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Information Technology— SCSI Media Changer Commands - 2 (SMC-2)

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ANSI
INCITS XXX–200x

American National Standard
for Information Technology —

SCSI Media Changer Commands - 2 (SMC-2)

Secretariat
Information Technology Industry Council

Approved mm dd yy
American National Standards Institute, Inc.

ABSTRACT

This standard defines the SCSI commands and model for independent media changer devices and attached media changer functions integrated into other SCSI devices.

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Foreword

The SCSI Media Changer Commands - 2 (SMC-2) standard specifies the commands and external behavioral characteristics of a device server that declares itself a medium changer in the PERIPHERAL DEVICE TYPE field of the INQUIRY command response data. This standard also specifies the behavior of the attached media changer commands available when the MCHNGR bit is set to one in INQUIRY command response data.

SMC -2 is specified independent of any service delivery subsystem used to carry commands, command parameter data, command response data and status. The SMC-2 standard conforms to the requirements specified in the SCSI-3 Architecture Model standard.

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Introduction

The SCSI Media Changer Command Set (SMC-2) standard is divided into seven clauses:

Clause 1 is the scope.

Clause 2 enumerates the normative and informative references that apply to this standard.

Clause 3 describes definitions, symbols, abbreviations and conventions used in this standard.

Clause 4 is an overview of this standard.

Clause 5 describes the model for this device class.

Clause 6 describes the commands and responses.

Clause 7 describes the parameters.

One annex provides information to assist with implementation and understanding of the requirements and recommendations in this standard:

Annex A defines flags used by the TapeAlert mode page.

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AMERICAN NATIONAL STANDARD ANSI INCITS XXX-200X

American National Standard for
Information Technology -
SCSI Media Changer Commands - 2 (SMC-2)

1 Scope

This standard defines the command set extensions for operation of SCSI media changer devices, and command set extensions that allow media changer functions in other types of SCSI devices.

The objectives of the SCSI-3 Media Changer Commands - 2 standard are:

To permit an application client to communicate with a logical unit that declares itself to be a medium changer device in the PERIPHERAL DEVICE TYPE field of the INQUIRY command response data.

To permit an application client to access the media changer functions in a logical unit that sets the MCHNGR bit to one in INQUIRY command response data.

To define commands and parameter data to manage the operation of SCSI media changer devices.

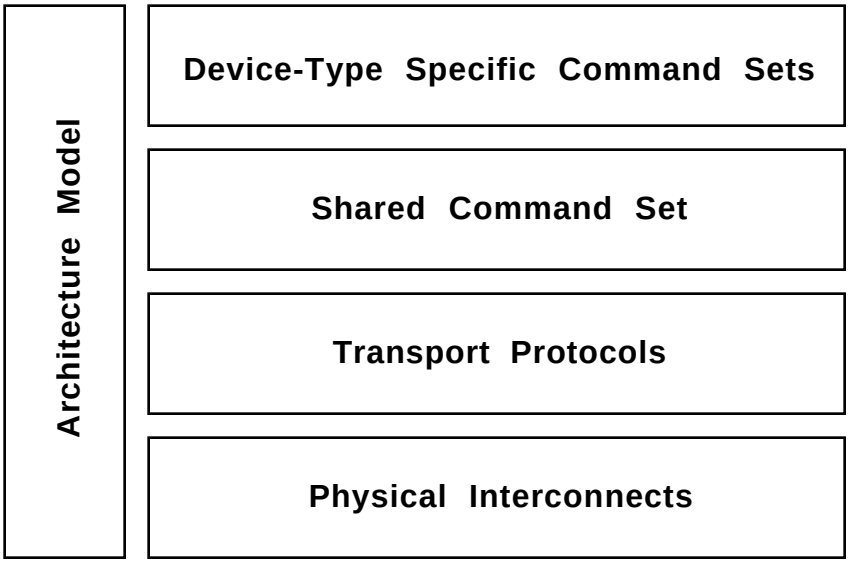

Figure 1 — General structure of SCSI standards

Figure 1 is intended to show the general structure of SCSI-3 standards. The figure is not intended to imply a relationship such as a hierarchy, protocol stack, or system architecture.

At the time this standard was generated, examples of the SCSI general structure included:

Interconnects:

Fibre Channel Arbitrated Loop - 2	FC-AL-2	[ISO/IEC 14165-122] [ANSI NCITS.332-1999] [ANSI NCITS.332-1999/AM1]
Fibre Channel Physical Interfaces	FC-PI	[ANSI INCITS.352-2002]
Fibre Channel Physical Interfaces - 2	FC-PI-2	[T11/1506-D]
Fibre Channel Framing and Signaling Interface	FC-FS	[T11/1331-D]
High Performance Serial Bus		[ANSI IEEE 1394-1995]
High Performance Serial Bus		[ANSI IEEE 1394a-2000] (supplement to ANSI/IEEE 1394-1995)
SCSI Parallel Interface - 2	SPI-2	[ISO/IEC 14776-112] [ANSI X3.302-1999]
SCSI Parallel Interface - 3	SPI-3	[ISO/IEC 14776-113] [ANSI NCITS.336-2000]
SCSI Parallel Interface - 4	SPI-4	[ISO/IEC 14776-114] [ANSI INCITS.362-2002]
SCSI Parallel Interface - 5	SPI-5	[ISO/IEC 14776-115] [ANSI INCITS.367:200x]
Serial Storage Architecture Physical Layer 1	SSA-PH	[ANSI X3.293-1996]
Serial Storage Architecture Physical Layer 2	SSA-PH-2	[ANSI NCITS.307-1998]
Serial Attached SCSI	SAS	[T10/1562-D]
Serial Attached SCSI - 2	SAS-2	[T10/1601-D]

SCSI Transport Protocols:

Automation/Drive Interface - Transport Protocol	ADT	[T10/1557-D]
Serial Storage Architecture Transport Layer 1	SSA-TL-1	[ANSI X3.295-1996]
Serial Storage Architecture Transport Layer 2	SSA-TL-2	[ANSI NCITS.308-1998]
SCSI-3 Fibre Channel Protocol	FCP	[ISO/IEC 14776-221] [ANSI X3.269-1996]
SCSI Fibre Channel Protocol - 2	FCP-2	[ISO/IEC 14776-222] [ANSI NCITS.350-2003]
SCSI Fibre Channel Protocol - 3	FCP-3	[ISO/IEC 14776-223] [T10/1560-D]
Serial Bus Protocol - 2	SBP-2	[ISO/IEC 14776-232] [ANSI NCITS.325-1999]
Serial Bus Protocol - 3	SBP-3	[ISO/IEC 14776-233] [T10/1467-D]
Serial Storage Architecture SCSI-3 Protocol	SSA-S3P	[ANSI NCITS.309-1998]
SCSI RDMA Protocol SRP [T10/1415-D]		

Shared Command Sets:

SCSI-3 Primary Commands	SPC	[ISO/IEC 14776-311] [ANSI X3.301-1997]
SCSI Primary Commands - 2	SPC-2	[ISO/IEC 14776-312] [ANSI NCITS.351-2001]
SCSI Primary Commands - 3	SPC-3	[ISO/IEC 14776-313] [T10/1416-D]

Device-Type Specific Command Sets:

SCSI-3 Block Commands	SBC	[ISO/IEC 14776-321] [ANSI NCITS.306-1998]
SCSI Block Commands - 2	SBC-2	[ISO/IEC 14776-322] [T10/1417-D]
SCSI-3 Stream Commands	SSC	[ISO/IEC 14776-331] [ANSI NCITS.335-2000]
SCSI Stream Commands - 2	SSC-2	[ISO/IEC 14776-332] [T10/1434-D]
SCSI Stream Commands - 3	SSC-3	[ISO/IEC 14776-333] [T10/1611-D]
SCSI-3 Medium Changer Commands	SMC	[ISO/IEC 14776-351] [ANSI NCITS.314-1998]
SCSI Media Changer Commands - 2	SMC-2	[ISO/IEC 14776-352] [T10/1383-D]
SCSI-3 Multimedia Command Set	MMC	[ANSI X3.304-1997]
SCSI Multimedia Command Set - 2	MMC-2	[ISO/IEC 14776-362] [ANSI NCITS.333-2000]
SCSI Multimedia Command Set - 3	MMC-3	[ISO/IEC 14776-363] [ANSI INCITS.360-2002]
SCSI Multimedia Command Set - 4	MMC-4	[ISO/IEC 14776-364] [T10/1545-D]
SCSI Controller Commands - 2	SCC-2	[ISO/IEC 14776-342] [ANSI NCITS.318-1998]
SCSI Reduced Block Commands	RBC	[ISO/IEC 14776-326] [ANSI NCITS.330-2000]
SCSI-3 Enclosure Services Commands	SES	[ISO/IEC 14776-371] [ANSI NCITS.305-1998]
SCSI Enclosure Services Commands - 2	SES-2	[ISO/IEC 14776-372] [T10/1559-D]
SCSI Specification for Optical Card Reader/Writer	OCRW	[ISO/IEC 14776-381]
Object-based Storage Devices Commands	OSD	[T10/1355-D]
SCSI Management Server Commands	MSC	[T10/1528-D]
Automation/Drive Interface - Commands	ADC	[T10/1558-D]

Architecture Model:

SCSI-3 Architecture Model	SAM	[ISO/IEC 14776-411] [ANSI X3.270-1996]
SCSI Architecture Model - 2	SAM-2	[ISO/IEC 14776-412] [ANSI INCITS.366-2003]
SCSI Architecture Model - 3	SAM-3	[ISO/IEC 14776-413] [T10/1561-D]

The term SCSI is used to refer to the family of standards described in this clause.

2 Normative references

The following standards contain provisions that, through reference in the text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards listed below.

Copies of the following documents may be obtained from ANSI: Approved ANSI standards, approved and draft international and regional standards (ISO, IEC, CEN/CENELEC, ITUT), and approved standards of other countries (including BSI, JIS, and DIN). For further information, contact ANSI Customer Service Department at 212–642–4900 (telephone), 212–302–1286 (fax) or via the World Wide Web at http://www.ansi.org.

ISO/IEC 14776-412, *SCSI Architecture Model - 2 (SAM-2) [ANSI INCITS.366-2003]*
ISO/IEC 14776-312, *Information Technology – SCSI Primary Commands -2*

3 Definitions, symbols and abbreviations

3.1 Definitions

3.1.1 additional sense code: The value in the ADDITIONAL SENSE CODE and ADDITIONAL SENSE CODE QUALIFIER fields of the sense data (see SPC-2).

3.1.2 application client: An object that is the source of SCSI commands. Further definition of an application client may be found in SAM-2.

3.1.3 attached media changer: A media changer that accepts commands issued to the same logical unit as a SCSI device that is not a media changer.

3.1.4 byte: An 8-bit construct.

3.1.5 command: A request describing a unit of work to be performed by a device server. A detailed definition of a command may be found in SAM-2.

3.1.6 command descriptor block (CDB): The structure used to communicate commands from an application client to a device server.

3.1.7 data transfer device: A device for reading or writing data on medium. Examples are magnetic disk drives, cartridge tape drives, optical disk drives and CD-ROM drives. Use in a media changer environment implies that the device supports removable volumes.

3.1.8 data transfer element: A component of a media changer used to access the data stored on a volume. The address in media changer element space of a data transfer device.

3.1.9 device service request: A request, submitted by an application client, conveying a SCSI command to a device server. A detailed definition of a device service request may be found in SAM-2.

3.1.10 device type: The type of device (or device model) implemented by the device server.

3.1.11 element: An addressable physical component of a media changer device that may serve as the location of a removable unit of data storage medium.

3.1.12 field: A group of one or more contiguous bits.

3.1.13 hard reset: A target response to a reset event or TARGET RESET task management function. A detailed definition of hard reset may be found in SAM-2.

3.1.14 import/export element: A location within a media changer device that may be accessed by both the medium transport elements and by the operator or an external device.

3.1.15 independent media changer: A media changer addressed as a separate SCSI device or logical unit.

3.1.16 linked command: One in a series of SCSI commands executed by a single task. A detailed definition of a linked command may be found in SAM-2.

3.1.17 logical unit: An externally addressable entity within a SCSI target device that implements a SCSI device model and contains a device server. A detailed definition of a logical unit may be found in SAM-2.

3.1.18 logical unit number: An encoded identifier for a logical unit. A detailed definition of a logical unit number may be found in SAM-2.

3.1.19 medium: One unit of media, equivalent to volume as defined in this standard.

3.1.20 media changer: A media changer mechanizes the movement of media to and from the device that records on or reads from the media.

3.1.21 medium transport element: A component of a media changer device that is used to move volumes.

3.1.22 one: Value of 1, the logical true condition of a variable.

3.1.23 page: A regular parameter structure (or format) used by several commands. These pages are identified with a value known as a page code.

3.1.24 protocol-specific: Requirements for the referenced item are defined by a SCSI transport protocol standard. A detailed definition of protocol-specific may be found in SAM-2.

3.1.25 SCSI device: A device that is connected to a service delivery subsystem and supports a SCSI application protocol. A detailed definition of a SCSI device may be found in SAM-2.

3.1.26 SCSI domain: The interconnection of two or more SCSI devices and a service delivery subsystem forms a SCSI domain. A detailed definition of a SCSI domain may be found in SAM-2.

3.1.27 SCSI initiator device: A SCSI device containing application clients that originate device service requests to be processed in a device server. A detailed definition of a SCSI initiator device may be found in SAM-2.

3.1.28 SCSI initiator port: A SCSI initiator device object that acts as the connection between application clients and the service delivery subsystem through which requests and responses are routed. A detailed definition of SCSI target port may be found in SAM-2.

3.1.29 SCSI target device: A SCSI device containing one or more logical units that receive and execute commands from an application client. A detailed definition of a SCSI target device may be found in SAM-2.

3.1.30 SCSI target port: A SCSI target device object that acts as the connection between device servers and task managers and the service delivery subsystem through which requests and responses are routed. A detailed definition of SCSI target port may be found in SAM-2.

3.1.31 sense key: Contents of the SENSE KEY field of REQUEST SENSE command response data.

3.1.32 service delivery subsystem: That part of a SCSI I/O system that transmits service requests to a logical unit and returns logical unit responses to an application client. A detailed definition of a service delivery subsystem may be found in SAM-2.

3.1.33 status: One byte of response information sent from a device server to an application client upon completion of each command. A detailed definition of status may be found in SAM-2.

3.1.34 storage element: A component of a media changer device used only for physical storage of a volume.

3.1.35 system: A system is one or more SCSI domains operating as a single configuration.

3.1.36 task: An object within a logical unit that represents the work associated with a command or a group of linked commands. A detailed definition of a task may be found in SAM-2.

3.1.37 task set: A group of tasks within a logical unit, whose interaction is dependent on the queuing, contingent allegiance and auto contingent allegiance rules defined in SAM-2.

3.1.38 unit attention condition: A state that a logical unit maintains while it has asynchronous status information to report to one or more SCSI initiator ports. A detailed definition of the unit attention condition may be found in SAM-2.

3.1.39 vendor-specific: Something (e.g., a bit, field, code value, etc.) that is not defined by this standard and may be vendor defined.

3.1.40 volume: The recording medium and its carrier that is removable from a data transfer device and may be moved from one element to another by a media changer.

3.1.41 volume rotation: The process of changing the orientation of a volume. In particular this refers to inverting a two-sided volume cartridge so that a data transfer element that accesses only one side at a time may access data on the other side.

3.1.42 zero: Value of 0, the logical false condition of a variable.

3.2 Symbols and abbreviations

= is equal to

ADC Automation/Drive Interface Commands standard

CDB command descriptor block

I/O input/output

ID identifier

LSB least significant bit

LUN logical unit number

MSB most significant bit

MMC-4 SCSI Multi–Media Commands - 4 standard

RSVD reserved field or bit

SAM -2 SCSI-3 Architecture Model - 2

SBC-2 SCSI-3 Block Commands - 2 standard

SCSI-3 Only standards identified in the foreword as being part of the SCSI-3 standard document set

SMC-2 SCSI Media Changer Commands - 2, this standard

SPC-2 SCSI Primary Commands - 2 standard

SPC-3 SCSI Primary Commands - 3 standard

SSC-2 SCSI-3 Stream Commands - 2 standard

3.3 Keywords

3.3.1 expected: A keyword used to describe the behavior of the hardware or software in the design models assumed by this standard. Other hardware and software design models may also be implemented.

3.3.2 invalid: A keyword used to describe an illegal or unsupported bit, byte, word, field or code value. Receipt of an invalid bit, byte, word, field or code value shall be reported as error.

3.3.3 mandatory: A keyword indicating an item that is required to be implemented as defined in this standard.

3.3.4 may: A keyword that indicates flexibility of choice with no implied preference.

3.3.5 may not: A keyword that indicates flexibility of choice with no implied preference.

3.3.6 obsolete: A keyword indicating that an item was defined in prior SCSI standards but has been removed from this standard.

3.3.7 optional: A keyword that describes features that are not required to be implemented by this standard. However, if any optional feature defined by this standard is implemented, then it shall be implemented as defined in this standard.

3.3.8 reserved: A keyword referring to bits, bytes, words, fields and code values that are set aside for future standardization. A reserved bit, byte, word or field shall be set to zero, or in accordance with a future version of this standard. Recipients may check reserved bits, bytes, words or fields for zero values and report errors if non-zero values are received. Receipt of reserved code values in defined fields shall be reported as error.

3.3.9 shall: A keyword indicating a mandatory requirement. Designers are required to implement all such mandatory requirements to ensure interoperability with other products that conform to this standard.

3.3.10 should: A keyword indicating flexibility of choice with a strongly preferred alternative; equivalent to the phrase "it is strongly recommended."

3.4 Conventions

Certain words and terms used in this standard have a specific meaning beyond the normal English meaning. These words and terms are defined either in 3.1 or in the text where they first appear. Names of commands, statuses, sense keys, additional sense codes, and additional sense code qualifiers are in all uppercase (e.g., REQUEST SENSE). Field names and bit names are in SMALL CAPS. Lower case is used for words having the normal English meaning.

Fields containing only one bit are usually referred to as the name bit instead of the name field.

Numbers that are not immediately followed by lowercase b or h are decimal values.

Numbers immediately followed by lowercase b (xxb) are binary values.

Numbers or upper case letters immediately followed by lowercase h (xxh) are hexadecimal values.

Lists sequenced by letters (e.g., a-red, b-blue, c-green) show no priority relationship between the listed items. Numbered lists (e.g., 1-red, 2-blue, 3-green) show a priority ordering between the listed items.

If a conflict arises between text, tables, or figures, the order of precedence to resolve the conflicts is text; then tables; and finally figures. Not all tables or figures are fully described in the text. Tables show data format and values. NOTES do not constitute any requirements for implementors.

4 Overview

The SCSI media changer device class specifies a logical unit that is involved, primarily, with the movement of removable volumes in a controlled environment without human intervention. The SCSI device classes that provide for removable volumes are block, multimedia and sequential. (See the SBC-2, MMC-4 and SSC-2 standards.)

A media changer logical unit receives commands to move volumes between various element types in the element address space of the media changer. The element types are storage, data transfer, medium transport, and import/export. A volume handling robotics subsystem, addressed as a medium transport element, moves volumes within a media changer. Volumes may also be moved between media changers with interconnected import/export ports.

A media changer logical unit maintains an inventory of volumes and the element addresses at which they may be found. The media changer logical unit reports this inventory when requested and identifies the element addresses assigned to different types of elements.

Different levels of sophistication may be implemented in how this inventory is managed, reported, detected and maintained. The elements in a media changer may be reserved to different SCSI initiator ports. For example, one data transfer element may be reserved for exclusive use by one SCSI initiator port. The data transfer device, located at that data transfer element, may then be attached to various systems for their use. In some cases, the data transfer device associated with a data transfer element may not be a SCSI device.

The split between load and unload control of the medium and read and write control by a data transfer device is a key feature of this device class. The mechanism for coordinating this kind of sophisticated activity is not specified in this standard. The media changer device class provides the means for mount/dismount management only.

Figure 2 shows an example of an independent media changer. The data transfer elements (data transfer devices) shown may be any type of removable media device such as a tape drive, disk drive or optical drive. Supporting multiple types of removable media within the same media changer is also permitted. Also, the ports on each data transfer device may or may not attach to the same service delivery subsystem and the interfaces to the data transfer devices may or may not be SCSI target ports. The number and arrangement of elements is arbitrary.

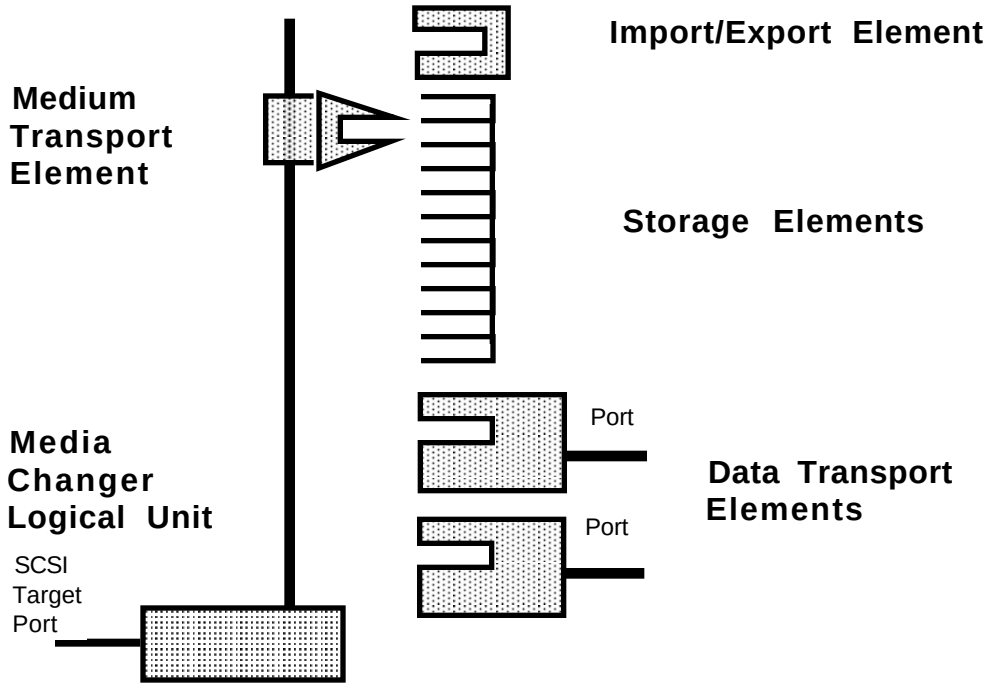

Figure 2 — Example independent media changer device

The independent changer model applies to implementations where the media changer is addressed as a separate logical unit. The logical unit for the media changer may be accessed via the same SCSI target port as the data transfer device, or via a different SCSI target port. This type of media changer may support more than one data transfer element.

The attached media changer model permits a subset of the functions of an independent changer to be incorporated directly into a data transfer device. Only one data transfer element is permitted. In this case, only one logical unit is used to access all functions.

A media changer moves volumes among the elements accessible to it on command from an application client. Media changers shall be capable of reporting the full or empty status of any element.

5 Media changer models

5.1 Independent media changer

An independent media changer is a device server that returns 8h in the PERIPHERAL DEVICE TYPE field (see SPC-2) of INQUIRY command response data.

Independent media changers respond to a LUN different from those used by a data transfer device. Communication with a data transfer device may use the same service delivery subsystem as the media changer device, or a different SCSI service delivery subsystem. Data transfer devices that are not SCSI devices are also permitted. Multiple data transfer devices may be attached to an independent changer.

If a data transfer device served by the media changer is a SCSI device, the data transfer device may be addressed on a SCSI service delivery subsystem though the same SCSI target port as the media changer but with a different LUN. The data transfer device may also be addressed through independent SCSI target ports and any LUN on the same or a different service delivery subsystem.

The READ ELEMENT STATUS command response data page for each data transfer element may provide the identity of the data transfer device serviced by a media changer device. This support is optional since a data transfer device is not required to be a SCSI device.

5.2 Attached media changer

An attached media changer is part of a device server that sets the MCHNGR bit to one in its standard INQUIRY data (see SPC-2). Attached media changers respond to the same LUN as a data transfer device that is not a media changer. In an attached media changer, the PERIPHERAL DEVICE TYPE field of standard INQUIRY data returns the type of the data transfer device.

Two media changer commands, READ ELEMENT STATUS ATTACHED and MOVE MEDIUM ATTACHED are added to the command set of the data transfer device. The other commands available depend on the model for the data transfer device.

5.3 Media changer elements

5.3.1 Elements overview

A media changer has an address space separate and distinct from the physical address space of a SCSI-3 service delivery subsystem. The term element is used throughout this standard to refer to one member of the media changer address space. Within a media changer, the element addresses are a set of physical locations and mechanisms within the scope of a media changer device.

Each element is an instance of one of four element types:

a) medium transport element;
b) storage element;
c) import/export element; or
d) data transfer element.

Each element is a discrete physical entity with a unique element address that may provide storage for zero or one volume. A volume is in exactly one element at a time. When moving from one element to another, the point in time when the volume changes element address is not specified by this standard. When requested to report element status, a volume shall be reported as being at exactly

one element address. The element address shall not be arbitrarily changed by the media changer. However, in configurations with multiple initiators, volumes may be moved by one application client without notification of other application clients.

Volumes are addressed indirectly by this model. Volumes may be moved to or from any of the elements of the media changer device using element addresses. The method of detecting the presence of a volume at any element in a media changer is vendor specific.

In order to ensure exclusive access to a volume, the element where the volume is located (the element address) may be reserved by a SCSI initiator port. Exclusive access shall be released if the volume is moved to an unreserved element. Exclusive access shall be retained if a volume is moved between two reserved elements. Reservation of the medium transport element used is not required to preserve exclusive access. Elements may be reserved by the PERSISTENT RESERVE OUT (see SPC-2) command.

Providing independent storage for medium is optional for medium transport, import/export, and data transfer elements. The capabilities of a particular media changer may be determined from mode parameters in the Device Capabilities mode page (see 7.3.2).

NOTE 1 — An example of an element not providing independent storage for a volume is a carousel style storage for volumes. The import/export function may be provided by a port that allows operator access to one of the storage elements. In such a media changer a MOVE MEDIUM command to move a volume from a storage element to the import/export element rotates the carousel to align the addressed storage element to the import/export position. In this case, the import/export element does not provide independent storage but rather access to one of the storage elements.

Each element type shall be assigned a contiguous range of element addresses. The element address ranges assigned to element types shall not overlap. Element addresses are not required to form one contiguous range over all element types. Element address zero is reserved for use as the default medium transport element address.

5.3.2 Medium transport element

A medium transport element contains the functions of the media changer device that moves a volume from one element address to another. When a medium transport element may serve (even temporarily) as a storage location for a volume, each location where a volume may be held shall have a separate medium transport element address. Support for a medium transport element address being the source and/or destination address in a MOVE MEDIUM and EXCHANGE MEDIUM command is optional. The maximum number of medium transport elements is 127.

In larger media changer devices, the medium movement functions may be performed by multiple independent robotics subsystems. Each of these subsystems may have a number of medium transport element addresses. Sets of medium transport elements for the same common robotics system shall have their medium transport element addresses assigned contiguously.

Any of the medium transport element addresses within a media changer may be used in the medium transport element address field of any MOVE MEDIUM or EXCHANGE MEDIUM command. An application client may determine the capabilities of the medium transport elements of a media changer in the Transport Geometry Parameters mode page.

Element address zero is reserved for use in the MEDIUM TRANSPORT ELEMENT field of MOVE MEDIUM and EXCHANGE MEDIUM commands to direct the media changer to use a default, or any available medium transport element. Support for element address zero is mandatory.

Attached media changer devices shall have only one medium transport element. In an attached changer, element address zero is reserved for the medium transport element.

5.3.3 Storage element

Storage elements are locations of volumes while a volume is not in some other element type. A volume in a storage element is available for access by medium transport elements. If the device has no storage elements, then it shall have at least one import/export element with independent storage capability.

A storage element may be a source or destination address in a MOVE MEDIUM command or the optional EXCHANGE MEDIUM command.

5.3.4 Import/export element

Import/export elements are locations of volumes that are being inserted into or withdrawn from the media changer. A volume in one of these elements is accessible by at least one medium transport element in the media changer, by the operator, or by another media changer device (i.e., interconnected media changer devices). Support for an import/export element is optional.

Any import/export element may be capable of import actions only, export actions only, or both.

An import/export element address may be a source or destination address in a MOVE MEDIUM command or the optional EXCHANGE MEDIUM command. Import/export elements may or may not provide independent storage of a volume.

5.3.5 Data transfer element

A data transfer element represents the interface between the media changer and a data transfer device (e.g., a removable media optical disk drive or tape drive). A data transfer element is considered part of the media changer and is not part of a data transfer device.

NOTE 2 — It should be possible to place a data transfer device of a compatible device class in proximity to a media changer, specify the interface as a data transfer element to the media changer, and begin operation without any change to the data transfer device. Closer coordination between the media changer and a data transfer device may be required in some implementations. Coordination may be implemented using ADC or a vendor specific-method.

Data transfer devices are capable of reading or writing the medium in a volume. Data transfer elements may also be viewed as media changer element addresses of volumes loaded in or available for loading in or removal from data transfer devices (e.g., disk or tape drives). Any data transfer element shall be accessible to at least one medium transport element.

A data transfer element address may be a source or destination address in a MOVE MEDIUM command or the optional EXCHANGE MEDIUM command. Data transfer elements may or may not provide independent storage of a unit of media, see the Device Capabilities mode page (7.3.2). Attached media changers shall have only one data transfer element.

5.3.6 Element status maintenance requirements

When a media changer receives a valid READ ELEMENT STATUS command with a CURDATA bit of zero, the media changer returns information required by each page type (e.g., full, error) as

command response data. The media changer may maintain this information at all times or it may regenerate it after receiving a valid READ ELEMENT STATUS command. The optional INITIALIZE ELEMENT STATUS and INITIALIZE ELEMENT STATUS WITH RANGE commands may be used to force regeneration of this information.

5.4 Volume tag information

5.4.1 Volume tag overview

The READ ELEMENT STATUS command response data descriptor format for all element types includes fields that contain volume tag information. These optional fields are used to report volume identification information that the media changer has acquired either by reading an external label (e.g., bar code labels), by a SEND VOLUME TAG command, reading MAM or by other means that may be vendor-specific. The same volume tag information shall be available to all SCSI initiator ports regardless of whether the volume tag information was assigned by that SCSI initiator, by some other SCSI initiator, or by the media changer.

The volume tag information field values may be independent of any volume identification information recorded on the medium or a volume.

This standard does not impose any requirement that volume tag information be unique for all volumes within a media changer. If volume tag information is implemented, the media changer shall retain the association between volume tag information and a volume as the volume is moved from element address to element address.

Volume tag information provides a means to confirm the identity of a volume that is stored at a media changer element address. When volume tag information is implemented, this standard does not specify any direct addressing of volumes based on the values in these fields. Optional commands are defined that provide translation between volume tag information and the element addresses of zero or more volumes with matching volume tags information.

The following commands support the optional volume tag functionality:

a) SEND VOLUME TAG – used either as a translation request or to associate a volume tag with the volume currently residing at an element address. This is an optional command for independent media changers;

b) REQUEST VOLUME ELEMENT ADDRESS – returns the element address currently associated with the volume tag information transferred with the last SEND VOLUME TAG command. This is an optional command for independent media changers;

c) READ ELEMENT STATUS – optionally reports volume tag information for all element types. Volume tag information is an optional function of a media changer.

5.4.2 Primary and alternate volume tag information

Element status descriptors, as optionally reported by the READ ELEMENT STATUS command, permit defining a primary volume tag and an alternate volume tag. Alternate volume tag information provides a means for a system to use different volume identification information for each side of a volume. Primary volume tag information refers to the logical medium accessible via a MOVE MEDIUM or EXCHANGE MEDIUM command with the INVERT bit set to zero. Alternate volume tag information refers to the other side of the media (i.e., the side that would be accessed via a MOVE MEDIUM or EXCHANGE MEDIUM command with the INVERT bit set to one). Some volumes may be recorded on both sides. The INVERT bit setting permits an application client to select the side to use when a volume is mounted.

All volumes shall have a primary volume tag information attribute.

5.4.3 Volume tag information format

Volume tag information consists of a VOLUME IDENTIFICATION field plus a VOLUME SEQUENCE NUMBER field.

Table 1 defines the fields within the primary and alternate volume tag information fields that may be present in READ ELEMENT STATUS descriptors and in the data format for the SEND VOLUME TAG command.

Table 1 — Volume tag information format

Byte \ Bit	7	6	5	4	3	2	1	0
0	VOLUME IDENTIFICATION							
31								
32	VIQ							
33	Reserved							
34	(MSB) VOLUME SEQUENCE NUMBER							
35								(LSB)

The VOLUME IDENTIFICATION field shall consist of a left justified sequence of characters. Unused positions shall be blank (20h) filled. In order for the SEND VOLUME TAG translate with template to work, the characters '*' and '?' (2Ah and 3Fh) shall not appear in the VOLUME IDENTIFICATION field and there shall be no blanks (20h) in the significant part (non blank filled) of the VOLUME IDENTIFICATION field. If volume tag information for a particular element cannot be determined, the VOLUME IDENTIFICATION field shall be filled with 00h.

The Volume Identification Qualifier (VIQ) field provides additional information as defined by table 2.

The VOLUME SEQUENCE NUMBER is a 2-byte integer field. If the volume sequence number is not used, this field shall be zero.

NOTE 3 — For compatibility with existing volume label conventions, it is recommended that the characters in the significant non-blank portion of the VOLUME IDENTIFICATION field be restricted to the set: '0'…'9', 'A'…'Z" and '_'.

Table 2 — Volume Identification Qualifier

Code	Description
0h	This value shall be returned when the volume identifier has been determined or the medium changer does not contain a volume tag reader (see device capabilities mode page description).
1h	The volume identifier is currently inaccessible (e.g. medium is loaded in a data transfer element such that a barcode label can not be accessed and there is no prior knowledge of the label).
2h	The volume identifier is unreadable or there is a problem with the volume tag reader.
3h - FFh	Reserved

5.5 TapeAlert information

5.5.1 TapeAlert introduction

TapeAlert information is accessed using the TapeAlert log page (see 7.2.2) and configuration is performed using the Informational Exceptions Control mode page (see SPC-2). The MODE SENSE and MODE SELECT configuration of the TapeAlert interface is compatible with the Informational Exceptions Control mode page. The application client should first check the media changer to determine whether it supports the TapeAlert log page. The default application client access to the TapeAlert log page is performed using a polling method, with the page control bits in the LOG SENSE command set to 00h. The TapeAlert log page may be read at any time and should be read from the media changer device following an error.

The application client may also poll the TapeAlert log page at regular intervals (e.g., every 60 seconds) while the media changer is idle. The application client may use the Information Exceptions Control mode page to configure other access methods, depending on what options are supported by the media changer.

Each time the application client reads the TapeAlert log page, it should check all 64 flags (see Table A.1) to discover which flags are active (there may be more than one). The definitions of the 64 flags are device type specific. For each flag active, the application client should communicate the defined error message and severity for that flag to the user and log it. If multiple flags are active simultaneously, they should be displayed together in ascending order of severity. At the beginning of each set of TapeAlert error messages, the device that initiated them should be identified.

5.5.2 TapeAlert log sense format

The TapeAlert interface to the media changer is based on a LOG SENSE page (see 7.2.2) containing 64 one-byte flags (see table A.1). The specific conditions for any specific flag to be active and inactive are vendor-specific.

The TapeAlert data is event based and the page control bits in the LOG SENSE command are not applicable and shall be ignored by the device server.

All flags shall be deactivated in the following circumstances:

a) after the TapeAlert log page is read. The TapeAlert flags shall be deactivated on a per-initiator basis such that active flags are available for other initiators;
b) when the specified corrective action has been taken (e.g., closing the door);
c) on logical unit reset; or
d) when the PCR field in the LOG SELECT command descriptor block is one (see SPC-3).

If a LOG SELECT command is enabled for the TapeAlert log page, the device server shall terminate the command with CHECK CONDITION status, the sense key shall be set to ILLEGAL REQUEST and the additional sense code shall be set to INVALID FIELD IN PARAMETER LIST.

When a flag is deactivated by reading the TapeAlert log page, a flag shall not be active again until the error condition is removed (i.e., the specified corrective action has been taken). For example, if the media changer door is open, once flag 10h has been deactivated by the application client reading the log page, it shall not be activated again until the door is closed. All other methods of deactivating the flag allow the flag to be activated again.

6 Commands for media changer logical units

6.1 Summary of commands for independent media changers

The commands for independent media changers shall be as shown in table 3.

Table 3 — Commands for independent media changers (part 1 of 2)

Command	Operation Code	Type	Reference
ACCESS CONTROL IN	86h	O	SPC-3
ACCESS CONTROL OUT	87h	O	SPC-3
CHANGE ALIASES	A4h/0Bh [a]	O	SPC-3
EXCHANGE MEDIUM	A6h	O	6.4
INITIALIZE ELEMENT STATUS	07h	O	6.5
INITIALIZE ELEMENT STATUS WITH RANGE	37h	O	6.6
INQUIRY	12h	M	SPC-2
LOG SELECT	4Ch	O	SPC-2
LOG SENSE	4Dh	O	SPC-2
MODE SELECT (6)	15h	O	SPC-2
MODE SELECT (10)	55h	O	SPC-2
MODE SENSE (6)	1Ah	O	SPC-2
MODE SENSE (10)	5Ah	O	SPC-2
MOVE MEDIUM	A5h	M	6.7
PERSISTENT RESERVE IN	5Eh	O	SPC-2
PERSISTENT RESERVE OUT	5Fh	O	SPC-2
POSITION TO ELEMENT	2Bh	O	6.8
PREVENT ALLOW MEDIUM REMOVAL	1Eh	O	SPC-2
READ ATTRIBUTE	8Ch	O	6.9
READ BUFFER	3Ch	O	SPC-2
READ ELEMENT STATUS	B8h	M	6.10
RECEIVE DIAGNOSTIC RESULTS	1Ch	O	SPC-2
RELEASE (6)	17h	O	SPC-2
RELEASE (10)	57h	O	SPC-2
REPORT ALIASES	A3h/0Bh [a]	O	SPC-3
REPORT DEVICE IDENTIFIER	A3h/05h [a]	O	SPC-3
REPORT SUPPORTED OPERATION CODES	A3h/0Ch [a]	O	SPC-3

Key: M = command implementation is mandatory.
O = command implementation is optional.

[a] This command is defined by a combination of operation code and service action. The operation code value is shown preceding the slash and the service action value is shown after the slash.

Table 3 — Commands for independent media changers (part 2 of 2)

Command name	Operation Code	Type	Subclause
REPORT SUPPORTED TASK MANAGEMENT FUNCTIONS	A3h/0Dh [a]	O	SPC-3
REPORT LUNS	A0H	O	SPC-2
REPORT TARGET PORT GROUPS	A3h/0Ah [a]	O	SPC-3
REQUEST VOLUME ELEMENT ADDRESS	B5h	O	6.11
REQUEST SENSE	03h	M	SPC-2
RESERVE (6)	16h	O	SPC-2
RESERVE (10)	56h	O	SPC-2
SEND DIAGNOSTIC	1Dh	M	SPC-2
SEND VOLUME TAG	B6h	O	SPC-2
SET DEVICE IDENTIFIER	A4h/06h [a]	O	SPC-3
SET TARGET PORT GROUPS	A4h/0Ah [a]	O	SPC-3
TEST UNIT READY	00h	M	SPC-2
WRITE ATTRIBUTE	8Dh	O	6.13
WRITE BUFFER	3Bh	O	SPC-2

Key: M = command implementation is mandatory.
O = command implementation is optional.

[a] This command is defined by a combination of operation code and service action. The operation code value is shown preceding the slash and the service action value is shown after the slash.

6.2 Summary of commands for attached media changers

Attached media changers shall support the READ ELEMENT STATUS ATTACHED and MOVE MEDIUM ATTACHED commands (see table 4) in addition to the commands defined by the data transfer device type. Attached media changers shall not support other media changer commands (e.g. EXCHANGE MEDIUM).

Table 4 — Commands for attached media changers

Command name	Operation Code	Type	Subclause
MOVE MEDIUM ATTACHED	A7h	M	6.7
MOVE MEDIUM	A5h	S	6.7
READ ELEMENT STATUS ATTACHED	B4h	M	6.10
READ ELEMENT STATUS	B8h	S	6.10

Key: M = command implementation is mandatory.
O = command implementation is optional.
S = optional operation codes for use by sequential devices only.

Sequential devices, (data transfer device type 1) may also use operation codes A5h for MOVE MEDIUM and B8h for READ ELEMENT STATUS.

6.3 Commands allowed in the presence of various reservations

Reservation restrictions are placed on commands as a result of access qualifiers associated with the type of reservation.

The details of which SMC commands are allowed under what types of reservations are described in table 5. For the reservation restrictions placed on commands for the reserve/release management method, see table 5 column [A]. For the reservation restrictions placed on commands for the persistent reservations management method, see the columns under [B] in table 5. Reservation restrictions of commands defined by SPC-2 are described in SPC-2.

In table 5 the following key words are used:

allowed: Commands received from SCSI initiators not holding the reservation or from SCSI initiator ports not registered when a registrants only or all registrants persistent reservation is present should complete normally.

conflict:: Commands issued by received from SCSI initiators not holding the reservation or from SCSI initiator ports not registered when a registrants only or all registrants persistent reservation is present shall not be performed and the device server shall terminate the command with a RESERVATION CONFLICT status.

Commands from SCSI initiator ports holding a reservation should complete normally. The behavior of commands from registered SCSI initiator ports when a registrants only or all registrants persistent reservation is present is specified in table 5.

An unlinked command shall be checked for reservation conflicts before the task containing that command enters the enabled task state. The reservation state as it exists when the first command in a group of linked commands enters the enabled task state shall be used in checking for reservation conflicts for all commands in the task. Once a task has entered the enabled task state, the command or commands comprising that task shall not be terminated with a RESERVATION CONFLICT due to a subsequent reservation. Any command in a group of linked commands that changes the reservation state shall be the last command in the group.

For each command, this standard, SPC-2, or a related command standard defines the conditions that result in RESERVATION CONFLICT. Depending on the particular command standard the conditions are defined in that standard's device model clause or in the subclauses that define the specific commands. An annex in SPC-2 contains the RESERVATION CONFLICT information for some of the command sets.

Table 5 — SMC commands allowed in the presence of various reservations

Command	Addressed LU is reserved by another initiator [A]	Addressed LU has this type of persistent reservation held by another initiator [B]				
		From any initiator		From registered initiator (RR all types)	From any initiator not registered	
		Write Excl	Excl Access		Write Excl - RR	Excl Access - RR
EXCHANGE MEDIUM	Conflict	Conflict	Conflict	Allowed	Conflict	Conflict
INITIALIZE ELEMENT STATUS	Conflict	Conflict	Conflict	Allowed	Conflict	Conflict
INITIALIZE ELEMENT STATUS WITH RANGE	Conflict	Conflict	Conflict	Allowed	Conflict	Conflict
MOVE MEDIUM	Conflict	Conflict	Conflict	Allowed	Conflict	Conflict
MOVE MEDIUM ATTACHED	Conflict	Conflict	Conflict	Allowed	Conflict	Conflict
POSITION TO ELEMENT	Conflict	Conflict	Conflict	Allowed	Conflict	Conflict
READ ATTRIBUTE	Conflict	Conflict	Conflict	Allowed	Conflict	Conflict
READ ELEMENT STATUS CURDATA=0	Conflict	Conflict	Conflict	Allowed	Conflict	Conflict
READ ELEMENT STATUS CURDATA=1	Allowed	Allowed	Allowed	Allowed	Allowed	Allowed
READ ELEMENT STATUS ATTACHED CURDATA =0	Conflict	Conflict	Conflict	Allowed	Conflict	Conflict
READ ELEMENT STATUS ATTACHED CURDATA =1	Allowed	Allowed	Allowed	Allowed	Allowed	Allowed
REQUEST VOLUME ELEMENT ADDRESS	Conflict	Conflict	Conflict	Allowed	Conflict	Conflict
SEND VOLUME TAG	Conflict	Conflict	Conflict	Allowed	Conflict	Conflict
WRITE ATTRIBUTE	Conflict	Conflict	Conflict	Allowed	Conflict	Conflict

Key: LU=Logical Unit, Excl=Exclusive, RR=Registrants Only or All Registrants

6.4 EXCHANGE MEDIUM command

The EXCHANGE MEDIUM command (see table 6) provides a means to replace the volume at an element address with another volume. Support of this command requires that the logical unit have the capability of handling two volumes at the same time or that it emulate this capability.

Support for this command is optional for an independent media changer.

Table 6 — EXCHANGE MEDIUM command

Byte \ Bit	7	6	5	4	3	2	1	0
0	OPERATION CODE (A6h)							
1	Reserved							
2	(MSB)							
3	MEDIUM TRANSPORT ADDRESS							(LSB)
4	(MSB)							
5	SOURCE ADDRESS							(LSB)
6	(MSB)							
7	FIRST DESTINATION ADDRESS							(LSB)
8	(MSB)							
9	SECOND DESTINATION ADDRESS							(LSB)
10	Reserved						INV1	INV2
11	CONTROL							

The volume in the SOURCE ADDRESS element is moved to the FIRST DESTINATION ADDRESS element and the volume that previously occupied the FIRST DESTINATION ADDRESS element is moved to the SECOND DESTINATION ADDRESS element. The SECOND DESTINATION ADDRESS element may or may not be the same as the SOURCE ADDRESS element. In the case of a simple exchange, SOURCE ADDRESS and SECOND DESTINATION ADDRESS are the same. The device capabilities page (see 7.3.2) of the MODE SENSE command provides a matrix that defines the supported source element type and first destination element type combinations for EXCHANGE MEDIUM commands when the source element type is the same as second destination element type.

If the SOURCE ADDRESS element is empty, or the FIRST DESTINATION ADDRESS element is empty, the command shall be terminated with CHECK CONDITION status. The sense key shall be ILLEGAL REQUEST and the additional sense code MEDIUM SOURCE ELEMENT EMPTY. If the SECOND DESTINATION ADDRESS element is full, and not the same as the SOURCE ADDRESS element, the command shall be terminated with CHECK CONDITION status. The sense key shall be ILLEGAL REQUEST and the additional sense code MEDIUM DESTINATION ELEMENT FULL.

The MEDIUM TRANSPORT ADDRESS field specifies the medium transport element that is to be used in executing this command. The default transport element address of zero may be used. If the MEDIUM

TRANSPORT ADDRESS element has not been assigned or that element address has been assigned to a different element type, the logical unit shall return CHECK CONDITION status. The sense key shall be ILLEGAL REQUEST and the additional sense code INVALID ELEMENT ADDRESS.

The SOURCE ADDRESS, the FIRST DESTINATION ADDRESS, and the SECOND DESTINATION ADDRESS fields may represent a storage element, an import/export element, a data transfer element, or a medium transport element. If the element address specified has not been assigned to a specific element of the media changer, the logical unit shall return CHECK CONDITION status. The sense key shall be ILLEGAL REQUEST and the additional sense code INVALID ELEMENT ADDRESS.

An INV1 bit of one specifies that the volume shall be inverted prior to depositing the volume into the FIRST DESTINATION ADDRESS element. Support for this bit set to one is optional.

An INV2 bit of one specifies that the volume shall be inverted prior to depositing the volume into the SECOND DESTINATION ADDRESS element. Support for this bit set to one is optional.

If the media changer does not support volume rotation for handling double sided volumes, the INV1 and INV2 bits should be set to zero. If either of these bits is one, a device server that is not capable of volume rotation shall return CHECK CONDITION status. The sense key shall be ILLEGAL REQUEST and the additional sense code INVALID FIELD IN CDB.

6.5 INITIALIZE ELEMENT STATUS command

The INITIALIZE ELEMENT STATUS command (see table 7) shall cause the media changer to check all assigned element addresses for volume and any other status relevant to that element address. The intent of this command is to enable the application client to get a quick response from a subsequent READ ELEMENT STATUS command. It may be useful to issue this command after a power failure, or if a volume has been changed by an operator, or if configurations have been changed. The device server shall not return GOOD status for this command until checking is complete.

Table 7 — INITIALIZE ELEMENT STATUS command

Byte \ Bit	7	6	5	4	3	2	1	0
0	OPERATION CODE (07h)							
1	Reserved							
2								
3								
4								
5	CONTROL							

Support for this command is optional for an independent media changer.

If an implementation does not support this command, the same function is provided in the READ ELEMENT STATUS command.

6.6 INITIALIZE ELEMENT STATUS WITH RANGE command

The INITIALIZE ELEMENT STATUS WITH RANGE command (see table 8) shall cause the media changer to check the specified elements for volume status and any other relevant status. The intent of this command is to enable the application client o get a quick response from a subsequent READ ELEMENT STATUS command. It may be useful to issue this command after a power failure, if a volume has been changed by an operator, or if configurations have been changed. The device server shall not return GOOD status for this command until checking is complete.

Table 8 — INITIALIZE ELEMENT STATUS WITH RANGE command

Byte \ Bit	7	6	5	4	3	2	1	0
0	OPERATION CODE (37h)							
1	Reserved						FAST	RANGE
2	(MSB)							
3	STARTING ELEMENT ADDRESS							(LSB)
4	Reserved							
5	Reserved							
6	(MSB)							
7	NUMBER OF ELEMENTS							(LSB)
8	Reserved							
9	CONTROL							

Support for this command is optional for an independent media changer.

A RANGE bit of zero indicates that all element addresses shall be checked and that the NUMBER OF ELEMENTS and STARTING ELEMENT ADDRESS fields are ignored. A RANGE bit of one indicates that the series of elements beginning at the specified STARTING ELEMENT ADDRESS for the specified NUMBER OF ELEMENTS shall be checked. If the NUMBER OF ELEMENTS field is zero, the range checked shall start with STARTING ELEMENT ADDRESS and continue through the last element address on the unit.

A FAST bit of one indicates that the specified elements shall be scanned for media presence only. A FAST bit of zero indicates that the specified elements shall be scanned for all relevant status.

NOTE 4 — Prior to standardization, many medium changers implemented this command using a vendor specific OPERATION CODE of E7h.

6.7 MOVE MEDIUM commands

The MOVE MEDIUM and MOVE MEDIUM ATTACHED commands (see table 9) request that the device server move a volume from a source element to a destination element. Support for the MOVE MEDIUM command is mandatory for independent media changers. Support for the MOVE MEDIUM ATTACHED command is mandatory for attached media changers.

Table 9 — MOVE MEDIUM and MOVE MEDIUM ATTACHED command

Byte \ Bit	7	6	5	4	3	2	1	0
0	OPERATION CODE							
1	Reserved							
2	(MSB)							
3	MEDIUM TRANSPORT ADDRESS							(LSB)
4	(MSB)							
5	SOURCE ADDRESS							(LSB)
6	(MSB)							
7	DESTINATION ADDRESS							(LSB)
8	(MSB)							
9	Reserved							(LSB)
10	Reserved							INVERT
11	CONTROL							

The MOVE MEDIUM OPERATION CODE for an independent media changer shall be A5h. An attached media changer shall use OPERATION CODE A7h for the MOVE MEDIUM ATTACHED command. Attached changers connected to a sequential data transfer device are also permitted to implement OPERATION CODE A5h as the MOVE MEDIUM ATTACHED command.

This command moves the volume from the element specified by SOURCE ADDRESS to the element specified by DESTINATION ADDRESS.

If the SOURCE ADDRESS element is empty, the device server shall return CHECK CONDITION status. The sense key shall be ILLEGAL REQUEST and the additional sense code MEDIUM SOURCE ELEMENT EMPTY. If the DESTINATION ADDRESS element is full, and different from the SOURCE ADDRESS element, the device server target shall return CHECK CONDITION status. The sense key shall be ILLEGAL REQUEST and the additional sense code MEDIUM DESTINATION ELEMENT FULL.

The MEDIUM TRANSPORT ADDRESS field specifies the medium transport element that is to be used in executing this command. Attached media changers shall set this field to zero. Independent changers may set this field to zero to specify the default medium transport element. If the address specified has not been assigned or has been assigned to an element other than a medium transport element, the device server hall return CHECK CONDITION status. The sense key shall be ILLEGAL REQUEST and the additional sense code INVALID ELEMENT ADDRESS.

The SOURCE ADDRESS and the DESTINATION ADDRESS fields may represent a storage element, an import/export element, a data transfer element, or a medium transport element. If the address specified has not been assigned to a specific element of the media changer, the device server shall return CHECK CONDITION status. The sense key shall be ILLEGAL REQUEST and the additional sense code INVALID ELEMENT ADDRESS.

The Device Capabilities mode page (see 7.3.2), provides a matrix with the supported source element or destination element combinations for the MOVE MEDIUM and MOVE MEDIUM ATTACHED commands.

An INVERT bit of one specifies that the volume shall be inverted or rotated prior to depositing the medium into the DESTINATION ADDRESS element. If the media changer does not support volume rotation for handling double sided media, the INVERT bit should be set to zero. If this bit is one, a device server that is not capable of volume rotation shall return CHECK CONDITION status. The sense key shall be ILLEGAL REQUEST and the additional sense code INVALID FIELD IN CDB.

6.8 POSITION TO ELEMENT command

The POSITION TO ELEMENT command (see table 10) shall position the MEDIUM TRANSPORT ADDRESS element such that further motion of the MEDIUM TRANSPORT ADDRESS element is unnecessary to execute an appropriate MOVE MEDIUM command between the MEDIUM TRANSPORT ADDRESS element and the DESTINATION ADDRESS element.

Support for this command is optional for independent media changers.

Table 10 — POSITION TO ELEMENT command

Byte \ Bit	7	6	5	4	3	2	1	0
0	OPERATION CODE (2Bh)							
1	Reserved							
2	(MSB)							
3	MEDIUM TRANSPORT ADDRESS							(LSB)
4	(MSB)							
5	DESTINATION ADDRESS							(LSB)
6	Reserved							
7								
8	Reserved							INVERT
9	CONTROL							

The MEDIUM TRANSPORT ADDRESS field specifies the medium transport element used to execute this command. The default transport element address of zero may be used. If the MEDIUM TRANSPORT ADDRESS element has not been assigned or that element address has been assigned to a different element type, the logical unit shall return CHECK CONDITION status. The sense key shall be ILLEGAL REQUEST and the additional sense code INVALID ELEMENT ADDRESS.

The DESTINATION ADDRESS field may represent a storage element, an import/export element, a data transfer element, or a medium transport element. If the address specified has not been assigned to a specific element of the media changer, the target shall return CHECK CONDITION status. The sense key shall be ILLEGAL REQUEST and the additional sense code INVALID ELEMENT ADDRESS.

The Device Capabilities mode page (see 7.3.2), provides a matrix with the supported source element or destination element combinations for the POSITION TO ELEMENT command.

An INVERT bit of one specifies that the medium transport element be inverted or rotated prior to positioning at the DESTINATION ADDRESS element. If the media changer does not support volume rotation for handling double-sided media, the INVERT bit should be set to zero. If this bit is one, a target that is not capable of volume rotation shall return CHECK CONDITION status. The sense key shall be ILLEGAL REQUEST and the additional sense code INVALID FIELD IN CDB.

6.9 READ ATTRIBUTE command

The READ ATTRIBUTE command (see table 11) allows an application client to read attribute values from Medium Auxiliary Memory (MAM) and also to discover what MAM exists at the device server.

Support for this command is optional for independent media changers.

Table 11— READ ATTRIBUTE command

Byte \ Bit	7	6	5	4	3	2	1	0
0	OPERATION CODE (8Ch)							
1	Reserved			SERVICE ACTION (04H)				
2	(MSB)							
3	ELEMENT ADDRESS							(LSB)
4	Reserved				ELEMENT TYPE CODE			
5	VOLUME NUMBER							
6	Reserved							
7	PARTITION NUMBER							
8	(MSB)							
9	FIRST ATTRIBUTE ID							(LSB)
10	(MSB)							
11				ALLOCATION LENGTH				
12								
13								(LSB)
14	Reserved							
15	CONTROL							

The ELEMENT ADDRESS field specifies the element where the MAM currently resides as part of a medium. This might mean, for example, a MAM inside a medium residing in a storage element or a MAM inside a medium residing in a data transfer element. Note that this field forms an additional location qualifier hierarchically superior to VOLUME NUMBER and PARTITION NUMBER.

If the element specified by ELEMENT ADDRESS is empty, the device server shall return CHECK CONDITION status. The sense key shall be ILLEGAL REQUEST and the additional sense code MEDIUM SOURCE ELEMENT EMPTY. If the device server does not support READ ATTRIBUTE at the specified ELEMENT ADDRESS, CHECK CONDITION status shall be returned. The sense key shall be ILLEGAL REQUEST and the additional sense code INVALID FIELD IN CDB.

For the definition of all other fields in this command see SPC-3.

6.10 READ ELEMENT STATUS commands

6.10.1 READ ELEMENT STATUS introduction

The READ ELEMENT STATUS and READ ELEMENT STATUS ATTACHED commands (see table 12) request that the device server report the status of its internal elements to the application client. Support for the READ ELEMENT STATUS command is mandatory for independent media changers. Support for the READ ELEMENT STATUS ATTACHED command is mandatory for attached media changers.

Table 12 — READ ELEMENT STATUS & READ ELEMENT STATUS ATTACHED command

Bit / Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE							
1	Reserved			VOLTAG	ELEMENT TYPE CODE			
2	(MSB)	STARTING ELEMENT ADDRESS						
3								(LSB)
4	(MSB)	NUMBER OF ELEMENTS						
5								(LSB)
6	Reserved						CURDATA	DVCID
7	(MSB)	ALLOCATION LENGTH						
8								
9								(LSB)
10	Reserved							
11	CONTROL							

The READ ELEMENT STATUS OPERATION CODE for an independent media changer shall be B8h. An attached media changer shall use OPERATION CODE B4h for the READ ELEMENT STATUS ATTACHED command. Attached changers connected to a sequential data transfer device may also implement OPERATION CODE B8h as the READ ELEMENT STATUS ATTACHED command.

A volume tag (VOLTAG) bit of one indicates that the device server shall report volume tag information if this feature is supported. A value of zero indicates that volume tag information shall not be reported. If the volume tag feature is not supported this bit shall be treated as reserved.

If the current data (CURDATA) bit is one, the device server shall return element status data without causing device motion. If the CURDATA bit is zero, the device server may cause device motion to confirm element status data. Support for the CURDATA bit set to one is mandatory.

The ELEMENT TYPE CODE field specifies the particular element type(s) selected for reporting by this command. A value of zero specifies that status for all element types shall be reported. The element type codes are defined in table 13.

Table 13 — Element type code

Code	Description
0h	All element types reported (valid in CDB only)
1h	Medium transport element
2h	Storage element
3h	Import/export element
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 field, and an element address greater than or equal to STARTING ELEMENT ADDRESS shall be reported. Element descriptor blocks are not generated for undefined element addresses.

The NUMBER OF ELEMENTS field specifies the maximum number of element descriptors to be created by the device server 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. If the ALLOCATION LENGTH field is not sufficient to transfer all the element descriptors, the device server shall transfer all those descriptors whose complete contents fit within the allocation field and this shall not be considered an error.

A device ID (DVCID) bit of one specifies that the device server shall return device identifiers (see 6.10.8), if available, for the specified range. A DVCID bit of zero specifies that the target shall not return device identifiers. If the DVCID is set to one and the device ID feature is not supported by the media changer, CHECK CONDITION status shall be returned. The sense key shall be set to ILLEGAL REQUEST and the additional sense code set to INVALID FIELD IN CDB.

6.10.2 Element status data

The data returned by the READ ELEMENT STATUS or READ ELEMENT STATUS ATTACHED command is defined in table 14 and 6.10.3 through 6.10.8. Element status data consists of an eight-byte header (see table 14), followed by zero or more element status pages.

Table 14 — Element status data

Byte \ Bit	7	6	5	4	3	2	1	0
0	(MSB)	FIRST ELEMENT ADDRESS REPORTED						
1								(LSB)
2	(MSB)	NUMBER OF ELEMENTS AVAILABLE						
3								(LSB)
4	Reserved							
5	(MSB)	BYTE COUNT OF REPORT AVAILABLE (all pages, n-7)						
6								
7								(LSB)
8		Element status page(s)						
n								

The FIRST ELEMENT ADDRESS REPORTED field indicates the element address of the element with the smallest element address found to meet the CDB request.

The NUMBER OF ELEMENTS AVAILABLE field indicates the number of elements meeting the request in the command descriptor block. The status for these elements is returned if sufficient ALLOCATION LENGTH was specified.

The BYTE COUNT OF REPORT AVAILABLE field indicates the number of bytes of element status page data available for all elements meeting the request in the command descriptor block. This value shall not be adjusted to match the ALLOCATION LENGTH available.

NOTE 6 — The READ ELEMENT STATUS and READ ELEMENT STATUS ATTACHED commands may be issued with an ALLOCATION LENGTH of eight bytes in order to determine the ALLOCATION LENGTH required to transfer all the element status data specified by the command.

6.10.3 Element status page

The element status page is defined in table 15. Each element status page includes an eight-byte header followed by zero or more element descriptor blocks. The header includes the element type code, the length of each descriptor block and the number of bytes of element descriptor information that follow the header for this element type.

Table 15 — Element status page

Bit / Byte	7	6	5	4	3	2	1	0
0	Reserved				ELEMENT TYPE CODE			
1	PVOLTAG	AVOLTAG	Reserved					
2	(MSB)	ELEMENT DESCRIPTOR LENGTH (z)						
3								(LSB)
4	Reserved							
5	(MSB)	BYTE COUNT OF DESCRIPTOR DATA AVAILABLE (this page, y - 7)						
6								
7								(LSB)
8	Element descriptor(s)							
y								

The ELEMENT TYPE CODE field indicates the element type (see table 13) reported by this page.

A primary volume tag (PVOLTAG) bit of one indicates that the PRIMARY VOLUME TAG INFORMATION field is present in each of the following element descriptor blocks. A value of zero indicates that these bytes are omitted from the element descriptors that follow.

An alternate volume tag (AVOLTAG) bit of one indicates that the ALTERNATE VOLUME TAG INFORMATION field is present in each of the following element descriptor blocks. A value of zero indicates that these bytes are omitted from the element descriptors that follow.

The ELEMENT DESCRIPTOR LENGTH field indicates the number of bytes in each element descriptor.

The BYTE COUNT OF DESCRIPTOR DATA AVAILABLE field indicates the number of bytes of element descriptor data available for elements of this element type meeting the request in the CDB. This value shall not be adjusted to match the ALLOCATION LENGTH available.

Each element descriptor includes the element address and status flags; it may also contain sense code information as well as other information depending on the element type (see 6.10.4 through 6.10.8). For each element type, element descriptors shall be returned in ascending ELEMENT ADDRESS order.

6.10.4 Medium transport element descriptor

Table 16 defines the medium transport element descriptor.

Table 16 — Medium transport element descriptor

Byte \ Bit	7	6	5	4	3	2	1	0
0	(MSB)							
1	ELEMENT ADDRESS							(LSB)
2	Reserved					EXCEPT	RSVD	FULL
3	Reserved							
4	ADDITIONAL SENSE CODE							
5	ADDITIONAL SENSE CODE QUALIFIER							
6	Reserved							
8								
9	SVALID	INVERT	Reserved		ED	MEDIUM TYPE		
10	(MSB)							
11	SOURCE STORAGE ELEMENT ADDRESS							(LSB)
•••								
(36 bytes)	PRIMARY VOLUME TAG INFORMATION (field omitted if PVOLTAG=0)							
(36 bytes)	ALTERNATE VOLUME TAG INFORMATION (field omitted if AVOLTAG =0)							
•••								
(1 byte)	Reserved				CODE SET			
(1 byte)	Reserved				IDENTIFIER TYPE			
(1 byte)	Reserved							
(1 byte)	IDENTIFIER LENGTH (x)							
(x bytes)	IDENTIFIER							
•••								
to z-1	Vendor-specific							

The ELEMENT ADDRESS field gives the address of the media changer element whose status is reported by this element descriptor block.

An exception (EXCEPT) bit of one indicates the element is in an abnormal state. An exception bit of zero indicates the element is in a normal state. If this bit is one, information on the abnormal state may be available in the ADDITIONAL SENSE CODE and ADDITIONAL SENSE CODE QUALIFIER fields.

A FULL bit value of one indicates that the element contains a unit of media. A value of zero indicates that the element does not contain a unit of media.

The ADDITIONAL SENSE CODE field may provide specific information on an abnormal element state. The values in this field are as defined for the ADDITIONAL SENSE CODE field of REQUEST SENSE command response data (see SPC-2). This field is valid only if the EXCEPT bit is one.

The ADDITIONAL SENSE CODE QUALIFIER field may provide more detailed information on an abnormal element state. The values in this field are as defined for the ADDITIONAL SENSE CODE QUALIFIER field of REQUEST SENSE command response data (see SPC-2). This field is valid only if the EXCEPT bit is one.

A source valid (SVALID) bit value of one indicates that the SOURCE STORAGE ELEMENT ADDRESS field and the INVERT bit information are valid. A value of zero indicates that the values in these fields are not valid.

An INVERT bit value of one indicates that the unit of media now in this element was inverted by MOVE MEDIUM or EXCHANGE MEDIUM operations since it was last in the SOURCE STORAGE ELEMENT ADDRESS. A value of zero indicates that no inversion occurred during the operation.

An ED bit value of one indicates the element is disabled (e.g., a magazine or drive is not installed or has been logically disabled). An ED bit value of zero indicates the element is enabled.

The MEDIUM TYPE field provides the type of medium currently present in the element as determined by the medium changer. Table 17 describes the values for the Medium Type field.

Table 17 — Medium Type codes

Code	Description
0h	Unspecified. The medium changer does not support this field, cannot determine the medium type, or the element is empty
1h	Data medium
2h	Cleaning medium
3h – 7h	Reserved

The SOURCE STORAGE ELEMENT ADDRESS field provides the address of the last storage element this unit of media occupied. This field is valid only if the SVALID bit is one.

The PRIMARY VOLUME TAG INFORMATION and ALTERNATE VOLUME TAG INFORMATION fields provide for identifying the unit of media residing in this element (see 5.4). Either or both of these fields may be omitted for all the element descriptor blocks that comprise an element status page as indicated by the PVOLTAG and AVOLTAG bits in the element status page header.

The CODE SET field and IDENTIFIER TYPE field are defined in 6.10.8.

The IDENTIFIER LENGTH field contains the length in bytes of the IDENTIFIER field (see 6.10.8). If no device identifier is available, or the DVCID bit in the CDB is zero, the IDENTIFIER LENGTH field shall be zero and the CODE SET and IDENTIFIER TYPE fields shall also be zero.

The IDENTIFIER field provides a device identifier for this medium transport element as defined in 6.10.8. If no device identifier is available for this element, or the DVCID bit in the CDB is zero, this field shall be omitted.

6.10.5 Storage element descriptor

Table 18 defines the storage element descriptor.

Table 18 — Storage element descriptor

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			ELEMENT ADDRESS				
1								(LSB)
2	Reserved				ACCESS	EXCEPT	RSVD	FULL
3	Reserved							
4	ADDITIONAL SENSE CODE							
5	ADDITIONAL SENSE CODE QUALIFIER							
6				Reserved				
8								
9	SVALID	INVERT	Reserved		ED	MEDUIM TYPE		
10	(MSB)			SOURCE STORAGE ELEMENT ADDRESS				
11								(LSB)
...								
(36 bytes)	PRIMARY VOLUME TAG INFORMATION (field omitted if PVOLTAG=0)							
(36 bytes)	ALTERNATE VOLUME TAG INFORMATION (field omitted if AVOLTAG=0)							
...								
(1 byte)	Reserved				CODE SET			
(1 byte)	Reserved				IDENTIFIER TYPE			
(1 byte)	Reserved							
(1 byte)	IDENTIFIER LENGTH (x)							
(x bytes)	IDENTIFIER							
...								
to z-1	Vendor-specific							

An ACCESS bit value of one indicates that access to the element by a medium transport element is allowed. An ACCESS bit of zero 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 this unit of media occupied. This element address value may or may not be the same as this element. This field is valid only if the SVALID bit is one.

The CODE SET field and IDENTIFIER TYPE field are defined in 6.10.8.

The IDENTIFIER LENGTH field contains the length in bytes of the IDENTIFIER field (see 6.10.8). If no device identifier is available, or the DVCID bit in the CDB is zero, the IDENTIFIER LENGTH field shall be zero and the CODE SET and IDENTIFIER TYPE fields shall also be zero.

The IDENTIFIER field provides a device identifier for this storage element as defined in 6.10.8. If no device identifier is available for this element, or the DVCID bit in the CDB is zero, this field shall be omitted.

For fields not defined in this subclause, see 6.10.4.

6.10.6 Import/export element descriptor

Table 19 defines the import/export element descriptor.

Table 19 — Import/export element descriptor

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			ELEMENT ADDRESS				
1								(LSB)
2	OIR	CMC	INENAB	EXENAB	ACCESS	EXCEPT	IMPEXP	FULL
3	Reserved							
4	ADDITIONAL SENSE CODE							
5	ADDITIONAL SENSE CODE QUALIFIER							
6				Reserved				
8								
9	SVALID	INVERT	Reserved		ED	MEDIUM TYPE		
10	(MSB)			SOURCE STORAGE ELEMENT ADDRESS				
11								(LSB)
...								
(36 bytes)	PRIMARY VOLUME TAG INFORMATION (field omitted if PVOLTAG=0)							
(36 bytes)	ALTERNATE VOLUME TAG INFORMATION (field omitted if AVOLTAG=0)							
...								
(1 byte)	Reserved				CODE SET			
(1 byte)	Reserved				IDENTIFIER TYPE			
(1 byte)	Reserved							
(1 byte)	IDENTIFIER LENGTH (x)							
(x bytes)	IDENTIFIER							
...								
To z-1	Vendor-specific							

An operator intervention required (OIR) bit of one indicates operator intervention is required to make the import/export element accessible. The OIR bit shall be set to zero if no operator intervention is required or if the ACCESS bit is set to one.

A connected media changer (CMC) bit of one indicates that exports are to a connected media changer and imports are from a connected media changer. A CMC bit of zero indicates that exports are to the operator and imports are from the operator.

If the CMC bit is zero, media shall not leave the media changer when prevented by the PREVENT ALLOW MEDIA REMOVAL command (see SPC-2). If the CMC bit is one, the PREVENT ALLOW MEDIA REMOVAL command shall not prevent export operations to a connected media changer.

An import enable (INENAB) bit of one indicates that the import/export element supports movement of media into the scope of the media changer device. An INENAB bit of zero indicates that this element does not support import actions.

An export enable (EXENAB) bit of one indicates that the import/export element supports movement of media out of the scope of the media changer device. An EXENAB bit of zero indicates that this element does not support export actions.

An ACCESS bit of one indicates that access to the import/export element by a medium transport element is allowed. An ACCESS bit of zero indicates access to the import/export element by medium transport elements is denied.

NOTE 7 — An example of when access would be denied is when the operator has exclusive access to the import/export element.

An import export (IMPEXP) bit of one indicates the unit of media in the import/export element was placed there by an operator. An IMPEXP bit of zero indicates the unit of media in the import/export element was placed there by the medium transport element.

The CODE SET field and IDENTIFIER TYPE field are defined in 6.10.8.

The IDENTIFIER LENGTH field contains the length in bytes of the IDENTIFIER field (see 6.10.8). If no device identifier is available, or the DVCID bit in the CDB is zero, the IDENTIFIER LENGTH field shall be zero and the CODE SET and IDENTIFIER TYPE fields shall also be zero.

The IDENTIFIER field provides a device identifier for this import/export element as defined in 6.10.8. If no device identifier is available for this element, or the DVCID bit in the CDB is zero, this field shall be omitted.

For fields not defined in this subclause, see 6.10.4.

6.10.7 Data transfer element descriptor

Table 20 defines the data transfer element descriptor.

Table 20 — Data transfer element descriptor

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)							
1	ELEMENT ADDRESS							(LSB)
2	Reserved				ACCESS	EXCEPT	RSVD	FULL
3	Reserved							
4	ADDITIONAL SENSE CODE							
5	ADDITIONAL SENSE CODE QUALIFIER							
6	Obsolete	RSVD	Obsolete	Obsolete	RSVD	Obsolete		
7	Obsolete							
8	Reserved							
9	SVALID	INVERT	Reserved		ED	MEDIUM TYPE		
10	(MSB)							
11	SOURCE STORAGE ELEMENT ADDRESS							(LSB)
•••								
(36 bytes)	PRIMARY VOLUME TAG INFORMATION (field omitted if PVOLTAG=0)							
(36 bytes)	ALTERNATE VOLUME TAG INFORMATION (field omitted if AVOLTAG=0)							
•••								
(1 byte)	Reserved				CODE SET			
(1 byte)	Reserved				IDENTIFIER TYPE			
(1 byte)	Reserved							
(1 byte)	IDENTIFIER LENGTH (x)							
(x bytes)	IDENTIFIER							
•••								
to z-1	Vendor-specific							

An ACCESS bit value of one indicates access to the data transfer element by the medium transport element is allowed. A value of zero indicates access to the data transfer element by a medium transport element is denied.

NOTE 8— Access to the data transfer element by medium transport elements might be denied if a data transfer operation was under way. Note that a one value in this bit may not be sufficient to ensure a successful operation. This bit only reflects the best information available to the media changer device, which may not accurately reflect the state of the data transfer device.

The CODE SET field and IDENTIFIER TYPE field are defined in 6.10.8.

The IDENTIFIER LENGTH field contains the length in bytes of the IDENTIFIER field (see 6.10.8). If no device identifier is available, or the DVCID bit in the CDB is zero, the IDENTIFIER LENGTH field shall be zero and the CODE SET and IDENTIFIER TYPE fields shall also be zero.

The IDENTIFIER field provides a device identifier for the data transfer device associated with this data transfer element as defined in 6.10.8. If no device identifier is available for this element, or the DVCID bit in the CDB is zero, this field shall be omitted.

For fields not defined in this subclause, see 6.10.4.

6.10.8 Identification descriptor

Table 21 defines the identification descriptor fields returned in element descriptors.

Table 21 — Identification descriptor fields

Bit / Byte	7	6	5	4	3	2	1	0
(1 byte)	Reserved				CODE SET			
(1 byte)	Reserved				IDENTIFIER TYPE			
(1 byte)	Reserved							
(1 byte)	IDENTIFIER LENGTH (x)							
(x bytes)	IDENTIFIER							

The CODE SET, IDENTIFIER TYPE, IDENTIFIER LENGTH and IDENTIFIER fields in element descriptors are defined by the device identification page in SPC-2. Device identifiers may be available for some or all elements in a media changer. If no device identifier is available or the DVCID bit in the CDB is zero, the IDENTIFIER LENGTH shall be zero, the IDENTIFIER field is omitted, and the CODE SET and IDENTIFIER TYPE fields shall be zero.

Within the element descriptors for a single element status page, the device server may pad IDENTIFIER fields to the right with 00h to achieve a consistent length between such fields.

For a data transfer element, the IDENTIFIER field returns a device identifier from the data transfer device (disk or tape drive) associated with this element. With the exception of 00h padding in the IDENTIFIER field, the same CODE SET, IDENTIFIER TYPE, IDENTIFIER LENGTH and IDENTIFIER fields should be available via an INQUIRY command (see SPC-2) issued to the data transfer device.

For an import/export element, the IDENTIFIER field returns a unique identifier for the import/export device. An element used to exchange media between two media changers should return the same CODE SET, IDENTIFIER TYPE, IDENTIFIER LENGTH and IDENTIFIER fields via either media changer.

For a storage or medium transport element the CODE SET, IDENTIFIER TYPE, IDENTIFIER LENGTH and IDENTIFIER fields refer to the element, and are not an identifier for a volume stored in this location.

6.11 REQUEST VOLUME ELEMENT ADDRESS command

The REQUEST VOLUME ELEMENT ADDRESS command (see table 22) is used to transfer the results of a SEND VOLUME TAG command. Multiple REQUEST VOLUME ELEMENT ADDRESS commands may be used to retrieve the results of a single SEND VOLUME TAG command with the translate option.

Support for this command is optional for independent media changers. This command has no command parameter data. This command returns command response data.

Table 22 — REQUEST VOLUME ELEMENT ADDRESS command

Bit / Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (B5h)							
1	Reserved			VOLTAG	Obsolete			
2	(MSB)							
3	ELEMENT ADDRESS							(LSB)
4	(MSB)							
5	NUMBER OF ELEMENTS TO REPORT							(LSB)
6	Reserved							
7	(MSB)							
8	ALLOCATION LENGTH							
9								(LSB)
10	Reserved							
11	CONTROL							

The command response data returned by this command consists of a header as defined by table 23, plus zero or more element type specific pages in the same format as defined by the READ ELEMENT STATUS command (see 6.10).

Table 23 — Volume element address header

Byte \ Bit	7	6	5	4	3	2	1	0
0	(MSB)	FIRST ELEMENT ADDRESS REPORTED						
1								(LSB)
2	(MSB)	NUMBER OF ELEMENTS REPORTED						
3								(LSB)
4	Reserved			SEND ACTION CODE				
5	(MSB)	BYTE COUNT OF REPORT AVAILABLE (all pages, x - 7)						
6								
7								(LSB)
8	Element status page(s)							
x								

For each SEND VOLUME TAG command, the logical unit shall report in response to a REQUEST VOLUME ELEMENT ADDRESS command zero or more elements that match a volume tag template in element address order. Once information for a given element address has been reported, only higher element addresses shall be reported by subsequent REQUEST VOLUME ELEMENT ADDRESS commands.

If a REQUEST VOLUME ELEMENT ADDRESS command is received and no prior SEND VOLUME TAG command has been executed or the element list has been completely reported for the most recent successful SEND VOLUME TAG command, the logical unit shall return command response data consisting of only the volume element address header. Once information for an element address has been reported following a SEND VOLUME TAG command, another SEND VOLUME TAG command is required before reporting that element address again.

NOTE 10 — In order to ensure the successful completion of a SEND VOLUME TAG, REQUEST VOLUME ELEMENT ADDRESS command sequence in a configuration with multiple SCSI initiator devices, it may be necessary to reserve the logical unit to the SCSI initiator port prior to sending the SEND VOLUME TAG command and release the logical unit after the last REQUEST VOLUME ELEMENT ADDRESS command has completed.

A volume tag (VOLTAG) bit of one indicates that the logical unit shall report volume tag information, if implemented by the logical unit. A value of zero indicates that volume tag information shall not be reported. Support for this bit set to one is optional.

The ELEMENT ADDRESS field specifies a media changer element address whose interpretation depends on the SEND ACTION CODE field (see table 25) of the last successful SEND VOLUME TAG command. The SEND ACTION CODE is returned in the volume element address header. When the last SEND ACTION CODE was a translate, the ELEMENT ADDRESS field gives the minimum element address to be reported by this command. When the SEND ACTION CODE is assert, replace, or undefine, the ELEMENT ADDRESS field gives the particular element whose volume tag information was modified.

The NUMBER OF ELEMENTS TO REPORT field specifies the maximum number of elements to be reported for this command. The value specified in this field is the number of elements to report of those that match the last SEND VOLUME TAG command translate template. If the ALLOCATION LENGTH is not

sufficient to transfer all the element descriptors, the device server shall all those descriptors whose complete contents fit within the allocation length and this shall not be considered an error.

The SEND ACTION CODE field (see table 25) reports the function performed by the last SEND VOLUME TAG command.

For fields not defined in this subclause, see the READ ELEMENT STATUS command description in 6.10.

6.12 SEND VOLUME TAG command

6.12.1 SEND VOLUME TAG introduction

The SEND VOLUME TAG command (see table 24) transfers a volume tag template to be used for a search of existing volume tag information or new volume tag information for one media changer element address. The function of the command is conveyed by the SEND ACTION CODE field value. The REQUEST VOLUME ELEMENT ADDRESS command may be used to transfer the results of a translate search operation.

Support for this command is optional for independent media changers.

Table 24 — SEND VOLUME TAG command

Byte \ Bit	7	6	5	4	3	2	1	0
0	OPERATION CODE (B6h)							
1	Reserved				ELEMENT TYPE CODE			
2	(MSB)	ELEMENT ADDRESS						
3								(LSB)
4	Reserved							
5	Reserved			SEND ACTION CODE				
6	Reserved							
7								
8	(MSB)	PARAMETER LIST LENGTH						
9								(LSB)
10	Reserved							
11	CONTROL							

The ELEMENT TYPE CODE field specifies an element type specification as defined in the READ ELEMENT STATUS command (see table 13). If the SEND ACTION CODE field indicates a translate operation, this field indicates the element types to be searched. If the value is zero, all element types are candidates for a translate operation. If the SEND ACTION CODE field does not indicate a translate, this field shall be treated as reserved.

The ELEMENT ADDRESS field gives a media changer element address whose interpretation depends on the SEND ACTION CODE field. When the SEND ACTION CODE field is a translate, the element address field

gives the starting element to be examined for satisfaction of the search criteria. When the SEND ACTION CODE field is assert, replace, or undefine, the ELEMENT ADDRESS field gives the specific element address where volume tag information for a volume is to be modified.

6.12.2 Send action codes

The SEND ACTION CODE field gives the function to be performed by this command as listed in table 25.

Table 25 — Send action codes

Code	Description
0h	Translate - search all defined volume tags
1h	Translate - search only primary volume tags
2h	Translate - search only alternate volume tags
3h	Reserved
4h	Translate - search all defined tags - ignore sequence numbers
5h	Translate - search primary tags - ignore sequence numbers
6h	Translate - search alternate tags - ignore sequence numbers
7h	Reserved
8h	Assert - as the primary volume tag - if tag now undefined
9h	Assert - as the alternate volume tag - if tag now undefined
Ah	Replace - the primary volume tag - current tag ignored
Bh	Replace - the alternate volume tag - current tag ignored
Ch	Undefine - the primary volume tag - current tag ignored
Dh	Undefine - the alternate volume tag - current tag ignored
Eh – 1Bh	Reserved
1Ch – 1Fh	Vendor-specific

Translate operations request that the logical unit search the volume tag information available for volumes at defined element addresses for volume tag information that matches the template given by the command parameter data. The resulting information may be reported via the REQUEST VOLUME ELEMENT ADDRESS command.

Assert operations define volume tag information for a single volume at an element address that does not currently have defined volume tag information. If the volume at the selected element address already has defined volume tag information, CHECK CONDITION status shall be returned. The sense key shall be set to ILLEGAL REQUEST and the additional sense code set to INVALID FIELD IN CDB. In this case, the original volume tag information shall not be changed. Support for this field set to an assert function value is optional.

Replace operations define or overwrite volume tag information for a single volume at one element address. Any previously defined volume tag information is overwritten. Support for this field set to a replace function value is optional.

Undefine operations cause any previously defined volume tag information for the volume at the specified element address to be cleared. It shall not be considered an error to undefine volume tag

information that was not previously defined. Support for this field set to an undefine function value is optional.

If a logical unit implements volume tag information, it may choose to not implement the functions that modify volume tag information. For such an implementation a request for any assert, replace or undefine function shall cause the SEND VOLUME TAG command to be terminated with CHECK CONDITION status. The sense key shall be set to ILLEGAL REQUEST and the additional sense code set to INVALID FIELD IN CDB.

6.12.3 SEND VOLUME TAG parameter data

The PARAMETER LIST LENGTH field shall be zero for undefine functions. The volume tag information sent as command parameter data for translate, assert and replace functions is defined in table 26.

Table 26 — Send volume tag parameters format

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)	VOLUME IDENTIFICATION TEMPLATE						
31								(LSB)
32	(MSB)	Reserved						
33								(LSB)
34	(MSB)	MINIMUM VOLUME SEQUENCE NUMBER						
35								(LSB)
36		Reserved						
37								
38	(MSB)	MAXIMUM VOLUME SEQUENCE NUMBER						
39								(LSB)

The VOLUME IDENTIFICATION TEMPLATE field specifies a search template for translate functions and the exact value of the new volume identification information for other SEND VOLUME TAG command functions.

As a search template, this field may contain the wildcard characters ‘?’ and ‘*’ (3Fh and 2Ah).

a) ‘?’ shall match any single character;

b) ‘*’ shall match any string of characters. When it appears in a template the remainder of the template at higher offsets in the field is not used.

For an assert, replace, or undefine function, if the VOLUME IDENTIFICATION TEMPLATE field contains the ‘?’ or ‘*’ wildcard characters, the device server shall return CHECK CONDITION status. The sense key shall be ILLEGAL REQUEST and the additional sense code INVALID FIELD IN PARAMETER LIST.

The MINIMUM VOLUME SEQUENCE NUMBER field specifies the new sequence number for the assert and replace functions. For a translate, this field specifies the least value in the volume sequence number field of the volume tag information that meets the search specification.

The MAXIMUM VOLUME SEQUENCE NUMBER field specifies the maximum value in a volume sequence number field of the volume tag information that meets the search specification. This field is ignored for assert, replace and undefine functions.

6.13 WRITE ATTRIBUTE command

The WRITE ATTRIBUTE command (see table 27) allows an application client to write attribute values to Medium Auxiliary Memory (MAM).

Table 27 — WRITE ATTRIBUTE command

Bit / Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (8Dh)							
1	Reserved							
2	(MSB)			ELEMENT ADDRESS				
3								(LSB)
4	Obsolete							
5	VOLUME NUMBER							
6	Reserved							
7	PARTITION NUMBER							
8	Reserved							
9	Reserved							
10	(MSB)			PARAMETER LIST LENGTH				
11								
12								
13								(LSB)
14	Reserved							
15	CONTROL							

The ELEMENT ADDRESS field specifies the element where the MAM currently resides as part of a medium. This might mean, for example, a MAM inside a medium residing in a storage element or a MAM inside a medium residing in a data transfer element. Note that this field forms an additional location qualifier hierarchically superior to volume number and partition number.

If the element specified by ELEMENT ADDRESS is empty, the device server shall return CHECK CONDITION status. The sense key shall be ILLEGAL REQUEST and the additional sense code MEDIUM SOURCE ELEMENT EMPTY. If the device server does not support WRITE ATTRIBUTE at the specified ELEMENT ADDRESS, CHECK CONDITION status shall be returned. The sense key shall be ILLEGAL REQUEST and the additional sense code INVALID FIELD IN CDB.

For the definitions of all other fields, and parameter data format, see SPC-3.

7 Parameters

7.1 Diagnostic parameters

This subclause defines the descriptors and pages for diagnostic parameters used with independent media changer devices. Attached media changers shall use the descriptors and pages defined for the data transfer device type.

The diagnostic page codes for independent media changer devices are defined in table 28.

Table 28 — Diagnostic page codes

Page code	Description	Reference
00h	Supported diagnostic page	SPC-2
01h – 1Fh	SES diagnostic pages	SES-2
20h – 3Fh	Diagnostic pages assigned by SPC	SPC-2
40h – 7Fh	Reserved for this standard	
80H – FFh	Vendor-specific pages	

7.2 Log parameters

7.2.1 Log page codes.

This subclause defines the descriptors and pages for log parameters used with independent media changer devices. Attached media changers shall use the descriptors and pages defined for the data transfer device type.

The log page codes for independent media changer devices are defined in table 29.

Table 29 — Log page codes

Page code	Description	Reference
00h	Supported log pages	SPC-2
01h – 05h	Reserved	
06h	Non medium error page	SPC-2
07h	Last *n* error events page	SPC-2
08h – 0Ah	Reserved	
0Bh	Last *n* deferred errors or asynchronous events page	SPC-2
0Ch	Reserved	
0Dh	Temperature page	SPC-2
0Eh	Start-stop cycle counter log page	SPC-2
0Fh	Application client page	SPC-2
10h	Self-test results page	SPC-2
11h - 2Dh	Reserved	
2Eh	TapeAlert log page	7.2.2, 7.3.1
2Fh	Reserved	
30h – 3Eh	Vendor-specific pages	

7.2.2 TapeAlert log page

Support for the TapeAlert log page (see table 30) is optional for independent media changers. If supported, the TapeAlert log page shall operate using the flag definitions in Annex A of this standard. Attached media changers operating with an SSC-2 data transfer device that supports the TapeAlert page shall use the flags as defined in SSC-2.

Table 30 — TapeAlert log page

Bit / Byte	7	6	5	4	3	2	1	0
0	Reserved		PAGE CODE (2Eh)					
1	Reserved							
2	(MSB)	PARAMETER LENGTH (140h)						
3								(LSB)
5n-1	(MSB)	PARAMETER CODE (n)						
5n								(LSB)
5n+1	du(0)	ds(1)	tsd(0)	etc(0)	tmc(00b)		lbin(0)	lp(0)
5n+2	PARAMETER LENGTH (1)							
5n+3	Value of flag							

7.3 Mode parameters

7.3.1 Mode page codes

This subclause defines the descriptors and pages for mode parameters used with independent media changer devices. Attached media changers shall only return pages and descriptors defined for the data transfer device type.

The mode parameter list, including the mode parameter header and mode block descriptor, are defined in SPC-2.

The MEDIUM TYPE code field is contained in the mode parameter header. This field is reserved for independent media changer devices.

The DEVICE–SPECIFIC PARAMETER field is contained in the mode parameter header. This field is reserved for independent media changer devices.

The DENSITY CODE, NUMBER OF BLOCKS and BLOCK LENGTH fields are contained in the mode parameter block descriptor. These fields are reserved for independent media changer devices.

The mode page codes for independent media changer devices are shown in table 31.

Table 31 — Mode page codes

Page code	Description	Reference
00h	Vendor-specific (does not require page format)	
01h	Reserved	
02h	Disconnect Reconnect page	SPC-2
03h - 09h	Reserved	
0Ah	Control Mode page	SPC-2
0Bh - 17h	Reserved	
18h	Protocol specific LUN page	SPC-2
19h	Protocol specific port page	SPC-2
1Ah	Power condition page	SPC-2
1Bh	Reserved	
1Ch	Informational exceptions control page	SPC-2
1Dh	Element address assignment page	7.3.3
1Eh	Transport geometry parameters page	7.3.4
1Fh	Device capabilities page	7.3.2
20H – 3Eh	Vendor-specific (page format required)	
3Fh	Return all pages (valid only for the MODE SENSE command)	SPC-2

7.3.2 Device Capabilities mode page

The Device Capabilities mode page (see table 32) defines characteristics of the element types of an independent media changer. Attached media changers shall not return this page. This information may be employed by the application client to determine functions permitted by the MOVE MEDIUM and EXCHANGE MEDIUM commands.

Table 32 — Device Capabilities mode page

Bit / Byte	7	6	5	4	3	2	1	0
0	PS	RSVD	PAGE CODE (1Fh)					
1	PARAMETER LENGTH (12h)							
2	Reserved				STORDT	STORI/E	STORST	STORMT
3	Reserved					ACE	VTRP	S2C
4	MT->RA		Reserved		MT->DT	MT->I/E	MT->ST	MT->MT
5	ST->RA		Reserved		ST->DT	ST->I/E	ST->ST	ST->MT
6	I/E->RA		Reserved		I/E->DT	I/E->I/E	I/E->ST	I/E->MT
7	DT->RA		Reserved		DT->DT	DT->I/E	DT->ST	DT->MT
8	Reserved							
11								
12	MT->WA		Reserved		MT<>DT	MT<>I/E	MT<>ST	MT<>MT
13	MT->WA		Reserved		ST<>DT	ST<>I/E	ST<>ST	ST<>MT
14	MT->WA		Reserved		I/E<>DT	I/E<>I/E	I/E<>ST	I/E<>MT
15	MT->WA		Reserved		DT<>DT	DT<>I/E	DT<>ST	DT<>MT
16	Reserved							
19								

The parameters savable (PS) bit is only used with the MODE SENSE command. This bit is reserved with the MODE SELECT command. A PS bit of one indicates that the SCSI device is capable of saving the page in a nonvolatile, vendor-specific location.

The field names in table 32 use the following element type abbreviations:

a) MT — a medium transport element,
b) ST — a storage element,
c) I/E — an import/export element, and
d) DT — a data transfer element.

In the descriptions, XX and YY are any of the element type abbreviations.

A STORXX bit value of one indicates that the defined elements of type XX may provide independent storage for a unit of media. A value of zero indicates that elements of type XX provide virtual sources or destinations and that the location of the unit of media is provided by an element of some other type. If any storage elements exist, the value of STORST is one by the definition of that type (see 5.3.3).

An XX->YY bit value of one indicates that the media changer device supports all MOVE MEDIUM commands where the source is element type XX, the destination is element type YY and these element addresses are otherwise valid. An XX->YY bit value of zero indicates that these MOVE MEDIUM commands may or may not be valid depending on the particular elements requested. Those that are not valid shall be rejected with CHECK CONDITION STATUS and a sense key of ILLEGAL REQUEST.

An XX<>YY bit value of one indicates that the media changer device supports all EXCHANGE MEDIUM commands where the source is element type XX, FIRST DESTINATION ADDRESS is element type YY, SECOND DESTINATION ADDRESS is the same type as the source element type and these element addresses are otherwise valid. An XX<>YY bit value of zero indicates that these EXCHANGE MEDIUM commands may or may not be valid depending on the particular elements requested. Those which are not valid shall be rejected with CHECK CONDITION STATUS and a sense key of ILLEGAL REQUEST.

The SMC-2 Capabilities (S2C) bit shall be set to one when the VTRP, ACE, XX-RA, and XX-WA fields are supported. The S2C bit shall be set to zero when any of these fields are not supported.

The Volume Tag Reader Present (VTRP) bit shall be set to one by the device server to indicate that a volume tag reader is installed in the medium changer (e.g. optical bar code reader). The VTRP bit shall be set to zero to indicate that a volume tag reader is not present or is not functional.

The Auto-clean Enabled (ACE) shall be set to one if the device server is managing the data transfer element cleaning process. This ACE bit shall be set to zero if the device server is not managing the cleaning process.

The XX-RA and XX-WA fields indicate the resources required to support the READ ATTRIBUTE (RA) and WRITE ATTRIBUTE (WA) commands for each element type. If the required resources are not available the device server may reject a READ ATTRIBUTE or WRITE ATTRIBUTE command. Alternately, the device server may accept the command but delay processing it until resources are available. Table 33 describes the values for these fields.

Table 33 — XX-RA and XX-WA codes

Code	Description
0h	No MAM access available. READ ATTRIBUTE and WRITE ATTRIBUTE commands that access elements of this type shall be rejected by the device server with CHECK CONDITION status. The Sense Key shall be set to Illegal Request and the additional sense code shall be INVALID FIELD IN CDB.
1h	No resources required for MAM access. The device server shall introduce little or no delay in processing of READ ATTRIBUTE and WRITE ATTRIBUTE commands due to resources.
2h	Medium transport element required for MAM access. If no medium transport elements are available, the device server may return CHECK CONDITION status to a READ ATTRIBUTE or WRITE ATTRIBUTE command addressed to elements of this type. The Sense Key shall be set to Illegal Request and the additional sense code shall be INVALID FIELD IN CDB.
3h	Medium transport and data transfer element required for MAM access. If no medium transport elements are available, or no data transfer elements are available, the device server may return CHECK CONDITION status to a READ ATTRIBUTE or WRITE ATTRIBUTE command addressed to elements of this type. The Sense Key shall be set to Illegal Request and the additional sense code shall be INVALID FIELD IN CDB.

7.3.3 Element Address Assignment mode page

The Element Address Assignment mode page (see table 34) is used to assign addresses to the elements of the independent media changer (MODE SELECT) and to report those assignments (MODE SENSE). This page also defines the number of each type of element present. An attached media changer shall not return this page.

Table 34 — Element Address Assignment mode page

Bit / Byte	7	6	5	4	3	2	1	0
0	PS	RSVD	PAGE CODE (1Dh)					
1	PARAMETER LIST LENGTH							
2	(MSB)	FIRST MEDIUM TRANSPORT ELEMENT ADDRESS						
3								(LSB)
4	(MSB)	NUMBER OF MEDIUM TRANSPORT ELEMENTS						
5								(LSB)
6	(MSB)	FIRST STORAGE ELEMENT ADDRESS						
7								(LSB)
8	(MSB)	NUMBER OF STORAGE ELEMENTS						
9								(LSB)
10	(MSB)	FIRST IMPORT/EXPORT ELEMENT ADDRESS						
11								(LSB)
12	(MSB)	NUMBER OF IMPORT/EXPORT ELEMENTS						
13								(LSB)
14	(MSB)	FIRST DATA TRANSFER ELEMENT ADDRESS						
15								(LSB)
16	(MSB)	NUMBER OF DATA TRANSFER ELEMENTS						
17								(LSB)
18		Reserved						
19								

The parameters savable (PS) bit is only used with the MODE SENSE command. This bit is reserved with the MODE SELECT command. A PS bit of one indicates that the device server is capable of saving the page in a nonvolatile vendor-specific location.

The FIRST MEDIUM TRANSPORT ELEMENT ADDRESS field identifies the first medium transport element contained in the media changer (other than the default medium transport address of zero). The NUMBER OF MEDIUM TRANSPORT ELEMENTS field defines the total number of medium transport elements contained in the media changer. If the NUMBER OF MEDIUM TRANSPORT ELEMENTS field in a MODE SELECT command is greater than the default value returned in the MODE SENSE parameter data,

the device server shall return CHECK CONDITION status. The sense key shall be ILLEGAL REQUEST and the additional sense code PARAMETER VALUE INVALID.

The FIRST STORAGE ELEMENT ADDRESS field identifies the first medium storage element contained in the media changer. The NUMBER OF STORAGE ELEMENTS field defines the total number of medium storage elements contained in the media changer. If the NUMBER OF MEDIUM STORAGE ELEMENTS field in a MODE SELECT command is greater than the default value returned in the MODE SENSE parameter data, the device server shall return CHECK CONDITION status. The sense key shall be ILLEGAL REQUEST and the additional sense code PARAMETER VALUE INVALID.

The FIRST IMPORT/EXPORT ELEMENT ADDRESS field identifies the first medium portal that is accessible both by the medium transport devices and also by an operator from outside the media changer. The NUMBER OF IMPORT/EXPORT ELEMENTS field defines the total number of import/export elements contained in the media changer and accessible to the medium transport elements. If the NUMBER OF IMPORT/EXPORT ELEMENTS field in a MODE SELECT command is greater than the default value returned in the MODE SENSE parameter data, the device server shall return CHECK CONDITION status. The sense key shall be ILLEGAL REQUEST and the additional sense code PARAMETER VALUE INVALID.

The FIRST DATA TRANSFER ELEMENT ADDRESS field identifies the first data transfer element contained in the media changer. The data transfer elements may be either read/write or read-only devices. The NUMBER OF DATA TRANSFER ELEMENTS field defines the total number of data transfer elements contained within the media changer and accessible to the medium transport elements. If the NUMBER OF DATA TRANSFER ELEMENTS field in a MODE SELECT command is greater than the default value returned in the MODE SENSE parameter data, the device server shall return CHECK CONDITION status. The sense key shall be ILLEGAL REQUEST and the additional sense code PARAMETER VALUE INVALID.

NOTE 14 — The number of import/export elements or data transfer elements may be zero. The number of storage elements may only be zero when there is at least one import/export element with independent storage capability (see 5.3.3).

Each element in the media changer shall have a unique address. If the address ranges defined for any of the element types overlap for a MODE SELECT command, the device server shall return CHECK CONDITION status. The sense key shall be ILLEGAL REQUEST and the additional sense code INVALID ELEMENT ADDRESS.

7.3.4 Transport Geometry Parameters mode page

The Transport Geometry Parameters mode page (see table 35) indicates whether each medium transport element of an independent media changer is a member of a set of elements that share common robotics and whether the element is capable of media rotation. One transport geometry descriptor is transferred for each medium transport element, beginning with the first medium transport element (other than the default transport element address of zero).

Table 35 — Transport Geometry Parameters mode page

Bit / Byte	7	6	5	4	3	2	1	0
0	PS	RSVD	PAGE CODE (1Eh)					
1	PARAMETER LENGTH (n-1)							
2	Transport geometry descriptor(s)							
n								

The parameters savable (PS) bit is only used with the MODE SENSE command. This bit is reserved with the MODE SELECT command. A PS bit of one indicates that the SCSI device is capable of saving the page in a nonvolatile vendor-specific location.

The PARAMETER LENGTH specifies the number of bytes of transport geometry descriptors that follow. The geometry of each medium transport element is defined using a two-byte field as defined by table 36.

Table 36 — Transport geometry descriptor

Bit / Byte	7	6	5	4	3	2	1	0
0	Reserved							ROTATE
1	MEMBER NUMBER IN TRANSPORT ELEMENT SET							

A ROTATE bit of one indicates that the medium transport element supports media rotation for handling double-sided media. A ROTATE bit of zero indicates that the medium transport element does not support media rotation.

The MEMBER NUMBER IN TRANSPORT ELEMENT SET field indicates the position of this element in a set of medium transport elements that share common robotics. The first element in a set has a MEMBER NUMBER IN TRANSPORT ELEMENT SET of zero.

NOTE 15 — This mode page reports information about the way transport elements are physically clustered in a system. The model for this is a media changer device with more than one independent robotics subsystem, where each of these supports multiple transport elements. The elements that are supported by a particular robotics subsystem form a set. This sort of information is helpful for optimization and error recovery in such a large system. The individual transport element is addressed, not the robotics subsystem. An element is defined to be a place where a unit of media may be at any point in time. See clause 5.3.

Annex A
(normative)

A.1 TapeAlert Flags

Table A.1 is a listing of TapeAlert flags in numeric order.

Table A.1 — TapeAlert Flags for independent media changers (part 1 of 4)

Code	Flag	Type	Flag Type	Recommended application client message	Probable cause
01h	Library Hardware A	O	C	The library mechanism is having difficulty communicating with the drive: 1. Turn the library off then on. 2. Restart the operation. 3. If the problem persists, call the library supplier help line.	Changer mechanism is having trouble communicating with the internal drive
02h	Library Hardware B	M	W	There is a problem with the library mechanism. If problem persists, call the library supplier help line.	Changer mechanism has a hardware fault
03h	Library Hardware C	O	C	The library has a hardware fault: 1. Reset the library. 2. Restart the operation. Check the library users manual for device specific instructions on resetting the device.	The changer mechanism has a hardware fault that requires a reset to recover
04h	Library Hardware D	M	C	The library has a hardware fault: 1. Turn the library off then on again. 2. Restart the operation. 3. If the problem persists, call the library supplier help line. Check the library users manual for device specific instructions on turning the device power on and off.	The changer mechanism has a hardware fault that is not mechanically related or requires a power cycle to recover
05h	Library Diagnostics Required	O	W	The library mechanism may have a hardware fault. Run extended diagnostics to verify and diagnose the problem. Check the library users manual for device specific instructions on running extended diagnostic tests.	The changer mechanism may have a hardware fault that would be identified by extended diagnostics .
06h	Library Interface	O	C	The library has a problem with the host interface: 1. Check the cables and connections. 2. Restart the operation.	The library has identified an interface fault
07h	Predictive Failure	O	W	A hardware failure of the library is predicted. Call the library supplier help line.	Predictive failure of library hardware

Type Key:
M - Mandatory
O - Optional

Flag Type Key:
C - Critical
W - Warning
I - Information

Table A.1 — TapeAlert Flags for independent media changers (part 2 of 4)

Code	Flag	Type	Flag Type	Recommended application client message	Probable cause
08h	Library Maintenance	O	W	Preventive maintenance of the library is required. Check the library users manual for device specific preventative maintenance tasks, or call your library supplier help line.	Library preventative maintenance required
09h	Library Humidity Limits	O	C	General environmental conditions inside the library are outside the specified humidity range.	Library humidity limits exceeded
0Ah	Library Temperature Limits	O	C	General environmental conditions inside the library are outside the specified temperature range.	Library temperature limits exceeded
0Bh	Library Voltage Limits	O	C	The voltage supply to the library is outside the specified range. There is a potential problem with the power supply or failure of a redundant power supply.	Library voltage limits exceeded
0Ch	Library Stray Tape	O	C	A cartridge has been left inside the library by a previous hardware fault: 1. Insert an empty magazine to clear the fault. 2. If the fault does not clear, turn the library off and then on again. 3. If the problem persists, call the library supplier help line.	Stray cartridge left in library after previous error recovery
0Dh	Library Pick Retry	M	W	There is a potential problem with the drive ejecting cartridges or with the library mechanism picking a cartridge from a slot. 1. No action needs to be taken at this time. 2. If the problem persists, call the library supplier help line.	Operation to pick a cartridge from a slot had to perform an excessive number of retries before succeeding
0Eh	Library Place Retry	M	W	There is a potential problem with the library mechanism placing a cartridge into a slot. 1. No action needs to be taken at this time. 2. If the problem persists, call the library supplier help line.	Operation to place a cartridge in a slot had to perform an excessive number of retries before succeeding
0Fh	Library Load Retry	M	W	There is a potential problem with the drive or the library mechanism loading cartridges, or an incompatible cartridge.	Operation to load a cartridge in a drive had to perform an excessive number of retries before succeeding
10h	Library Door	M	C	The library has failed because the door is open: 1. Clear any obstructions from the library door. 2. Close the library door. 3. If the problem persists, call the library supplier help line.	Changer door open prevents library functioning
11h	Library Mailslot	O	C	There is a mechanical problem with the library media import/export mailslot.	Mechanical problem with import/export mailslot

Type Key:
M - Mandatory
O - Optional

Flag Type Key:
C - Critical
W - Warning
I - Information

Table A.1 — TapeAlert Flags for independent media changers (part 3 of 4)

Code	Flag	Type	Flag Type	Recommended application client message	Probable cause
12h	Library Magazine	O	C	The library cannot operate without the magazine. 1. Insert the magazine into the library. 2. Restart the operation.	Library magazine not present
13h	Library Security	O	W	Library security has been compromised.	Library door opened then closed during operation
14h	Library Security Mode	O	I	The library security mode has been changed. The library has either been put into secure mode, or the library has exited the secure mode. This is for information purposes only. No action is required.	Library security mode changed
15h	Library Offline	O	I	The library has been manually turned offline and is unavailable for use.	Library manually turned offline
16h	Library Drive Offline	O	I	A drive inside the library has been taken offline. This is for information purposes only. No action is required.	Library turned internal drive offline.
17h	Library Scan Retry	M	W	There is a potential problem with the bar code label or the scanner hardware in the library mechanism. 1. No action needs to be taken at this time. 2. If the problem persists, call the library supplier help line.	Operation to scan the bar code on a cartridge had to perform and excessive number of retries before succeeding
18h	Library Inventory	O	C	The library has detected an inconsistency in its inventory. 1. Redo the library inventory to correct inconsistency. 2. Restart the operation. Check the applications users manual or the hardware users manual for specific instructions on redoing the library inventory.	Inconsistent media inventory
19h	Library Illegal Operation	O	W	A library operation has been attempted that is invalid at this time.	Illegal operation detected
1Ah	Dual-Port Interface Error	O	W	A redundant interface port on the library has failed.	Failure of one interface port in a dual-port configuration
1Bh	Cooling Fan Failure	O	W	A library cooling fan has failed.	One or more fans inside the library have failed. Internal flag state only cleared when all flags are working again
1Ch	Power Supply	O	W	A redundant power supply has failed inside the library. Check the library users manual for instructions on replacing the failed power supply.	Redundant power supply failure inside the library subsystem

Type Key:
M - Mandatory
O - Optional

Flag Type Key:
C - Critical
W - Warning
I - Information

Table A.1 — TapeAlert Flags for independent media changers (part 4 of 4)

Code	Flag	Type	Flag Type	Recommended application client message	Probable cause
1Dh	Power Consumption	O	W	The library power consumption is outside the specified range.	Power consumption of one or more devices inside the library is outside the specified range
1Eh	Pass-through mechanism failure	O	C	A failure has occurred in the cartridge pass-through mechanism between two library modules.	Error occurred in pass-through mechanism during self test or while attempting to transfer a cartridge between library modules
1Fh	Cartridge in pass-through mechanism	O	C	A cartridge has been left in the pass-through mechanism from a previous hardware fault. Check the library users guide for instructions on clearing this fault.	Cartridge left in the pass-through mechanism between two library modules
20h	Unreadable bar code labels	O	I	The library was unable to read the bar code on a cartridge.	Unable to read a bar code label on a cartridge during library inventory/scan

Type Key:
M - Mandatory
O - Optional

Flag Type Key:
C - Critical
W - Warning
I - Information