Page

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

The PS field is set to 0 to indicate that the 3581 Tape Autoloader does not save this page to non-volatile memory.

The Page Code field is set to 1Eh to indicate that this is the Transport Geometry Descriptor Page.

The Parameter Length field is set to 02h to indicate the number of bytes of parameter data.

The Rotate field is set to 0 to indicate that the 3581 Tape Autoloader uses only one-sided media.

The Member Number in Transport Element Set field is set to 0 to indicate that the autoloader has only one transport element.

Device Capabilities Page

Table 39. Device Capabilities Page

Bit Byte	7	6	5	4	3	2	1	0
0	PS (0)	Rsv (0)	Page Code (1Fh)					
1	Page Length (0Eh)							
2	Reserved (0)				StorDT (1)	StorIE (0)	StorST (1)	StorMT (1)
3	Reserved (0)							
4	Reserved (0)				MT→DT (1)	MT→IE (0)	MT→ST (1)	MT→MT (0)
5	Reserved (0)				ST→DT (1)	ST→IE (0)	ST→ST (1)	ST→MT (1)
6	Reserved (0)				IE→DT (0)	IE→IE (0)	IE→ST (0)	IE→MT (0)
7	Reserved (0)				DT→DT (0)	DT→IE (0)	DT→ST (1)	DT→MT (1)
8-11	(MSB) Reserved (0) (LSB)							
12	Reserved (0)				MT⇔DT (0)	MT⇔IE (0)	MT⇔ST (0)	MT⇔MT (0)
13	Reserved (0)				ST⇔DT (0)	ST⇔IE (0)	ST⇔ST (0)	ST⇔MT (0)
14	Reserved (0)				IE⇔DT (0)	IE⇔IE (0)	IE⇔ST (0)	IE⇔MT (0)
15	Reserved (0)				DT⇔DT (0)	DT⇔IE (0)	DT⇔ST (0)	DT⇔MT (0)

Note: Element-type abbreviations:
MT = Medium Transport Element
ST = Storage Element
IE = Import/Export Element
DT = Data Transfer Element

The Device Capabilities Page defines characteristics of the element types in the 3581 Tape Autoloader. This information may be used by the host to determine functions permitted by the MOVE MEDIUM and EXCHANGE MEDIUM commands.

A PS bit of 1 indicates that an autoloader is capable of saving the page in a non-volatile, vendor-specific location. Because the autoloader does not save parameters, the PS bit value is 0.

In the following descriptions, XX and YY are any of the element-type abbreviations in Table 39 on page 33 (MT, ST, IE, or DT):

- A StorXX bit value of 1 indicates that the elements of type XX may provide independent storage for a unit of media. A value of 0 indicates that elements of type XX provide virtual sources or destinations. The value of StorST is 1, by the definition of that element type.
- An XX→YY bit value of 1 indicates that the Medium Changer device supports MOVE MEDIUM commands where the source address is of element type XX and the destination address is of element type YY.
- An XX→YY value of 0 indicates that these MOVE MEDIUM commands are rejected with ILLEGAL REQUEST.
- An XX⇔YY bit value of 1 indicates that the Medium Changer device supports EXCHANGE MEDIUM commands where the source address is of element type XX, the first destination address is of type YY, and the second destination address is of the same element type as the source element.
- An XX⇔YY bit value of 0 indicates that these EXCHANGE MEDIUM commands are rejected with ILLEGAL REQUEST.

Because the autoloader does not support the EXCHANGE MEDIUM command, these bits are 0 for all element type combinations.

MOVE MEDIUM (A5h) Command

Table 40. CDB Format of the MOVE MEDIUM Command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (A5h)							
1	LUN (0)			Reserved (0)				
2-3	(MSB) Medium Transport Element Address (LSB)							
4-5	(MSB) Source Element Address (LSB)							
6-7	(MSB) Destination Element Address (LSB)							
8	Reserved (0)							
9	Reserved (0)							
10	Reserved (0)							Inv (0)
11	Control (0)							

Note: If the element status for an element has the EXCEPTION bit set, the 3581 Tape Autoloader does not check for EMPTY or FULL status, but assumes that the element is in the correct state for the requested operation. Therefore, the host software should first check the status of the source and destination elements, and, if an EXCEPTION bit is set, perform any appropriate inquiries or initializations prior to performing a MOVE MEDIUM operation.

The MOVE MEDIUM command requests that the autoloader move a unit of medium from a source element to a destination element.

The Transport Element Address field specifies the Medium Transport Element that is to be used in executing this command. A value of 0 may be used to indicate the default Medium Transport Element.

The source address and the destination address may represent a Storage Element, Data Transfer Element, or Medium Transport Element. If the address specified has not been assigned to a specific element of the autoloader, or if the source and destination element-type combination is not supported, the autoloader sets the Sense Key to ILLEGAL REQUEST, sets the Additional Sense to INVALID ELEMENT ADDRESS, and returns Check Condition status.

An Invert bit (Inv) of 1 specifies that the medium should be inverted or rotated prior to depositing the medium into the destination element. The autoloader does not support medium rotation. If this command is received and the source element status is EMPTY with the EXCEPTION bit cleared, or if the destination element status is FULL with the EXCEPTION bit cleared, the autoloader sets the Sense Key to

ILLEGAL REQUEST, sets the Additional Sense to SOURCE ELEMENT EMPTY or DESTINATION ELEMENT FULL, and returns Check Condition status.

If a MOVE MEDIUM command to Pick from Drive is received when the drive has not logically unloaded, the autoloader returns Check Condition status and the sense data is set to ILLEGAL REQUEST, DRIVE NOT LOGICALLY UNLOADED (SK/ASC/ASCQ of 05h/3Bh/90h).

POSITION TO ELEMENT (2Bh) Command

Table 41. CDB Format of the POSITION TO ELEMENT Command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (2Bh)							
1	LUN (0)			Reserved (0)				
2-3	(MSB) Medium Transport Element Address (LSB)							
4-5	(MSB) Destination Element Address (LSB)							
6	Reserved (0)							
7	Reserved (0)							
8	Reserved (0)							Inv (0)
9	Control (0)							

The POSITION TO ELEMENT command positions the specified Medium Transport Element for access to the specified destination element.

The Transport Element Address field specifies the Medium Transport Element that is to be used in executing this command. A Transport Element Address value of 0 may also be used to indicate the default Medium Transport Element.

An Invert bit (Inv) value of 1 requests that the transport element be inverted or rotated before positioning in front of the destination element. The 3581 Tape Autoloader does not support media rotation and the Invert bit must, consequently, contain a value of 0.

PREVENT/ALLOW MEDIUM REMOVAL (1Eh) Command

Table 42. CDB Format of the PREVENT/ALLOW MEDIUM REMOVAL Command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (1Eh)							
1	LUN (0)			Reserved (0)				
2	Reserved (0)							
3	Reserved (0)							
4	Reserved (0)							Prv
5	Control (0)							

The PREVENT/ALLOW MEDIUM REMOVAL command is provided solely for compatibility. The Prv field indicates whether a PREVENT or ALLOW operation is issued.

READ BUFFER (3Ch) Command

Table 43. CDB Format of the READ BUFFER Command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (3Ch)							
1	LUN (0)			Reserved (0)		Mode		
2	Buffer ID (1)							
3-5	(MSB) Buffer Offset (0) (LSB)							
6-8	(MSB) Allocation Length (LSB)							
9	Control (0)							

Use the READ BUFFER command in conjunction with the WRITE BUFFER command to read and write specific areas of the 3581 Tape Autoloader's electrically erasable programmable read-only memory (EEPROM).

The function of this command and the meaning of the other fields within this CDB depend on the contents of the Mode field. The possible values for the Mode field are:

- 2h (Data Mode)
- 3h (Descriptor Mode)

The Buffer Offset field is considered to be reserved by the autoloader in all modes; therefore, this value is 0.

Data Mode

In Data Mode, the autoloader returns buffer data to the host. The Buffer ID field identifies the specific buffer from which to return data. The buffer is the Event Log, with a Buffer ID of 1h. The autoloader only supports a Buffer ID value of 1.

Descriptor Mode

In Descriptor Mode, a 4-byte buffer descriptor is returned. The Buffer ID field identifies the specific buffer of the descriptor to be returned. The buffer descriptor is defined in Table 44.

Table 44. Buffer Descriptor

Bit Byte	7	6	5	4	3	2	1	0
0	Offset Boundary (0)							
1-3	(MSB) Buffer Capacity (LSB)							

The Offset Boundary field defines the byte alignment for the buffer. In Descriptor Mode (3h), the Offset Boundary value is FFh to indicate that only a Buffer Offset of 0 is accepted.

The Buffer Capacity fields return the size of the buffer in bytes. The READ BUFFER command must be used in the Descriptor Mode to obtain the maximum length of valid data for these buffers.

READ ELEMENT STATUS (B8h) Command

Table 45. CDB Format of the READ ELEMENT STATUS Command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (B8h)							
1	LUN (0)			VolTag	Element Type Code			
2-3	(MSB) Starting Element Address (LSB)							
4-5	(MSB) Number of Elements (LSB)							
6	Reserved (0)						CurData	DVCID
7-9	(MSB) Allocation Length (LSB)							
10	Reserved (0)							
11	Control (0)							

The READ ELEMENT STATUS command requests the 3581 Tape Autoloader to return the status tables of its elements to the host.

The VolTag field indicates whether the autoloader returns the volume tag (bar code label) information. When this bit is set to 1, the autoloader returns volume tag information. When the bit is set to 0, the autoloader does not return volume tag information.

The Element Type Code field specifies the particular element types selected for reporting by this command. A value of 0 specifies that status for all element types is reported. The Element Type Codes are defined in Table 46.

Table 46. Element Type Codes

Code	Description
0h	All element types (valid in CDB only)
1h	Medium Transport Element
2h	Storage Element
3h	Import/Export Element (not supported)
4h	Data Transfer Element
5h-Fh	Reserved

The Starting Element Address field specifies the minimum element address to report. Only elements with an element type code permitted by the Element Type Code specification and an element address greater than or equal to the Starting Element Address are reported.

The Number of Elements field specifies the maximum number of element descriptors to be returned by the 3581 Tape Autoloader for this command. The value specified by this field is not the range of element addresses to be considered for reporting, but rather the number of defined elements to report.

The CurData field is ignored.

The DVCID field specifies whether the autoloader returns device identifiers (if available) for the specified range. A DVCID bit of 0 specifies that the autoloader not return device identifiers. A DVCID bit of 1 specifies that the autoloader return device identifier information, but only for the Data Transfer Element Descriptor.

The Allocation Length field specifies the maximum number of bytes of data to return. If the allocation length is not sufficient to transfer all of the element descriptors, the autoloader transfers all those descriptors that can be completely transferred. This is not considered an error.

READ ELEMENT STATUS Data

The data returned by the READ ELEMENT STATUS command consists of an 8-byte Element Status Data Header, followed by from one to four Element Status Pages. Each status page consists of an 8-byte Element Status Page Header, followed by one or more Element Descriptors.

A sample configuration of the full Element Status Data is shown in Table 47. Note that there is only one Status Data Header. There are up to four Element Status Pages, each of which include only one Element Status Page Header and any number of Element Descriptors.

Table 47. Full Element Status Data Structure

Element Status Data Header
MT Element Status Page Header
MT Element Descriptor
ST Element Status Page Header
ST #0 Element Descriptor
...
ST #*n* Element Descriptor
DT Element Status Page Header
DT #0 Element Descriptor
...
DT #*n* Element Descriptor

Element Status Data Header

Table 48. Element Status Data Header

Bit Byte	7	6	5	4	3	2	1	0
0-1	(MSB) First Element Address Reported (LSB)							
2-3	(MSB) Number of Elements Reported (LSB)							
4	Reserved (0)							
5-7	(MSB) Byte Count of Report Available (LSB)							

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

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

The Byte Count of Report Available field indicates the number of bytes of Element Status Page Data that are available for all elements that meet the request in the command. This value is not truncated to match the allocation length.

Element Status Pages

Each Element Status Page consists of an 8-byte Element Status Page Header, followed by one or more 12-byte Element Descriptors.

The Element Status Page Header includes the Element Type Code of the elements being reported, the length of each descriptor block, and the total number of bytes of element descriptor information that follow the header for this element type.

Each element descriptor contains the element address and the element status table of a specific element of the 3581 Tape Autoloader. The exact format of the element status table depends on the element type.

Element Status Page Header

Table 49. Element Status Page Header

Bit Byte	7	6	5	4	3	2	1	0
0	Element Type Code							
1	PVT(0)	AVT(0)	Reserved (0)					
2-3	(MSB) Element Descriptor Length (LSB)							
4	Reserved (0)							
5-7	(MSB) Byte Count of Descriptor Data Available (LSB)							

The Element Type Code field indicates the element type reported by this Element Status Page.

When PVT is 1, Primary Volume Tag information is available and returned with each element descriptor. Primary Volume Tags are not supported and therefore PVT is always 0.

When AVT is 1, Alternate Volume Tag information is available and returned with each element descriptor. Alternate Volume Tags are not supported and therefore AVT is always 0.

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

The Byte Count of Descriptor Data Available field indicates the total number of bytes of element descriptor data that are available for elements of this element type that meet the request in the command. This value is not truncated to match the allocation length.

Primary Volume Tag Information: The READ ELEMENT STATUS descriptor format for all element types includes two sets of fields that contain volume tag information. These optional fields report media identification information that the Medium Changer has acquired by reading an external label (for example, a bar code label), by a SEND VOLUME TAG command, or by other means that may be vendor specific. The same volume tag information is available to all hosts, whether assigned by that host, by some other host, or by the Medium Changer itself.

Volume tag information provides a means to confirm the identity of a unit of media that resides in a Medium Changer element. This command set does not define any direct addressing of units of media based on these fields. However, commands are defined that provide translation between volume tag information and the element address where that unit of media currently resides.

The Medium Changer command-set definition does not impose the requirement that volume tag information be unique over the units of media within the scope of the changer device.

The following commands support the optional volume tag functionality:

SEND VOLUME TAG
Acts as a translation request or associates a volume tag with the unit of media that resides at an element address. The SEND VOLUME TAG command is not supported by the 3581 Tape Autoloader.

READ ELEMENT STATUS
Optionally reports volume tag information or all element types.

MOVE MEDIUM and EXCHANGE MEDIUM
If volume tags are implemented, these commands must retain the association between volume tag information and units of media as they are moved from element to element. The EXCHANGE MEDIUM command is not supported by the 3581 Tape Autoloader.

Volume Tag Format:

Table 50. Volume Tag Information Format

Bit Byte	7	6	5	4	3	2	1	0
0-31	(MSB) Volume Identification (LSB)							
32	Reserved (0)							
33	Reserved (0)							
34-35	(MSB) Volume Sequence Number (LSB)							

Volume tag information consists of a volume identifier field of 32 bytes, plus a volume sequence number field of 2 bytes. The volume identifier consists of a left-justified sequence of ASCII characters. Unused positions are blank (20h) filled. To avoid problems with the operation of the Send Volume Tag and Request Volume Element Address commands, make sure that * and ? (2Ah and 3Fh) do not appear in the volume identification data. Also, there must be no blank (20h) within the significant part of the volume identifier. If volume tag information for a particular element is undefined, the volume field is set to 0.

The volume sequence number is a 2-byte integer field. If the volume sequence number is not used, this field is 0. The volume tag contents are independent of the volume identification information recorded on the media. The 3581 Tape Autoloader does not use the Volume Sequence field.

Primary and Alternate Volume Tag Information: Element status descriptors (as reported by the READ ELEMENT STATUS command) define a primary volume tag and an alternate volume tag. Alternate volume tags are not supported by the 3581 Tape Autoloader.

Medium Transport Element Descriptor

Table 51. Medium Transport Element Descriptor

Bit Byte	7	6	5	4	3	2	1	0
0-1	(MSB) Element Address (LSB)							
2	Reserved (0)					Exc	Rsv (0)	Full
3	Reserved (0)							
4	Additional Sense Code							
5	Additional Sense Code Qualifier							
6-8	(MSB) Reserved (0) (LSB)							
9	Sval (0)	Inv (0)	Reserved (0)					
10-11	(MSB) Source Storage Element Address (0) (LSB)							
12-47	(MSB) Primary Volume Tag Information (LSB)							
48-51	(MSB) Reserved (0) (LSB)							

The Element Address field gives the address of the 3581 Tape Autoloader's Medium Transport Element.

An Exception (Exc) bit of 1 indicates that the element is in an abnormal state (EXCEPTION state), and that the settings of the other status fields may not accurately describe the element's true status. An Exception bit of 0 indicates that the element is in a normal state and the settings of the other status fields may be used to determine the element's current status.

Note: The occurrence of an EXCEPTION state for an element does not imply that the 3581 Tape Autoloader cannot process motion commands for that element. It simply means that the true status of that element is unknown. If the changer receives a motion command that affects an element in an EXCEPTION state, the changer assumes that the element is in the correct state for that command and attempts to determine the true status of the element in carrying out the command. If the EXCEPTION bit is not set, the changer relies on the other status flags within the status tables in accepting and carrying out or rejecting the motion command received. In this manner, the host can attempt corrective operations or allow the changer to make these attempts itself.

The Additional Sense Code and Additional Sense Code Qualifier fields may provide specific information about an abnormal element state. The values in these fields are the same as those for the Additional Sense Code and Additional Sense Code Qualifier of the REQUEST SENSE data.

A Source Valid (SVal) bit value of 1 indicates that the data in the Source Storage Element Address field is valid. A value of 0 indicates that the value in this field is not valid.

An Invert (Inv) bit value of 1 indicates that the media in the Medium Transport Element was inverted by a MOVE MEDIUM or EXCHANGE MEDIUM command because it was last in a Storage Element. Because the 3581 Tape Autoloader does not support medium rotation, this value is 0.

The Source Storage Element Address field provides the address of the last Storage Element from which a unit of media was moved into the Medium Transport Element. This field is valid only if the SVal bit is 1.

Storage Element Descriptor

Table 52. Storage Element Descriptor

Bit Byte	7	6	5	4	3	2	1	0
0-1	(MSB) Element Address (LSB)							
2	Reserved (0)				Acc	Exc	Rsv (0)	Full
3	Reserved (0)							
4	Additional Sense Code							
5	Additional Sense Code Qualifier							
6-8	(MSB) Reserved (0) (LSB)							
9	Sval (0)	Inv (0)	Reserved (0)					
10-11	(MSB) Source Storage Element Address (0) (LSB)							
12-47	(MSB) Primary Volume Tag Information (LSB)							
48-51	(MSB) Reserved (0) (LSB)							

The Element Address field gives the address of the 3581 Tape Autoloader's Medium Transport Element.

An Access bit (Acc) value of 1 indicates that access to the element by a Medium Transport Element is allowed. An Access bit of 0 indicates that access to the element by the Medium Transport Element is denied.

The Source Storage Element Address field provides the address of the last Storage Element that a unit of media was moved from. The element address value may or may not be the same as this element. This field is valid only if the source valid bit is 1.

An Exception (Exc) bit of 1 indicates that the element is in an abnormal state (EXCEPTION state), and the settings of the other status fields may not accurately describe the element's true status. An Exception bit of 0 indicates that the element is in a normal state and the settings of the other status fields may be used to determine the element's current status.

Note: The occurrence of an EXCEPTION state for an element does not imply that the 3581 Tape Autoloader cannot process motion commands for that element. It simply means that the true status of that element is unknown. If the changer receives a motion command that affects an element in an

EXCEPTION state, the changer assumes that the element is in the correct state for that command and attempts to determine the true status of the element in carrying out the command. If the EXCEPTION bit is not set, the changer relies on the other status flags within the status tables in accepting and carrying out or rejecting the motion command received. In this manner, the host can attempt corrective operations or allow the changer to make these attempts itself.

The Additional Sense Code and Additional Sense Code Qualifier fields may provide specific information about an abnormal element state. The values in these fields are the same as those for the Additional Sense Code and Additional Sense Code Qualifier of the REQUEST SENSE data.

A Source Valid (SVal) bit value of 1 indicates that the data in the Source Storage Element Address field is valid. A value of 0 indicates that the value in this field is not valid.

An Invert (Inv) bit value of 1 indicates that the media in the Medium Transport Element was inverted by a MOVE MEDIUM or EXCHANGE MEDIUM command because it was last in a Storage Element. Because the 3581 Tape Autoloader does not support medium rotation, this value is 0.

The Source Storage Element Address field provides the address of the last Storage Element from which a unit of media was moved into the Medium Transport Element. This field is valid only if the SVal bit is 1.

Data Transfer Element Descriptor

Table 53. Data Transfer Element Descriptor

Bit Byte	7	6	5	4	3	2	1	0
0-1	(MSB) Element Address (LSB)							
2	Reserved (0)				Acc	Exc	Rsv (0)	Full
3	Reserved (0)							
4	Additional Sense Code							
5	Additional Sense Code Qualifier							
6	NBus	Rsv (0)	IDVal	LUNVal (0)	Rsv (0)	LUN (0)		
7	SCSI Bus Address							
8	Reserved (0)							
9	Sval (0)	Inv (0)	Reserved (0)					
10-11	(MSB) Source Storage Element Address (0) (LSB)							
12-47	(MSB) Primary Volume Tag Information (Omitted if PVT = 0 in CDB) (LSB)							
48	Reserved				Code Set			
49	Reserved				Identifier Type			
50	Reserved							
51	Identifier Length							
52-61	(MSB) Identifier (Omitted if DVCID= 0 in CDB) (LSB)							

An Access (Acc) bit value of 1 indicates that access to the Data Transfer Element by the Medium Transport Element is allowed. A value of 0 indicates that access to the Data Transfer Element by a Medium Transport Element is denied.

The Exception (Exc) field indicates the current condition of the drive. When this bit is 0, the tape drive is in a normal state. When this bit is 1, the tape drive is in an abnormal state, as indicated by the Additional Sense Code and the Additional Sense Code Qualifier fields.

The Full field, when set to 0, indicates that the tape drive does not contain a cartridge. When the field is set to 1, the tape drive contains a cartridge.

A Not This Bus (NBus) bit value of 1 indicates that the SCSI Bus Address and LUN values are not valid for the same SCSI bus used to communicate with the 3581 Tape Autoloader. A Not This Bus bit value of 0 indicates that the SCSI Address and LUN values, if valid, are on the same SCSI bus as the autoloader.

An ID Valid (IDVal) bit value of 1 indicates that the SCSI Bus Address field contains valid information.

A LUN Valid (LUNVal) bit value of 1 indicates that the LUN field contains valid information.

The LUN field, if valid, provides the logical unit number (within the SCSI bus device) of the tape drive that is served by the autoloader at this element address. This field is valid only if the LUN Valid bit is 1.

The SCSI Bus Address field, if valid, provides the SCSI address (binary representation) of the tape drive that is served by the autoloader at this element address. This field is valid only if the ID Valid bit is 1.

The Source Storage Element Address field provides the address of the last Storage Element that a unit of media was moved from. The field is valid only if the Source Valid bit is 1.

The Code Set field is set to 2h to indicate that ASCII values are returned.

The Identifier Type field is set to 0h to indicate that the identifier is vendor specific.

The Identifier Length field contains the length (in bytes) of the Identifier field and is set to 0Ah. If no identifier is available or if the DVCID bit in the CDB is 0, the Identifier Length field is 0h and the Code Set and Identifier Type are also 0h.

The Identifier field provides the serial number of the device associated with the Data Transfer Element. If no device identifier is available for the element or if the DVCID bit in the CDB is 0, this field is omitted.

RELEASE (17h) Command

Table 54. CDB Format of the RELEASE Command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (17h)							
1	LUN (0)			3rdPty (0)	Third Party Device ID (0)			Element (0)
2	Reservation Identification (0)							
3	Reserved (0)							
4	Reserved (0)							
5	Control (0)							

The RELEASE command releases previously reserved units. It is not an error for a host to attempt to release a reservation that is not currently active. In this case, the 3581 Tape Autoloader returns Good status without altering other reservations.

This command causes the autoloader to terminate a unit reservation that is active from the host to the specified logical unit.

REQUEST SENSE (03h) Command

Table 55. CDB Format of the REQUEST SENSE Command

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

The REQUEST SENSE command requests that the 3581 Tape Autoloader transfer sense data to the host.

The autoloader is capable of returning 18 bytes of data in response to a REQUEST SENSE command. If the allocation length is 18 or greater, the autoloader returns 18 bytes of data. If the allocation length is less than 18, the data-transfer size equals the allocation length. If the allocation length is less than the sense data that is available, the additional sense length field of the sense data is not adjusted to reflect truncation.

Standard Sense Data Format

Table 56. Standard Sense Data

Bit Byte	7	6	5	4	3	2	1	0
0	Val (0)	Error Code (70h)						
1	Segment Number (0)							
2	FM (0)	EOM (0)	ILI (0)	Rsv (0)	Sense Key			
3-6	(MSB) Information (0) (LSB)							
7	Additional Sense Length							
8-11	(MSB) Command-specific Information (0) (LSB)							
12	Additional Sense Code							
13	Additional Sense Code Qualifier							
14	Field Replaceable Unit Code							
15-17	SKSV (MSB) Sense Key Specific (0) (LSB)							

The Segment Number, Information, Command-specific Information, Sense Key Specific Valid (SKSV), and Sense Key Specific fields are not supported by the 3581 Tape Autoloader. They are set to 0.

The FM, EOM, and ILI fields are reserved for all Medium Changer devices and are set to 0.

The Sense Key field contains information about the current status of the most recent operations. This field may contain any of the values in Table 57.

Table 57. Sense Keys

Sense Key	Definition
00h	NO SENSE
02h	NOT READY
04h	HARDWARE ERROR
05h	ILLEGAL REQUEST
06h	UNIT ATTENTION
09h	VENDOR-SPECIFIC SENSE KEY
0Bh	ABORTED COMMAND

The Additional Sense Length field contains a value that represents the amount of data available in the sense data following the Additional Sense Length field.

The Additional Sense Code and Additional Sense Code Qualifier fields contain information that is relevant to the status of the unit. These two fields together are frequently referred to as the Additional Sense. The possible values for these fields are shown in Table 58.

Table 58. Additional Sense Values

ASC	ASCQ	Definition
04	01	Initializing
04	03	Manual intervention required
04	8D	Unit off-line (vendor-specific)
20	00	Invalid command code
21	01	Invalid element address
24	00	Invalid CDB field
25	00	Logical unit not supported
28	00	Medium may have changed
28	8D	Unit off-line to on-line (vendor-specific)
29	00	POR or BDR occurred
39	00	Saving parameters not supported
3A	00	Medium not present
3B	0D	Destination element full
3B	0E	Source element empty
3B	90	Drive not logically unloaded
3D	00	Invalid bits in identify message
3F	88	Cannot download due to flash problem
48	00	Initiator-detected error message received
53	00	Media load or eject failed
5A	00	Illegal request
83	03	FULL info questionable; only used in READ ELEMENT STATUS return data
FF	xx	Other vendor-specific errors (xx = internal error code)

RESERVE (16h) Command

Table 59. CDB Format of the RESERVE Command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (16h)							
1	LUN (0)			3rdPty (0)	Third Party Device ID (0)			Element (0)
2	Reservation Identification							
3-4	(MSB) Element List Length (LSB)							
5	Control (0)							

The RESERVE command reserves units for the use of the host. The RESERVE and RELEASE commands provide the basic mechanism for contention resolution in multiple-host systems.

This command requests that the entire unit be reserved for the exclusive use of the host until one of the following occurs:

- The reservation is superseded by another valid RESERVE command from the same host that made the reservation
- A RELEASE command is issued from the same host that made the reservation
- The host sends a BUS DEVICE RESET message
- The operation results in a hard SCSI bus RESET condition
- The operator performs a power-off and power-on cycle

A unit reservation is not granted if the 3581 Tape Autoloader is reserved by another host.

If, after honoring the reservation, another host attempts to perform any command on the autoloader other than an INQUIRY command, a REQUEST SENSE command, a RESERVE command, or a RELEASE command (which is ignored), the command is rejected with a Reservation Conflict status.

The autoloader does not support element reservation.

REZERO (01h) Command

Table 60. CDB Format of the REZERO Command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (01h)							
1	LUN (0)			Reserved (0)				
2	Reserved (0)							
3	Reserved (0)							
4	Reserved (0)							
5	Reserved (0)							

When a REZERO command is received, the 3581 Tape Autoloader performs a calibration and returns the appropriate status.

SEND DIAGNOSTIC (1Dh) Command

Table 61. CDB Format of the SEND DIAGNOSTIC Command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (1Dh)							
1	LUN (0)			PF (0)	Rsv (0)	SlfT (1)	DOfl (0)	UOfl (0)
2	Reserved (0)							
3-4	(MSB) Parameter List Length (0) (LSB)							
5	Control (0)							

The SEND DIAGNOSTIC command requests that the 3581 Tape Autoloader perform diagnostic operations on itself, on the specified logical unit, or on both. The only mandatory implementation of this command is the self-test feature with the parameter list length of 0.

The autoloader only implements the self-test function of the SEND DIAGNOSTIC command. All normal power-on self-test functions are performed.

TEST UNIT READY (00h) Command

Table 62. CDB Format of the TEST UNIT READY Command

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

The TEST UNIT READY command checks whether the 3581 Tape Autoloader is ready to accept other commands. This is not a request for a self test. If the autoloader accepts an appropriate medium-access command without returning Check Condition status, this command returns a Good status.

WRITE BUFFER (3Bh) Command

Table 63. CDB Format of the WRITE BUFFER Command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (3Bh)							
1	LUN (0)			Reserved (0)		Mode		
2	Buffer ID							
3-5	(MSB) Buffer Offset (0) (LSB)							
6-8	(MSB) Parameter List Length (LSB)							
9	Control (0)							

The WRITE BUFFER command is used in conjunction with the READ BUFFER command to read and write specific areas of the 3581 Tape Autoloader's Flash EPROM.

The Buffer ID field determines which area of the Flash will be written to. The Buffer ID of 0 indicates that the autoloader reads and writes data from and to the Main CPU Flash Firmware Area.

The function of this command and the meaning of the other fields within this CDB depend on the contents of the Mode field. The possible values for the Mode field are shown in Table 64.

Table 64. WRITE BUFFER Modes

Mode	**Description**
1h	Reserved
2h	Reserved
3h - 4h	Reserved
5h	Download Firmware and Save
6h - 7h	Reserved

The Buffer Offset field is considered reserved by the 3581 Tape Autoloader in all modes.

Download Firmware and Save Mode

In this mode, the 3581 Tape Autoloader writes data starting at the lowest address of the specified area of the Flash and continues until the number of bytes specified in the Parameter List Length field have been transferred. If the Parameter List Length is larger than 63,488 (00F800h) bytes, the autoloader sets the Sense Key to ILLEGAL REQUEST, sets the Additional Sense to INVALID FIELD IN CDB, and returns a Check Condition status.

Note: The firmware download is actually performed by the boot ROM. Control of the autoloader is returned to the boot ROM for the duration of the download; the operating firmware does not resume control until after the autoloader successfully resets itself upon completion of the download.

General SCSI Information

The 3581 Tape Autoloader connects to supported hosts through a Small Computer Systems Interface (SCSI). The interface conforms to SCSI standards specified by ANSI standard X3.131-1994 (SCSI-2).

The 3581 Tape Autoloader offers a standard set of features and functions that includes:

- Asynchronous communication
- Single-ended or differential configuration
- Implementation of SCSI-2 commands for Medium Changer devices

Overview

The 3581 Tape Autoloader handles the physical loading and unloading of tape cartridges into and out of a tape drive. When the cartridges are not loaded in the drive, the autoloader holds them in fixed storage slots. The front storage slots hold up to five cartridges. The rear slots hold up to two cartridges.

There are three types of elements in the 3581 Tape Autoloader:

Medium Transport Element Picker (addresses the movement of tape cartridges between other element types)

Data Transfer Element Tape drive

Storage Element Cartridge storage slots

Each element in the 3581 Tape Autoloader has a unique address assigned to it. The driver determines the actual addresses and numbers for each element type of a particular autochanger by using the Element Address Assignment page of the MODE SENSE command (see “Element Address Assignment Page” on page 31). The drive uses the Device Capabilities page of the MODE SENSE command to determine which element types are capable of storing a tape cartridge (see “Device Capabilities Page” on page 33).

Table 65 shows the addresses that the 3581 Tape Autoloader assigns to the elements.

Table 65. Element Addresses Assigned by the 3581 Tape Autoloader

Element Type	Symbol	Address
Medium Transport	MT	56h
Data Transfer	DT	52h
Storage (maximum of 1)	ST	01h to 07h

The host controls movement of the tape cartridges within the 3581 Tape Autoloader through the use of the MOVE MEDIUM or POSITION TO ELEMENT commands. When issuing one of these commands to the autoloader, the host supplies a source element address and a destination element address.

Up to seven combinations of source and destination element types are supported by the 3581 Tape Autoloader:

- MT to ST
- ST to MT
- MT to DT
- DT to MT
- ST to ST
- ST to DT
- DT to ST

The permitted combinations of source and destination element types for a particular autoloader are determined by the Device Capabilities page of the MODE SENSE command.

A move with DT elements as the source or destination causes the autoloader to load and unload a tape cartridge into and out of the tape drive.

If the 3581 Tape Autoloader cannot determine the status of an element, it sets the EXCEPTION status bit for that element, indicating that it does not have reliable status information. When EXCEPTION is set for an element, the autoloader omits source-empty and destination-full checking prior to executing a MOVE MEDIUM command that uses that element.

Logical Characteristics

Bus Phases

The SCSI bus uses the following eight bus phases. The SCSI bus can never be in more than one phase at any given time.

BUS FREE Phase

The BUS FREE phase indicates that no SCSI device is actively using the bus and that it is available. In some cases, the 3581 Tape Autoloader reverts to the BUS FREE phase to indicate an error condition that it cannot handle. This is called an Unexpected Bus Free condition.

ARBITRATION Phase

The ARBITRATION phase allows one SCSI device to gain control of the SCSI bus so that it can initiate or resume a process.

SELECTION Phase

The SELECTION phase allows the host to select the 3581 Tape Autoloader to initiate a medium-changer function. If more than two SCSI IDs are on the data bus, the autoloader will not respond to selection. The autoloader will either respond to or ignore selection within 250 milliseconds.

RESELECTION Phase

RESELECTION is an optional phase that allows the 3581 Tape Autoloader to reconnect to a host to complete a lengthy operation which it had previously disconnected. The autoloader disconnects by notifying the host that it is about to release the SCSI bus, but will later reselect the host and complete the operation. The autoloader sends a DISCONNECT message to the host, then goes to the Bus Free phase (this is not an Unexpected Bus Free condition). The autoloader disconnects from the SCSI bus when it processes any command that requires robotics movement (for example, the MOVE MEDIUM command) and when the host indicates that it supports disconnection and reselection.

Note: Because the 3581 Tape Autoloader's robotics are a narrow SCSI device (with a SCSI ID less than 7) and cannot specify a SCSI ID greater than 7 for the host, disconnection and reselection are disabled whenever the autoloader detects a SCSI ID of greater than 7 for the host.

INFORMATION TRANSFER Phase

The INFORMATION TRANSFER phase consists of the COMMAND, DATA IN, DATA OUT, STATUS, MESSAGE IN, and MESSAGE OUT. These phases are grouped together because they transfer data or control information by using the data bus.

- **COMMAND Phase** - The host transfers the 6, 10, or 12 bytes of the command descriptor block to the autoloader.
- **DATA IN Phase** - The autoloader transfers blocks of data to the host (for example, INQUIRY response data).
- **DATA OUT Phase** - The host transfers blocks of data to the autoloader (for example, MODE SELECT parameter data).
- **STATUS Phase** - The autoloader sends command status to the host. The autoloader supports the following status codes: Good (00h), Check Condition (02h), Busy (08h), and Reservation Conflict (18h).

- **MESSAGE IN Phase** - The autoloader sends messages to the host.
- **MESSAGE OUT Phase** - The host sends messages to the autoloader.

Asynchronous Conditions

The SCSI bus has two asynchronous conditions: the Attention Condition and the Reset Condition. These conditions cause the SCSI device to perform certain actions and can alter the phase sequence.

Attention Condition

Allows a host to inform the 3581 Tape Autoloader that the host has a message ready. The host creates the Attention Condition by asserting ATN at any time except during the ARBITRATION or BUS FREE phases. The autoloader gets the message by performing a MESSAGE OUT phase. It checks the ATN line for a MESSAGE IN phase at selection, at any phase change, and prior to release REQ. When it detects the Attention Condition, the autoloader immediately responds with the MESSAGE OUT phase.

Reset Condition

Immediately clears all SCSI devices from the bus. The BUS FREE phase always follows the Reset Condition. The 3581 Tape Autoloader implements the hard reset alternative of SCSI-2, implying that from a SCSI standpoint a Reset Condition will be handled just as a power-on reset. If a reset is received while the positioning systems are in motion, the motion operation will not be affected. Following a Reset Condition, the autoloader is available for selection by a host within 250 milliseconds.

Unit Attention Conditions

The 3581 Tape Autoloader generates Unit Attention Conditions for the following types of events. The Unit Attention Condition exists for each host until cleared by each, as specified in the SCSI specification.

Resets	Includes Power-on Reset, SCSI Reset, or Bus Device Reset. The 3581 Tape Autoloader creates a Unit Attention Condition at power-on, as well as in response to a SCSI RESET or a BUS DEVICE RESET message.
Medium Inventory Changes	The autoloader creates a Unit Attention Condition when it detects a change in the empty or full state of a storage slot that is not the source or destination of a pick or place operation (for example, when a user inserts or removes a cartridge into or from a front storage slot.

SCSI Message System

The message system allows communication between a host and the 3581 Tape Autoloader.

Message Protocol

The first message sent by the host after the SELECTION phase is the IDENTIFY message. This allows the establishment of the logical connection to a particular logical unit that is specified by the host. Under some exceptional conditions, a host may send the ABORT message or the BUS DEVICE RESET message instead of the IDENTIFY message as the first message. Only one logical unit number should be identified for any one selection sequence; do not issue a second IDENTIFY message with a new logical unit number before the SCSI bus has been released (BUS FREE phase).

After the RESELECTION phase, the 3581 Tape Autoloader's first message is IDENTIFY. This allows the logical connection to be re-established between the autoloader's specified logical unit number and the host.

The 3581 Tape Autoloader supports the messages listed in Table 66.

Table 66. Supported SCSI Messages

Message and Description	Logical Address
ABORT Sent from the host to the autoloader to clear the present operation: • If a logical unit has been identified, all pending data and status for the issuing host from the affected logical unit is cleared, and the autoloader goes to the BUS FREE phase. Pending data and status for other hosts are not cleared. • If a logical unit has not been identified, the autoloader goes to the BUS FREE phase. In either case, no status or ending message is sent for the operation. If an ABORT message is received while the robotics systems are in motion, the motion operation is not halted and all affected status tables are updated accordingly; however, no status or ending message is sent for the operation.	06h
BUS DEVICE RESET Sent from a host to direct the autoloader to clear all current commands. This message forces the autoloader to an initial state with no operations pending for any host. On recognizing this message, the autoloader goes to the BUS FREE phase. If a BUS DEVICE RESET message is received while the robotics systems are in motion, the motion operation is not halted, and all affected status tables are updated accordingly; however, no status or ending message is sent for the operation.	0Ch
COMMAND COMPLETE Sent from the autoloader to a host to indicate that the execution of a command has terminated and that valid status has been sent to the host. After successfully sending this message, the autoloader goes to the BUS FREE phase by releasing BSY. As indicated in the status, the command may have been executed successfully or unsuccessfully.	00h
DISCONNECT Sent from the autoloader to inform a host that the autoloader plans to disconnect by going to the BUS FREE phase, but will later reselect the host to complete the current operation.	04h
EXTENDED MESSAGES Returned by the autoloader and ended with `Message Reject`.	01h

Table 66. Supported SCSI Messages (continued)

Message and Description	Logical Address
IDENTIFY Sent by either the host or the autoloader to establish the logical connection between a host and the autoloader for a particular logical unit, and also allow a host to indicate its support of disconnection or reselection. The bit values for IDENTIFY messages are defined as follows. **Bit 7** Always set to 1 to distinguish these messages as IDENTIFY messages. **Bit 6** Only set to 1 by the host. When set to 1, it indicates that the host has the ability to accommodate disconnection and reselection. **Bits 5-3** Reserved. **Bits 2-0** Specify the logical unit number to which a logical connection is requested. Only one logical unit number should be identified for any one selection sequence; a second IDENTIFY message with a new logical unit number should not be issued before the bus has been released (BUS FREE phase).	80h - FFh
INITIATOR DETECTED ERROR Sent from a host to inform the autoloader that an error (for example, a data parity error) has occurred that does not preclude the autoloader from retrying the operation. This message causes the autoloader to hang the SCSI bus: • If the status byte has not yet been successfully sent, the autoloader returns a status of Check Condition, with the SK/ASC/ASCQ set to 0Bh/48h/00h (Aborted Command, Initiator Detected Error Message Received). • If the status byte has already been successfully sent, the autoloader goes to the Unexpected Bus Free condition.	05h
MESSAGE PARITY ERROR Sent from the host to the autoloader to indicate that one or more bytes in the last message it received contained a parity error. To indicate its intention of sending this message, the host should assert the ATN signal prior to releasing ACK for the REQ/ACK handshake of the message that contains the parity error. This provides an interlock so that the autoloader can determine which message has the parity error.	09h
MESSAGE REJECT Sent from either the host or the autoloader to indicate that the last message it received was inappropriate or has not been implemented. To indicate its intentions of sending this message, the host should assert the ATN signal prior to releasing ACK for the REQ/ACK handshake of the message that is to be rejected. When the autoloader sends this message, it changes to the MESSAGE IN phase and sends it prior to requesting additional message bytes from the host. This provides an interlock so that the host can determine which message is rejected.	07h
NO OPERATION Sent from a host in response to autoloader's request for a message when the host does not currently have any other valid message to send.	08h
SAVE DATA POINTER Sent from the autoloader to inform the host that the autoloader plans to disconnect in the middle of a DATA OUT phase, but that the autoloader will later reselect the host to complete the current data transfer. This message is normally immediately followed by a DISCONNECT message.	02h

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