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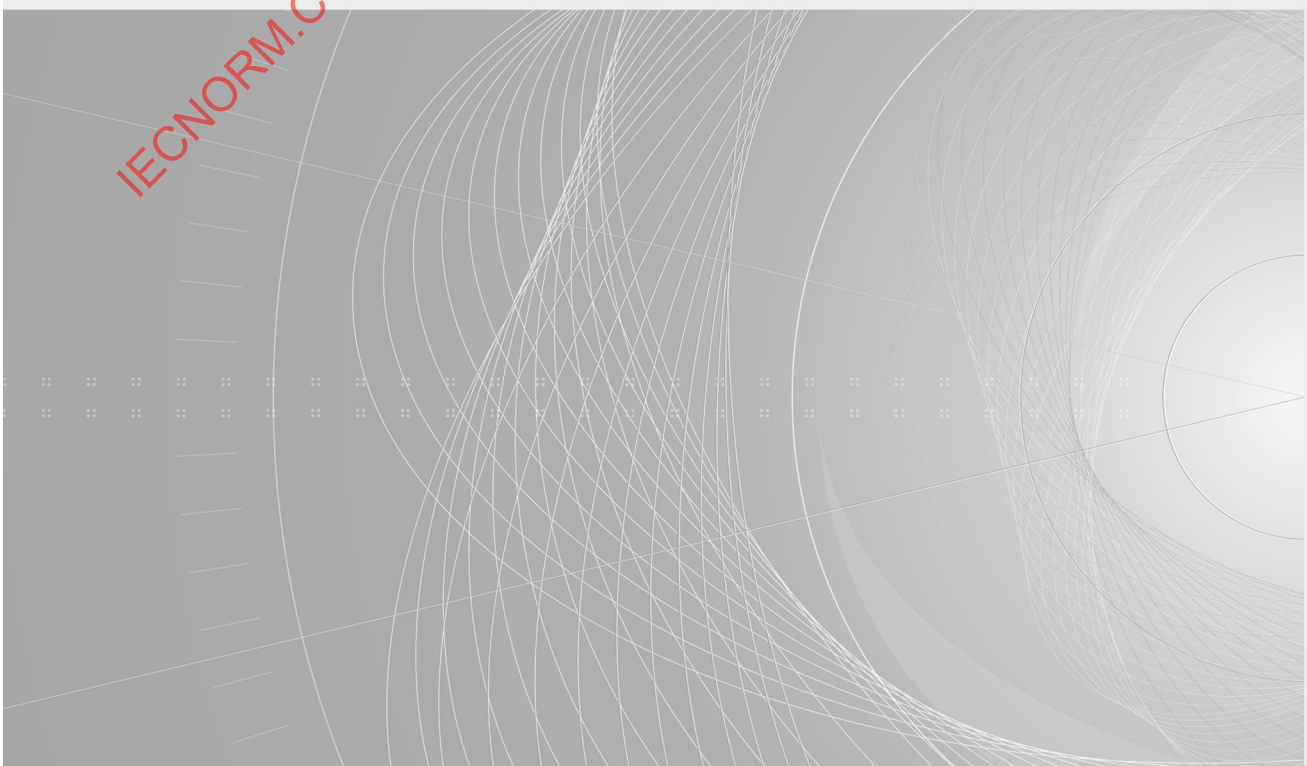
INTERNATIONAL STANDARD

Information technology – Small Computer System Interface (SCSI) – Part 333: SCSI Stream Commands – 3 (SSC-3)



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IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
Fax: +41 22 919 03 00
info@iec.ch
www.iec.ch

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INFORMATION TECHNOLOGY - Small Computer System Interface (SCSI) - Part 333: SCSI Stream Commands - 3 (SSC-3)

FOREWORD

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International Standard ISO/IEC 14776-333 was prepared by subcommittee 25: Interconnection of information technology equipment, of ISO/IEC joint technical committee 1: Information technology.

A list of all currently available parts of the ISO/IEC 14776 series, under the general title *Information technology – Small computer system interface (SCSI),* can be found on the IEC web site.

This International Standard has been approved by vote of the member bodies and the voting results may be obtained from the address given on the second title page.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

For any information concerning Technical Committee T10 (SCSI Storage Interfaces), contact ANSI/INCITS (American National Standards Institute, http://www.ansi.org/).

INTRODUCTION

The SCSI Stream Commands - 3 (SSC-3) standard is divided into eight clauses:

Clause 1 is the scope.
Clause 2 enumerates the normative references that apply to this standard.
Clause 3 describes the definitions, acronyms, keywords, and conventions used in this standard.
Clause 4 describes an overview and model of the sequential-access type device.
Clause 5 describes the explicit address command set for sequential-access type devices.
Clause 6 describes the implicit address command set for sequential-access type devices.
Clause 7 describes the common command set for sequential-access type devices.
Clause 8 describes the parameters for sequential-access type devices.

The annexes provide information to assist with implementation of this standard.

INFORMATION TECHNOLOGY - Small Computer System Interface (SCSI) - Part 333: SCSI Stream Commands - 3 (SSC-3)

1 Scope

This part of ISO/IEC 14776 defines the command set extensions in order to facilitate operation of the sequential-access device type. This part of ISO/IEC 14776, implemented in conjunction with the requirements of the SCSI Architecture Model-4 (SAM-4) standard and the applicable clauses of the SCSI Primary Commands-4 (SPC-4) standard, fully specify the standard command set for the sequential-access device type.

This standard provides the following:

a) it permits an application client to communicate over a SCSI service delivery subsystem, with a logical unit that declares itself to be a sequential-access device in the PERIPHERAL DEVICE TYPE field of the standard INQUIRY data (see SPC-4);
b) it defines commands unique to the sequential-access device type; and
c) it defines commands in order to manage the operation of the sequential-access device type.

Figure 1 shows the relationship of this standard to the other standards and related projects in the SCSI family standards as of the publication of this standard.

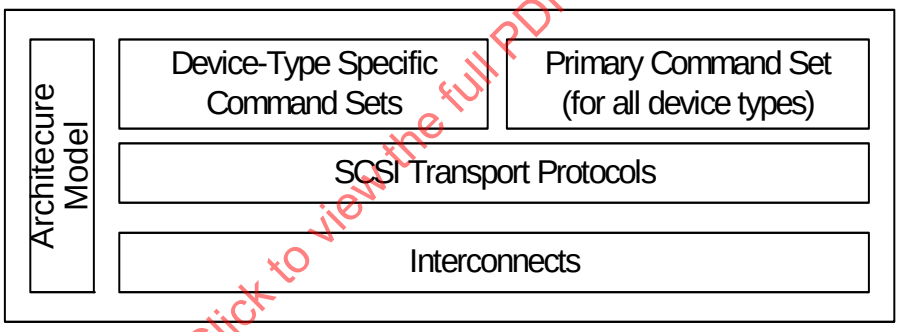

Figure 1 — SCSI document relationships

The roadmap in figure 1 is intended to show the general applicability of the documents to one another. The figure is not intended to imply a relationship such as a hierarchy, protocol stack, or system architecture. It specifies the applicability of a standard to the implementation of a given SCSI protocol.

This standard makes obsolete the following concepts from previous versions of this standard:

a) the GAP SIZE field;
b) RSMK and setmarks; and
c) Attached Media Changer model.

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

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC 14776-414, *Information technology – Small Computer System Interface (SCSI) – Part 414: Architecture model - 4 (SAM-4)*

ISO/IEC 14776-452, *Information technology – Small Computer System Interface (SCSI) – Part 452: Primary Commands - 2 (SPC-2)*

ANSI X9.63:2001, *Public Key Cryptography for the Financial Services Industry – Key Agreement and Key Transport Using Elliptic Curve Cryptography*

ANSI INCITS 382-2004, *Information technology – SCSI Media Changer Commands - 2 (SMC-2)*

ANSI INCITS 513-2004, *Information technology – SCSI Primary Commands - 4 (SPC-4)* [T10/1731-D]

RFC 3447, *Public-Key Cryptography Standards (PKCS) #1: RSA Cryptography Specifications Version 2.1*

3 Terms, definitions, acronyms, keywords and conventions

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1.1
additional sense code
see SPC-4

3.1.2
application client
object that is the source of SCSI commands and task management requests

Note 1 to entry: Further definition of an application client may be found in SAM-4.

3.1.3
authorization white list
set of identifiers, typically public keys, for entities that are authorized to perform some operation

3.1.4
auxiliary memory
memory component that is accessible to the device server

Note 1 to entry: This memory is usually non-volatile and independent of the main function of the device server.

3.1.5
BOx
beginning-of-medium (see 3.1.6) or beginning-of-partition (see 3.1.7)

3.1.6
beginning-of-medium
BOM
extreme position along the medium in the direction away from the supply reel that is accessible by the device

Note 1 to entry: This position may be different from a beginning-of-partition position.

3.1.7
beginning-of-partition
BOP
position at the beginning of the permissible recording region of a partition

Note 1 to entry: This position may not coincide with a beginning-of-medium position.

3.1.8
block address mode
mode of operation that the logical unit is currently supporting (see 4.2.17)

Note 1 to entry: The block address mode is either the explicit address mode (see 3.1.22) or the implicit address mode (see 3.1.30).

3.1.9
buffered mode
mode of logical block transfer in write operations that facilitates tape streaming

Note 1 to entry: Buffered mode is specified by a non-zero value (1h or 2h) in the BUFFER MODE field in the mode parameter header (see 8.3). Buffered mode is the opposite of unbuffered mode (see 3.1.80).

3.1.10
byte
8-bit construct

3.1.11
command
request describing a unit of work to be performed by a device server

Note 1 to entry: A detailed definition of a command may be found in SAM-4.

3.1.12
command descriptor block
CDB
structure used to communicate commands from an application client to a device server

Note 1 to entry: A command descriptor block may have a fixed length of up to 16 bytes or a variable length of between 12 bytes and 260 bytes.

3.1.13
common command
command that is contained in both the explicit and implicit address command sets

3.1.14
device entity
object in a SCSI target device that performs operations on a volume, stores parameters, and communicates between device servers

Note 1 to entry: See 4.2.4.

3.1.15
device server
object within a logical unit that processes SCSI tasks according to the rules of task management

Note 1 to entry: See SAM-4.

3.1.16
device type
type of device (or device model) implemented by the device server

3.1.17
early-warning
EW
physical mark or device computed position near but logically before the end-of-partition, independent of physical direction (see 4.2.5)

3.1.18
encrypted logical block
logical block containing data that has been subjected to a ciphering process by the device server

Note 1 to entry: Within this standard, a logical block is only considered encrypted if the ciphering process was performed by a device server.

3.1.19
end-of-data
EOD
recorded indication that no valid logical objects are recorded between this position and end-of-partition (see 3.1.21)

Note 1 to entry: End-of-data is denoted in a format-specific manner (see 4.2.8.1).

3.1.20
end-of-medium
EOM
extreme position along the medium in the direction away from the take-up reel that is accessible by the device

Note 1 to entry: This position may be different from an end-of-partition position.

3.1.21
end-of-partition
EOP
position at the end of the permissible recording region of a partition

3.1.22
explicit address mode
mode of operation in which the logical unit is supporting the explicit address command set (see 3.1.23)

3.1.23
explicit address command set
command set in which read and writes contain positioning information

3.1.24
explicit command
command contained only in the explicit address command set (see table 22)

3.1.25
field
group of one or more contiguous bits, a part of a larger structure such as a CDB (see 3.1.12) or sense data (see 3.1.68)

3.1.26
filemark
special recorded logical object within a partition, not containing user data, that provides a segmentation scheme for the contents of a partition

3.1.27
fixed-block transfer
read or write type command with the FIXED bit set to one

3.1.28
format label
vendor-specific series of logical objects that contain information used to identify the volume or data set

3.1.29
generic command
explicit command (see 3.1.24) that is not a read type or write type command

3.1.30
implicit address mode
mode of operation in which the logical unit is supporting the implicit address command set (see 3.1.31)

3.1.31
implicit address command set
command set in which read and writes do not contain positioning information, and positioning is implied relative to the current position

3.1.32
implicit command
command contained only in the implicit address command set (see table 30)

3.1.33
information field
command-specific field in the sense data (see SPC-4)

3.1.34
I_T nexus
nexus between a SCSI initiator port and a SCSI target port (see SAM-4)

3.1.35
I_T nexus loss
condition resulting from the events defined by SAM-4 in which the SCSI device performs the operations described in SAM-4 and this standard

3.1.36
I_T nexus lossevent
SCSI transport protocol specific event that triggers I_T nexus loss as described in SAM-4

3.1.37
logical block
logical object that is a unit of data supplied or requested by an application client

3.1.38
logical block encryption parameters
set of parameters (see 4.2.22.14) that controls the logical block encryption and decryption processes in the device entity (see 3.1.14)

3.1.39
logical file
zero or more logical blocks starting immediately after BOP or a filemark (see 4.2.9)

3.1.40
logical file identifier
unique identifier, within a partition, for a logical file (see 4.2.9.2)

3.1.41
logical identifer
logical object identifier or logical file identifier

3.1.42
logical object
logical block or a filemark (see 4.2.8)

3.1.43
logical object identifier
unique identifier, within a partition, for a logical object (see 4.2.8.2)

3.1.44
logical unit reset
logical unit action in response to a logical unit reset event in which the logical unit performs the operations described in SAM-4

3.1.45
logical unit reset event
event that triggers a logical unit reset from a logical unit as described in SAM-4

3.1.46
medium auxiliary memory
MAM
auxiliary memory residing in a volume (e.g., a tape cartridge) that is accessible to the device server

Note 1 to entry: See SPC-4.

3.1.47
message authentication code
information used to validate the integrity of encrypted logical blocks (see 3.1.18)

3.1.48
native capacity
capacity assuming one-to-one compression (e.g., compression disabled), the medium is in good condition, and that the device recommended typical block size is used

3.1.49
nexus
relationship between two SCSI devices, and the SCSI initiator port and SCSI target port objects within those devices (see SAM-4)

3.1.50
nonce
unpredictable random value used only for a single instance or invocation of a cryptographic algorithm or protocol

3.1.51
one
logical true condition of a variable

3.1.52
overlength
incorrect-length condition that exists after processing a read command when the length of the actual logical block read exceeds the requested transfer length in the command descriptor block or the mode header block size field, whichever is appropriate

3.1.53
page
several commands use regular parameter structures that are referred to as pages

Note 1 to entry: These pages are identified with a value known as a page code.

3.1.54
partition
entire usable region for recording and reading in a volume or in a portion of a volume, defined in a vendor-specific or format-specific manner (see 4.2.7)

3.1.55
principal density code
principal density code is a density code selected by the device server

Note 1 to entry: The logical unit specifies the principal density code by reporting a DEFLT bit of one in the density support data block descriptor for supported densities in response to the REPORT DENSITY SUPPORT command (see 7.8). The selection of the principal density code is vendor specific.

3.1.56
programmable-early-warning zone
PEWZ
zone within a partition that has its EOP side established at early warning and extends towards BOP for a distance indicated by the PEWS field (see 8.3.8)

Note 1 to entry: See 4.2.6.

3.1.57
reservation loss
event caused by the release of a reserve/release method reservation (see SPC-2) or by the transition within the device server from the state where a persistent reservation holder exists to the state where a persistent reservation holder does not exist (see SPC-4)

3.1.58
SCSI device
device that contains one or more SCSI ports that are connected to a service delivery subsystem and supports a SCSI application protocol (see SAM-4)

3.1.59
SCSI domain
interconnection of two or more SCSI devices and a service delivery subsystem

Note 1 to entry: A detailed definition of a SCSI domain may be found in SAM-4.

3.1.60
SCSI initiator device
SCSI device containing application clients and SCSI initiator ports that originates device service and task management requests to be processed by a SCSI target device and receives device service and task management responses from the SCSI target devices

Note 1 to entry: When used this term refers to SCSI initiator devices or SCSI target/initiator devices that are using the SCSI target/initiator port as a SCSI initiator port.

3.1.61
SCSI initiator port
SCSI initiator device object that acts as the connection between application clients and the service delivery subsystem through which requests, indications, responses, and confirmations are routed

Note 1 to entry: In all cases when this term is used it refers to a SCSI initiator port or a SCSI target/initiator port operating as a SCSI initiator port.

3.1.62
SCSI port
SCSI device resident object that connects the application client, device server or task manager to the service delivery subsystem through which requests and responses are routed

Note 1 to entry: SCSI port is synonymous with port. A SCSI port is one of: a SCSI initiator port, a SCSI target port, or a SCSI target/initiator port.

3.1.63
SCSI target device
SCSI device containing logical units and SCSI target ports that receives device service and task management requests for processing and sends device service and task management responses to SCSI initiator devices

Note 1 to entry: When used this term refers to SCSI target devices or SCSI target/initiator devices that are using the SCSI target/initiator port as a SCSI target port.

3.1.64
SCSI target port
SCSI target device object that contains a task router and acts as the connection between device servers and task managers and the service delivery subsystem through which indications and responses are routed

Note 1 to entry: When this term is used it refers to a SCSI target port or a SCSI target/initiator port operating as a SCSI target port.

3.1.65
SCSI target/initiator device
SCSI device that has all the characteristics of a SCSI target device and a SCSI initiator device

3.1.66
SCSI target/initiator port
SCSI device resident object that has all the characteristics of a SCSI target port and a SCSI initiator port

3.1.67
security metadata
data used by security methods to enable user data to be returned in the form it existed prior to the application of the security methods (e.g., logical block encryption parameters, passwords, wrapped keys)

Note 1 to entry: Security meta-data may be used for vendor-specific security methods.

3.1.68
sense data
see SPC-4

3.1.69
sense key
see SPC-4

3.1.70
service delivery subsystem
part of an SCSI I/O system that transmits service requests to a logical unit or SCSI target device and returns logical unit or SCSI target device responses to a SCSI initiator device

Note 1 to entry: A detailed definition of a service delivery subsystem may be found in SAM-4.

3.1.71
spacing
act of positioning the medium on a sequential-access device while processing a SPACE command

3.1.72
status
one byte of response information sent from a device server to an application client upon completion of each command

Note 1 to entry: A detailed definition of status may be found in SAM-4.

3.1.73
synchronize operation
process of writing buffered logical objects to the medium (see 4.2.11)

3.1.74
tagged write sequence
one or more WRITE(16), WRITE FILEMARKS(16), or ERASE(16) commands delineated by the FCS and LCS bits (see 5.6, 5.7, and 5.2)

3.1.75
tape
medium on which data is recorded

Note 1 to entry: See 4.2.2.

3.1.76
TapeAlert
device server capability that provides detailed device diagnostic information using a standard interface

3.1.77
thread
process in which the medium is being engaged for positioning on a suitable transport mechanism (e.g., spooled on to a take-up reel, wrapped around the surface of a helical scan drum)

Note 1 to entry: After threading is complete the tape device may begin positioning the medium to an initial position.

3.1.78
track
contiguous line on the medium consisting of a pattern of recorded signals written by one write component

3.1.79
track group
set of tracks that are recorded at the same time

3.1.80
unbuffered mode
mode of operation where write data is written directly to the medium without being buffered

Note 1 to entry: Unbuffered mode is specified by a zero value (0h) in the BUFFER MODE field in the mode parameter header (see 8.3). Unbuffered mode is the opposite of buffered mode (see 3.1.9).

3.1.81
underlength
incorrect-length condition that exists after processing a read command when the requested transfer length in the command descriptor block or the mode header block size field, whichever is appropriate, exceeds the length of the actual logical block read

3.1.82
unencrypted logical block
logical block containing cleartext (i.e., logical block that has not been enciphered by the device server)

3.1.83
unthread
part of the unloading process in which the medium is being disengaged from the suitable transport mechanism (e.g., de-spooled from a take-up reel, unwrapped from around the surface of a helical scan drum)

3.1.84
variable-block transfer
read or write type command with the FIXED bit set to zero

3.1.85
vendor-specific control metadata
vendor-specific information stored on the volume outside the user data area(s) that is used to control or specify how the volume is being used by application clients (e.g., directory information, partition information, EOD locations, copies of data stored in a vendor-specific manner, volume serial number information, number of logical blocks on the medium)

3.1.86
volume
medium together with its physical carrier

Note 1 to entry: See 4.2.2.

3.1.87
zero
logical false condition of a variable.

3.2 Acronyms

A-KAD	authenticated key-associated data
ADC	Automation Device Control
ALDC	Adaptive Lossless Data Compression: ISO/IEC 15200:1996
BOM	beginning-of-medium
BOP	beginning-of-partition
CbCS	capability-based command security
CDB	command descriptor block
DCLZ	Data Compression according to Lempel and Ziv: ISO/IEC 11558:1992
DEM	data encapsulation mechanism
ECC	error correction code
ECC	elliptic curve cryptography
ECDSA	Elliptic Curve Digital Signature Algorithm
ECIES	Elliptic Curve Integrated Encryption Scheme
ECMA	European Computer Manufacturers Association
EOD	end-of-data
EOM	end-of-medium
EOP	end-of-partition
EW	early-warning
HC	hybrid cipher
I/O	input-output
ID	identifier
IDRC	Improved Data Recording Capability
INCITS	InterNational Committee for Information Technology Standards
KDF	key derivation function
KEM	key encapsulation mechanism
LSB	least significant bit
M	mandatory
M-KAD	metadata key-associated data
MA	MAC algorithm
MAC	message authentication code
MAM	medium auxiliary memory
MSB	most significant bit
NA	not applicable
O	optional
PEWZ	programmable-early-warning zone
RSA	Rivest-Shimir-Adleman
Rsvd	reserved
SA	security association
SAM-4	SCSI Architecture Model - 4
SC	symmetric cipher
SCSI	Small Computer System Interface
SDK	supplemental decryption keys
SMC-2	SCSI Media Changer Commands - 2
SPC-2	SCSI Primary Commands - 2
SPC-4	SCSI Primary Commands - 4
SSC-3	SCSI Stream Commands - 3 (this standard)
U-KAD	unauthenticated key-associated data

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 field or code value. Receipt of an invalid field or code value shall be reported as an error.

3.3.3 ignored

A keyword used to describe an unused field or code value. The contents or value of an ignored field or code value shall not be examined by the receiving SCSI device and may be set to any value by the transmitting SCSI device.

3.3.4 mandatory

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

3.3.5 may

A keyword that specifies flexibility of choice with no implied preference (equivalent to "may or may not").

3.3.6 may not

A keyword that specifies flexibility of choice with no implied preference (equivalent to "may or may not").

3.3.7 obsolete

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

3.3.8 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.

3.3.9 reserved

A keyword referring to fields and code values that are set aside for future standardization. A reserved field shall be set to zero, or in accordance with a future extension to this standard. Recipients are not required to check reserved fields for zero values. Receipt of reserved code values in defined fields shall be reported as an error.

3.3.10 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.

3.3.11 should

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

3.3.12 vendor specific

Items (e.g., fields, code values, etc.) that are not defined by this standard and may be vendor defined.

3.4 Editorial 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 clause 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). Lowercase is used for words having the normal English meaning.

The names of fields are in small uppercase (e.g., ALLOCATION LENGTH). When a field name is a concatenation of acronyms, uppercase letters may be used for readability (e.g., NORMACA). Normal case is used when the contents of a field are being discussed. 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 lower-case b or h are decimal values.

Numbers immediately followed by lower-case b (xxb) are binary values.

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

The most significant bit of a binary quantity is shown on the left side and represents the highest algebraic value position in the quantity.

If a field is specified as not meaningful or the field is to be ignored, the entity that receives the field shall not take any action based on the value of that field.

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.

This standard uses the following conventions for representing decimal numbers:

a) the decimal separator (i.e., separating the integer and fractional portions of the number) is a period;
b) the thousands separator (i.e., separating groups of three digits in a portion of the number) is a space; and
c) the thousands separator is used in both the integer portion and the fraction portion of a number.

Table 1 shows some examples of decimal numbers represented using various conventions.

Table 1 — **Numbering conventions examples**

ISO/IEC	US	This standard
0,6	0.6	0.6
3,141 592 65	3.14159265	3.141 592 65
1 000	1,000	1 000
1 323 462,95	1,323,462.95	1 323 462.95

3.5 Notation conventions – State diagrams

All state diagrams use the notation shown in figure 2.

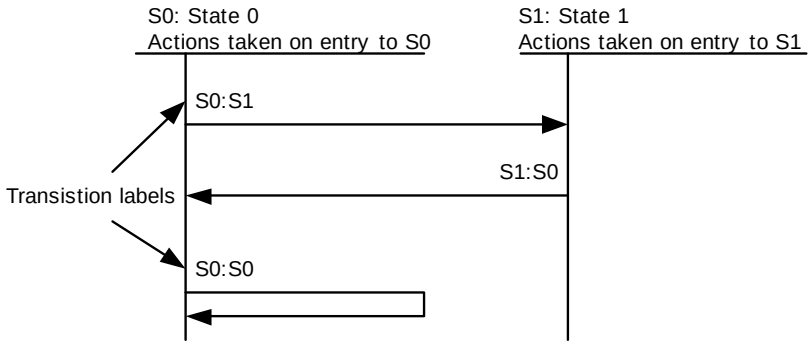

Figure 2 — Example state diagram

The state diagram is followed by a list of the state transitions, using the transition labels. Each transition is described in the list with particular attention to the conditions that cause the transition to occur and special conditions related to the transition. Using figure 2 as an example, the transition list might read as follows:

Transition S0:S1: This transition occurs when state S0 is exited and state S1 is entered.

Transition S1:S0: This transition occurs when state S1 is exited and state S0 is entered.

Transition S0:S0: This transition occurs when state S0 transitions to itself. It is particularly important to note that the actions taken whenever state S0 is entered are repeated every time this transition occurs.

A system specified in this manner has the following properties:

a) time elapses only within discrete states;
b) state transitions are logically instantaneous; and
c) every time a state is entered, the actions of that state are started. Note that this means that a transition that points back to the same state restarts the actions from the beginning.

4 General concepts

4.1 Overview

The sequential-access device type has the characteristic of primarily handling data in a sequential manner (i.e., a stream). This does not limit the device's ability to position randomly within the data although a sequential-access device is not truly random-access.

This standard describes two modes and associated command sets for communicating with a sequential-access device:

a) implicit address mode. Commands to read and write on a sequential-access device do not contain any positioning information fields. Instead, the device position is normally determined by previous commands; and
b) explicit address mode. Commands to read and write on a sequential-access device contain positioning information fields.

Commands are available for absolute and relative positioning. Writing to a sequential-access device may cause all data starting at the point at which the data is written to be invalidated. There may be restrictions on where write operations may be initiated. Reading or writing data as a long string of data, as in a stream, tends to be the most efficient.

4.2 Sequential-access device model

4.2.1 Sequential-access device model overview

Sequential-access devices are described herein from the point of view of a tape device. However, other implementations are not precluded.

Sequential-access devices optimize their use in storing or retrieving user data in a sequential manner. Since access is sequential, position changes typically take a long time, when compared to random-access devices.

4.2.2 Physical elements

The medium for tape devices consists of various widths and lengths of a flexible substrate coated with a semi-permanent magnetic material. The medium may be spooled onto single reels or encapsulated into cartridges containing both a supply reel and a take-up reel. Several American National Standards exist covering the construction of reels and cartridges for interchange as well as recording techniques for many of the format or density combinations.

For a sequential-access device, a medium exists between two reels, the supply reel and take-up reel. The read/write mechanism may only access the medium between the reels. As the medium is taken out of one reel, it passes by the read/write mechanism and into the other reel. Transferring data as a stream is most efficient, since the medium may traverse the read/write mechanism producing a flow of data. To position to a given point requires moving the medium until the appropriate position is found.

The medium has two physical attributes called beginning-of-medium (BOM) and end-of-medium (EOM). Beginning-of-medium is at the end of the medium that is attached to the take-up reel. End-of-medium is at the end of the medium that is attached to the supply reel. In some cases, the medium is permanently affixed to one or both of the reel hubs. BOM or EOM is not required to be related to BOP or EOP of any partition.

A volume is composed of the medium, its physical carrier (e.g., reel, cartridge, cassette), and MAM if present. Volumes have an attribute of being mounted or demounted on a suitable transport mechanism.

A volume is defined as mounted when the device is physically capable of processing commands that cause the medium to be moved. A volume is defined as demounted when it is being loaded, threaded, unloaded, unthreaded, or when not attached to the device.

A logical unit is defined as ready when medium access commands are able to be processed. A logical unit is defined as not ready when no volume is mounted or whenever any medium access command reports CHECK CONDITION status and a NOT READY sense key. The logical unit is not ready during the transition from mounted to demounted, or demounted to mounted. Devices may have a physical control that places the device in a not ready state even when a volume is mounted.

As shown in figure 3, a portion of the physical length of medium is not usable for recording data. For most volumes, a length of the medium is reserved between the take-up reel and the beginning-of-medium, and between the end-of-medium position and the supply reel.

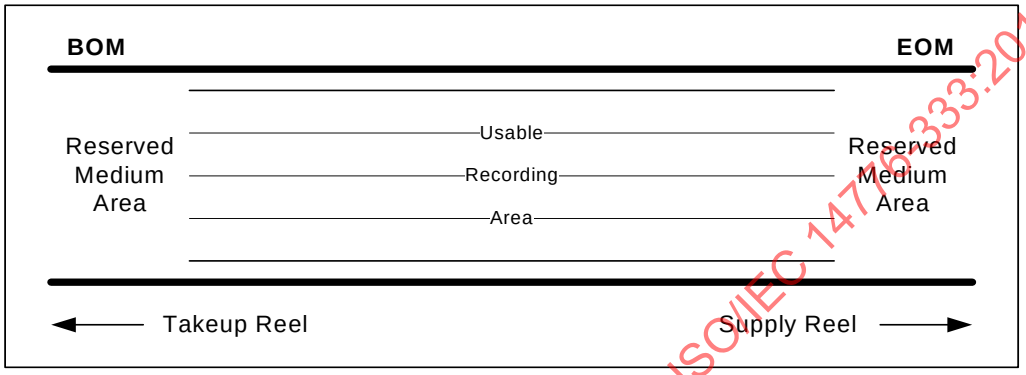

Figure 3 — Typical volume layout

The position on the medium where a pattern of recorded signals may be written by one write component is called a track (see figure 4). A device may write or read from one or more tracks at a time, depending on the format.

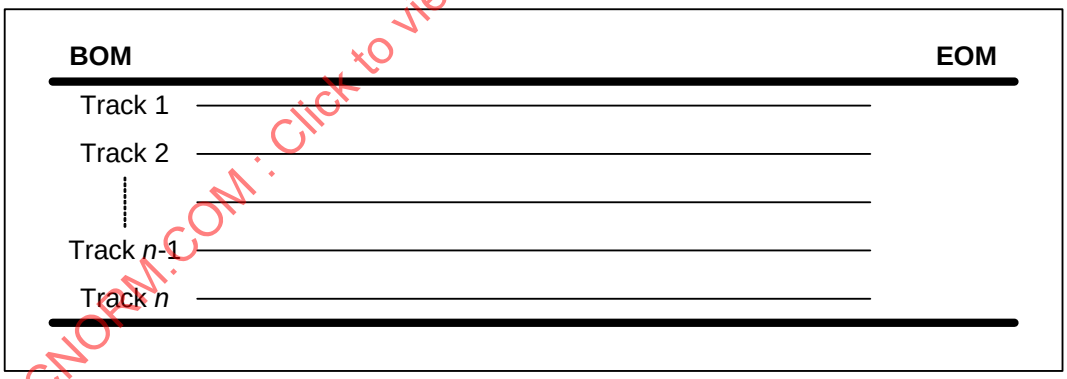

Figure 4 — Typical medium track layout

On a new volume, recording of one or more tracks begins after mounting the volume and moves from beginning-of-medium toward end-of-medium. The number of tracks written at one time is called a track group (TrkGrp). Track groups may be used by any recording format. For recorded volumes, reading in the forward direction follows the same course of tracks when writing.

In serpentine recording, not all tracks are recorded at the same time. At the end-of-medium or beginning-of-medium, the device reverses direction and begins recording the next track group. The process of reversing direction and recording the next track group may be repeated until all track groups are recorded. For serpentine devices that record only one track at a time, each physical track represents one track group (see figure 5).

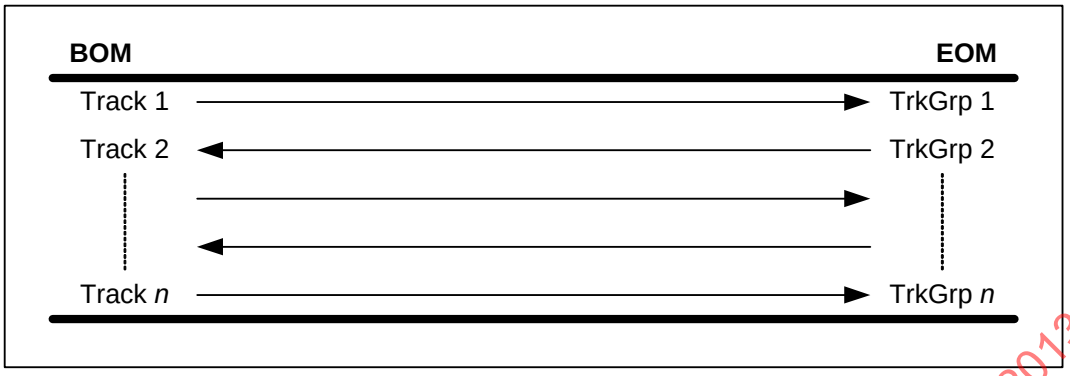

Figure 5 — Serpentine recording example

Some multi-track devices have only one track group, using a parallel storage format that supports the simultaneous recording of all available tracks (see figure 6).

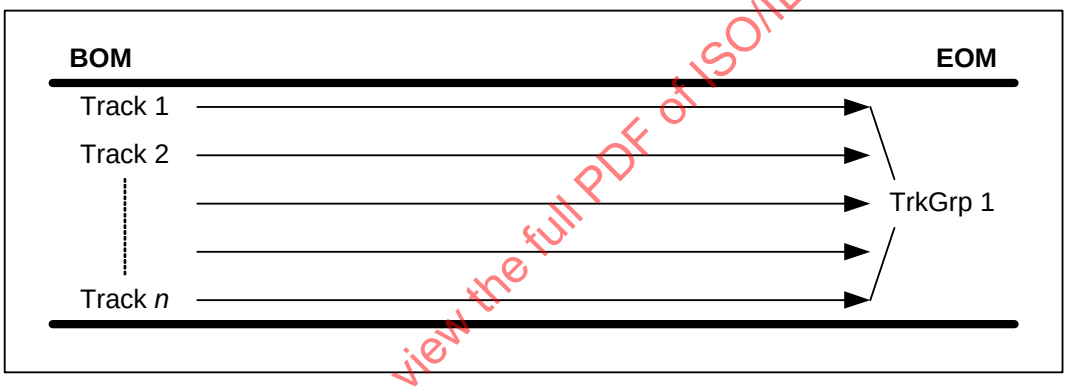

Figure 6 — Parallel recording example

The serpentine and parallel recording formats shown in the previous examples define tracks as longitudinal patterns of recorded information. One other storage format used by some devices records tracks diagonally across the medium. One or more tracks may be recorded at the same time. This recording technique is known as helical scan (see figure 7).

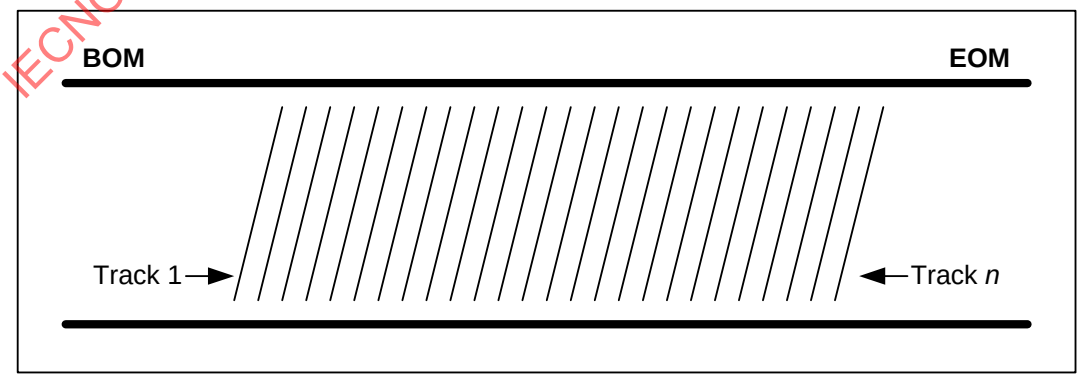

Figure 7 — Helical scan recording example

For most recording formats, a format identification in the form of a tone burst or some other recognizable pattern is recorded outside the user data area. The format identification is an attribute of a volume used for interchange purposes and is defined in applicable standards.

4.2.3 Removable volumes

A sequential-access device may support removable volumes (see 4.2.2). The sequential access device indicates that volumes are removable by setting the RMB bit to one in its standard INQUIRY data (SPC-4).

A removable volume has an attribute of being mounted or demounted on a suitable transport mechanism in a sequential-access device (see 4.2.2).

If the volume in a sequential-access device is removable, and a volume transitions from demounted to mounted, then the device server shall establish a unit attention condition with the additional sense code set to NOT READY TO READY CHANGE, MEDIUM MAY HAVE CHANGED.

The LOAD UNLOAD command (see 7.2) is used to mount or demount the volume.

The PREVENT ALLOW MEDIUM REMOVAL command (see 7.4) allows an application client to restrict the demounting of the removable volume.

4.2.4 Device entity

A sequential-access device contains one or more device entities. A device entity provides storage for values that are shared between multiple device servers and performs operations upon the volume (e.g., loading, unloading, positioning, writing and reading the medium, and reading and writing medium auxiliary memory).

The device entity is controlled by various other entities, which may include:

a) one or more SCSI device servers (e.g., where a device entity is associated with an automation device that performs medium movement, both a device server that implement the command set defined in this standard and a device server that impements another command set such as ADC-2 may control the device);
b) an operator interface;
c) a management interface; and
d) a media changer.

A media changer may control the device entity by inserting a volume into or removing a volume from the device entity. When inserting a volume into or removing a volume from the device entity, the operator acts in the role of a media changer.

These entities perform operations that change various attributes of the device entity. These attributes affect the operations on a volume. Figure 8 shows in UML notation an example of the entities in a SCSI target device, and shows the attributes of the device entity.

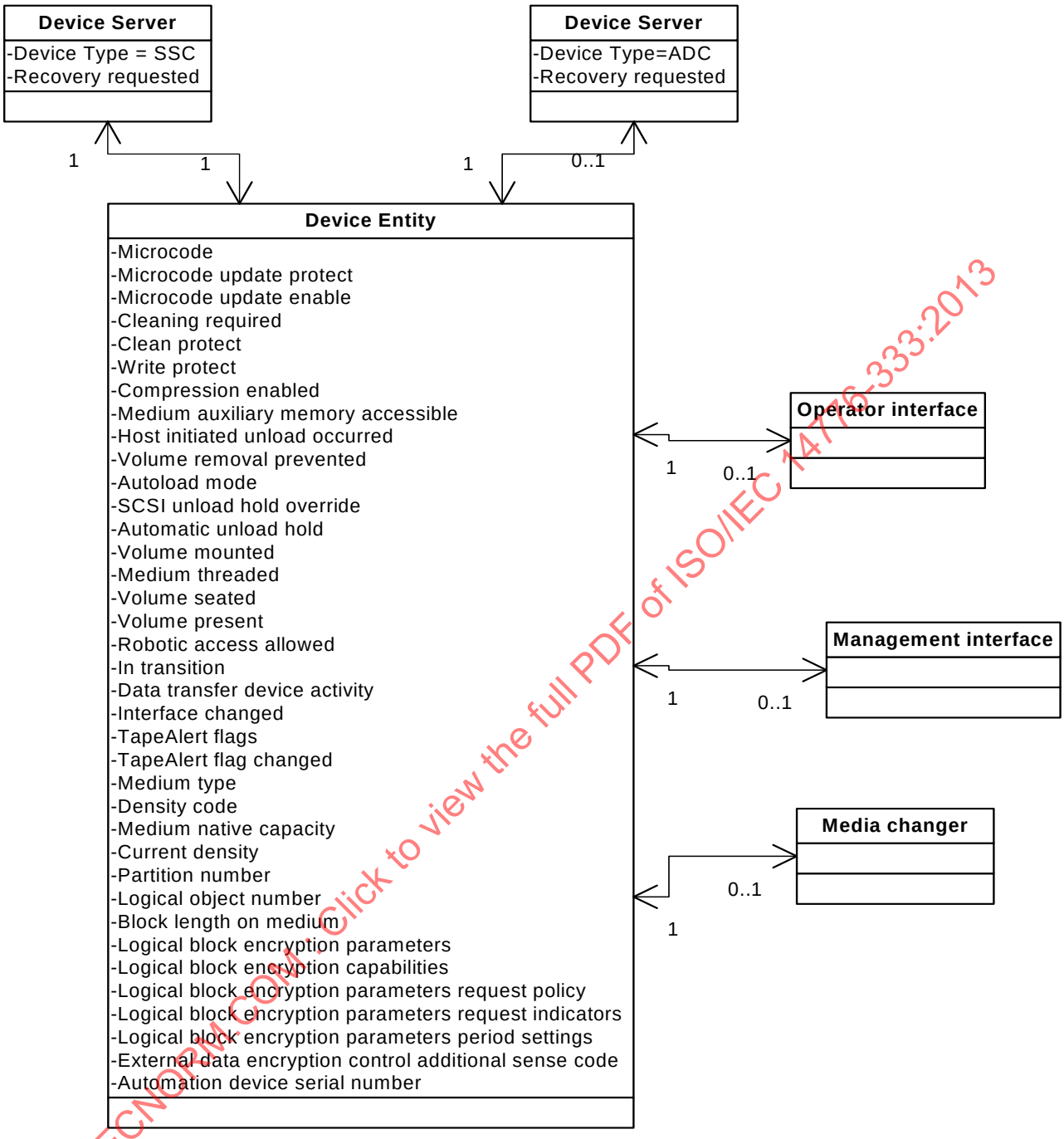

Figure 8 — UML example of SCSI target device and device entity

Table 2 specifies the standard that defines each attribute shown in figure 8.

Table 2 — Device entity attributes

Attribute	Reference
Microcode	SPC-4
Microcode update protect	ADC-3
Microcode update enable	ADC-3
a) Medium native capacity is the value reported in the CAPACITY field of the density support data block descriptor when the MEDIA bit is one, and a SET CAPACITY command has not been used to affect the capacity of the medium.	

Table 2 — Device entity attributes (Continued)

Attribute	Reference
Cleaning required	ADC-3
Clean protect	ADC-3
Write protect	ADC-3
Compression enabled	ADC-3
Medium auxiliary memory accessible	ADC-3
Host initiated unload occurred	ADC-3
Volume removal prevented	ADC-3
Autoload mode	SPC-4
SCSI unload hold override	ADC-3
Automatic unload hold	ADC-3
Volume mounted	ADC-3
Medium threaded	ADC-3
Volume seated	ADC-3
Volume present	ADC-3
Robotic access allowed	ADC-3
In transition	ADC-3
Data transfer device activity	ADC-3
Interface changed	ADC-3
TapeAlert flags	Table 10
TapeAlert flag changed	ADC-3
Medium type	7.8.4
Density code	8.2.4.3
Medium native capacity[a]	7.8.3
Current density	ADC-3
Partition number	7.6.3
Logical object number	7.6.3
Block length on medium	SPC-4
Logical block encryption parameters	4.2.22.14
Logical block encryption capabilities	4.2.22.7
Logical block encryption parameters request policy	4.2.23.3.2
Logical block encryption parameters request indicators	4.2.23.3.3
Logical block encryption parameters period settings	4.2.23.3.4
External data encryption control additional sense code	4.2.23.5
Automation device serial number	8.4.5

a) Medium native capacity is the value reported in the CAPACITY field of the density support data block descriptor when the MEDIA bit is one, and a SET CAPACITY command has not been used to affect the capacity of the medium.

4.2.5 Early-warning

When writing, the application client needs an indication that it is approaching the end of the permissible recording area when moving in a direction toward the end of the partition (see 4.2.7). This position, called early-warning (EW), is typically reported to the application client at a position early enough for the device to write any buffered logical objects to the medium while still leaving enough room for additional recorded logical objects (see figure 9). Some American National Standards include physical requirements for a marker placed on the medium to be detected by the device as early-warning.

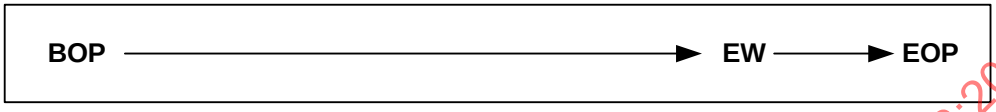

Figure 9 — Early-warning example

Devices are expected to report early warning to the application client when sufficient recording space is nominally available before EOP to record logical objects in the object buffer(s) and some additional logical objects. A logical concept of early-warning may be required to signal the application client at an appropriate location prior to the physical marker, particularly for devices that implement object buffers.

4.2.6 Programmable early warning

When writing, the application client may need an indication prior to early warning (see 4.2.5) to allow for the application client to prepare to be ready for early warning (e.g., flush buffers in the application client).

Application clients that need this indication may set the PEWS field (see 8.3.8) to a value that creates a PEWZ of the specified size.

Application clients that need this indication may request the device server to create a zone called the programmable-early-warning zone (PEWZ) (see figure 10) by setting the PEWS field (see 8.3.8) to the requested size of the PEWZ. The EOP side of PEWZ is established at early-warning and extends towards BOP for a distance indicated by the PEWS field.

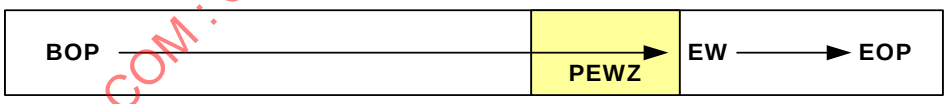

Figure 10 — Programmable early warning example

The REW bit in the Device Configuration mode page (see 8.3.3) shall have no effect on the device server behavior in the PEWZ.

The device server shall return CHECK CONDITION status, with the sense key set to NO SENSE, the EOM bit set to one and the additional sense code set to PROGRAMMABLE EARLY WARNING DETECTED at the completion of a command that caused the medium to transition into the PEWZ if that command is:

a) WRITE(6);
b) WRITE(16);
c) WRITE FILEMARKS(6); or
d) WRITE FILEMARKS(16).

Encountering the PEWZ shall not cause the device server to perform a synchronize operation or terminate the command. If processing this command results in any other exception condition except early-warning, the CHECK CONDITION status associated with that exception condition shall be reported instead. If early-warning is crossed prior to the PROGRAMMABLE EARLY WARNING DETECTED additional sense

being reported, the PROGRAMMABLE EARLY WARNING DETECTED additional sense shall be reported before the early-warning CHECK CONDITION.

If the PROGRAMMABLE EARLY WARNING DETECTED additional sense code was not reported, the next write in PEWZ or beyond early-warning that would otherwise complete with GOOD status, shall return the programmable-early-warning CHECK CONDITION instead.

If the PEWZ is entered and exited on the BOP side before the PROGRAMMABLE EARLY WARNING DETECTED additional sense code is returned, the device server shall not report CHECK CONDITION status with the additional sense code set to PROGRAMMABLE EARLY WARNING DETECTED.

4.2.7 Partitions within a volume

Partitions consist of one or more non-overlapped logical volumes, each with its own beginning and ending points, contained within a single physical volume. Each partition (*n*) within a volume has a defined beginning-of-partition (BOP *n*), an early-warning position (EW *n*), and an end-of-partition (EOP *n*).

All volumes have a minimum of one partition called partition 0, the default data partition. For devices that support only one partition, the beginning-of-partition zero (BOP 0) may be equivalent to the beginning-of-medium and the end-of-partition zero (EOP 0) may be equivalent to the end-of-medium. For devices that support more than one partition, they shall be numbered sequentially starting with zero (i.e., beginning-of-partition 0).

When a volume is mounted, it is logically positioned to the beginning of the default data partition (BOP 0). When a REWIND command is received in any partition (*x*), the device positions to the beginning-of-partition of the current partition (BOP *x*).

Partitions on a volume may be recorded in any order and use any partition number unique to the physical volume. It is sufficient for a device to be able to locate a partition, given its partition number, or to determine that it does or does not exist on the volume. For interchange, information about which partitions are present on a volume may be stored on the volume in a format specified area, possibly unavailable to the application client, or the information may be an intrinsic attribute of the device implementation.

Figure 11 shows a possible partition implementation for a four-track serpentine recording device, assuming that each track group defines a partition.

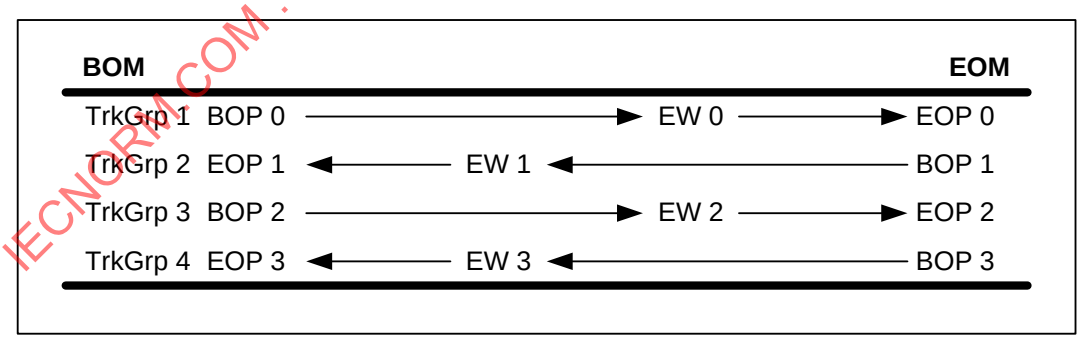

Figure 11 — Partitioning example - one partition per track group

Another possible partition implementation for this four-track serpentine recording device is shown in figure 12, using two track groups to define each partition.

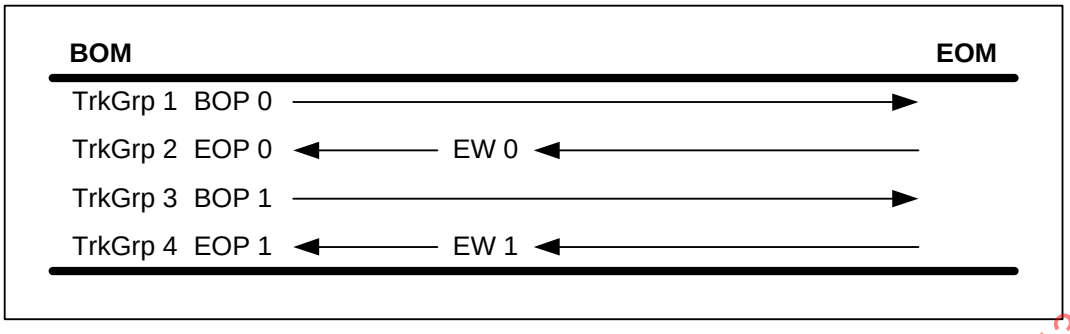

Figure 12 — Partitioning example - one partition per two track groups

The previous examples show the beginning and ending points for a partition aligned with physical bounds of the medium. This is not required for partitioning. It is sufficient for a device to be able to locate to and stay in any partition bounded by a BOP *x* and EOP *x*. In this case, a device-recognizable attribute could be used to delineate the partitions. Figure 13 shows a possible two-partition implementation for a device with only one track group.

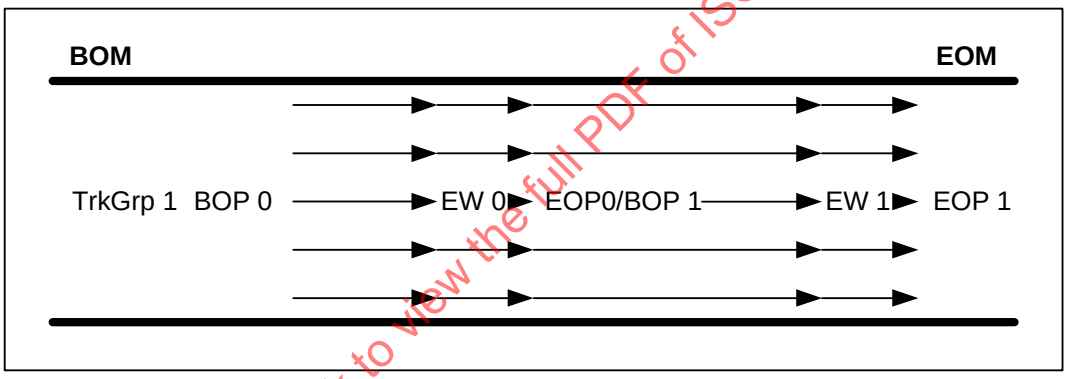

Figure 13 — Partitioning example - two partitions per track group

Three methods are defined in the MODE SENSE and MODE SELECT commands for managing partitions:

a) device-defined fixed locations;
b) device-defined based on an application client supplied number of partitions and a vendor-specific allocation algorithm; and
c) definition by partition number and capacity by an application client.

4.2.8 Logical objects

4.2.8.1 Logical objects within a partition

The area between BOP *n* and EOP *n* on a recorded volume contains application client accessible logical objects. Logical objects are controlled and transferred between the application client and the medium using commands defined in this standard. Each logical object shall have a logical object identifier that is unique within a partition.

The basic unit of data transferred by an application client is called a logical block. Logical blocks are stored according to the specifications of the format for the volume and may be recorded as portions of one or more physical blocks on the medium. The mapping between physical and logical blocks is the responsibility of the device server.

Filemarks are special recorded logical objects not containing user data. Proper recording and detection of filemarks is the responsibility of the device server. Application clients traditionally use filemarks to separate

groups of user data from each other. Since some format standards do not define an explicit EOD, operating system software has often used conventions with filemarks to represent an EOD indication. In some implementations, the device's EOD definition may be specified by the application client using the Device Configuration mode page (see 8.3.3).

After writing data from BOP *n*, the medium is considered to contain a contiguous grouping of logical objects. Depending on the format, blank medium may be treated as an end-of-data indication, an error recovery area, or an unrecoverable medium error causing an interchange error. Unrecorded volumes, new or erased, may exhibit blank medium characteristics if an attempt is made to read or space the volume before data has been written.

A sequential-access device may be capable of supporting fixed-block transfers or variable-block transfers. The concept of fixed or variable mode for writing and reading logical blocks only specifies the method by which the application client specifies the size of a logical block for transfer, and not the method of recording physical blocks on the medium. However, a device that supports only fixed-length physical blocks may only be capable of supporting logical blocks of the same length. The length of a logical block is always described in bytes. Refer to the READ BLOCK LIMITS command (see 7.5) for additional information about fixed-block transfers and variable-block transfers.

4.2.8.2 Logical object identifier

The logical object identifier value shall be a sequentially increasing number assigned to each logical object recorded in the partition starting with zero for the recorded logical object at BOP.

The READ POSITION command (see 7.6) may be used to determine a logical object identifier and the application client may use this value with a LOCATE command (see 6.3 and 7.3) or an explicit command (see clause 5) to position to the same location at some future time.

4.2.9 Logical files

4.2.9.1 Logical files within a partition

Application clients may use filemarks to separate groups of user data into logical files. A logical file shall contain zero or more logical blocks and shall begin with the next logical object following a filemark or BOP. Each logical file shall have a logical file identifier that is unique within the partition.

4.2.9.2 Logical file identifier

The logical file identifier value shall be a sequentially increasing number assigned to each logical file recorded in the partition starting with zero for the recorded logical file beginning at BOP.

The READ POSITION command may be used to determine a logical file identifier and the application client may use this value with a LOCATE(16) command to position to the BOP side of the same logical file at some future time.

4.2.10 Object buffering

A device may contain a temporary storage area capable of holding one or more logical objects - an object buffer. A device object buffer may include any combination of logical objects in the process of being written to the medium, or it may contain read-ahead logical objects transferred from the medium.

A device with an object buffer may be capable of operating in either a buffered mode or an unbuffered mode. A device with no object buffer operates only in unbuffered mode. Either term is only applicable to the manner in which the device manages information to be written to the medium. Buffered mode is not applicable during read commands, regardless of whether read data passes through an object buffer.

A device operating in buffered mode may return GOOD status for write operations when all logical objects have been successfully transferred from the application client into the device object buffer. For devices operating in unbuffered mode, GOOD status is not returned until all requested logical objects are successfully recorded on the medium.

When issuing a buffered WRITE FILEMARKS command with the immediate bit set to one, GOOD status shall be returned as soon as the command is validated. For a WRITE FILEMARKS command with the immediate bit set to zero, the device server shall perform a synchronize operation (see 4.2.11).

If an unrecoverable write error occurs while in buffered mode, the device generates an error condition to the current active command. If no command is active, the error may be reported on the next applicable operation as a deferred error (see SPC-4). For some implementations auto contingent allegiance may be required. Refer to SAM-4 for a description auto contingent allegiance.

The READ POSITION command may be used to determine the number and storage space of buffered logical objects not written before the unrecoverable error was encountered.

A device that encounters an unrecoverable error during a read-ahead operation shall not report the error unless the logical object in error is accessed by an application client.

Prior to performing some commands, the device server shall perform a synchronize operation (see 4.2.11) as stated in table 22 and table 30.

4.2.11 Synchronize operation behavior

As stated in table 22 and table 30, some commands may require the device server to perform a synchronize operation (see 3.1.73). If a command requires a synchronize operation, the synchronize operation shall be performed prior to initiating any command-specific operations. Upon successful completion of the synchronize operation, no logical objects shall remain in the object buffer that have not been written to the medium. A synchronize operation shall have no effect on an object buffer that contains only read-ahead logical objects, or logical objects that have already been successfully written to the medium.

For a WRITE BUFFER command specifying modes 4, 5, 6, or 7 (download microcode operations), the device server shall perform a synchronize operation before performing the download operation.

For a MODE SELECT command specifying the Medium Partition mode page, the device server shall perform a synchronize operation before the logical unit partitions the volume.

For a SEND DIAGNOSTICS command, the device server shall perform a synchronization operation before any diagnostic tests that may affect the buffered logical objects, medium, or logical position, are initiated.

4.2.12 Direction and position definitions

For sequential-access devices, positioning has the connotation of logically being in, at, before, or after some defined place within a volume. Positioning requires that the position is capable of being repeated under the same circumstances. The orientation of usage for the four words (in, at, before, or after) is in one direction, from BOP *x* toward EOP *x*. All positioning defined below is worded from this perspective. Devices without object buffers have some physical position that relates to these logical positions. However, these definitions do not require the medium to have a physical position equivalent to the logical position unless explicitly stated.

The forward direction is defined as logically progressing from BOP *x* toward EOP *x*. The reverse direction is defined as logically progressing from EOP *x* toward BOP *x*. In serpentine devices, the logical forward or reverse direction has an alternating relationship to the physical motion of the medium.

The concept of being in some position means not being outside a defined region. The definition allows the position to be on the boundary of a defined region. When a volume is first mounted, the logical position is always at the beginning of the default data partition (BOP 0). Whenever a volume is mounted and the medium motion is stopped, the position is in some partition. While moving between partitions, there is no stable position.

The concept of being at some position specifies being positioned to a logical or physical extremity of a partition. A sequential-access device may be positioned at BOM, at BOP *x*, at EOD, at EOP *x*, or EOM, since these are stable positions at extremities of a partition.

The concept of being before some position specifies that there is some logical object or other defined point that may be encountered when moving toward EOP *x*, if the proper commands are issued. Being positioned before a particular logical block means that if the device receives a valid READ command, the logical block is transferred to the application client. This position may also be before EW *x* and EOP *x*, since these are defined points within any partition. However, if data has not been written to the end-of-partition, these points may not be accessible by the SCSI initiator device.

The concept of being after some position specifies that there is some logical object or other defined point on the BOP *x* side of the current position that may be encountered if the proper commands are issued. When a READ command for a single logical block has been successfully processed, the logical position is after the transferred logical block.

4.2.13 Error reporting

4.2.13.1 Overview

Sequential-access devices compliant with this standard shall support both the fixed and descriptor sense data formats (see SPC-4). If fixed format sense data is specified, but the INFORMATION field value exceeds the maximum value allowed in the fixed format sense data, the VALID bit shall be set to zero. Refer to SPC-4 for a description of the sense data VALID bit and INFORMATION field contained in the REQUEST SENSE sense data. In addition, this standard describes the use of the INFORMATION field specific to the sequential-access device type.

4.2.13.2 Stream commands sense data descriptor

Table 3 defines the stream commands sense data descriptor for sequential-access devices.

Table 3 — Stream commands sense data descriptor

Bit / Byte	7	6	5	4	3	2	1	0
0	DESCRIPTOR TYPE (04h)							
1	ADDITIONAL LENGTH (02h)							
2	Reserved							
3	FILEMARK	EOM	ILI	Reserved				

See SPC-4 for a description of the DESCRIPTOR TYPE and ADDITIONAL LENGTH fields.

See the READ(16) (see 5.3), READ(6) (see 6.4), SPACE(6) (see 6.6), RECOVER BUFFERED data (see 7.7), and SPACE(16) (see 7.11) commands for a description of FILEMARK bit usage.

See the READ(16) (see 5.3), READ REVERSE(16) (see 5.4), WRITE(16) (see 5.6), WRITE FILEMARKS(16) (see 5.7), LOCATE(10) (see 6.3), READ(6) (see 6.4), READ REVERSE(6) (see 6.5), SPACE(6) (see 6.6), WRITE(6) (see 6.8), WRITE FILEMARKS(6) (see 6.9), LOCATE(16) (see 7.3), RECOVER BUFFERED data (see 7.7), and SPACE(16) (see 7.11) commands, and the Device Configuration mode page (see 8.3.3) for end-of-medium (EOM) bit usage.

See the READ(16) (see 5.3) and READ(6) (see 6.4) commands and the Data Compression mode page (see 8.3.2) for incorrect length indicator (ILI) bit usage.

4.2.13.3 Information sense data descriptor

If reporting descriptor format sense data, the device server shall include an information sense data descriptor (see table 4) for a unit attention condition established:

a) by a TapeAlert specific informational exception condition; or
b) by a TapeAlert flag meeting its threshold criteria if the corresponding ETC bit in the TapeAlert log parameter is set to one.

The information sense data descriptor format is specified in table 4.

Table 4 — Information sense data descriptor

Bit / Byte	7	6	5	4	3	2	1	0
0	DESCRIPTOR TYPE (00h)							
1	ADDITIONAL LENGTH (0Ah)							
2	VALID (1b)	Reserved						
3	Reserved							
4	FLAG01h	FLAG02h	FLAG03h	FLAG04h	FLAG05h	FLAG06h	FLAG07h	FLAG08h
5	FLAG09h	FLAG0Ah	FLAG0Bh	FLAG0Ch	FLAG0Dh	FLAG0Eh	FLAG0Fh	FLAG10h
6	FLAG11h	FLAG12h	FLAG13h	FLAG14h	FLAG15h	FLAG16h	FLAG17h	FLAG18h
7	FLAG19h	FLAG1Ah	FLAG1Bh	FLAG1Ch	FLAG1Dh	FLAG1Eh	FLAG1Fh	FLAG20h
8	FLAG21h	FLAG22h	FLAG23h	FLAG24h	FLAG25h	FLAG26h	FLAG27h	FLAG28h
9	FLAG29h	FLAG2Ah	FLAG2Bh	FLAG2Ch	FLAG2Dh	FLAG2Eh	FLAG2Fh	FLAG30h
10	FLAG31h	FLAG32h	FLAG33h	FLAG34h	FLAG35h	FLAG36h	FLAG37h	FLAG38h
11	FLAG39h	FLAG3Ah	FLAG3Bh	FLAG3Ch	FLAG3Dh	FLAG3Eh	FLAG3Fh	FLAG40h

The VALID bit shall be set to one.

An active TapeAlert flag has the corresponding FLAGXX bit set to one. An inactive TapeAlert flag has the corresponding FLAGXX bit set to zero.

4.2.13.4 Error conditions

If any of the conditions specified in table 5 occur during the processing of a command or if a deferred error prevented the command from processing, the device server shall terminate the command with CHECK CONDITION status with the sense key set to the specified value and the additional sense code set to the appropriate value for the condition.

Table 5 specifies some error conditions and the applicable sense keys. Table 5 does not provide a complete list of all conditions that may cause the CHECK CONDITION status.

Table 5 — Error conditions and sense keys

Condition	Sense key
Unsupported option requested.	ILLEGAL REQUEST
Logical unit reset, I_T nexus loss, or volume change since last command from this I_T nexus.	UNIT ATTENTION
Self diagnostic failed.	HARDWARE ERROR
Unrecovered read error.	MEDIUM ERROR HARDWARE ERROR
Recovered read or write error.	RECOVERED ERROR
Attempt a WRITE, READ, READ REVERSE, VERIFY, or RECOVER BUFFERED data command with the FIXED[a] bit set to zero and variable-block transfers are not supported.	ILLEGAL REQUEST

a) See the READ(16) (see 5.3), READ REVERSE(16) (see 5.4), VERIFY(16) (see 5.5), WRITE(16) (see 5.6), READ(6) (see 6.4), READ REVERSE(6) (see 6.5), VERIFY(6) (see 6.7), WRITE(6) (see 6.8), and RECOVER BUFFERED data (see 7.7) commands for a description of the FIXED bit.

Table 5 — Error conditions and sense keys (Continued)

Condition	Sense key
Attempt a WRITE, READ, READ REVERSE, VERIFY, or RECOVER BUFFERED data command with the FIXED[a] bit set to zero and requested block length is not supported.	ILLEGAL REQUEST
Attempt a WRITE, READ, READ REVERSE, VERIFY, or RECOVER BUFFERED data command with the FIXED[a] bit set to one and MODE SENSE block length set to zero.	ILLEGAL REQUEST
Attempt to perform an erase, format, partition, set capacity, or write-type operation on write protected medium.	DATA PROTECT
Deferred write error.	MEDIUM ERROR VOLUME OVERFLOW HARDWARE ERROR
Medium failed to thread or unthread during the process of mounting or demounting.	MEDIUM ERROR HARDWARE ERROR
a) See the READ(16) (see 5.3), READ REVERSE(16) (see 5.4), VERIFY(16) (see 5.5), WRITE(16) (see 5.6), READ(6) (see 6.4), READ REVERSE(6) (see 6.5), VERIFY(6) (see 6.7), WRITE(6) (see 6.8), and RECOVER BUFFERED data (see 7.7) commands for a description of the FIXED bit.	

The Read-Write Error Recovery mode page (see 8.3.5) current values specify behavior when an unrecoverable read or write error is encountered. If the Read-Write Error Recovery mode page is not implemented, the behavior is vendor specific.

In the case of a deferred write error, the sense data VALID bit shall be set to zero.

In the case of an unrecovered write error or a deferred write error, if buffered mode 1h is selected, the error shall be reported to the first application client issuing a command (other than INQUIRY or REQUEST SENSE). If buffered mode 2h is selected, the error shall be reported to the SCSI initiator device with unwritten data in the object buffer.

In the case of a write attempt to write protected medium, the additional sense code specifies the cause of the DATA PROTECT sense key (see 4.2.14).

In the case of a medium thread or unthread failure, the additional sense code shall be set to MEDIUM THREAD OR UNTHREAD FAILURE. The sense key shall be set to MEDIUM ERROR or HARDWARE ERROR (see SPC-4).

4.2.14 Write protection

4.2.14.1 Write protection introduction

Write protection of the medium prevents the alteration of logical objects on the medium, and any change to the accessibility of logical objects on the medium, by commands issued to the device server. Write protection is usually controlled by the user of the volume through manual intervention (e.g., mechanical lock) or may result from hardware controls (e.g., tabs on the volume housing), conditions such as positioning within unrecoverable data, or software write protections. All sources of write protection are independent. When present, any write protection shall cause otherwise valid commands that request alteration of logical objects on the medium, or affect the accessibility of logical objects on the medium, to be rejected with a CHECK CONDITION status with the sense key set to DATA PROTECT (see 4.2.14.2). Only when all write protections are disabled shall the device server process commands that request alteration of logical objects on the medium, or commands that may affect the accessibility of logical objects on the medium.

Hardware write protection results when a physical attribute of the drive or volume is changed to specify that writing shall be prohibited. Changing the state of the hardware write protection requires physical intervention, either with the drive or the volume. If allowed by the drive, changing the hardware write protection while the

volume is mounted results in vendor-specific behavior that may include the writing of previously buffered logical objects.

Conditions such as positioning within unrecoverable data may result in a temporary write protection condition. To preserve future data integrity, the device server may reject any command that requires writing data to the medium when the recovery of the data is uncertain. A temporary write protection condition may be released by the device server at any time. Buffered logical objects may not be written to the medium (e.g., the application client unloads the volume before the temporary write protection condition is removed). The exact behavior of the device server during a temporary write protection condition is vendor specific.

Software write protection results when either the device server, volume, or medium is marked as write protected by a command from the application client. Four optional means of setting a software write protection state are available to an application client through the Device Configuration and Control mode pages:

a) software write protection for the device server across mounts;
b) associated write protection for the currently mounted volume;
c) persistent write protection of a volume across mounts; and
d) permanent write protection of a volume across mounts.

The application client may control these write protections using the Control mode page (see SPC-4) and the Device Configuration mode page (see 8.3.3). All of the software write protection methods are optional. Changing the state of any software write protection shall not prevent previously buffered logical objects from transferring to the medium.

4.2.14.2 Write protection additional sense code use

The additional sense code associated with the DATA PROTECT sense key depends on the write protection in effect at the time. Table 6 specifies the preferred additional sense code for the given write protection. Alternatively, the generic additional sense code of WRITE PROTECTED may be returned by the device server.

Table 6 — Write protect additional sense code combinations

Cause of DATA PROTECT error	Additional sense code
Hardware Write Protection	HARDWARE WRITE PROTECTED
Permanent Write Protection	PERMANENT WRITE PROTECT
Persistent Write Protection	PERSISTENT WRITE PROTECT
Associated Write Protection	ASSOCIATED WRITE PROTECT
Software Write Protection	LOGICAL UNIT SOFTWARE WRITE PROTECTED

If more than one condition exists, the device server shall:

a) report the generic additional sense code of WRITE PROTECTED; or
b) report the applicable condition in order of:
   1) HARDWARE WRITE PROTECTED;
   2) PERMANENT WRITE PROTECT;
   3) PERSISTENT WRITE PROTECT;
   4) ASSOCIATED WRITE PROTECT; and
   5) LOGICAL UNIT SOFTWARE WRITE PROTECTED.

Other conditions that may cause a command to be rejected with a DATA PROTECT sense key include:

a) the current volume is maintained as read-only by the device server;
b) the device server is only able to write from BOP or EOD and the current logical position is neither;
c) the volume is a WORM volume (see 4.2.21) and an attempt to write in an unrecordable location is detected;
d) the set of logical block encryption parameters in the device entity is not correct for the operation requested; and
e) vendor-specific conditions.

4.2.14.3 Software write protection for the device server

Software write protection controls write protection for the device server. This method of write protection is optionally controlled from the Control mode page (see SPC-4) or the SWP bit in the Device Configuration mode page (see 8.3.3). Either or both methods may be implemented by the device server. If both methods are implemented, each control bit is independently set. Software write protection exists if either bit is non-zero. The state of software write protection for the device server shall not be recorded on the medium. The value of the SWP bit may be altered by the application client (if the SWP bit is changeable). The state of each control bit shall be set to its default state after a logical unit reset.

4.2.14.4 Associated write protection

Associated write protection controls write protection for the currently mounted volume as long as the current volume is mounted. The associated write protection state is controlled by the ASOCWP bit in the Device Configuration mode page (see 8.3.3). Associated write protection exists if the ASOCWP bit is non-zero. Associated write protection may be altered by the application client (if the ASOCWP bit is changeable) if a volume is mounted. If a volume is demounted or after a logical unit reset occurs, associated write protection shall be removed.

4.2.14.5 Persistent write protection

Persistent write protection controls write protection for the currently mounted volume. The persistent write protection state is controlled by the PERSWP bit in the Device Configuration mode page (see 8.3.3). If enabled, persistent write protection shall exist for the mounted volume until disabled by the application client. The state of persistent write protection shall be recorded with the volume and the persistent write protection shall only affect the application client accessible medium. The device server shall report the PERSWP bit as one when a mounted volume is marked with persistent write protection. If a volume is demounted or after a logical unit reset occurs, the device server shall report the PERSWP bit as zero prior to the mounting of a volume. The means for recording the state of persistent write protection for the volume may be specified in the applicable recording format standard or be vendor specific.

4.2.14.6 Permanent write protection

Permanent write protection controls write protection for the currently mounted volume. The permanent write protection state is controlled by the PRMWP bit in the Device Configuration mode page (see 8.3.3). If enabled, permanent write protection shall exist for the mounted volume until disabled by a vendor-specific method. The state of permanent write protection shall be recorded with the volume and the permanent write protection shall only affect the application client accessible medium. The device server shall report the PRMWP bit as one when a mounted volume is marked with permanent write protection. If a volume is demounted or after a logical unit reset occurs, the device server shall report the PRMWP bit as zero prior to the mounting of a volume. The means for recording the state of permanent write protection for the volume may be specified in the applicable recording format standard or be vendor specific. Permanent write protection shall not be removed by a MODE SELECT command using the PRMWP bit. Methods to remove this protection may exist and are vendor specific.

4.2.15 Progress indication

For the following immediate operations where the device server remains ready, an application client may test the progress of the operation (see table 7).

Table 7 — Commands providing progress indication without changing ready state

Operation	Options	Subclause	Additional Sense Code
ERASE	LONG = 1	5.2, 6.2	ERASE OPERATION IN PROGRESS
LOCATE		5.2, 6.3	LOCATE OPERATION IN PROGRESS
REWIND		7.9	REWIND OPERATION IN PROGRESS
SET CAPACITY		7.10	SET CAPACITY OPERATION IN PROGRESS
VERIFY		5.5, 6.7	VERIFY OPERATION IN PROGRESS

While the device server is performing the operation, an application client may test the progress of the operation by interpreting the progress indication information in the sense-key specific field of the sense data. During the operation, the device server may report a sense key value of NO SENSE and additional sense code as specified in table 7. The device server should use the sense key specific function for progress indication to provide information on the completion of the operation.

For the following immediate operations where the device server is ready. An application client may follow the progress of the operations specified in table 8.

Table 8 — Commands changing ready state and providing progress indication

Operation	Options	Subclause	Additional Sense Code
FORMAT MEDIUM		7.1	LOGICAL UNIT NOT READY, FORMAT IN PROGRESS
LOAD UNLOAD	LOAD = 1, EOT = 0	7.2	LOGICAL UNIT IS IN PROCESS OF BECOMING READY
LOAD UNLOAD	LOAD = 0, EOT = 1	7.2	LOGICAL UNIT NOT READY, OPERATION IN PROG-RESS

While the device server is performing the operation, an application client may test the progress of the operation by interpreting the progress indication information in the sense key specific field of the sense data. During the operation, the device server may report a sense key value of NOT READY and an additional sense code as specified in table 8. The sense key specific function for progress indication may be used by the device server to provide information on the completion of the operation.

NOTE 1 - A REQUEST SENSE command following a TEST UNIT READY command that results in CHECK CONDITION status may provide information that, if acted upon, may lead to unexpected conditions. For example, progress indication reporting is useful when a media changer is used to service a sequential-access device following an unload operation with IMMED=1b. A TEST UNIT READY command may receive CHECK CONDITION status and a NOT READY sense key reported in the subsequent sense data. This may imply that the unload operation is finished. If the application client ignores the progress indication information in the sense data, an EXCHANGE MEDIUM or MOVE MEDIUM command (see SMC-2) to move the demounted volume from the SCSI device may fail to grab the volume if the unload operation is still in progress.

4.2.16 Tagged command queuing

4.2.16.1 Tagged command queuing overview

A device server may choose to implement support for tagged tasks (i.e., command queuing). Issuing tagged write commands with object buffering disabled facilitates streaming operations up to the limit of the number of outstanding tagged commands supported by the application client and the device server. This limit may effectively reduce the usable portion of the object buffer which may affect device server performance.

For proper operation when performing tagged command queuing operations, an application client should wait for status to be returned for any MODE SELECT command before issuing the next command.

NOTE 2 - Since the EXTENDED COPY command does not specify an immediate bit, the use of tagged command queuing may be required to prevent an overlapped command condition (e.g., when querying the progress of the extended copy operation using the RECEIVE COPY RESULTS command).

4.2.16.2 Explicit address mode tagged write sequences

When operating in explicit address mode, tagged write sequences (see 3.1.74) are used to support tagged command queuing for write operations.

For explicit address mode tagged write sequences, the following rules apply:

a) for a tagged write sequence consisting of more than one command, the FCS bit (see 5.2, 5.6, 5.7) shall be set to one in the first command of the tagged write sequence. For all other commands within the tagged write sequence, the FCS bit shall be set to zero;

b) for a tagged write sequence consisting of more than one command, the LCS bit (see 5.2, 5.6, 5.7) shall be set to one in the last command of the tagged write sequence. For all other commands within the tagged write sequence, the LCS bit shall be set to zero;
c) for a tagged write sequence consisting of only one command, the FCS bit and LCS bit shall be set to one;
d) for a tagged write sequence consisting of more than one command, the application client shall issue the commands in sequentially-increasing logical object identifier order;
e) the application client shall not issue a tagged write sequence prior to receiving status for all outstanding read type commands; and
f) the application client shall specify a Command Reference Number (see SAM-4) for each command in a tagged write sequence.

4.2.17 Block address mode

4.2.17.1 Block address mode overview

When operating in implicit address mode, spacing operations and commands to read from and write on the medium do not contain positioning information (i.e., a command is processed based on the medium position relative to the last command that was processed). As such, the application client does not contain explicit knowledge of the medium position. If an error occurs, to maintain data integrity, the application client is required to determine the medium position before re-issuing a command that affects the medium position.

When operating in explicit address mode, commands to read from and write on the medium contain positioning information fields (i.e., a command is processed based on the medium position information specified in the command). As such, the application client contains explicit knowledge of the medium position. This results in enhanced error detection and recovery functionality that allows the application client to maintain data integrity while performing various operations without first determining the medium position. Some example operations include:

a) the re-issuing of a command that affects the medium position;
b) multi-path I/O; and
c) tagged command queuing.

The device server shall support explicit address mode only, implicit address mode only, or both explicit address mode and implicit address mode. At any instance, the device server shall be in or transitioning between one of the following block address mode states (see 4.2.17.3):

a) A0:Idle;
b) E0:Explicit Address Mode - Neutral;
c) E1:Explicit Address Mode - Write Capable; or
d) F0:Implicit Address Mode.

4.2.17.2 Block address mode selection

The block address mode shall be selected as follows:

a) if the BAML bit in the Device Configuration mode page (see 8.3.3) is set to zero, then the setting of the BAM bit in the Device Configuration mode page (see 8.3.3) shall be ignored and the block address mode shall be determined based on the first block address mode unique command that is received after a successful load operation or successful completion of a command that positions the medium to BOP;
b) if the BAML bit in the Device Configuration mode page is set to one and the BAM bit in the Device Configuration mode page is set to zero, the logical unit shall support implicit address mode; or
c) if the BAML bit in the Device Configuration mode page is set to one and the BAM bit in the Device Configuration mode page is set to one, the logical unit shall support explicit address mode.

Prior to performing a block address mode change, the logical unit shall perform a synchronize operation (see 4.2.11).

If the device server receives a command that is not supported by the currently selected mode, the device server shall return CHECK CONDITION, the sense key shall be set to ILLEGAL REQUEST, and the additional sense code shall be set to:

a) ILLEGAL COMMAND WHILE IN EXPLICIT ADDRESS MODE if the currently selected mode is the explicit address mode;
b) ILLEGAL COMMAND WHILE IN IMPLICIT ADDRESS MODE if the currently selected mode is the implicit address mode; or
c) ILLEGAL COMMAND WHILE IN WRITE CAPABLE STATE if the device server is in explicit address mode write capable state.

4.2.17.3 Block address mode state diagrams

For the block address mode state diagrams (see figure 15, figure 16, figure 17, and figure 18), the following terminology shall apply:

a) explicit command: a command contained only in the explicit address command set (see table 22);
b) implicit command: a command contained only in the implicit address command set (see table 30); and
c) generic command: an explicit command that is not a read type or write type command (see table 22).

A common command containing a BAM bit (e.g., LOCATE(16)) shall be processed as either an explicit or implicit command based on the setting of the BAM bit contained in the common command.

The SPACE(16) command shall be processed as either an explicit or implicit command based on the setting of the PARAMETER LENGTH field in the command descriptor block.

Figure 14 provides an overview of the block address model state diagram. Refer to figure 15, figure 16, figure 17, and figure 18 for detailed descriptions of the block address model state diagram.

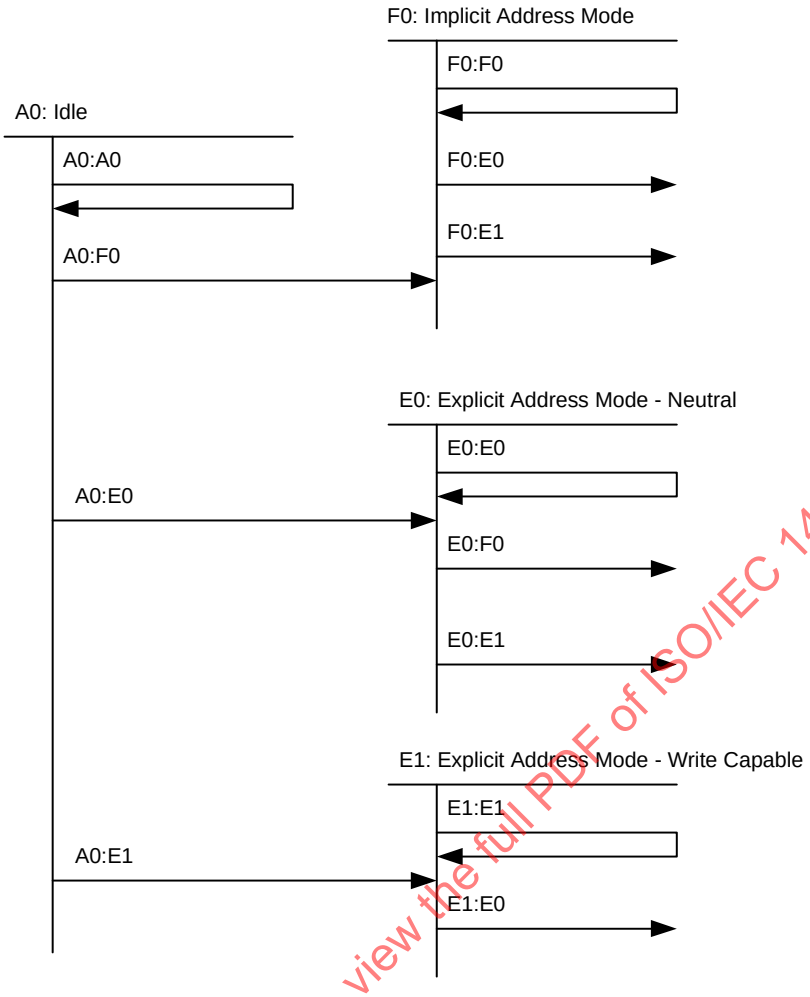

Figure 14 — Block address mode state diagram, overview

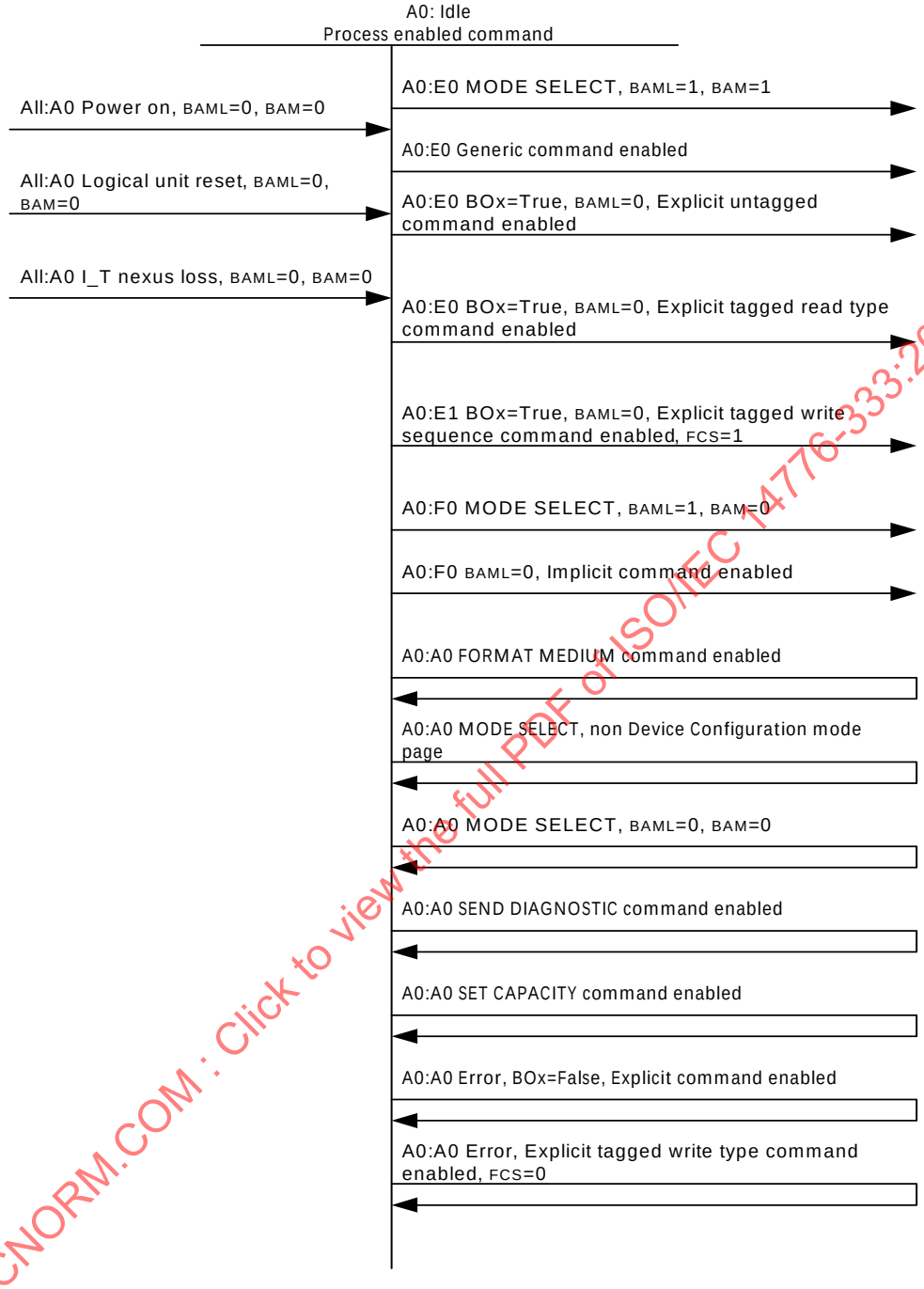

Figure 15 — Block address mode state diagram, Idle state

State A0:Idle: This is the idle state.

Transition All:A0: This transition shall occur when a power-on, logical unit reset, or I_T nexus loss event occurs and the BAML bit is set to zero and the BAM bit is set to zero.

Transition A0:E0: This transition shall occur when:

a) a MODE SELECT command specifying a Device Configuration mode page with the BAML bit set to one and the BAM bit set to one completes with GOOD status;
b) a generic command is enabled;
c) an explicit untagged command is enabled, the medium position is at BOx, and the BAML bit is set to zero; or

d) an explicit tagged read type command is enabled, the medium position is at BOx, and the BAML bit is set to zero.

Transition A0:E1: This transition shall occur when an explicit tagged write sequence command is enabled with the FCS bit set to one, the medium position is at BOx, and the BAML bit is set to zero.

Transition A0:F0: This transition shall occur when:

a) a MODE SELECT command specifying a Device Configuration mode page with the BAML bit set to one and the BAM bit set to zero completes with GOOD status; or
b) an implicit command is enabled, the medium position is at BOx, and the BAML bit is set to zero.

Transition A0:A0: This transition shall occur when:

a) a FORMAT MEDIUM command is enabled;
b) a MODE SELECT command specifying a mode page other than the Device Configuration mode page is enabled;
c) a MODE SELECT command specifying a Device Configuration mode page with the BAML bit set to zero and the BAM bit set to zero is enabled;
d) a SEND DIAGNOSTIC command is enabled;
e) a SET CAPACITY command is enabled;
f) an explicit command is enabled and the medium position is not at BOx. In this case the device server shall return CHECK CONDITION status, the sense key shall be set to ILLEGAL REQUEST and the additional sense code shall be set to SEQUENTIAL POSITIONING ERROR; or
g) an explicit tagged write type command is enabled with the FCS bit set to zero. In this case the device server shall return CHECK CONDITION status, the sense key shall be set to ILLEGAL REQUEST and the additional sense code shall be set to INVALID FIELD IN CDB.

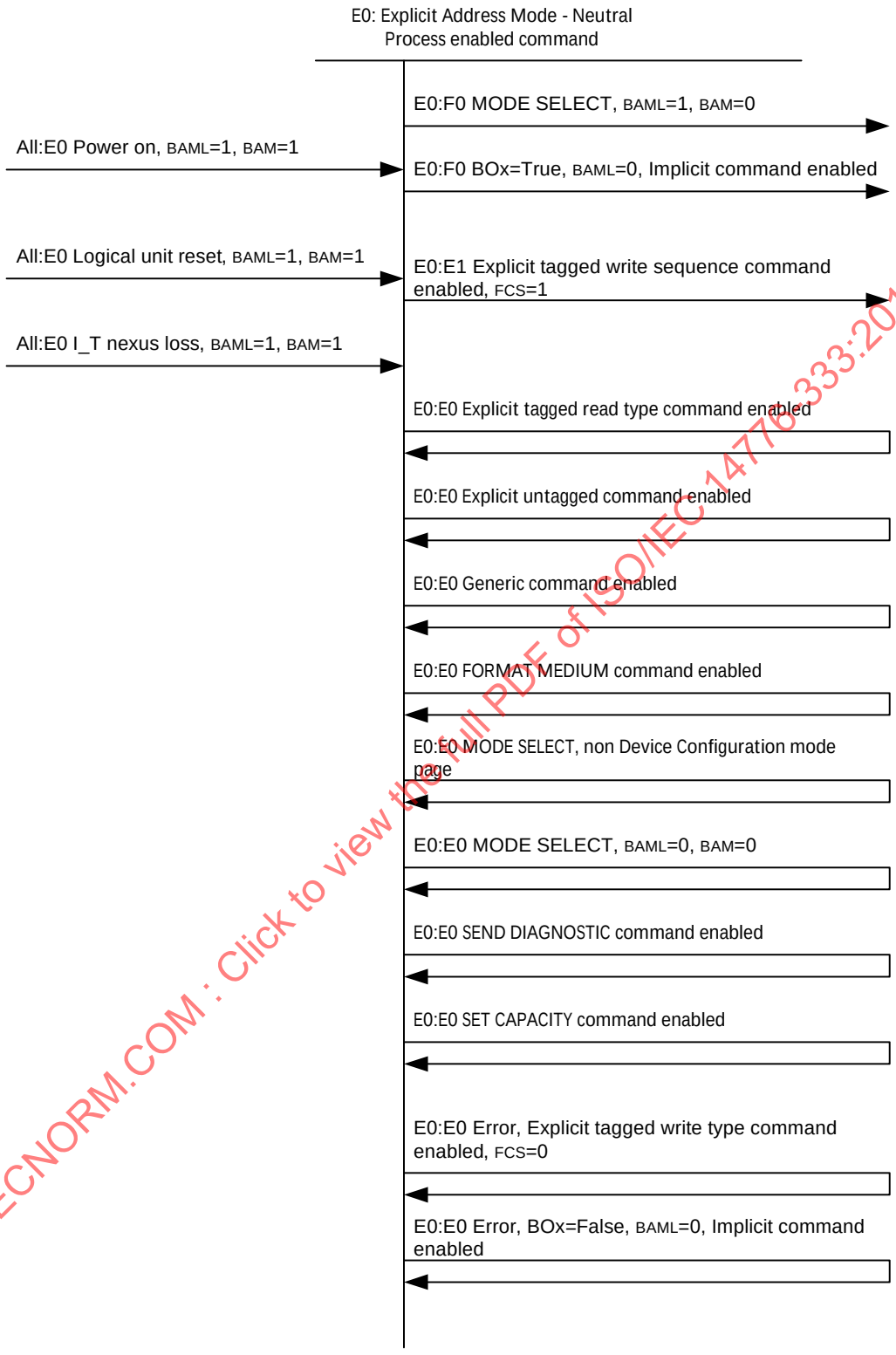

Figure 16 — Block address mode state diagram, Explicit Address Mode - Neutral

State E0:Explicit Address Mode - Neutral: This is the neutral state for explicit address mode.

Transition All:E0: This transition shall occur when a power-on, logical unit reset, or I_T nexus loss event occurs and the BAML bit is set to one and the BAM bit is set to one.

Transition E0:F0: This transition shall occur when:

a) a MODE SELECT command specifying a Device Configuration mode page with the BAML bit set to one and the BAM bit set to zero completes with GOOD status; or
b) an implicit command is enabled, the medium position is at BOx, and the BAML bit is set to zero.

Transition E0:E1: This transition shall occur when an explicit tagged write sequence command is enabled with the FCS bit set to one.

Transition E0:E0: This transition shall occur when:

a) an explicit tagged read type command is enabled;
b) an explicit untagged command is enabled;
c) a generic command is enabled;
d) a FORMAT MEDIUM command is enabled;
e) a MODE SELECT command specifying a mode page other than the Device Configuration mode page is enabled;
f) a MODE SELECT command specifying a Device Configuration mode page with the BAML bit set to zero and the BAM bit set to zero is enabled;
g) a SEND DIAGNOSTIC command is enabled;
h) a SET CAPACITY command is enabled;
i) an explicit tagged write type command is enabled with the FCS bit set to zero. In this case the device server shall return CHECK CONDITION status, the sense key shall be set to ILLEGAL REQUEST and the additional sense code shall be set to INVALID FIELD IN CDB; or
j) an implicit command is enabled, the medium position is not at BOx, and the BAML bit is set to zero. In this case the device server shall return CHECK CONDITION status, the sense key shall be set to ILLEGAL REQUEST and the additional sense code shall be set to ILLEGAL COMMAND WHILE IN EXPLICIT ADDRESS MODE.

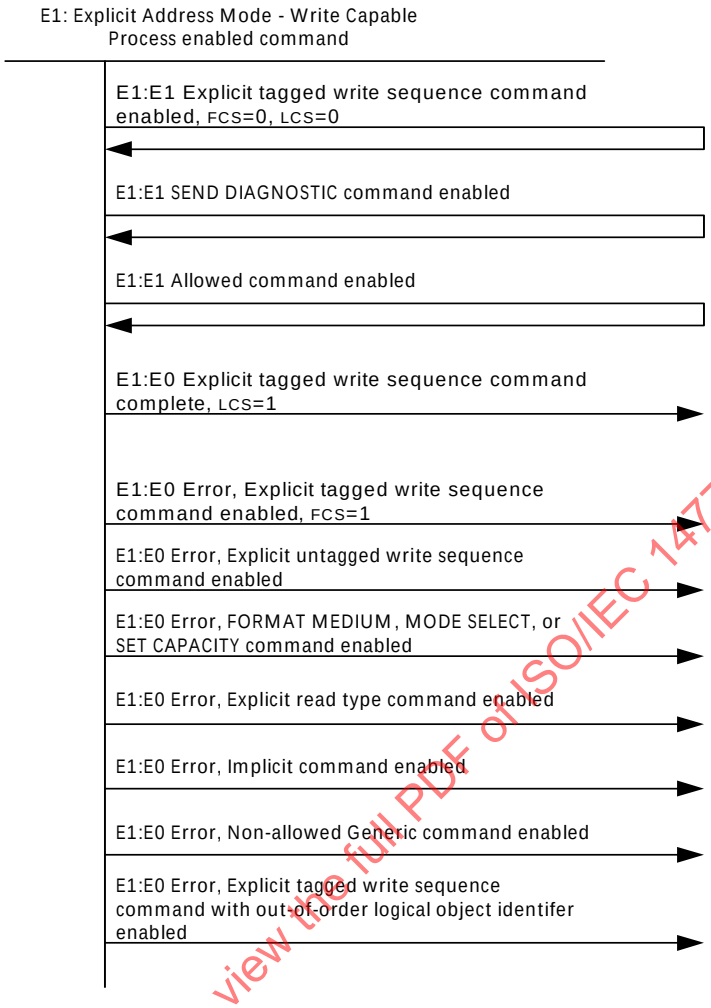

Figure 17 — Block address mode state diagram, Explicit Address Mode - Write Capable

State E1:Explicit Address Mode - Write Capable: This is the write capable state for explicit address mode.

Transition E1:E1: This transition shall occur when:

a) an explicit tagged write sequence command is enabled with the FCS bit set to zero and the LCS bit set to zero;
b) a SEND DIAGNOSTIC command is enabled; or
c) an allowed command (see table 22) is enabled.

Transition E1:E0: This transition shall occur when:

a) an explicit tagged write sequence command with the LCS bit set to one completed with GOOD status;
b) an explicit tagged write sequence command with the FCS bit set to one and the LCS bit set to one completed with GOOD status;
c) an explicit tagged write sequence command is enabled with the FCS bit set to one. In this case the device server shall return CHECK CONDITION status, the sense key shall be set to ILLEGAL REQUEST, and the additional sense code shall be set to INVALID FIELD IN CDB;
d) an explicit untagged write sequence command is enabled. In this case the device server shall return CHECK CONDITION status, the sense key shall be set to ILLEGAL REQUEST, and the additional sense code shall be set to ILLEGAL COMMAND WHILE IN WRITE CAPABLE STATE;
e) a FORMAT MEDIUM, MODE SELECT, or SET CAPACITY command is enabled. In this case the device server shall return CHECK CONDITION status, the sense key shall be set to ILLEGAL REQUEST, and the additional sense code shall be set to ILLEGAL COMMAND WHILE IN WRITE CAPABLE STATE;

f) an explicit read type command is enabled. In this case the device server shall return CHECK CONDITION status, the sense key shall be set to ILLEGAL REQUEST, and the additional sense code shall be set to ILLEGAL COMMAND WHILE IN WRITE CAPABLE STATE;
g) an implicit command is enabled. In this case the device server shall return CHECK CONDITION status, the sense key shall be set to ILLEGAL REQUEST, and the additional sense code shall be set to ILLEGAL COMMAND WHILE IN WRITE CAPABLE STATE;
h) a non-allowed generic command (see table 22) is enabled. In this case the device server shall return CHECK CONDITION status, the sense key shall be set to ILLEGAL REQUEST, and the additional sense code shall be set to ILLEGAL COMMAND WHILE IN WRITE CAPABLE STATE; or
i) an explicit tagged write sequence command with an out-of-order logical object identifier is enabled. In this case the device server shall return CHECK CONDITION status, the sense key shall be set to ILLEGAL REQUEST and the additional sense code shall be set to INVALID FIELD IN CDB.

Following an error condition that does not result in a transition out of write capable state, the following commands may be issued to transition from write capable state to neutral state:

a) a WRITE(16) command with the LCS bit set to one and the TRANSFER LENGTH field set to zero; or
b) a WRITE FILEMARKS(16) command with the LCS bit set to one, the IMMED bit set to zero, and the FILEMARK COUNT field set to zero.

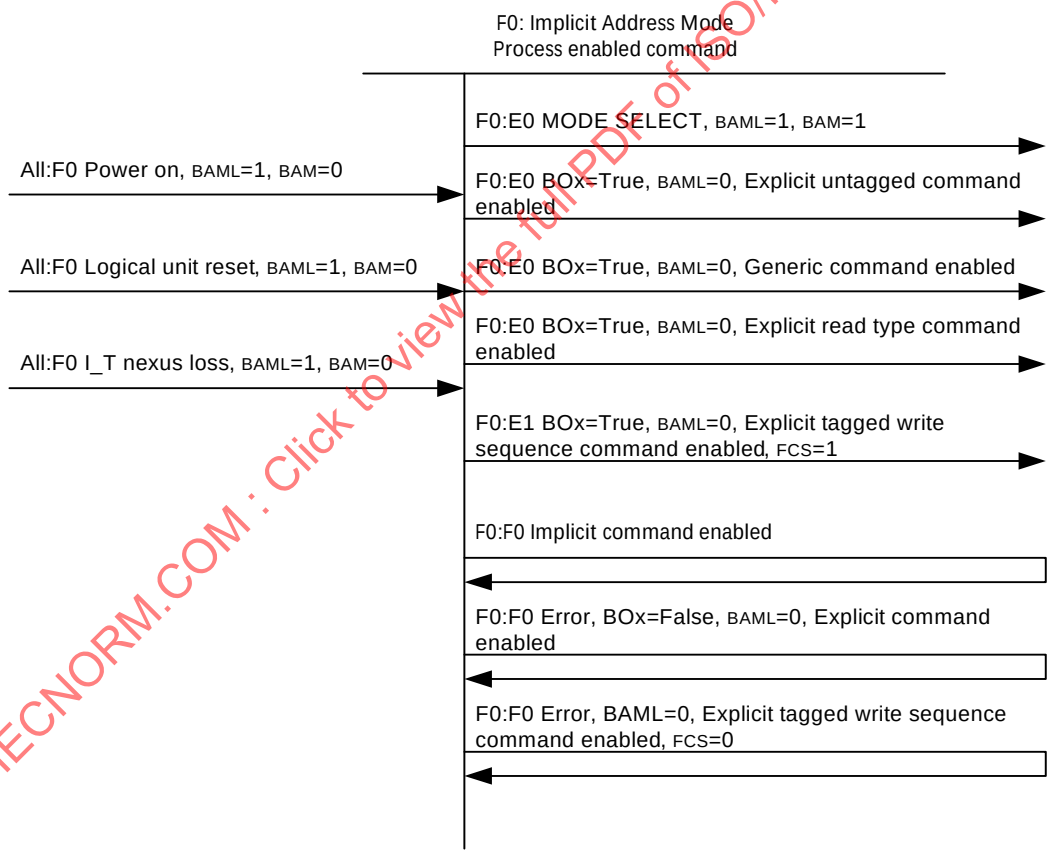

Figure 18 — Block address mode state diagram, Implicit Address Mode

State F0:Implicit Address Mode: This is the state for implicit address mode.

Transition All:F0: This transition shall occur when a power-on, logical unit reset, or I_T nexus loss event occurs and the BAML bit is set to one and the BAM bit is set to zero.

Transition F0:E0: This transition shall occur when:

a) a MODE SELECT command specifying a Device Configuration mode page with the BAML bit set to one and the BAM bit set to one completes with GOOD status;

b) an explicit untagged command is enabled, the medium position is at BOx, and the BAML bit is set to zero;
c) a generic command is enabled, the medium position is at BOx, and the BAML bit is set to zero; or
d) an explicit read type command is enabled, the medium position is at BOx, and the BAML bit is set to zero.

Transition F0:E1: This transition shall occur when an explicit tagged write sequence command is enabled with the FCS bit set to one, the medium position is at BOx, and the BAML bit is set to zero.

Transition F0:F0: This transition shall occur when:

a) an implicit command is enabled;
b) an explicit command is enabled, the medium position is not at BOx, and the BAML bit is set to zero. In this case the device server shall return CHECK CONDITION status, the sense key shall be set to ILLEGAL REQUEST, and the additional sense code shall be set to ILLEGAL COMMAND WHILE IN IMPLICIT ADDRESS MODE; or
c) an explicit tagged write sequence command is enabled with the FCS bit set to zero. In this case the device server shall return CHECK CONDITION status, the sense key shall be set to ILLEGAL REQUEST, and the additional sense code shall be set to ILLEGAL COMMAND WHILE IN IMPLICIT ADDRESS MODE.

4.2.18 TapeAlert application client interface

4.2.18.1 TapeAlert introduction

TapeAlert provides an application client with the capability to receive notification of various events and conditions arising in the SCSI target device. This standard defines 64 unique TapeAlert flags for a sequential-access device. A service information log parameter (see table 74) is also defined for each TapeAlert flag that provides information necessary for an application client to decide appropriate error recovery procedures.

TapeAlert flag severity is specified in table 9. TapeAlert flags fall into three categories of default severity (see table 10).

Table 9 — TapeAlert flags severity

Value	Severity	Definition
01h	Informational	No guidance about continued operation without corrective action is given by this standard. The condition should be logged and/or the operator informed.
06h	Retryable	The event that generated this information may be retried.
0Bh	Warning	The system may not be operating optimally. Continued operation without corrective action may cause a failure or raise critical TapeAlert flags. The condition should be logged and/or the operator informed.
10h	Critical	Either a failure has already occurred or a failure is imminent. Corrective action is required. The condition should be logged and/or an operator informed.
15h	Intervention required	If this condition is not corrected, a data loss failure may occur. The condition should be logged and/or an operator informed.
1Ah	Call service	Action by service personnel is required. The condition should be logged and service personnel informed.
All others	-	Reserved

Table 10 specifies the 64 TapeAlert flags for a sequential-access device. See Annex A for additional information about each TapeAlert flag.

Table 10 — TapeAlert flags

Flag	Name	Type	Default severity	Deactivation condition	TapeAlert Flag specific information available (see 8.2.3.x)
01h	Read warning	O	W	Start of next volume load	Y
02h	Write warning	O	W	Start of next volume load	Y
03h	Hard error	M	W	Start of next volume load[a]	N
04h	Medium	M	C	Start of next volume load[a]	Y
05h	Read failure	M	C	Start of next volume load[a]	N
06h	Write failure	M	C	Start of next volume load[a]	N
07h	Medium life	O	W	Start of next volume load	Y
08h	Not data grade	O	W	Start of next volume load	N
09h	Write protect	O	C	Start of next volume load or removal of write protect	N
0Ah	Volume removal prevented	O	I	After volume removal allowed	N
0Bh	Cleaning volume	O	I	Start of next volume load	N
0Ch	Unsupported format	O	I	Start of next volume load or format change	N
0Dh	Recoverable mechanical cartridge failure	O	C	Start of next volume load	N
0Eh	Unrecoverable mechanical cartridge failure	O	C	After service resolution	N
0Fh	Memory chip in cartridge failure	O	W	Start of next volume load	N
10h	Forced eject	O	C	Start of next volume load	N
11h	Read only format	O	W	Start of next volume load or format change	N
12h	Tape directory corrupted on load	O	W	Start of next volume load	N
13h	Nearing medium life	O	I	Start of next volume load	Y
14h	Cleaning required	O	C	After successful cleaning or cause resolved	Y
15h	Cleaning requested	O	W	After successful cleaning	Y
16h	Expired cleaning volume	O	C	Start of next volume load	Y
17h	Invalid cleaning volume	O	C	Start of next volume load	
18h	Retension requested	O	W	After successful retention	N

Type Key: M=Mandatory
O=Optional
W=Warning
C=Critical
I=Informational

a) Devices compliant with previous versions of this standard may deactivate this TapeAlert flag when demounting the current volume.

Table 10 — TapeAlert flags (Continued)

Flag	Name	Type	Default severity	Deactivation condition	TapeAlert Flag specific information available (see 8.2.3.x)
19h	Multi-port interface error on a primary port	O	W	After interface returns to operation	N
1Ah	Cooling fan failure	O	W	After service resolution	N
1Bh	Power supply failure	O	W	After service resolution	N
1Ch	Power consumption	O	W	After power consumption returns to within specification	Y
1Dh	Drive preventive maintenance required	O	W	After service resolution	N
1Eh	Hardware A	O	C	After service resolution	N
1Fh	Hardware B	M	C	At power on event	N
20h	Primary interface	O	W	After interface returns to operation	N
21h	Eject volume	O	C	After volume is ejected	N
22h	Microcode update fail	O	W	Start of next microcode update	N
23h	Drive humidity	O	W	After humidity returns to within specification	Y
24h	Drive temperature	O	W	After temperature returns to within specification	Y
25h	Drive voltage	O	W	After voltage returns to within specification	Y
26h	Predictive failure	O	C	After service resolution	Y
27h	Diagnostics required	O	W	After service resolution	N
28h - 2Eh	Obsolete				N
2Fh - 31h	Reserved				N
32h	Lost statistics	O	W	Start of next volume load	N
33h	Tape directory invalid at unload	O	W	Start of next volume load	N
34h	Tape system area write failure	O	C	Start of next volume load	N
35h	Tape system area read failure	O	C	Start of next volume load	N
36h	No start of data	O	C	Start of next volume load	N
37h	Loading or threading failure	O	C	Start of next volume load	N
38h	Unrecoverable unload failure	O	C	After service resolution	N

Type Key: M=Mandatory
O=Optional
W=Warning
C=Critical
I=Informational

a) Devices compliant with previous versions of this standard may deactivate this TapeAlert flag when demounting the current volume.

Table 10 — TapeAlert flags (Continued)

Flag	Name	Type	Default severity	Deactivation condition	TapeAlert Flag specific information available (see 8.2.3.x)
39h	Automation interface failure	O	C	After service resolution	N
3Ah	Microcode failure	O	W	After service resolution	N
3Bh	WORM volume - integrity check failed	O	W	Start of next volume load	N
3Ch	WORM volume - overwrite attempted	O	W	Start of next volume load	N
3Dh - 40h	Reserved				
Type Key: M=Mandatory O=Optional W=Warning C=Critical I=Informational					
a) Devices compliant with previous versions of this standard may deactivate this TapeAlert flag when demounting the current volume.					

4.2.18.2 TapeAlert usage model

4.2.18.2.1 TapeAlert usage model introduction

This standard specifies three methods for an application client to monitor activation of TapeAlert flags:

a) polling either the TapeAlert log page or the TapeAlert Response log page;
b) configuring the device server to establish an Informational exception condition upon activation of one or more TapeAlert flags; and
c) establishing a threshold for one or more of the parameters in the TapeAlert log page.

An application client may use any of these methods or a mixture of them.

Prior to using the TapeAlert Response log page with method (a), an application client should determine whether the device server supports the TapeAlert Response log page. An application client may determine if a device server supports a log page by issuing a LOG SENSE command with the PAGE CODE field set to 00h and examining the data returned.

4.2.18.2.2 TapeAlert polling usage model

The application client configures the device server for the TapeAlert polling usage model by:

a) setting the TASER bit in the Device Configuration Extension mode page to one (see 8.3.8); and
b) setting the ETC bit of every parameter in the TapeAlert log page to zero (see 8.2.3).

NOTE 3 - Devices that comply with earlier versions of this standard set the ETC bit in each TapeAlert log parameter to zero and do not allow the application client to change this value.

If using the TapeAlert polling usage model, the application client reads the TapeAlert log page or the TapeAlert Response log page without receiving notification from the device server that a TapeAlert flag has changed state. The application client may read the TapeAlert log page or the TapeAlert Response log page at any time (e.g., polled at a regular interval of 60 seconds). The application client should read either the TapeAlert log page or the TapeAlert Response log page:

a) prior to mounting a volume and at the beginning of a data transfer sequence;

b) immediately after detecting an unrecoverable error during the data transfer sequence;
c) before demounting each volume; and
d) at the end of a data transfer sequence.

4.2.18.2.3 TapeAlert informational exception usage model

The application client configures the device server for the TapeAlert informational exception usage model by:

a) setting the TASER bit in the Device Configuration Extension mode page to zero (see 8.3.8);
b) setting the DEXCPT bit in the Informational Exceptions Control mode page to zero and the test bit in the Informational Exceptions Control mode page to zero (see 8.3.6);
c) setting the MRIE field in the Informational Exceptions Control mode page to a supported value greater than zero (see 8.3.6); and
d) setting the ETC bit of every parameter in the TapeAlert log page to zero (see 8.2.3).

NOTE 4 - Devices that comply with earlier versions of this standard set the ETC bit in each TapeAlert log parameter to zero and do not allow the application client to change this value.

If using the TapeAlert informational exception usage model, the application client receives TapeAlert flag information upon or after receiving notification from the device server that an informational exception condition has occurred. The device server generates an informational exception condition due to an activated TapeAlert flag. The device server does not generate an informational exception condition due to a deactivated TapeAlert flag. The method used by the device server to report the informational exception condition depends on the value of the MRIE field (see SPC-4). If the device server returns descriptor format sense data (see SPC-4), the current state of all TapeAlert flags appears in the information sense data descriptor (see 4.2.13.3). If the device server returns fixed format sense data (see SPC-4), the application client should read the TapeAlert log page to retrieve the state of the TapeAlert flags.

If the TEST bit is set to zero, a device server reporting an informational exception condition for a TapeAlert flag sets the additional sense code to FAILURE PREDICTION THRESHOLD EXCEEDED.

4.2.18.2.4 TapeAlert threshold usage model

The application client configures the device server for the TapeAlert threshold usage model by:

a) setting the TASER bit in the Device Configuration Extension mode page to one (see 8.3.8);
b) setting to one the ETC bit of each parameter in the TapeAlert log page for which the application client wishes to receive a unit attention condition (see 8.2.3);
c) setting to zero the ETC bit of each parameter in the TapeAlert log page for which the application client does not wish to receive a unit attention condition (see 8.2.3); and
d) establishing a threshold value and a threshold met criteria (TMC) value for each TapeAlert log page parameter with the ETC bit set to one (see SPC-4).

NOTE 5 - Devices that comply with earlier versions of this standard set the ETC bit in each TapeAlert log parameter to zero and do not allow the application client to change this value. These devices do not support the TapeAlert threshold usage model.

If using the TapeAlert threshold usage model, the application client receives a unit attention when a TapeAlert log page parameter meets its threshold criteria. If the device server returns descriptor format sense data (see SPC-4), the current state of all TapeAlert flags appears in the information sense data descriptor (see 4.2.13.3). If the device server returns fixed format sense data (see SPC-4), the application client should read the TapeAlert log page to retrieve the state of the TapeAlert flags.

The threshold and TMC values determine whether the device server establishes a unit attention condition on TapeAlert flag activation or deactivation.

4.2.18.3 TapeAlert flag activation and deactivation

The device server shall activate a TapeAlert flag upon detecting the condition or event specified in table 11.

Table 11 — TapeAlert flag activation conditions

Flag	Name	Activation condition
03h	Hard error	An unrecoverable read/write/positioning error.
04h	Medium	An unrecoverable read/write/positioning error due to a faulty medium.
05h	Read failure	An unrecoverable read error due to either a faulty medium or faulty device hardware.
06h	Write failure	An unrecoverable write/positioning error due to either a faulty medium or faulty device hardware.
1Fh	Hardware B	An error during power on self test.

The device server may activate a TapeAlert flag not listed in table 11 upon detection of a vendor-specific condition.

Initialization processing due to a power-on condition may activate some TapeAlert flags.

The device server shall deactivate a TapeAlert flag upon detecting the condition or event specified for that flag in table 10. The device server shall not deactivate any TapeAlert flag due to a vendor-specific condition/event. The device server shall deactivate all TapeAlert flags:

a) upon processing a LOG SENSE command with the PAGE CODE field set to 2Eh if the TAPLSD bit is set to zero in the Device Configuration Extension mode page (see 8.3.8); or
b) upon detecting a logical unit reset condition (see SAM-4).

The device server may deactivate any TapeAlert flag on a vendor-specific basis due to:

a) processing a LOG SELECT command with the PCR bit set to one (see SPC-4); or
b) processing a LOG SELECT command with the PARAMETER LIST LENGTH field set to zero and the PC field set to 11b.

If the device server deactivates a TapeAlert flag by processing a LOG SENSE command with the PAGE CODE field set to 2Eh, the device server shall not activate the flag again until the device server:

a) detects the deactivation condition specified in table 10;
b) detects a logical unit reset condition; or
c) processes a LOG SELECT command with the PCR bit set to one.

If the device server deactivates a TapeAlert flag through some other mechanism, the device server may activate the flag before

a) detecting the deactivation condition given in table 10;
b) detecting a logical unit reset condition; or
c) processing a LOG SELECT command with the PCR bit set to one.

If the TAPLSD bit in the Device Configuration Extension mode page (see 8.3.8) is set to zero, the device server should deactivate flags on a per I_T nexus basis such that active flags are available for reading by other I_T nexus. If the TAPLSD bit in the Device Configuration Extension mode page (see 8.3.8) is set to one, the device server may deactivate flags on a per I_T nexus basis.

NOTE 6 - Backwards compatibilty with previous versions of this standard is violated if the TAPLSD bit is set to zero and the device server deactivates TapeAlert flags on any basis other than per I_T nexus.

4.2.18.4 WORM TapeAlert flags

Two TapeAlert flags exist to support Write Once Read Many (WORM) volumes:

a) 3Bh (i.e., WORM volume - integrity check failed); and
b) 3Ch (i.e., WORM volume - overwrite attempted).

If the device server supports TapeAlert flag 3Bh, it shall activate that flag upon detecting that the integrity of the volume may be compromised. If the device server supports TapeAlert flag 3Ch, it shall activate that flag if an application client attempts to overwrite or erase user data on a WORM volume (see 4.2.21).

The device server shall deactivate TapeAlert flags 3Bh and 3Ch:

a) upon processing of a LOAD UNLOAD command with a LOAD bit set to one (see 7.2) that results in a not ready to ready transition;
b) upon processing of a LOAD UNLOAD command with a LOAD bit set to one (see 7.2), if both the volume and device server support MAM, that results in access to medium auxiliary memory only;
c) upon processing of an autoload operation (see SPC-4) that results in a not ready to ready transition;
d) when both the volume and device server support MAM, that results in access to medium auxiliary memory only; or
e) upon the occurrence of a deactivation condition as specified in 4.2.18.3.

4.2.18.5 TapeAlert Response log page

The TapeAlert flags reported through the TapeAlert Response log page (see 8.2.1) represent states. This approach facilitates accurate reporting of the conditions encountered by the device and allows the application client to manage the information directly. The device server does not maintain unique TapeAlert information for each I_T nexus, and the state flags are not affected by SCSI port events (e.g., I_T nexus loss).

The application client is responsible for determining which flags have changed state upon subsequent retrieval of the TapeAlert Response log page. The application client may maintain a state change history.

If the TAPLSD bit in the Device Configuration Extension mode page (see 8.3.8) is set to one, the device server shall maintain the value of the flags in the TapeAlert Response log page independently of the TapeAlert flags reported through the TapeAlert log page (see 8.2.3). A LOG SENSE command that retrieves the TapeAlert Response log page shall not set the flags in that page to zero and shall not set the flags in the TapeAlert log page to zero. A LOG SENSE command that retrieves the TapeAlert log page shall not set the flags in the TapeAlert Response log page to zero.

4.2.19 READ ATTRIBUTE and WRITE ATTRIBUTE command support

Support for the READ ATTRIBUTE and WRITE ATTRIBUTE commands (see SPC-4) is described in table 12 and table 13.

Table 12 — Device common attributes

ID	Attribute name	Number of bytes	Format
0002h	TAPEALERT FLAGS	8	Binary
0005h	ASSIGNING ORGANIZATION	8	ASCII
0006h	FORMATTED DENSITY CODE	1	Binary

The TAPEALERT FLAGS attribute provides a means of reporting the state of the TapeAlert flags for the previous load of the volume. Each TapeAlert flag occupies one bit (Flag 1 = MSB, byte 1; Flag 64 = LSB, byte 8). The bits specify all the TapeAlert flags that were set to one during the previous load, (i.e., the bits remain set to one for the duration of the load).

The ASSIGNING ORGANIZATION attribute identifies the organization responsible for the specifications defining the values in the FORMATTED DENSITY CODE attribute. The ASSIGNING ORGANIZATION

attribute should contain a vendor identification. A vendor identification other than the one associated with the device may be used.

NOTE 7 - It is intended that the ASSIGNING ORGANIZATION attribute provide a unique vendor identification of the FORMATTED DENSITY CODE attribute. In the absence of a formal registration procedure, T10 maintains a list of known vendor identification codes for use in the Standard INQUIRY data (see SPC-4). Vendors are requested to voluntarily submit their identification codes to T10 to prevent duplication of codes (see SPC-4).

If the device server formats the medium using a format other than the one specified in the MEDIUM DENSITY CODE attribute (e.g., for compatibility with a previous generation format), then the FORMATTED DENSITY CODE attribute specifies the DENSITY CODE of the format chosen (see SPC-4). Otherwise this attribute shall be the same as the MEDIUM DENSITY CODE attribute.

Table 13 — Medium common attributes

ID	Attribute name	Number of bytes	Format
0402h	MEDIUM LENGTH	4	Binary
0403h	MEDIUM WIDTH	4	Binary
0404h	ASSIGNING ORGANIZATION	8	ASCII
0405h	MEDIUM DENSITY CODE	1	Binary

The MEDIUM LENGTH attribute specifies the length of the medium in meters. A value of 0h specifies that the length of the medium is undefined.

The MEDIUM WIDTH attribute specifies the width of the medium supported by this density. This attribute has units of tenths of millimeters. The value in this attribute shall be rounded up if the fractional value of the actual value is greater than or equal to 0,5. The MEDIUM WIDTH attribute may vary for a given density depending on the mounted volume. A value of 0h specifies the width of the medium is undefined.

The ASSIGNING ORGANIZATION attribute identifies the organization responsible for the specifications defining the values in the MEDIUM DENSITY CODE attribute. The ASSIGNING ORGANIZATION attribute should contain a vendor identification.

NOTE 8 - It is intended that the ASSIGNING ORGANIZATION attribute provide a unique vendor identification of the MEDIUM DENSITY CODE attribute. In the absence of a formal registration procedure, T10 maintains a list of known vendor identification codes for use in the Standard INQUIRY data (see SPC-4). Vendors are requested to voluntarily submit their identification codes to T10 to prevent duplication of codes (see SPC-4).

4.2.20 Reservations

Reservation restrictions are placed on commands as a result of access qualifiers associated with the type of reservation. See SPC-4 for a description of reservations. The details of which commands are allowed under what types of reservations are described in table 14.

Commands from I_T_nexus holding a reservation should complete normally. Table 14 specifies the behavior of commands from registered I_T_nexus when a registrants only or all registrants persistent reservation is present.

Due to the nature of the sequential-access device type, Write Exclusive and Write Exclusive, Registrants Only modes of reservation do not protect an application client's continuity of operations when using the implicit address command set. While these modes do protect unauthorized modification of data, they do not protect from medium position changes that may result in errors due to incorrect position. It is the responsibility of the application client to manage this using means outside the scope of this specification. Application clients should use exclusive modes of reservation while accessing the volume to prevent interference from other applications.

For each command, this standard and the SPC-4 standard define the conditions that result in RESERVATION CONFLICT.

Table 14 — SSC-3 commands that are allowed in the presence of various reservations

Command	Addressed LU has this type of persistent reservation held by another I_T_nexus				
	From any I_T_nexus		From registered I_T_nexus (RR all types)	From I_T_nexus not registered	
	Write Exclusive	Exclusive Access		Write Exclusive - RR	Exclusive Access - RR
ERASE(6)	Conflict	Conflict	Allowed	Conflict	Conflict
ERASE(16)	Conflict	Conflict	Allowed	Conflict	Conflict
FORMAT MEDIUM	Conflict	Conflict	Allowed	Conflict	Conflict
LOAD UNLOAD	Conflict	Conflict	Allowed	Conflict	Conflict
LOCATE(10)	Allowed	Conflict	Allowed	Allowed	Conflict
LOCATE(16)	Allowed	Conflict	Allowed	Allowed	Conflict
READ(6)	Allowed	Conflict	Allowed	Allowed	Conflict
READ(16)	Allowed	Conflict	Allowed	Allowed	Conflict
READ BLOCK LIMITS	Allowed	Allowed	Allowed	Allowed	Allowed
READ POSITION	Allowed	Conflict	Allowed	Allowed	Conflict
READ REVERSE(6)	Allowed	Conflict	Allowed	Allowed	Conflict
READ REVERSE(16)	Allowed	Conflict	Allowed	Allowed	Conflict
RECOVER BUFFERED DATA	Allowed	Conflict	Allowed	Allowed	Conflict
REPORT DENSITY SUPPORT	Allowed	Allowed	Allowed	Allowed	Allowed
REWIND	Allowed	Conflict	Allowed	Allowed	Conflict
SET CAPACITY	Conflict	Conflict	Allowed	Conflict	Conflict
SPACE(6)	Allowed	Conflict	Allowed	Allowed	Conflict
SPACE(16)	Allowed	Conflict	Allowed	Allowed	Conflict
VERIFY(6)	Allowed	Conflict	Allowed	Allowed	Conflict
VERIFY(16)	Allowed	Conflict	Allowed	Allowed	Conflict
WRITE(6)	Conflict	Conflict	Allowed	Conflict	Conflict
WRITE(16)	Conflict	Conflict	Allowed	Conflict	Conflict
WRITE FILEMARKS(6)	Conflict	Conflict	Allowed	Conflict	Conflict
WRITE FILEMARKS(16)	Conflict	Conflict	Allowed	Conflict	Conflict

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

Allowed: Commands received from I_T nexus not holding the reservation or from I_T nexus not registered when a registrants only or an all registrants type persistent reservation is present should complete normally.

Conflict: Commands received from I_T nexus not holding the reservation or from I_T nexus not registered when a registrants only or an all registrants type persistent reservation is present shall not be performed and the device server shall terminate the command with RESERVATION CONFLICT status.

4.2.21 WORM volume and WORM mode

4.2.21.1 WORM overview

The device server may support a Write Once, Read Many (WORM) mode of operation. This mode of operation places additional restrictions on the processing of commands by the device server.

4.2.21.2 WORM volume

A WORM volume is identified by a format-defined method (e.g., the Medium Type attribute in the MAM data returning a Write Once Medium type value).

4.2.21.3 WORM mode

A device server that supports WORM mode and detects a WORM volume is mounted shall enter WORM mode. While in WORM mode, WRITE, WRITE FILEMARKS, ERASE, FORMAT MEDIUM, SET CAPACITY, and MODE SELECT commands that alter the partitioning or format are subject to the restrictions applied to WORM volume by the device server (see 8.3.7).

If a device server operating in WORM mode detects that one of these additional restrictions would be violated by a command being processed, the device server shall terminate the command with CHECK CONDITION status. The sense key shall be set to DATA PROTECT and the additional sense code shall be set to WORM MEDIUM - OVERWRITE ATTEMPTED. If a write protection is in effect for the device server, volume, or medium (see 4.2.14), it shall take precedence over the WORM mode violation.

If a device server operating in WORM mode is unable to determine if the volume is such that one of these additional restrictions would be violated by a command being processed, the device server shall terminate the command with CHECK CONDITION status, the sense key shall be set to DATA PROTECT, and the additional sense code shall be set to WORM MEDIUM - OVERWRITE ATTEMPTED. If a write protection is in effect for the device server, volume, or medium (see 4.2.14), it shall take precedence over the WORM mode violation.

If a device server that does not support WORM mode detects that a WORM volume is mounted, it shall treat the volume as write protected. Any command that attempts to alter the WORM volume shall be terminated with CHECK CONDITION status. The sense key shall be set to DATA PROTECT and the additional sense code shall be set to CANNOT WRITE MEDIUM - INCOMPATIBLE FORMAT.

4.2.22 Logical block encryption

4.2.22.1 Logical block encryption overview

A device compliant with this standard may contain hardware or software that is capable of encrypting logical blocks as those blocks are stored on the medium, and decrypting logical blocks as those blocks are read from the medium, to provide security against unauthorized access to that data. The SECURITY PROTOCOL IN and SECURITY PROTOCOL OUT commands specifying the Tape Data Encryption security protocol (see 8.5.2 and 8.5.3) provide a means for the application client to monitor and control the encryption and decryption processes within the device entity. A device server that supports the SECURITY PROTOCOL OUT command shall also support the SECURITY PROTOCOL IN command.

The SECURITY PROTOCOL OUT command specifying the Tape Data Encryption security protocol is used to set logical block encryption parameters. The SECURITY PROTOCOL IN command specifying the Tape Data Encryption security protocol is used to discover the type of data security features supported by the device server, the current configuration of data security features, and status of the encryption and decryption processes.

4.2.22.2 Encrypting logical blocks on the medium

The application client controls the logical block encryption process by use of the SECURITY PROTOCOL OUT command specifying the Tape Data Encryption security protocol. Logical block encryption shall be managed within the device server on a per I_T_L nexus basis. The logical block encryption process is enabled for an I_T_L nexus upon successful completion of a SECURITY PROTOCOL OUT command that

sends a Set Data Encryption page (see 8.5.3.2) with the ENCRYPTION MODE field set to ENCRYPT and with a valid logical block encryption key. If the logical block encryption scope parameter for an I_T_L nexus is set to PUBLIC (see 4.2.22.13), the logical block encryption process may be enabled by another I_T_L nexus that establishes a set of logical block encryption parameters with a logical block encryption scope of ALL I_T NEXUS (see 4.2.22.13).

If logical block encryption is enabled for an I_T_L nexus and the mounted volume supports the selected encryption algorithm at the current logical position, all logical blocks received by the device server from that I_T_L nexus as part of a WRITE(6) or WRITE(16) command shall be encrypted before being recorded on the medium. Filemarks are logical objects that shall not be encrypted.

If logical block encryption is enabled for an I_T_L nexus and the mounted volume does not support the selected encryption algorithm at the current logical position, then the device server shall terminate a WRITE(6) or WRITE(16) command with CHECK CONDITION status, with the sense key set to DATA PROTECT, and the additional sense code set to ENCRYPTION PARAMETERS NOT USEABLE.

If logical block encryption is enabled for an I_T_L nexus and the mounted volume does not support the selected encryption algorithm at the current logical position, then the device server may terminate a WRITE FILEMARKS(6) or WRITE FILEMARKS(16) command with CHECK CONDITION status, with the sense key set to DATA PROTECT, and the additional sense code set to ENCRYPTION PARAMETERS NOT USEABLE.

4.2.22.3 Reading encrypted logical blocks on the medium

A volume may contain no encrypted logical blocks, all encrypted logical blocks, or a mixture of encrypted logical blocks and unencrypted logical blocks. The fact that logical blocks are encrypted shall not alter space or locate operations. The decryption mode shall be ignored when processing a filemark during a read or verify operation.

A device entity that supports encryption should be capable of distinguishing encrypted logical blocks from unencrypted logical blocks. The device server reports the capability of the device entity for distinguishing encrypted logical blocks from unencrypted logical blocks using the DELB_C bit in the logical block encryption algorithm descriptor (see 8.5.2.4). If the device entity is capable of distinguishing encrypted logical blocks from unencrypted logical blocks, an attempt to read or verify an encrypted logical block when the decryption mode is set to DISABLED shall cause the device server to terminate the command with CHECK CONDITION status, with the sense key set to DATA PROTECT, and the additional sense code set to UNABLE TO DECRYPT DATA. The device entity shall establish the logical position at the BOP side of the encrypted logical block.

If the device entity is capable of distinguishing encrypted logical blocks from unencrypted logical blocks and the decryption mode is set to DECRYPT or RAW, an attempt to read or verify an unencrypted logical block shall cause the device server to terminate the command with CHECK CONDITION status, with the sense key set to DATA PROTECT, and the additional sense code set to UNENCRYPTED DATA ENCOUNTERED WHILE DECRYPTING. The device entity shall establish the logical position at the BOP side of the unencrypted logical block.

A device entity that supports encryption and has been configured to decrypt the logical block may be capable of determining that the logical block encryption key is correct for an encrypted logical block. The correct logical block encryption key to use for this encrypted logical block may be either the logical block encryption key or one of the supplemental decryption keys (SDK). The method for determining which logical block encryption key or supplemental decryption key to use for decryption is vendor specific. If the device entity is capable of determining that the logical block encryption key is correct, an attempt to read or verify an encrypted logical block when the decryption mode is set to either DECRYPT or MIXED, but all of the logical block encryption keys provided are incorrect for the encrypted logical block, shall cause the device server to terminate the command with CHECK CONDITION status, with the sense key set to DATA PROTECT, and the additional sense code set to INCORRECT DATA ENCRYPTION KEY. The device entity shall establish the logical position at the BOP side of the encrypted logical block.

A device entity that supports encryption and has been configured to decrypt the logical block may be capable of validating the integrity of the logical block after decrypting it (i.e., that the decrypted logical block matches the logical block that was encrypted). If the device entity is capable of validating the integrity of the logical

block after decrypting it, an attempt to read or verify an encrypted logical block when the decryption mode is set to either DECRYPT or MIXED, but the logical block fails the integrity validation process, shall cause the device server to terminate the command with CHECK CONDITION status, with the sense key set to DATA PROTECT, and the additional sense code set to CRYPTOGRAPHIC INTEGRITY VALIDATION FAILED. The device entity shall establish the logical position at the BOP side the encrypted logical block.

A device entity that is capable of distinguishing encrypted logical blocks from unencrypted logical blocks and has been configured to decrypt the logical block should perform at least one of the following for each encrypted logical block that is decrypted:

a) determine if the logical block encryption key is correct for the encrypted logical block; or
b) validate the integrity of the logical block after decrypting it.

A device entity that is capable of determining if the logical block encryption key is correct for the encrypted logical block and validating the integrity of the logical block after decrypting it shall for each encrypted logical block:

1) determine if the logical block encryption key is correct for the encrypted logical block; and
2) validate the integrity of the logical block.

4.2.22.4 Exhaustive-search attack prevention

To prevent an exhaustive-search attack from discovering the logical block encryption key or one of the supplemental decryption keys, the device server should provide a mechanism to prevent unlimited attempts at setting a logical block encryption key or supplemental decryption key(s) and then attempting to read the logical block. The use of such a mechanism may protect against an encryption algorithm being compromised.

If the device server has reached its limit on failed attempts to set the logical block encryption key or supplemental decryption key(s) and decrypt logical blocks, it shall disable encryption and decryption for all I_T_L nexus. All subsequent SECURITY PROTOCOL OUT commands specifying the Tape Data Encryption security protocol and with the SECURITY PROTOCOL SPECIFIC field set to Set Data Encryption page with the DECRYPTION MODE field or ENCRYPTION MODE field set to any value other than DISABLE shall be terminated with CHECK CONDITION status, with the sense key set to DATA PROTECT, and the additional sense code set to DATA DECRYPTION KEY FAIL LIMIT REACHED. This condition shall persist until the volume is demounted or a hard reset condition occurs.

4.2.22.5 Keyless copy of encrypted logical blocks

In some scenarios it is desirable to copy logical blocks from one volume to another without needing knowledge of the encryption parameters used to encrypt the logical blocks on the volume.

A keyless copy logical unit (KCLU) controls configuration and data flows related to a volume that is either a source or destination for encrypted logical blocks being transferred without requiring application client knowledge of a logical block encryption key.

A keyless copy source logical unit (KCSLU) controls configuration and data flows related to the volume from which the encrypted logical block is copied without requiring device server knowledge of a logical block encryption key when the decryption mode is set to RAW. The device servers capability to act as a KCSLU for a specific encryption algorithm is indicated in the RDMC_C field of the Data Encryption Capabilities page (see 8.5.2.4).

A keyless copy destination logical unit (KCDLU) controls configuration and data flows related to the volume to which the encrypted logical block is being copied without requiring device server knowledge of a logical block encryption key when the encryption mode is set to EXTERNAL. The device servers capability to act as a KCDLU for a specific encryption algorithm is indicated in the EEMC_C field of the Data Encryption Capabilities page (see 8.5.2.4).

To accomplish a keyless copy operation an application client sets the KCSLU decryption mode to RAW and the KCDLU encryption mode to EXTERNAL. The application client then reads one or more logical objects from the KCSLU and writes those logical objects to the KCDLU. During this process, if the KCSLU detects a

mismatch between the key-associated data in the logical block encryption parameters and the key-associated data on the medium during a read operation, then the KCSLU returns a CHECK CONDITION status to the application client to notify it that some action is required. An example of this is shown in the informative flowchart in Annex C.

It shall not be considered an error if a Set Data Encryption page has the DECRYPTION MODE field set to RAW and any of the key-associated data descriptors required by the algorithm specified by the value in the ALGORITHM INDEX field are not present.

If the encryption algorithm in use by the KCSLU requires key-associated data to be included in the Set Data Encryption page when the ENCRYPTION MODE field is set to EXTERNAL, then an attempt to read or verify an encrypted logical block while the decryption mode is set to RAW shall cause the KCSLU to compare all key-associated data associated with each encrypted logical block that is read or verified to the corresponding key-associated data that are part of the current encryption parameters. Key-associated data required to be compared by the decryption algorithm that do not match or are not present shall cause the KCSLU to terminate the command with CHECK CONDITION status, with the sense key set to DATA PROTECT, and the additional sense code set to INCORRECT ENCRYPTION PARAMETERS. The KCSLU shall establish the logical position at the BOP side of the logical block.

If a KCDLU receives a SECURITY PROTOCOL OUT command with a Set Data Encryption page with the ENCRYPTION MODE field set to EXTERNAL, and any of the key-associated data descriptors required by the logical block encryption algorithm specified by the ALGORITHM INDEX field are not present or are not supported, then the KCDLU shall terminate the command with CHECK CONDITION, with the sense key set to ILLEGAL REQUEST, and the additional sense code set to INVALID FIELD IN PARAMETER LIST.

Some encryption algorithms provide a mechanism to record with encrypted logical blocks the encryption mode setting when the encrypted logical block was written. The device server reports if an encryption algorithm supports this mechanism by way of the EAREM bit in the algorithm descriptor (see 8.5.2.4). If the encryption algorithm provides this capability, the device entity may support a feature to check during read and verify operations if the logical block was written with the encryption mode set to EXTERNAL. The CEEM field in the Set Data Encryption page (see 8.5.3.2) provides the means to control the process of checking the encryption mode used when an encrypted logical block was written to tape. If the decryption mode is set to DECRYPT or MIXED and the check external encryption mode logical block encryption parameter (see 8.5.3.2) is set to 10b, then:

1) the device entity shall verify that each encrypted logical block that is processed for read and verify commands was written with the encryption mode set to ENCRYPT; and
2) if an attempt is made to read or verify an encrypted logical block that was written with the encryption mode set to EXTERNAL, the device server shall terminate the command with CHECK CONDITION status, with the sense key set to DATA PROTECT and the additional sense key set to ENCRYPTION MODE MISMATCH ON READ.

If the decryption mode is set to DECRYPT or MIXED and the check external encryption mode logical block encryption parameter is set to 11b:

1) the device entity shall verify that each encrypted logical block that is processed for read and verify commands was written with the encryption mode set to EXTERNAL; and
2) if an attempt is made to read or verify an encrypted logical block that was written with the encryption mode set to ENCRYPT, then the device server shall terminate the command with CHECK CONDITION status, with the sense key set to DATA PROTECT and the additional sense key set to ENCRYPTION MODE MISMATCH ON READ.

The check external encryption mode logical block encryption parameter shall not affect space or locate operations. The check external encryption mode logical block encryption parameter shall not affect read or verify operations on filemarks and unencrypted logical blocks.

Some encryption algorithms provide a mechanism to record with encrypted logical blocks an indication that they are disabled for raw decryption mode operations. The device server reports if an encryption algorithm

supports this mechanism by way of the RDMC_C field in the algorithm descriptor (see 8.5.2.4). If the decryption mode is set to RAW and the encryption algorithm supports this feature, then:

1) the device entity shall check the format specific indication that disables raw decryption mode operations for each encrypted logical block that is processed for read and verify commands; and
2) if an attempt is made to read or verify an encrypted logical block that was disabled for raw decryption mode operations, then the device server shall terminate the command with CHECK CONDITION status, with the sense key set to DATA PROTECT and the additional sense key set to ENCRYPTED BLOCK NOT RAW READ ENABLED.

4.2.22.6 Managing logical block encryption keys within the device entity

To increase the security of logical block encryption keys, the logical block encryption parameters are volatile in the device entity and the logical block encryption keys are not reported to an application client.

A device server that supports logical block encryption shall support at least one of the key formats that are defined in this standard (see table 150).

A vendor-specific key reference is an identifier that is associated with a specific logical block encryption key. The method by which logical block encryption keys and their associated vendor-specific key references are made available to the device server is outside the scope of this standard. A device server that supports passing logical block encryption keys by vendor-specific key reference shall include the code for vendor-specific key reference format (see table 150) in the SUPPORTED KEY FORMATS LIST field in the Supported Key Formats page (see 8.5.2.5).

The device entity shall release the resources used to save a set of logical block encryption parameters (see 4.2.22.14) under the following conditions:

a) the CKOD bit is set to one in the saved logical block encryption parameters and the volume is demounted;
b) the CKORL bit is set to one and the logical block encryption scope is set to LOCAL in the saved logical block encryption parameters and the I_T_L nexus that established the set of logical block encryption parameters loses its reservation;
c) the CKORL bit is set to one and the logical block encryption scope is set to ALL I_T NEXUS in the saved logical block encryption parameters and a reservation loss (see 3.1.57) occurs;
d) the CKORP bit is set to one in the saved logical block encryption parameters and the device server processes a PERSISTENT RESERVE OUT command with a service action of either PREEMPT or PREEMPT AND ABORT;
e) a microcode update is performed on the device; or
f) a power on condition occurs.

The device entity may release the resources used to save a set of logical block encryption parameters if:

a) a volume is mounted that does not support logical block encryption using the algorithm specified by the algorithm index logical block encryption parameter; or
b) other vendor-specific events.

If a device server processes a Set Data Encryption page with the ENCRYPTION MODE field set to DISABLE and DECRYPTION MODE field set to DISABLE or RAW, the device entity shall:

a) release any resources that it had allocated to store logical block encryption parameters for the I_T_L nexus associated with the SECURITY PROTOCOL OUT command and shall change the contents of all memory containing a key value associated with the logical block encryption parameters that are released; and
b) establish a unit attention condition with the additional sense of DATA ENCRYPTION PARAMETERS CHANGED BY ANOTHER I_T NEXUS for all other I_T_L nexus that has its registered for logical block encryption unit attentions state set to one (see 4.2.22.13) and is affected by the loss of the logical block encryption key, (i.e., any I_T_L nexus that is using a logical block encryption scope of PUBLIC and the SCOPE field in the Set Data Encryption page is set to ALL I_T NEXUS).

If a device server processes a Set Data Encryption page that includes a logical block encryption key and the SDK bit is set to zero, the device server shall establish a unit attention condition with the additional sense code set to DATA ENCRYPTION PARAMETERS CHANGED BY ANOTHER I_T NEXUS for all other I_T_L nexus that have their registered for logical block encryption unit attentions state set to one (see 4.2.22.13) and are affected by the change of the logical block encryption key (i.e., any I_T _L nexus that is using a logical block encryption scope of PUBLIC and the SCOPE field in the Set Data Encryption page is set to ALL I_T NEXUS), and the device entity shall:

1) release all resources that it had allocated to store key values set by previous Set Data Encryption pages from that I_T_L nexus and shall change the contents of all memory containing a key value associated with the logical block encryption parameters that are released; and
2) establish a set of logical block encryption parameters with the values from the Set Data Encryption page.

A device entity shall save at most one set of logical block encryption parameters with a logical block encryption scope of ALL I_T NEXUS. If a device server processes a Set Data Encryption page with the SCOPE field set to ALL I_T NEXUS, the device server shall establish a unit attention condition with the additional sense code set to DATA ENCRYPTION PARAMETERS CHANGED BY ANOTHER I_T NEXUS for all other I_T_L nexus that have their registered for logical block encryption unit attentions state set to one (see 4.2.22.13) and are affected by the change of the logical block encryption key (i.e., any I_T_L nexus that is using a logical block encryption scope of PUBLIC) and the device entity shall:

a) release any resources that it had allocated to store logical block encryption parameters with a logical block encryption scope value of ALL I_T NEXUS and shall change the contents of all memory containing a key value associated with the logical block encryption parameters that are released; and
b) establish a set of logical block encryption parameters with the values from the Set Data Encryption page and a logical block encryption scope value of ALL I_T NEXUS.

If a vendor-specific event occurs that changes or clears a set of logical block encryption parameters, the device server shall establish a unit attention condition with the additional sense of DATA ENCRYPTION PARAMETERS CHANGED BY VENDOR SPECIFIC EVENT for any I_T_L nexus that has its registered for logical block encryption unit attentions state set to one (see 4.2.22.13) and is affected by the change of the logical block encryption key.

4.2.22.7 Logical block encryption capabilities

A device entity that supports logical block encryption shall have a set of logical block encryption capabilities. The set of logical block encryption capabilities determine the values reported through a SECURITY PROTOCOL IN command specifying the Tape Data Encryption security protocol and the Data Encryption Capabilities page (see 8.5.2.4). The set of logical block encryption capabilities includes the set of logical block encryption algorithms supported by the device entity.

The set of logical block encryption capabilities includes some values that may be changed by a method outside the scope of this standard. The capabilities that may be changed include:

a) the set of logical block encryption algorithms reported by the device server;
b) encryption capable;
c) decryption capable; and
d) other vendor-specific logical block encryption capabilities.

4.2.22.8 Key instance counters

The device server shall keep a counter for each set of logical block encryption parameters that it is managing called the logical block encryption parameters key instance counter. The device entity shall keep a separate key instance counter called the device entity key instance counter. There may be a device entity key instance counter associated with each I_T_L nexus or there may be one global device entity key instance counter.

All key instance counters shall be set to zero when a hard reset condition occurs. Any other event that sets, clears, or changes a parameter in a set of logical block encryption parameters, except the supplemental decryption keys, shall cause the device entity key instance counter associated with the I_T_L nexus to be

incremented. The value of the logical block encryption parameters key instance counter of the currently selected logical block encryption parameters for an I_T_L nexus is reported in the Data Encryption Status page of the SECURITY PROTOCOL IN command. The key instance counters are 32 bits and shall roll over to zero when incremented past their maximum value.

4.2.22.9 Encryption mode locking

There are conditions outside of the control of an application client that cause the device entity to release the resources used to save the logical block encryption parameters (see 4.2.22.6) or change the logical block encryption parameters used to control the encryption of logical blocks. Each of these conditions cause the device server to establish a unit attention condition to report the change of operating mode, but the unit attention condition may not always be reported to the application client through protocol bridges and driver stacks.

The LOCK bit in the Set Data Encryption page is set to one to lock set of data encryption parameters established at the completion of the processing of the command to the I_T_L nexus through which the SECURITY PROTOCOL OUT command was issued. The set of logical block encryption parameters remains locked to that I_T_L nexus until a hard reset condition occurs or another SECURITY PROTOCOL OUT command including a Set Data Encryption page through the same I_T_L nexus is processed.

If the device server processes a WRITE(6) or WRITE(16) command through an I_T_L nexus that has its ITL_lock variable set to one, and the logical block encryption parameters key instance counter value has changed since the time it was locked (i.e., the logical block encryption parameters key instance counter does not equal the ITL_lock_key_instance_cnt for this I_T_L nexus), the device server shall terminate the command with CHECK CONDITION status, with the sense key set to logical block PROTECT, and the additional sense code set to DATA ENCRYPTION KEY INSTANCE COUNTER HAS CHANGED. All subsequent WRITE(6) and WRITE(16) commands shall also be terminated in this manner until a hard reset condition occurs or a SECURITY PROTOCOL OUT command including a Set Data Encryption page through the same I_T_L nexus is processed.

4.2.22.10 Nonce generation

For a given encryption algorithm, the device entity may:

a) not require a nonce value;
b) generate its own nonce value;
c) require a nonce value or part of the nonce value be provided by the application client; or
d) be configurable with respect to the source of the nonce value.

The device server reports its nonce value capability in the logical block encryption algorithm descriptor(s) (see 8.5.2.4). If the device server reports that it requires a nonce value from the application client and a Set Data Encryption page is processed that does not include a nonce value descriptor, the device server shall terminate the command with CHECK CONDITION, with the sense key set to ILLEGAL REQUEST, and the additional sense code set to INCOMPLETE KEY-ASSOCIATED DATA SET.

4.2.22.11 Unauthenticated key-associated data (U-KAD) and authenticated key-associated data (A-KAD)

Some encryption algorithms allow or require the use of additional data that is associated with the logical block encryption key and the logical block, but is not encrypted. Key-associated data may be authenticated by being included in the message authentication code (MAC) calculations for the encrypted logical block if such a MAC exists, or unauthenticated by not being included in these calculations.

The device server reports its capability with respect to key-associated data in the logical block encryption algorithm descriptor(s) DKAD_C field (see 8.5.2.4).

NOTE 9 - A key identifier or key reference may be stored in the U-KAD or A-KAD.

The U-KAD field is provided for applications that do not require the key-associated data to be protected by an MAC.

4.2.22.12 Metadata key-associated data (M-KAD)

Some encryption algorithms allow or require the use of additional data that is associated with the logical block encryption key and every logical block encrypted with that logical block encryption key. This data is contained in an M-KAD descriptor.

4.2.22.13 Logical block encryption information per I_T_L nexus

If the device server supports logical block encryption it shall maintain I_T_L nexus logical block encryption information on a per I_T_L nexus basis. This I_T_L nexus logical block encryption information shall contain the:

a) ITL_scope (i.e., the logical block encryption scope for this I_T_L nexus);
b) ITL_lock (i.e., the LOCK bit value for this I_T_L nexus);
c) ITL_lock_key_instance_cnt (i.e., the logical block encryption parameters key instance counter value at the time the LOCK bit was set to one for this I_T_L nexus); and
d) ITL_encryption_UA_reg (i.e., the registered for logical block encryption unit attentions state for this I_T_L nexus).

Device servers shall support setting the ITL_scope to any value of logical block encryption scope supported in the logical block encryption parameters. A device server that supports logical block encryption shall support an ITL_scope value of PUBLIC.

If the ITL_scope for this I_T_L nexus is set to PUBLIC it indicates that the logical block encryption parameters with a logical block encryption scope of ALL I_T NEXUS shall be used for commands received through this I_T_L nexus.

When a device server successfully completes the processing of a Set Data Encryption page with a logical block encryption scope of PUBLIC through this I_T_L nexus, the device server shall:

a) set the ITL_scope for this I_T_L nexus to PUBLIC;
b) set the ITL_lock for this I_T_L nexus to the value of the LOCK bit in the Set Data Encryption page;
c) set the ITL_lock_key_instance_cnt for this I_T_L nexus to:
   A) zero if the LOCK bit in Set Data Encryption page is set to zero; or
   B) the value of the logical block encryption parameters key instance counter in the ALL I_T_L_NEXUS logical block encryption parameters if the LOCK bit in the Set Data Encryption page is set to one; and
d) set the ITL_encryption_UA_reg for this I_T_L nexus to one.

When a command is received through an I_T_L nexus with an ITL_scope of LOCAL, the logical block encryption parameters with a logical block encryption scope of LOCAL for that I_T_L nexus shall be used for processing commands. If the resources used to save a set of logical block encryption parameters for an I_T_L nexus are released, then the ITL_scope for that I_T_L nexus shall be set to PUBLIC.

When a device server successfully completes the processing of a Set Data Encryption page with a logical block encryption scope of LOCAL through this I_T_L nexus, the device entity shall:

a) increment the device entity key instance counter associated with this I_T_L nexus;
b) create a set of logical block encryption parameters with a logical block encryption scope of LOCAL for this I_T_L nexus; and
c) set the logical block encryption parameters key instance counter to the value of the device entity key instance counter associated with this I_T_L nexus.

When a device server successfully completes the processing of a Set Data Encryption page with a logical block encryption scope of LOCAL through this I_T_L nexus the device server shall:

a) set the ITL_scope for this I_T_L nexus to LOCAL;
b) set the ITL_lock for this I_T_L nexus to the value of the LOCK bit in the Set Data Encryption page;
c) set the ITL_lock_key_instance_cnt for this I_T_L nexus to:
   A) zero if the LOCK bit in the Set Data Encryption is set to zero; or

B) the value of the logical block encryption parameters key instance counter of the logical block encryption parameters with a logical block encryption scope of LOCAL for this I_T_L nexus if the LOCK bit in the Set Data Encryption page is set to one; and

d) set the ITL_encryption_UA_reg for this I_T_L nexus to one.

At most, one I_T_L nexus shall be assigned the logical block encryption scope of ALL I_T NEXUS. If the device entity releases resources used to store a set of logical block encryption parameters with a logical block encryption scope of ALL I_T NEXUS, it shall change the ITL_scope for the I_T_L nexus that established that set of logical block encryption parameters to PUBLIC. If a device server has a set of logical block encryption parameters with a logical block encryption scope of ALL I_T NEXUS, and it successfully completes the processing of a Set Data Encryption page with a logical block encryption scope value of ALL I_T NEXUS through a different I_T_L nexus than the one that established the set of logical block encryption parameters, the device entity shall change the ITL_scope for the I_T_L nexus that established the previous set of logical block encryption parameters to PUBLIC.

When a device server successfully completes the processing of a Set Data Encryption page with a logical block encryption scope of ALL I_T NEXUS through this I_T_L nexus, the device entity shall:

a) increment the device entity key instance counter associated with this I_T_L nexus;
b) perform the actions specified in 4.2.22.6 for when a Set Data Encryption page with a logical block encryption scope of ALL I_T NEXUS is received; and
c) set the logical block encryption parameters key instance counter to the value of the device entity key instance counter associated with this I_T_L nexus.

Table 15 specifies the values assigned to the I_T_L nexus data encryption information when a power on condition occurs.

Table 15 — Default I_T_L nexus logical block encryption information

Parameter	Value when a power on condition occurs
ITL_scope	PUBLIC
ITL_lock	Zero
ITL_lock_key_instance_cnt	Zero
ITL_encryption_UA_reg	Zero

The ITL_encryption_UA_reg is a state variable that indicates if the device server shall establish unit attention conditions related to logical block encryption status for this I_T_L nexus. The device server shall set ITL_encryption_UA_reg to one for this I_T_L nexus if the device server processes a:

a) SECURITY PROTOCOL IN command specifying the Tape Data Encryption protocol through this I_T_L nexus; or
b) SECURITY PROTOCOL OUT command specifying the Tape Data Encryption protocol through this I_T_L nexus.

The device server shall set ITL_encryption_UA_reg to zero for an I_T_L nexus if an I_T nexus loss occurs for that I_T_L nexus. The device server shall set ITL_encryption_UA_reg to zero for all I_T_L nexus if the device server processes a logical unit reset.

4.2.22.14 Logical block encryption parameters

A device server that supports logical block encryption shall have the ability to save the following information in the device entity as a set of logical block encryption parameters associated with the logical block encryption

scope, and if the logical block encryption scope is LOCAL, then also to the I_T_L nexus through which the command is received when a Set Data Encryption page is processed:

a) for SCSI transport protocols where SCSI initiator device port names are required, the SCSI initiator device port name; otherwise, the SCSI initiator device port identifier;
b) indication of the SCSI target port through which the logical block encryption parameters were established;
c) logical block encryption scope;
d) encryption mode;
e) decryption mode;
f) logical block encryption key;
g) supplemental decryption keys where supported;
h) algorithm index;
i) logical block encryption parameters key instance counter;
j) CKOD;
k) CKORL;
l) CKORP;
m) U-KAD;
n) A-KAD;
o) M-KAD;
p) nonce;
q) raw decryption mode disable where supported; and
r) check external encryption mode where supported.

A device entity may release a previously established set of logical block encryption parameters when a Set Data Encryption page is processed and there are not enough unused resources available. The method of choosing which set of logical block encryption parameters to release is vendor specific. If the device entity does release a previously established set of logical block encryption parameters to free the resource, the device server shall establish a unit attention condition for every affected I_T_L nexus (see 4.2.22.6) that has its registered for logical block encryption unit attentions state set to one (see 4.2.22.13). A device entity is not required to have separate resources to store logical block encryption parameters for every logical block encryption scope that is supported.

When resources to save a set of logical block encryption parameters are released, the value of each parameter in the set of logical block encryption parameters shall be set to a vendor-specific value.

When a power on condition occurs the logical block encryption parameters shall be set to vendor-specific values.

A device server that supports logical block encryption shall support a logical block encryption scope value of ALL I_T NEXUS and the device entity shall have resources to save one set of logical block encryption parameters with this logical block encryption scope.

If the device server supports an logical block encryption scope value of LOCAL, the device entity shall have resources to save one or more sets of logical block encryption parameters with this logical block encryption scope.

The logical block encryption parameters that shall be used for an I_T_L nexus shall be established by the following order of precedence:

a) if the ITL_scope for the I_T_L nexus is set to LOCAL or ALL I_T NEXUS (see 4.2.22.13), the logical block encryption parameters set by the last Set Data Encryption page processed through that I_T_L nexus; or
b) if the ITL_scope for the I_T_L nexus is set to PUBLIC:
   1) the logical block encryption parameters that have been saved by the device entity with a logical block encryption scope of ALL I_T NEXUS if any logical block encryption parameters have been saved with this logical block encryption scope; or
   2) the default logical block encryption parameters.

4.2.22.15 Effects of reservation loss on logical block encryption parameters

4.2.22.15.1 Effects of reservation loss on logical block encryption parameters overview

The CKORL bit (see table 144) specifies that logical block encryption parameters are cleared on a reservation loss (see 3.1.57). This subclause describes the effects of reservation loss on the different scopes of logical block encryption parameters.

4.2.22.15.2 Effects of reservation loss on logical block encryption parameters with a logical block encryption scope of LOCAL

If a reservation loss occurs and a device entity has a saved set of logical block encryption parameters with a logical block encryption scope set to LOCAL and the CKORL bit set to one, then the resources for that set of logical block encryption parameters shall be released. Any set of logical block encryption parameters with a logical block encryption scope of LOCAL that does not have the CKORL bit set to one shall not be affected by the reservation loss.

When unit attention conditions have been established and resources for the set of logical block encryption parameters have been released, the ITL_scope value for the affected I_T_L nexus shall be set to PUBLIC.

If a reservation loss occurs and a device entity has a saved set of logical block encryption parameters with a logical block encryption scope set to LOCAL and the CKORL bit set to zero, then the logical block encryption parameters shall not be affected unless the reservation loss occurred as the result of a reservation preempt. If the reservation loss occurred as the result of a reservation preempt, then the behavior shall be as specified in 4.2.22.16.2.

4.2.22.15.3 Effects of reservation loss on logical block encryption parameters with a logical block encryption scope of ALL I_T NEXUS

If a reservation loss occurs and a device entity has a saved set of logical block encryption parameters with a logical block encryption scope set to ALL I_T NEXUS and the CKORL bit set to one, then the resources for the set of logical block encryption parameters with a logical block encryption scope of ALL I_T NEXUS shall be released.

When unit attention conditions have been established and resources for the set of logical block encryption parameters have been released, the ITL_scope value for all affected I_T_L nexus shall be set to PUBLIC.

If a reservation loss occurs and device entity has a saved set of logical block encryption parameters with a logical block encryption scope set to ALL I_T NEXUS and the CKORL bit set to zero, then the logical block encryption parameters shall not be affected unless the reservation loss occurred as the result of a reservation preempt. If the reservation loss occurred as the result of a reservation preempt, then the behavior shall be as specified in 4.2.22.16.3.

4.2.22.16 Effects of reservation preempt on logical block encryption parameters

4.2.22.16.1 Effects of reservation preempt on logical block encryption parameters overview

The CKORP bit (see table 144) specifies that logical block encryption parameters are cleared on a reservation preempt. This subclause describes the effects of reservation preempt on the different scopes of logical block encryption parameters.

4.2.22.16.2 Effects of reservation preempt on logical block encryption parameters with a logical block encryption scope of LOCAL

If a reservation preempt occurs and a device entity has a saved set of logical block encryption parameters with a logical block encryption scope set to LOCAL and the CKORP bit set to one, then the resources for that set of logical block encryption parameters shall be released. Any set of logical block encryption parameters with a logical block encryption scope of LOCAL that does not have the CKORP bit set to one shall not be effected by the reservation preempt.

When unit attention conditions have been established and resources for the set of logical block encryption parameters have been released, the ITL_scope value for the affected I_T_L nexus shall be set to PUBLIC.

If a reservation preempt occurs and a device entity has a saved set of logical block encryption parameters with a logical block encryption scope set to LOCAL and the CKORP bit set to zero, then the logical block encryption parameters shall not be affected unless the reservation preempt causes a reservation loss. If the reservation preempt causes a reservation loss, then the behavior shall be as specified in 4.2.22.15.2.

4.2.22.16.3 Effects of reservation preempt on logical block encryption parameters with a logical block encryption scope of ALL I_T NEXUS

If a reservation preempt associated with the I_T_L nexus through which the logical block encryption parameters were set occurs or a reservation preempt associated with an I_T_L nexus that has an ITL_scope of PUBLIC occurs, and a device entity has a saved set of logical block encryption parameters with a logical block encryption scope set to ALL I_T NEXUS and the CKORP bit set to one, then the resources used for the set of logical block encryption parameters with a logical block encryption scope of ALL I_T NEXUS shall be released.

When unit attention conditions have been established and resources for the set of logical block encryption parameters have been released, the ITL_scope value for all affected I_T_L nexus shall be set to PUBLIC.

If a reservation preempt occurs and a device entity has a saved set of logical block encryption parameters with a logical block encryption scope set to ALL I_T NEXUS and the CKORP bit set to zero, then the logical block encryption parameters shall not be affected unless the reservation preempt causes a reservation loss. If the reservation preempt causes a reservation loss then the behavior shall be as specified in 4.2.22.15.3.

4.2.23 External data encryption control

4.2.23.1 External data encryption control overview

A device entity that supports logical block encryption may support external data encryption control and provide the ability for an entity that is not part of the device server to configure logical block encryption capabilities or logical block encryption parameters using an interface not specified by this standard (e.g., an ADC device server or a management interface).

4.2.23.2 External data encryption control of data encryption capabilities

4.2.23.2.1 External data encryption control of data encryption capabilities overview

If the device entity has a saved set of data encryption parameters associated with this device server or has a volume mounted, then the device entity shall not allow external data encryption control of logical block encryption capabilities (see 4.2.22.7). If the device entity does not have a set of logical block encryption parameters associated with this device server and does not have a volume mounted, then external data encryption control may be used to change the logical block encryption capabilities.

The device entity shall not allow external data encryption control to change the logical block encryption capabilities (e.g., change the logical block encryption parameters control policy, see ADC-3) if the device entity has a saved set of logical block encryption parameters associated with this device server, or:

a) has a volume mounted; and
b) has a primary port enabled (see ADC-3).

The device entity should allow external data encryption control to change the logical block encryption capabilities if the device entity does not have a saved set of logical block encryption parameters associated with this device server, and:

a) does not have a volume mounted; or
b) has no primary ports enabled.

If external data encryption control is used to change any of the logical block encryption capabilities of the device entity, then the device server shall establish a unit attention condition with the additional sense code of DATA ENCRYPTION CAPABILITIES CHANGED for all I_T nexus that have their registered for logical block encryption unit attentions state set to one (see 4.2.22.13).

4.2.23.2.2 External data encryption control detection

The SECURITY PROTOCOL IN command specifying the Tape Data Encryption security protocol and the Data Encryption Capabilities page may be used to determine whether the device server supports external data encryption control.

The SECURITY PROTOCOL IN command specifying the Tape Data Encryption security protocol and the Data Encryption Status page may be used to determine which device server has control of the logical block encryption parameters and whether external data encryption control has been used to establish or change a set of logical block encryption parameters.

4.2.23.2.3 External data encryption control of encryption algorithm support

External data encryption control may be used to change the device server encryption algorithm support by configuring the device entity to:

a) disable a supported logical block encryption algorithm; or
b) prevent device server control of logical block encryption parameters.

If a supported encryption algorithm has been disabled, then:

a) the device entity shall not accept logical block encryption parameters specifying that algorithm; and
b) the device server shall:
   A) not report the disabled logical block encryption algorithm in the Data Encryption Capabilities page; or
   B) report the disabled logical block encryption algorithm in the Data Encryption Capabilities page with the DECRYPT_C field set to no capability and the ENCRYPT_C field set to no capability.

If external data encryption control has been used to configure the device entity to prevent device server control of logical block encryption parameters (e.g., an ADC device server logical block encryption parameters control policy is set to ADC exclusive (see ADC-3), then the device server shall:

a) terminate a SECURITY PROTOCOL OUT command that attempts to establish or clear a set of logical block encryption parameters with CHECK CONDITION status, with the sense key set to ILLEGAL REQUEST, and the additional sense code set to DATA ENCRYPTION CONFIGURATION PREVENTED; and
b) set the CFG_C (see 8.5.2.4) field in the Data Encryption Capabilities page to 10b (i.e., the device entity is configured to not allow this device server to establish or change logical block encryption parameters) and:
   A) not report any encryption algorithms in the Data Encryption Capabilities page; or
   B) report all of the supported logical block encryption algorithms in the Data Encryption Capabilities page with the DECRYPT_C field set to capable with external control and the ENCRYPT_C field set to capable with external control.

NOTE 10 - The SECURITY PROTOCOL IN command specifying the Tape Data Encryption security protocol and the Data Encryption Status page may be used to determine whether external data encryption control has been used to provide a set of logical block encryption parameters.

4.2.23.3 External data encryption control of logical block encryption parameters

4.2.23.3.1 External data encryption control of logical block encryption parameters overview

External data encryption control may be used to control logical block encryption parameters by using:

a) a logical block encryption parameters request policy to set a logical block encryption parameters request indicator to TRUE;

b) a logical block encryption parameters period to determine how long to wait for the logical block encryption parameters request indicator to be set to FALSE; and
c) the set of logical block encryption parameters that have been set in the device entity.

A device entity that supports external data encryption control shall contain a logical block encryption parameters request policy (see 4.2.23.3.2) and a set of logical block encryption parameters request indicators (see 4.2.23.3.3).

4.2.23.3.2 Logical block encryption parameters request policy

The logical block encryption parameters request policy determines when the device entity shall request a set of logical block encryption parameters from an entity using external data encryption control. The logical block encryption parameters request policy shall contain a logical block encryption parameters for encryption request policy and a logical block encryption parameters for decryption request policy.

External data encryption control sets the logical block encryption parameters for encryption request policy (see table 16) and the logical block encryption parameters for decryption request policy (see table 17) to indicate to the device entity what events shall cause a logical block encryption parameters request indicator to be set to TRUE (see 4.2.23.3.3). If external data encryption control is not being used, then the logical block encryption parameters request policies shall be set to defaults.

The logical block encryption parameters for encryption request policies are specified in table 16.

Table 16 — Logical block encryption parameters for encryption request policies

Policy	Description
No logical block encryption parameter requests	The device entity shall not set the logical block encryption parameters for encryption request indicator to TRUE.

Request logical block encryption parameters every reposition	The device entity shall set the logical block encryption parameters for encryption request indicator to TRUE when the device server processes the first:
	a) WRITE(6) command;
	b) WRITE(16) command;
	c) WRITE FILEMARKS(6)[a] command with a non-zero FILEMARK COUNT field; or
	d) WRITE FILEMARKS(16)[a] command with a non-zero FILEMARK COUNT field;
	after:
	a) an ERASE(6) command;
	b) an ERASE(16) command;
	c) a FORMAT MEDIUM command;
	d) a LOCATE(10) command;
	e) a LOCATE(16) command;
	f) a LOAD UNLOAD command;
	g) a REWIND command;
	h) a READ(6) command;
	i) a READ(16) command;
	j) a READ REVERSE(6) command;
	k) a READ REVERSE(16) command;
	l) a VERIFY(6) command;
	m) a VERIFY(16) command;
	n) a SPACE(6) command; or
	o) a SPACE(16) command.

Table 16 — Logical block encryption parameters for encryption request policies (Continued)

Policy	Description

Request logical block encryption parameters when not set	The device entity shall set the logical block encryption parameters for encryption request indicator to TRUE before accepting any data into the buffer or adding any filemarks to the buffer if in buffered mode or to the medium if in unbuffered mode, when the device server processes the first:
	a) WRITE(6) command;
	b) WRITE(16) command;
	c) WRITE FILEMARKS(6)[a] command with a non-zero FILEMARK COUNT field; or
	d) WRITE FILEMARKS(16)[a] command with a non-zero FILEMARK COUNT field;
	after:
	a) there is not an established set of logical block encryption parameters; or
	b) an event that causes the logical block decryption parameters request indicator to be set to TRUE (see table 17).

a) The WRITE FILEMARKS command is included in the list of commands that cause the logical block encryption parameters for encryption request indicator to be set to TRUE to prevent an application client from writing a filemark as part of a new operation (e.g., a backup operation starting with a WRITE FILEMARKS command and followed by a series of WRITE commands) when the operation is not successful due to a failure to retrieve a set of logical block encryption parameters.	

The logical block encryption parameters for decryption request policies are specified in table 17.

Table 17 — Logical block encryption parameters for decryption request policies

Policy	Description
No logical block decryption parameter requests	The device entity shall not set the logical block encryption parameters for decryption request indicator to TRUE.

Request logical block decryption parameters as needed	The device entity shall set the logical block encryption parameters for decryption request indicator to TRUE when the device entity detects that the current set of logical block encryption parameters is not correct for a logical block being processed as a result of processing a:
	a) READ(6) command;
	b) READ(16) command;
	c) READ REVERSE(6) command;
	d) READ REVERSE(16) command;
	e) RECOVER BUFFERED DATA command;
	f) VERIFY(6) command with the BYTCMP bit set to one; or
	g) VERIFY(16) command with the BYTCMP bit set to one.

The logical block encryption parameters for encryption request policy and the logical block encryption parameters for decryption request policy settings shall be set to defaults upon:

a) a hard reset condition; or
b) other vendor specific events.

4.2.23.3.3 Logical block encryption parameters request indicators

The logical block encryption parameters request indicators indicate when the device entity requires a set of logical block encryption parameters from an entity using external data encryption control. The logical block encryption parameters request indicators shall contain a logical block encryption parameters for encryption request indicator and a logical block encryption parameters for a decryption request indicator.

The logical block encryption parameters for encryption request indicator settings are specified in table 18.

Table 18 — Logical block encryption parameters for encryption request indicator settings

Setting	Description
TRUE	The device entity is waiting for the logical block encryption parameters for encryption request indicator to be set to FALSE (e.g., an ADC device server processes a SECURITY PROTOCOL OUT command with a DATA ENCRYPTION PARAMETERS COMPLETE page and the clear encryption parameters request (CEPR) bit set to one, see ADC-3) before continuing to process the task in the enabled task state.
FALSE	The device entity is not waiting for the logical block encryption parameters for encryption request indicator to be set to FALSE before continuing to process the task in the enabled task state. This is the default setting for the logical block encryption parameters for encryption request indicator.

The device entity shall not change the logical position while the logical block encryption parameters for encryption request indicator is set to TRUE.

When the logical block encryption parameters for encryption request indicator is set to FALSE, the device server shall resume processing of the command that caused the logical block encryption parameters for encryption request indicator to be set to TRUE.

The logical block encryption parameters for decryption request indicator settings are specified in table 19.

Table 19 — Logical block encryption parameters for decryption request indicator settings

Setting	Description
TRUE	The device entity is waiting for the logical block encryption parameters for decryption request indicator to be set to FALSE (e.g., an ADC device server processes a SECURITY PROTOCOL OUT command with a DATA ENCRYPTION PARAMETERS COMPLETE page and the clear encryption parameters request (CEPR) bit set to one, see ADC-3) before continuing to process the task in the enabled task state.
FALSE	The device entity is not waiting for the logical block encryption parameters for decryption request indicator to be set to FALSE before continuing to process the task in the enabled task state. This is the default setting for the logical block encryption parameters for decryption request indicator.

The device entity shall not change the logical position while the logical block encryption parameters for decryption request indicator is set to TRUE.

When the logical block encryption parameters for decryption request indicator is set to FALSE, the device server shall resume processing of the command that caused the logical block encryption parameters for decryption request indicator to be set to TRUE.

The logical block encryption parameters for encryption request indicator and the logical block encryption parameters for decryption request indicator shall be set to defaults:

a) on a hard reset condition;
b) when a volume is demounted;
c) after a logical block encryption parameters request period timeout (see 4.2.23.3.4); or
d) after successfully processing a task management request that terminates processing of the task.

When the logical block encryption parameters for decryption request indicator is set to FALSE or the logical block encryption parameters for encryption request indicator is set to FALSE, then the logical block encryption period timer shall be set to zero.

4.2.23.3.4 Logical block encryption parameters period settings

The logical block encryption parameters period settings contain values that:

a) determine how long the device entity waits for the logical block encryption parameters request indicator to be set to FALSE;
b) track how long the device entity has waited for a set of logical block encryption parameters after a logical block encryption parameters request indicator has been set to TRUE; and
c) indicate when the time to wait for a set of logical block encryption parameters period has expired.

The logical block encryption parameters period settings (see 4.2.4) shall contain:

a) a logical block encryption parameters period time;
b) a logical block encryption period timer; and
c) a logical block encryption parameters period expired indicator.

The logical block encryption parameters period time shall contain a value indicating the amount of time that the device entity shall wait for a set of logical block encryption parameters when:

a) the logical block encryption parameters for encryption request indicator (see 4.2.23.3.3) is set to TRUE; or
b) the logical block encryption parameters for decryption request indicator (see 4.2.23.3.3) is set to TRUE.

The logical block encryption period timer shall contain the time since:

a) the logical block encryption parameters for encryption request indicator was set to TRUE; or
b) the logical block encryption parameters for decryption request indicator was set to TRUE.

The logical block encryption period timer shall be set to zero when:

a) the logical block encryption parameters for encryption request indicator is set to FALSE; or
b) the logical block encryption parameters for decryption request indicator is set to FALSE.

The values of the logical block encryption period timer expired indicator are specified in table 20.

Table 20 — Logical block encryption period timer expired indicator

Setting	Description
TRUE	The logical block encryption period timer has expired.
FALSE	The logical block encryption period timer has not expired.

If the logical block encryption period timer reaches the logical block encryption period time, then the:

a) logical block encryption period timer expired indicator shall be set to TRUE;
b) logical block encryption parameters for encryption request indicator shall be set to FALSE;
c) logical block encryption parameters for decryption request indicator shall be set to FALSE; and
d) the device server shall terminate the command that caused a request indicator to be set to TRUE with CHECK CONDITION status, the sense key set to DATA PROTECT, and the additional sense code set to EXTERNAL DATA ENCRYPTION CONTROL TIMEOUT.

4.2.23.4 Exclusive control of logical block encryption parameters by external data encryption control

An entity outside the scope of this standard may configure the device entity for exclusive control of logical block encryption using external data encryption control. If control of logical block encryption parameters by this device server has been prevented by external data encryption control and the device server returns a Data Encryption Status page (see 8.5.2.7), then the PARAMETERS CONTROL field shall be set to 011b or 100b.

4.2.23.5 External data encryption control error conditions

If external data encryption control is being used to control the logical block encryption parameters and the external data encryption control logical block encryption parameters lookup process returns an error, then the device server shall terminate the command that initiated the logical block encryption parameters lookup process with CHECK CONDITION status, with the sense key set to logical block PROTECT, and the additional sense code set to the value of the external data encryption control additional sense code in the device entity, or to EXTERNAL DATA ENCRYPTION CONTROL ERROR if the external data encryption control additional sense code is set to NO ADDITIONAL SENSE INFORMATION.

An application client may use the DTD Status log page to get information about the error that occurred (see ADC-3).

4.2.24 Logical block encryption key protection

4.2.24.1 Logical block encryption key protection overview

A SCSI device that supports logical block encryption should protect logical block encryption keys from disclosure. The probability of logical block encryption key disclosure may be reduced by several countermeasures (e.g., key wrapping and/or securing the channel used to transmit the logical block encryption key).

4.2.24.2 Logical block encryption key protection using security associations

A security association (SA) (see SPC-4) may be used to protect logical block encryption keys and associated logical block encryption parameters from disclosure and modification. A device server that supports SAs as a way to protect logical block encryption keys may require that all logical block encryption key operations be protected using an SA.

4.2.24.3 Key wrapping using public key cryptography

A device server that supports public key cryptography for key wrapping, shall have a secret private key and a public key. The public key is used for wrapping key material sent to the device server. The private key is used by the device server to unwrap the logical block encryption keys that it receives. The entity wrapping the logical block encryption key is assured that only the device server that knows the private key corresponding to this public key is able to unwrap the logical block encryption key.

Verifying the key wrapper's signature allows a device server that supports public key cryptography for key wrapping to ensure the authenticity of the wrapped key. The key wrapping entity's secret private key is used to sign the wrapped key. The key signing entity's public key is used by the device server to verify the signature.

A device server that supports signature verification shall store the key wrappers public keys in an authorization white list. To prevent an attacker from having the ability to send a wrapped key, the device server shall maintain the authorization white list in a manner that prevents an attacker from modifying the white list.

A device server that supports signature verification should be able to store a minimum of four public keys for signature verification to allow for two key wrapping entities and the ability to replace these keys.

The method of adding signature verification public keys to the authorization white list is outside the scope of this standard.

4.2.25 Appending data to a volume containing encrypted logical blocks

A volume contains no encrypted logical blocks, all encrypted logical blocks, or a mixture of encrypted logical blocks and unencrypted logical blocks.

A device server that supports encryption should be capable of determining when a mounted volume contains an encrypted logical block. The device server reports its capability of determining if a volume contains an encrypted logical block using the VCELB_C bit in the logical block encryption algorithm descriptor (see 8.5.2.4). If the device server is capable of determining whether a mounted volume contains an encrypted logical block,

it should support a value of one in the VCELBRE bit of the Device Configuration Extension mode page (see 8.3.8).

The device server shall terminate a command with CHECK CONDITION status, with the sense key set to DATA PROTECT, and the additional sense code set to ENCRYPTION PARAMETERS NOT USEABLE if the following are true:

a) the VCELBRE bit in the Device Configuration Extension mode page (see 8.3.8) is set to one;
b) the VCELB bit in the Data Encryption status page (see 8.5.2.7) is set to one;
c) the encryption mode of the set of logical block encryption parameters in use by the I_T_L nexus on which the command arrived is set to DISABLE;
d) the logical object identifier does not equal zero; and
e) the command is a:
   A) WRITE(6);
   B) WRITE(16);
   C) WRITE FILEMARKS(6); or
   D) WRITE FILEMARKS(16).

4.2.26 Self-test operations

The logical position following the completion of a self-test (see SPC-4) is not specified by this standard.

4.2.27 Capability-based command (CbCS) security

4.2.27.1 Capability-based command security overview

CbCS (see SPC-4) is a credential-based system that manages access to a logical unit or a volume.

4.2.27.2 Association between commands and permission bits

Table 21 specifies the permissions required in the PERMISSIONS BIT MASK field in the capability descriptor of a CbCS extension descriptor (see SPC-4) for each SCSI command specified in this standard. The permissions listed in table 21 are specified in SPC-4. This standard does not define any permissions specific to the sequential-access device type.

Table 21 — Association between commands and CbCS permissions

Requested Command	Permissions[a]				
	DATA READ	DATA WRITE	PARM READ	PARM WRITE	PHY ACC
ERASE(6)		1			
ERASE(16)		1			
FORMAT MEDIUM		1		1	
LOAD UNLOAD					1
LOCATE(10)	1				
LOCATE(16)	1				
PREVENT ALLOW MEDIUM REMOVAL					1
READ(6)	1				

a) A device server shall only process a command shown in this table as specified by the CDB field of an extended CDB (see SPC-4) that contains a CbCS capability descriptor when all of the bits marked with a 1 in the row for that command are set to one in the PERMISSIONS BIT MASK field in that descriptor. The permissions bits represented by the empty cells in a row are ignored. If a device server receives a command specified by the CDB field of an extended CDB that does not contain the CbCS capability descriptor with all of the bits set to one as defined in this table, then the device server shall terminate the command with CHECK CONDITION status with the sense key set to ILLEGAL REQUEST and the additional sense code set to INVALID FIELD IN PARAMETER LIST.

Table 21 — Association between commands and CbCS permissions (Continued)

Requested Command	Permissions[a]				
	DATA READ	DATA WRITE	PARM READ	PARM WRITE	PHY ACC
READ(16)	1				
READ BLOCK LIMITS			1		
READ POSITION	1				
READ REVERSE(6)	1				
READ REVERSE(16)	1				
RECOVER BUFFERED DATA	1	1			
REPORT DENSITY SUPPORT			1		
REWIND	1				
SET CAPACITY		1		1	
SPACE(6)	1				
SPACE(16)	1				
VERIFY(6)	1				
VERIFY(16)	1				
WRITE(6)		1			
WRITE(16)		1			
WRITE FILEMARKS(6)		1			
WRITE FILEMARKS(16)		1			

a) A device server shall only process a command shown in this table as specified by the CDB field of an extended CDB (see SPC-4) that contains a CbCS capability descriptor when all of the bits marked with a 1 in the row for that command are set to one in the PERMISSIONS BIT MASK field in that descriptor. The permissions bits represented by the empty cells in a row are ignored. If a device server receives a command specified by the CDB field of an extended CDB that does not contain the CbCS capability descriptor with all of the bits set to one as defined in this table, then the device server shall terminate the command with CHECK CONDITION status with the sense key set to ILLEGAL REQUEST and the additional sense code set to INVALID FIELD IN PARAMETER LIST.

5 Explicit address command descriptions for sequential-access devices

5.1 Summary of commands for explicit address mode

The explicit address command set for sequential-access devices shall be as shown in table 22. Commands specified as mandatory in table 22 shall be implemented if the explicit address command set is supported.

Refer to table 14 for a description of reservations.

The following operation codes are vendor specific: 02h, 06h, 07h, 09h, 0Ch, 0Dh, and 0Eh.

Table 22 — Explicit address command set for sequential-access devices

Command Name	Type	Operation code[g]	Synchronize operation required[a]	Command type	Reference
ACCESS CONTROL IN	O	86h	No	G	SPC-4
ACCESS CONTROL OUT	O	87h	No	G	SPC-4
CHANGE ALIASES	O	A4h/0Bh[c]	No	G	SPC-4
ERASE(16)	M	93h	Yes	W-E	5.2
EXTENDED COPY	O	83h	No	W or R[b]	SPC-4
FORMAT MEDIUM	O	04h	No	W	7.1
INQUIRY	M	12h	No	G-A	SPC-4
LOAD UNLOAD	O	1Bh	Yes	G	7.2
LOCATE(16)	M	92h	Yes	G-E	7.3
LOG SELECT	O	4Ch	No	G	SPC-4
LOG SENSE	O	4Dh	No	G-A	SPC-4
MANAGEMENT PROTOCOL IN	O	A3h/10h[c]	No	G	SPC-4
MANAGEMENT PROTOCOL OUT	O	A4h/10h[c]	No[d]	G[e]	SPC-4
MODE SELECT(10)	O	55h	Yes[a]	W or R[b]	SPC-4
MODE SELECT(6)	M	15h	Yes[a]	W or R[b]	SPC-4
MODE SENSE(10)	O	5Ah	No	G	SPC-4

Key: M = Command implementation is mandatory.
O = Command implementation is optional.
R = Read type command.
W = Write type command.
G = Generic type command.
E = Explicit command.
A = Allowed command while in write capable state.

a) Refer to 4.2.11.
b) This command has some specific actions that fall under write type commands and some that fall into read type commands.
c) 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.
d) Some vendor MANAGEMENT PROTOCOL OUT commands may require a syncronize operation.
e) Some vendor MANAGEMENT PROTOCOL OUT commands may be a read type or write type command.
f) The following operation codes are obsolete: 16h, 17h, 18h, 39h, 3Ah, 40h, 56h, 57h, A5h, A7h, B4h, B8h.
g) A complete summary of operation codes is available at http://www.t10.org/lists/2op.htm. The summary includes information about obsolete commands.

Table 22 — Explicit address command set for sequential-access devices (Continued)

Command Name	Type	Operation code[g]	Synchronize operation required[a]	Command type	Reference
MODE SENSE(6)	M	1Ah	No	G	SPC-4
PERSISTENT RESERVE IN	M	5Eh	No	G	SPC-4
PERSISTENT RESERVE OUT	M	5Fh	No	G	SPC-4
PREVENT ALLOW MEDIUM REMOVAL	O	1Eh	No	G-A	7.4
READ ATTRIBUTE	O	8Ch	No	G	SPC-4
READ BLOCK LIMITS	M	05h	No	G-A	7.5
READ BUFFER	O	3Ch	Yes	G	SPC-4
READ POSITION	M	34h	No	G-A	7.6
READ REVERSE(16)	O	81h	Yes	R-E	5.4
READ(16)	M	88h	Yes	R-E	5.3
RECEIVE COPY RESULTS	O	84h	No	G	SPC-4
RECEIVE DIAGNOSTIC RESULTS	O	1Ch	No	G	SPC-4
RECOVER BUFFERED DATA	O	14h	May	R	7.7
REPORT ALIASES	O	A3h/0Bh[c]	No	G	SPC-4
REPORT DENSITY SUPPORT	M	44h	No	G-A	7.8
REPORT IDENTIFYING INFORMATION	O	A3h/05h[c]	No	G	SPC-4
REPORT LUNS	M	A0h	No	G-A	SPC-4
REPORT PRIORITY	O	A3h/0Eh[c]	No	G	SPC-4
REPORT SUPPORTED OPERATION CODES	O	A3h/0Ch[c]	No	G	SPC-4
REPORT SUPPORTED TASK MANAGEMENT FUNCTIONS	O	A3h/0Dh[c]	No	G	SPC-4
REPORT TARGET PORT GROUPS	O	A3h/0Ah[c]	No	G	SPC-4
REPORT TIMESTAMP	M	A3h/0Fh[c]	No	G	SPC-4
REQUEST SENSE	M	03h	No	G	SPC-4
REWIND	M	01h	Yes	G	7.9
SECURITY PROTOCOL IN	O	A2h	No	G	SPC-4

Key: M = Command implementation is mandatory.
O = Command implementation is optional.
R = Read type command.
W = Write type command.
G = Generic type command.
E = Explicit command.
A = Allowed command while in write capable state.

a) Refer to 4.2.11.
b) This command has some specific actions that fall under write type commands and some that fall into read type commands.
c) 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.
d) Some vendor MANAGEMENT PROTOCOL OUT commands may require a syncronize operation.
e) Some vendor MANAGEMENT PROTOCOL OUT commands may be a read type or write type command.
f) The following operation codes are obsolete: 16h, 17h, 18h, 39h, 3Ah, 40h, 56h, 57h, A5h, A7h, B4h, B8h.
g) A complete summary of operation codes is available at http://www.t10.org/lists/2op.htm. The summary includes information about obsolete commands.

Table 22 — Explicit address command set for sequential-access devices (Continued)

Command Name	Type	Operation code[g]	Synchronize operation required[a]	Command type	Reference
SECURITY PROTOCOL OUT	O	B5h	No	G	SPC-4
SEND DIAGNOSTIC	M	1Dh	Yes[a]	W or R[b]	SPC-4
SET CAPACITY	O	0Bh	May	W	7.10
SET IDENTIFYING INFORMATION	O	A4h/06h[c]	No	G	SPC-4
SET PRIORITY	O	A4h/0Eh[c]	No	G	SPC-4
SET TARGET PORT GROUPS	O	A4h/0Ah[c]	No	G	SPC-4
SET TIMESTAMP	M	A4h/0Fh[c]	No	G	SPC-4
SPACE(16)	O	91h	May	G-E	7.11
TEST UNIT READY	M	00h	No	G	SPC-4
VERIFY(16)	O	8Fh	Yes	R-E	5.5
WRITE ATTRIBUTE	O	8Dh	No	G	SPC-4
WRITE BUFFER	O	3Bh	Yes[a]	G	SPC-4
WRITE FILEMARKS(16)	M	80h	May	W-E	5.7
WRITE(16)	M	8Ah	No	W-E	5.6
Obsolete[f]					
Reserved		all others			

Key: M = Command implementation is mandatory.
O = Command implementation is optional.
R = Read type command.
W = Write type command.
G = Generic type command.
E = Explicit command.
A = Allowed command while in write capable state.

a) Refer to 4.2.11.
b) This command has some specific actions that fall under write type commands and some that fall into read type commands.
c) 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.
d) Some vendor MANAGEMENT PROTOCOL OUT commands may require a syncronize operation.
e) Some vendor MANAGEMENT PROTOCOL OUT commands may be a read type or write type command.
f) The following operation codes are obsolete: 16h, 17h, 18h, 39h, 3Ah, 40h, 56h, 57h, A5h, A7h, B4h, B8h.
g) A complete summary of operation codes is available at http://www.t10.org/lists/2op.htm. The summary includes information about obsolete commands.

5.2 ERASE(16) command

The ERASE(16) command (see table 23) causes part or all of the volume to be erased beginning at the logical object identifier and partition specified in the command descriptor block. Prior to performing the erase operation, the device server shall perform a synchronize operation (see 4.2.11).

Table 23 — ERASE(16) command

Bit / Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (93h)							
1	Reserved				FCS	LCS	IMMED	LONG
2	Reserved		METHOD		Reserved		SMD	VCM
3	PARTITION							
4	(MSB)							
5								
6								
7								
8				LOGICAL OBJECT IDENTIFIER				
9								
10								
11								(LSB)
12	Reserved							
13	Reserved							
14	Reserved							
15	CONTROL							

A first command in sequence (FCS) bit of one specifies this command is the first command in a tagged write sequence. An FCS bit of zero specifies this command is not the first command in a tagged write sequence.

A last command in sequence (LCS) bit of one specifies this command is the last command in a tagged write sequence. An LCS bit of zero specifies this command is not the last command in a tagged write sequence.

An immediate (IMMED) bit of zero specifies the device server shall not return status until the erase operation has completed. Interpretation of an IMMED bit of one depends on the value of the LONG bit, see below. However, for all values of the LONG bit, if CHECK CONDITION status is returned for an ERASE(16) command with an IMMED bit of one, the erase operation shall not be performed.

Application clients should set the IMMED bit set to zero to guarantee the operation has completed successfully when setting the METHOD field to 10b. When the METHOD field is set to 10b, the duration of the processing may be extended (i.e., may be longer than just setting the LONG bit to one).

A LONG bit of one specifies all remaining medium shall be erased beginning at the specified logical object identifier and partition shall be erased using the method specified by the METHOD field value (see table 24). If the format on the medium specifies a recorded indication of EOD (see 3.1.19), the erase operation shall establish an EOD indication at the specified location as part of the erase operation. If the IMMED bit is one, the device server shall return status as soon as all buffered logical objects have been written to the medium and the command descriptor block of the ERASE(16) command has been validated. The logical position following an ERASE(16) command with a LONG bit of one is not specified by this standard.

NOTE 11 - Some logical units may reject an ERASE(16) command if the logical object identifier is not zero.

A LONG bit of zero specifies the device server shall perform the action specified by the short erase mode field in the Device Configuration Extension mode page (see 8.3.8) at the logical object identifier and partition specified in the command. The logical position following a ERASE(16) command with a LONG bit of zero shall be at the specified logical object identifier and partition. If the IMMED bit is one, the device server shall return status as soon as the command descriptor block has been validated.

The METHOD field specifies the erase method that shall be used to erase data. Table 24 defines the METHOD field values. If the LONG bit is set to zero, the METHOD field only applies to data outside the user data area(s).

Table 24 — METHOD field

Code	Description
00b	Vendor specific
01b	The device server shall erase or over-write the volume with a format-specific pattern. Upon successful processing of the command, the volume may contain fragments of data specified for erasure. The data specified for erasure shall not be recognizable as valid user data using normal volume processing methods.
10b	The device server shall erase or over-write the volume with a format-specific pattern(s). Upon successful processing of the command, the volume shall not contain fragments of data specified for erasure.
11b	Reserved

NOTE 12 - The METHOD field set to a value of 10b is intended to support data shredding (e.g., sanitization as specified in DoD 5220.22-M).

If the security metadata (SMD) bit is set to one, the device server shall alter the security meta-data stored on the volume with the method specified by the METHOD field. If the SMD bit is set to zero, the device server handling of the security meta-data stored on the volume is vendor specific.

If the vendor-specific control metadata (VCM) bit is set to one, the device server shall alter the vendor-specific control metadata stored on the volume with the method specified by the METHOD field. If the VCM bit is set to zero, the device server handling of the vendor-specific control metadata stored on the volume is vendor specific.

If the logical unit encounters early-warning during an ERASE(16) command, and any buffered logical objects remain to be written, the device server action shall be as defined for the early-warning condition of the WRITE(16) command (see 5.6). If the LONG bit is zero, the erase operation shall terminate with CHECK CONDITION status and the sense data shall be set as defined for the WRITE(16) command. Any count of pending buffered erases shall not be reported as part of the value returned in the INFORMATION field or in the READ POSITION response data.

The PARTITION and LOGICAL OBJECT IDENTIFIER fields specify the position at which the ERASE(16) command shall start. If the current position does not match the specified LOGICAL OBJECT IDENTIFIER and PARTITION fields, the device server shall perform a locate operation to the specified logical object identifier and partition prior to performing the erase operation. If the locate operation fails, the device server shall return CHECK CONDITION status and the additional sense code shall be set to LOCATE OPERATION FAILURE. The logical position is undefined following a locate operation failure with a LONG bit of zero.

See 4.2.6 for a description of the effect of a PEWZ on the completion of the ERASE(16) command.

5.3 READ(16) command

The READ(16) command (see table 25) requests that the device server transfer one or more logical block(s) to the application client beginning at the logical object identifier and partition specified in the command

descriptor block. Prior to performing the read operation, the device server shall perform a synchronize operation (see 4.2.11).

Table 25 — READ(16) command

Bit / Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (88h)							
1	Reserved						SILI	FIXED
2	Reserved							
3	PARTITION							
4	(MSB)							
5								
6								
7				LOGICAL OBJECT IDENTIFIER				
8								
9								
10								
11								(LSB)
12	(MSB)							
13				TRANSFER LENGTH				
14								(LSB)
15	CONTROL							

The FIXED bit specifies whether fixed-block transfers or variable-block transfers are to be used. Refer to the READ BLOCK LIMITS command (see 7.5) for additional information about fixed-block transfers and variable-block transfers.

If the FIXED bit is one, the TRANSFER LENGTH specifies the number of fixed-length blocks to be transferred, using the current block length reported in the mode parameters block descriptor (see SPC-4). If the FIXED bit is zero, a variable-length block is requested with the TRANSFER LENGTH specifying the maximum number of bytes allocated for the returned logical block.

A successful READ(16) command with a FIXED bit of one shall transfer the requested transfer length times the current block length in bytes to the application client. A successful READ(16) command with a FIXED bit of zero shall transfer the requested transfer length in bytes to the application client. Upon completion, the logical position shall be after the last logical block transferred (end-of-partition side).

If the suppress incorrect-length indicator (SILI) bit is one and the FIXED bit is zero, the device server shall:

a) report CHECK CONDITION status for an incorrect-length condition only if the overlength condition exists and the BLOCK LENGTH field in the mode parameter block descriptor is nonzero (see SPC-4); or
b) not report CHECK CONDITION status if the only error is the underlength condition, or if the only error is the overlength condition and the BLOCK LENGTH field of the mode parameters block descriptor is zero.

Since the residual information normally provided in the INFORMATION field of the sense data may not be available when the SILI bit is set to one, other methods for determining the actual block length should be used (e.g., including length information in the data).

If the SILI bit is one and the FIXED bit is one, the device server shall terminate the command with CHECK CONDITION status and the sense key shall be set to ILLEGAL REQUEST with an additional sense code of INVALID FIELD IN CDB.

If the SILI bit is zero and an incorrect-length logical block is read, CHECK CONDITION status shall be returned and the ILI and VALID bits shall be set to one in the sense data with an additional sense code of NO ADDITIONAL SENSE INFORMATION. Upon termination, the logical position shall be after the incorrect-length logical block (i.e., end-of-partition side). If the FIXED bit is one, the INFORMATION field shall be set to the requested transfer length minus the actual number of logical blocks read, not including the incorrect-length logical block. If the FIXED bit is zero, the INFORMATION field shall be set to the requested transfer length minus the actual logical block length. Logical units that do not support negative values shall set the INFORMATION field to zero if the overlength condition exists.

NOTE 13 - In the above case with the FIXED bit of one, only the position of the incorrect-length logical block may be determined from the sense data. The actual length of the incorrect logical block is not reported. Other means may be used to determine its actual length (e.g., read it again with the fixed bit set to zero).

The LOGICAL OBJECT IDENTIFIER and PARTITION fields specify the position at which the READ(16) command shall start. If the TRANSFER LENGTH field is not set to zero and the current logical position does not match the specified LOGICAL OBJECT IDENTIFIER and PARTITION fields, the device server shall perform a locate operation to the specified logical object identifier and partition prior to performing the read operation. If the locate operation fails, the device server shall return CHECK CONDITION status and the additional sense code shall be set to LOCATE OPERATION FAILURE. The INFORMATION field in the sense data shall be set to the requested transfer length. Following a locate operation failure the logical position is undefined.

If the TRANSFER LENGTH field is set to zero, no logical block shall be transferred and the current logical position shall not be changed. This condition shall not be considered an error.

In the case of an unrecovered read error, if the FIXED bit is one, the sense data VALID bit shall be set to one and the INFORMATION field shall be set to the requested transfer length minus the actual number of logical blocks read (not including the unrecovered logical blocks). If the FIXED bit is zero, the sense data VALID bit shall be set to one and the INFORMATION field shall be set to the requested transfer length. Upon termination, the logical position shall be after the unrecovered logical block.

If the device server encounters a filemark during a READ(16) command, CHECK CONDITION status shall be returned and the FILEMARK and VALID bits shall be set to one in the sense data. The sense key shall be set to NO SENSE or RECOVERED ERROR, as appropriate, and the additional sense code shall be set to FILEMARK DETECTED. Upon termination, the logical position shall be after the filemark (i.e., end-of-partition side). If the FIXED bit is one, the INFORMATION field shall be set to the requested transfer length minus the actual number of logical blocks read. If the FIXED bit is zero, the INFORMATION field shall be set to the requested transfer length.

If the device server encounters early-warning during a READ(16) command and the REW bit is set to one in the Device Configuration mode page (see 8.3.3), CHECK CONDITION status shall be returned upon completion of the current logical block. The sense key shall be set to NO SENSE or RECOVERED ERROR, as appropriate, and the additional sense code shall be set to END-OF-PARTITON/MEDIUM DETECTED. The EOM and VALID bits shall be set to one in the sense data. Upon termination, the logical position shall be after the last logical block transferred (i.e., end-of-partition side). If the FIXED bit is one, the INFORMATION field in the sense data shall be set to the requested transfer length minus the actual number of logical blocks read. If the FIXED bit is zero, the INFORMATION field in the sense data shall be set to the requested transfer length minus the actual logical block length. The device server shall not return CHECK CONDITION status when early-warning is encountered if the REW bit is zero.

NOTE 14 - A REW bit of one is not recommended for most applications since read data may be present after early-warning.

If the device server encounters end-of-data during a READ(16) command, CHECK CONDITION status shall be returned, the sense key shall be set to BLANK CHECK, and the VALID bit shall be set to one in the sense data. If end-of-data is encountered at or after early-warning, the EOM bit shall also be set to one. Upon termination, the logical position shall be immediately after the last recorded logical object (end-of-partition side). If the FIXED bit is one, the INFORMATION field in the sense data shall be set to the requested transfer length minus the actual number of logical blocks read. If the FIXED bit is zero, the INFORMATION field shall be set to the requested transfer length.

If the device server encounters end-of-partition during a READ(16) command, CHECK CONDITION status shall be returned, the sense key shall be set to MEDIUM ERROR, and the EOM and VALID bits shall be set to one in the sense data. The medium position following this condition is not defined. If the FIXED bit is one, the INFORMATION field shall be set to the requested transfer length minus the actual number of logical blocks read. If the FIXED bit is zero, the INFORMATION field in the sense data shall be set to the requested transfer length.

If a READ(16) command terminates with an error condition other than ILLEGAL REQUEST, and no data transfer has occurred, the logical position of the medium is undefined. The application client should issue a READ POSITION(16) command to determine the logical position.

5.4 READ REVERSE(16) command

The READ REVERSE(16) command (see table 26) requests that the device server transfer one or more logical block(s) to the application client beginning at the logical object identifier and partition specified in the command descriptor block. Prior to performing the read reverse operation, the device server shall perform a synchronize operation (see 4.2.11).

Table 26 — READ REVERSE(16) command

Bit / Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (81h)							
1	Reserved					BYTORD	SILI	FIXED
2	Reserved							
3	PARTITION							
4	(MSB)							
5								
6								
7								
8				LOGICAL OBJECT IDENTIFIER				
9								
10								
11								(LSB)
12	(MSB)							
13				TRANSFER LENGTH				
14								(LSB)
15	CONTROL							

This command is similar to the READ(16) command except that medium motion is in the reverse direction. Upon completion of a READ REVERSE(16) command, the logical position shall be before the last logical block transferred (i.e., beginning-of-partition side).

A byte order (BYTORD) bit of zero specifies all logical block(s), and the byte(s) within the logical block(s), are transferred in the reverse order. The order of bits within each byte shall not be changed. A BYTORD bit of one specifies all logical block(s) are transferred in the reverse order but the byte(s) within the logical block(s) are transferred in the same order as returned by the READ(16) command. Support for either value of the BYTORD bit is optional.

Refer to the READ(16) command (see 5.3) for a description of the FIXED bit, the SILI bit, the TRANSFER LENGTH field, and any conditions that may result from incorrect usage of these fields.

The LOGICAL OBJECT IDENTIFIER and PARTITION fields specify the position at which the READ REVERSE(16) command shall start. If the TRANSFER LENGTH field is not set to zero and the current logical position does not match the specified LOGICAL OBJECT IDENTIFIER and PARTITION fields, the device server shall perform a locate operation to the specified logical object identifier and partition prior to performing the read reverse operation. If the locate operation fails, the device server shall return CHECK CONDITION status and the additional sense code shall be set to LOCATE OPERATION FAILURE. The INFORMATION field in the sense data shall be set to the requested transfer length. Following a locate operation failure the logical position is undefined.

Filemarks, incorrect-length logical blocks, and unrecovered read errors are handled the same way as in the READ(16) command, except that upon termination the logical position shall be before the filemark, incorrect-length logical block, or unrecovered logical block (i.e., beginning-of-partition side).

If the device server encounters beginning-of-partition during a READ REVERSE(16) command, CHECK CONDITION status shall be returned and the EOM and VALID bits shall be set to one in the sense data. The sense key shall be set to NO SENSE or RECOVERED ERROR, as appropriate. If the FIXED bit is one, the INFORMATION field shall be set to the requested transfer length minus the actual number of logical blocks transferred. If the FIXED bit is zero, the INFORMATION field shall be set to the requested transfer length.

5.5 VERIFY(16) command

The VERIFY(16) command (see table 27) requests that the device server verify one or more logical block(s) beginning at the logical object identifier and partition specified in the command descriptor block. Prior to performing the verify operation, the device server shall perform a synchronize operation (see 4.2.11).

Table 27 — VERIFY(16) command

Bit / Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (8Fh)							
1	Reserved					IMMED	BYTCMP	FIXED
2	Reserved							
3	PARTITION							
4	(MSB)							
5								
6								
7								
8				LOGICAL OBJECT IDENTIFIER				
9								
10								
11								(LSB)
12	(MSB)							
13				VERIFICATION LENGTH				
14								(LSB)
15	CONTROL							

An immediate (IMMED) bit of zero specifies the command shall not return status until the verify operation has completed. An IMMED bit of one specifies status shall be returned as soon as the command descriptor block has been validated, but after all verification data has been transferred from the application client to the device server, if the BYTCMP bit is one.

In order to ensure that no errors are lost, the application client should set the IMMED bit to zero on the last VERIFY(16) command when issuing a series of VERIFY(16) commands.

A byte compare (BYTCMP) bit of zero specifies the verification shall be a verification of logical blocks on the medium (e.g., CRC, ECC). No data shall be transferred from the application client to the device server.

A BYTCMP bit of one specifies the device server shall perform a byte-by-byte compare of the data on the medium and the data transferred from the application client. Data shall be transferred from the application client to the device server as in a WRITE(16) command (see 5.6). If the BYTCMP bit is one and the byte compare option is not supported, 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 CDB.

The LOGICAL OBJECT IDENTIFIER and PARTITION fields specify the position where the VERIFY(16) command shall start. If the VERFICATION LENGTH field is not zero and the current logical position does not match the specified LOGICAL OBJECT IDENTIFIER and PARTITION fields, the device server shall perform a locate operation to the specified logical object identifier and partition prior to performing the verify operation. If the locate operation fails, the device server shall return CHECK CONDITION status and the additional sense code shall be set to LOCATE OPERATION FAILURE. The INFORMATION field in the sense data shall be set to the requested verification length. Following a locate operation failure the logical position is undefined.

The VERIFICATION LENGTH field specifies the amount of data to verify, in logical blocks or bytes, as specified by the FIXED bit. Refer to the READ(16) command (see 5.3) for a description of the FIXED bit and any error conditions that may result from incorrect usage. If the VERIFICATION LENGTH field is zero, no data shall be verified and the current logical position shall not be changed. This condition shall not be considered an error.

The VERIFY(16) command shall terminate as follows:

a) when the verification length has been satisfied;
b) when an incorrect-length logical block is encountered;
c) when a filemark is encountered;
d) when end-of-data is encountered;
e) when the end-of-partition is encountered;
f) when early-warning is encountered (if the REW bit is one in the Device Configuration mode page, see 8.3.3); or
g) when an unrecoverable read error is encountered.

The status and sense data for each of the termination conditions are handled in the same manner as in the READ(16) command (see 5.3). Upon successful completion of a VERIFY(16) command, the logical position shall be after the last logical block verified (i.e., end-of-partition side).

If the data does not compare (BYTCMP bit of one), the command shall terminate with CHECK CONDITION status, the sense data VALID bit shall be set to one, the sense key shall be set to MISCOMPARE, and the additional sense code shall be set to MISCOMPARE DURING VERIFY OPERATION. If the FIXED bit is one, the INFORMATION field shall be set to the requested verification length minus the actual number of logical blocks successfully verified. If the FIXED bit is zero, the INFORMATION field shall be set to the requested verification length minus the actual number of bytes successfully verified. This number may be larger than the requested verification length if the error occurred on a previous VERIFY(16) command with an IMMED bit of one. Upon termination, the medium shall be positioned after the logical block containing the miscompare (end-of-partition side).

5.6 WRITE(16) command

The WRITE(16) command (see table 28) requests that the device server write the logical block that is transferred from the application client to the logical object identifier and partition specified in the command descriptor block.

Table 28 — WRITE(16) command

Bit / Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (8Ah)							
1	Reserved				FCS	LCS	Rsvd	FIXED
2	Reserved							
3	PARTITION							
4	(MSB)							
5								
6								
7								
8				LOGICAL OBJECT IDENTIFIER				
9								
10								
11								(LSB)
12	(MSB)							
13				TRANSFER LENGTH				
14								(LSB)
15	CONTROL							

A first command in sequence (FCS) bit of one specifies this command is the first command in a tagged write sequence. An FCS bit of zero specifies this command is not the first command in a tagged write sequence.

A last command in sequence (LCS) bit of one specifies this command is the last command in a tagged write sequence. An LCS bit of zero specifies this command is not the last command in a tagged write sequence.

The FIXED bit specifies whether fixed-block transfers or variable-block transfers are to be used. See the READ BLOCK LIMITS command (see 7.5) for additional information about fixed-block transfers and variable-block transfers.

If the FIXED bit is one, the TRANSFER LENGTH value specifies the number of fixed-length blocks to be transferred, using the current block length reported in the mode parameter block descriptor (see 8.3). If the FIXED bit is zero, a single logical block is transferred with TRANSFER LENGTH specifying the logical block length in bytes.

The LOGICAL OBJECT IDENTIFIER and PARTITION fields specify the position where the WRITE(16) command shall start. If the TRANSFER LENGTH field is not set to zero and the current logical position does not match the specified LOGICAL OBJECT IDENTIFIER and PARTITION fields, the device server shall perform a locate operation to the specified logical object identifier and partition prior to performing the write operation. If the locate operation fails, the device server shall return CHECK CONDITION status and the additional sense code shall be set to LOCATE OPERATION FAILURE. The INFORMATION field in the sense data shall be set to the requested transfer length. Following a locate operation failure the logical position is undefined.

If the TRANSFER LENGTH field is zero, no data shall be transferred and the current logical position shall not be changed. This condition shall not be considered an error.

A WRITE(16) command may be buffered or unbuffered, as specified by the BUFFERED MODE field of the mode parameter header (see 8.3). When operating in unbuffered mode (see 3.1.80), the device server shall not return GOOD status until all logical block(s) are successfully written to the medium. When operating in buffered mode (see 3.1.9), the device server may return GOOD status as soon as all logical block(s) are successfully transferred to the logical unit's object buffer.

For compatibility with devices implemented prior to this version of this International Standard, a WRITE FILEMARKS(16) command with the IMMED bit set to zero should be issued when completing a buffered write operation to perform a synchronize operation (see 4.2.11).

If the device server enables a WRITE(16) command while positioned between EW and EOP, or encounters EW during the processing of a WRITE(16) command, an attempt to finish writing any data may be made as determined by the current settings of the REW and SEW bits in the Device Configuration mode page (see 8.3.3). The command shall terminate with CHECK CONDITION status and the additional sense code shall be set to END-OF-PARTITION/MEDIUM DETECTED. If all data that is to be written is successfully transferred to the medium, the sense key shall be set to NO SENSE or RECOVERED ERROR, as appropriate. If the device server is unable to transfer all the data to the medium, buffered or unbuffered, before end-of-partition is encountered, the sense key shall be set to VOLUME OVERFLOW. The EOM bit shall be set to one. If the SEW bit is set to one, then the VALID bit shall be set to one.

The INFORMATION field shall be set as follows:

a) if the FIXED bit is set to one, the INFORMATION field shall be set to the requested transfer length minus the actual number of logical blocks transferred to the device server; or
b) if the FIXED bit is set to zero, the INFORMATION field shall be set to the requested transfer length.

The device server should perform a synchronize operation (see 4.2.11) after the first early-warning indication has been returned to the application client (see 4.2.5).

NOTE 15 - For some application clients it is important to recognize an error if end-of-partition is encountered during the processing of a WRITE(16) command, without regard for whether all data that is to be written is successfully transferred to the medium. The VOLUME OVERFLOW sense key may always validly be returned if end-of-partition is encountered while writing, and such usage is recommended. Reporting the MEDIUM ERROR sense key may cause confusion as to whether there was really defective medium encountered during the processing of the last WRITE(16) command.

If a WRITE(16) command is terminated early, an incomplete logical block (i.e., a logical block not completely transferred to the device server from the initiator) shall be discarded. The incomplete logical block may be accessible prior to new logical block being written to the media. The device server shall be logically positioned after the last logical block that was successfully transferred.

See 4.2.6 for a description of the effect of a PEWZ on the completion of the WRITE(16) command.

5.7 WRITE FILEMARKS(16) command

The WRITE FILEMARKS(16) command (see table 29) requests that the device server write the specified number of filemarks to the logical object identifier and partition specified in the command descriptor block.

Table 29 — WRITE FILEMARKS(16) command

Bit / Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (80h)							
1	Reserved				FCS	LCS	Obsolete	IMMED
2	Reserved							
3	PARTITION							
4	(MSB)							
5								
6								
7								
8				LOGICAL OBJECT IDENTIFIER				
9								
10								
11								(LSB)
12	(MSB)							
13				FILEMARK COUNT				
14								(LSB)
15	CONTROL							

A first command in sequence (FCS) bit of one specifies this command is the first command in a tagged write sequence. An FCS bit of zero specifies this command is not the first command in a tagged write sequence.

A last command in sequence (LCS) bit of one specifies this command is the last command in a tagged write sequence. An LCS bit of zero specifies this command is not the last command in a tagged write sequence.

An immediate (IMMED) bit of one specifies the device server shall return status as soon as the command descriptor block has been validated. An IMMED bit of one is only valid if the device is operating in buffered mode (see 3.1.9). If the IMMED bit is set to one and the device is operating in unbuffered mode the command shall be terminated 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 CDB.

An IMMED bit of zero specifies the device server shall not return status until the write operation has completed. Any buffered logical objects shall be written to the medium prior to completing the command.

NOTE 16 - Upon completion of any buffered write operation, the application client may issue a WRITE FILEMARKS(16) command with the IMMED bit set to zero and the FILEMARK COUNT field set to zero to perform a synchronize operation (see 4.2.11).

The LOGICAL OBJECT IDENTIFIER and PARTITION fields specify the position where the WRITE FILEMARKS(16) command shall start. If the FILEMARK COUNT field is not set to zero and the current logical position does not match the specified LOGICAL OBJECT IDENTIFIER and PARTITION fields, the device server shall perform a locate operation to the specified logical object identifier and partition prior to performing the write filemarks operation. If the locate operation fails, the device server shall return CHECK CONDITION status and the additional sense code shall be set to LOCATE OPERATION FAILURE. The INFORMATION field in the sense data shall be set to the requested filemark count. Following a locate operation failure the logical position is undefined.

The FILEMARK COUNT field specifies the number of filemarks to be written. If the FILEMARK COUNT field is set to zero, the current logical position shall not be changed. It shall not be considered an error if the FILEMARK COUNT field is set to zero.

NOTE 17 - The FILEMARK COUNT field takes the place of the TRANSFER LENGTH field normally used by medium access commands that move data from the Data-Out Buffer to the device server (see SPC-4).

If the device server enables a WRITE FILEMARKS(16) command while positioned between EW and EOP, or encounters EW during the processing of a WRITE FILEMARKS(16) command, an attempt to finish writing any buffered logical objects may be made, as determined by the current settings of the REW and SEW bits in the Device Configuration mode page (see 8.3.3). The command shall terminate with CHECK CONDITION status and the additional sense code shall be set to END-OF-PARTITION/MEDIUM DETECTED. If all buffered logical objects to be written are successfully transferred to the medium, the sense key shall be set to NO SENSE or RECOVERED ERROR, as appropriate. If the device server is unable to transfer all the buffered logical objects to the medium before end-of-partition is encountered, the sense key shall be set to VOLUME OVERFLOW. The EOM bit shall be set to one. If the SEW bit is set to one, then the VALID bit shall be set to one.

The INFORMATION field shall be set to the FILEMARK COUNT field value minus the actual number of filemarks:

a) written to the object buffer if the IMMED bit is set to one; or
b) written to the medium if the IMMED bit is set to zero.

The device server should perform a synchronize operation (see 4.2.11) after the first early-warning indication has been returned to the application client (see 4.2.5).

See 4.2.6 for a description of the effect of a PEWZ on the completion of the WRITE FILEMARKS(16) command.

6 Implicit address command descriptions for sequential-access devices

6.1 Summary of commands for implicit address mode

The implicit address commands for sequential-access devices are shown in table 30. Commands specified as mandatory in table 30 shall be implemented if the implicit address command set is supported.

If a synchronize operation is required for a command, the synchronize operation shall be performed as specified in 4.2.11.

Refer to table 14 for a description of reservations.

The following operation codes are vendor specific: 02h, 06h, 07h, 09h, 0Ch, 0Dh, and 0Eh.

Table 30 — Implicit address command set for sequential-access devices

Command name	Type	Operation code[e]	Synchronize operation required[a]	Reference
ACCESS CONTROL IN	O	86h	No	SPC-4
ACCESS CONTROL OUT	O	87h	No	SPC-4
CHANGE ALIASES	O	A4h/0Bh[b]	No	SPC-4
ERASE(6)	M	19h	Yes	6.2
EXTENDED COPY	O	83h	No	SPC-4
FORMAT MEDIUM	O	04h	No	7.1
INQUIRY	M	12h	No	SPC-4
LOAD UNLOAD	O	1Bh	Yes	7.2
LOCATE(10)	M	2Bh	Yes	6.3
LOCATE(16)	M	92h	Yes	7.3
LOG SELECT	O	4Ch	No	SPC-4
LOG SENSE	O	4Dh	No	SPC-4
MANAGEMENT PROTOCOL IN	O	A3h/10h[b]	No	SPC-4
MANAGEMENT PROTOCOL OUT	O	A4h/10h[b]	No[c]	SPC-4
MODE SELECT(10)	O	55h	Yes[a]	SPC-4
MODE SELECT(6)	M	15h	Yes[a]	SPC-4
MODE SENSE(10)	O	5Ah	No	SPC-4
MODE SENSE(6)	M	1Ah	No	SPC-4
PERSISTENT RESERVE IN	M	5Eh	No	SPC-4

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

a) Refer to 4.2.11.
b) 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.
c) Some vendor MANAGEMENT PROTOCOL OUT commands may require a syncronize operation.
d) The following operation codes are obsolete: 16h, 17h, 18h, 39h, 3Ah, 40h, 56h, 57h, A5h, A7h, B4h, B8h.
e) A complete summary of operation codes is available at http://www.t10.org/lists/2op.htm. The summary includes information about obsolete commands.

Table 30 — Implicit address command set for sequential-access devices (Continued)

Command name	Type	Operation code[e]	Synchronize operation required[a]	Reference
PERSISTENT RESERVE OUT	M	5Fh	No	SPC-4
PREVENT ALLOW MEDIUM REMOVAL	O	1Eh	No	7.4
READ ATTRIBUTE	O	8Ch	No	SPC-4
READ BLOCK LIMITS	M	05h	No	7.5
READ BUFFER	O	3Ch	Yes	SPC-4
READ POSITION	M	34h	No	7.6
READ REVERSE(6)	O	0Fh	Yes	6.5
READ(6)	M	08h	Yes	6.4
RECEIVE COPY RESULTS	O	84h	No	SPC-4
RECEIVE DIAGNOSTIC RESULTS	O	1Ch	No	SPC-4
RECOVER BUFFERED DATA	O	14h	May	7.7
REPORT ALIASES	O	A3h/0Bh[b]	No	SPC-4
REPORT DENSITY SUPPORT	M	44h	No	7.8
REPORT IDENTIFYING INFORMATION	O	A3h/05h[b]	No	SPC-4
REPORT LUNS	M	A0h	No	SPC-4
REPORT PRIORITY	O	A3h/0Eh[b]	No	SPC-4
REPORT SUPPORTED OPERATION CODES	O	A3h/0Ch[b]	No	SPC-4
REPORT SUPPORTED TASK MANAGEMENT FUNCTIONS	O	A3h/0Dh[b]	No	SPC-4
REPORT TARGET PORT GROUPS	O	A3h/0Ah[b]	No	SPC-4
REPORT TIMESTAMP	M	A3h/0Fh[b]	No	SPC-4
REQUEST SENSE	M	03h	No	SPC-4
REWIND	M	01h	Yes	7.9
SECURITY PROTOCOL IN	O	A2h	No	SPC-4
SECURITY PROTOCOL OUT	O	B5h	No	SPC-4
SEND DIAGNOSTIC	M	1Dh	Yes[a]	SPC-4
SET CAPACITY	O	0Bh	May	7.10
SET IDENTIFYING INFORMATION	O	A4h/06h[b]	No	SPC-4
SET PRIORITY	O	A4h/0Eh[b]	No	SPC-4
SET TARGET PORT GROUPS	O	A4h/0Ah[b]	No	SPC-4

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

a) Refer to 4.2.11.
b) 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.
c) Some vendor MANAGEMENT PROTOCOL OUT commands may require a syncronize operation.
d) The following operation codes are obsolete: 16h, 17h, 18h, 39h, 3Ah, 40h, 56h, 57h, A5h, A7h, B4h, B8h.
e) A complete summary of operation codes is available at http://www.t10.org/lists/2op.htm. The summary includes information about obsolete commands.

Table 30 — Implicit address command set for sequential-access devices (Continued)

Command name	Type	Operation code[e]	Synchronize operation required[a]	Reference
SET TIMESTAMP	M	A4h/0Fh[b]	No	SPC-4
SPACE(16)	O	91h	May	7.11
SPACE(6)	M	11h	May	6.6
TEST UNIT READY	M	00h	No	SPC-4
VERIFY(6)	O	13h	Yes	6.7
WRITE ATTRIBUTE	O	8Dh	No	SPC-4
WRITE BUFFER	O	3Bh	Yes[a]	SPC-4
WRITE FILEMARKS(6)	M	10h	May	6.9
WRITE(6)	M	0Ah	No	6.8
Obsolete[d]				
Reserved		all others		

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

a) Refer to 4.2.11.
b) 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.
c) Some vendor MANAGEMENT PROTOCOL OUT commands may require a syncronize operation.
d) The following operation codes are obsolete: 16h, 17h, 18h, 39h, 3Ah, 40h, 56h, 57h, A5h, A7h, B4h, B8h.
e) A complete summary of operation codes is available at http://www.t10.org/lists/2op.htm. The summary includes information about obsolete commands.

6.2 ERASE(6) command

The ERASE(6) command (see table 31) causes part or all of the volume to be erased beginning at the current position. Prior to performing the erase operation, the device server shall perform a synchronize operation (see 4.2.11).

Table 31 — ERASE(6) command

Bit / Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (19h)							
1	Reserved						IMMED	LONG
2	Reserved		METHOD		Reserved		SMD	VCM
3	Reserved							
4	Reserved							
5	CONTROL							

An immediate (IMMED) bit of zero specifies the device server shall not return status until the erase operation has completed. Interpretation of an IMMED bit of one depends on the value of the LONG bit, see below. However, for all values of the LONG bit, if CHECK CONDITION status is returned for an ERASE(6) command with an IMMED bit of one, the erase operation shall not be performed.

Application clients should set the IMMED bit set to zero to guarantee the operation has completed successfully when setting the METHOD field to 10b. When the METHOD field is set to 10b, the duration of the processing may be extended (i.e., may be longer than just setting the LONG bit to one).

A LONG bit of one specifies all remaining medium in the current partition beginning at the current logical position shall be erased using the method specified by the METHOD field value (see table 24). If the format on the medium specifies a recorded indication of EOD (see 3.1.19), the erase operation shall establish an EOD indication at the current logical position as part of the erase operation. If the IMMED bit is one, the device server shall return status as soon as all buffered logical objects have been written to the medium and the command descriptor block of the ERASE(6) command has been validated. The logical position following an ERASE(6) command with a LONG bit of one is not specified by this standard.

NOTE 18 - Some logical units may reject an ERASE(6) command if the logical unit is not at beginning-of-partition.

A LONG bit of zero specifies the device server shall perform the action specified by the SHORT ERASE MODE field in the Device Configuration Extension mode page (see 8.3.8) at the current logical position. If the IMMED bit is one, the device server shall return status as soon as the command descriptor block has been validated.

If the logical unit encounters early-warning during an ERASE(6) command, and any buffered logical objects remain to be written, the device server action shall be as defined for the early-warning condition of the WRITE(6) command (see 6.8). If the LONG bit is zero, the erase operation shall terminate with CHECK CONDITION status and set the sense data as defined for the WRITE(6) command. Any count of pending buffered erases shall not be reported as part of the value returned in the INFORMATION field or in the READ POSITION response data.

The METHOD field, security metadata (SMD) bit, and the vendor-specific control metadata (VCM) bit are defined in 5.2.

See 4.2.6 for a description of the effect of a PEWZ on the completion of the ERASE(6) command.

6.3 LOCATE(10) command

The LOCATE(10) command (see table 32) causes the logical unit to position the medium to the specified logical object with a matching logical object identifier in the specified partition. Upon completion, the logical position shall be before the specified logical object. Prior to performing the locate operation, the device server shall perform a synchronize operation (see 4.2.11).

Table 32 — LOCATE(10) command

Bit / Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (2Bh)							
1	Reserved					BT	CP	IMMED
2	Reserved							
3	(MSB)			LOGICAL OBJECT IDENTIFIER				
4								
5								
6								(LSB)
7	Reserved							
8	PARTITION							
9	CONTROL							

A block identifier type (BT) bit of one specifies the value in the LOGICAL OBJECT IDENTIFIER field shall be interpreted as a vendor-specific value. A BT bit of zero specifies the value in the LOGICAL OBJECT IDENTIFIER field shall be interpreted as a logical object identifier (see 3.1.43).

A change partition (CP) bit of one specifies a change to the partition specified in the PARTITION field shall occur prior to positioning to the logical object specified in the LOGICAL OBJECT IDENTIFIER field. A CP bit of zero specifies no partition change shall occur and the PARTITION field shall be ignored.

An immediate (IMMED) bit of zero specifies the device server shall not return status until the locate operation has completed. If the IMMED bit is one, the device server shall return status as soon as all buffered logical objects have been written to the medium and the command descriptor block of the LOCATE(10) command has been validated. If CHECK CONDITION status is returned for a LOCATE(10) command with an IMMED bit of one, the locate operation shall not be performed.

The LOGICAL OBJECT IDENTIFIER field specifies the logical object identifier to which the logical unit shall position the medium based on the current setting of the BT bit. An otherwise valid LOCATE(10) command to any position between beginning-of-data and the position immediately after the last logical block in the partition (i.e., position at end-of-data) shall not return a sense key of ILLEGAL REQUEST. A LOCATE(10) to a position past end-of-data shall return CHECK CONDITION status and the sense key shall be set to BLANK CHECK. Additionally, the sense data EOM bit shall be set to one if end-of-data is located at or after early-warning.

If end-of-partition is encountered, CHECK CONDITION status shall be returned, the sense key shall be set to MEDIUM ERROR, and the sense data EOM bit shall be set to one.

The PARTITION field specifies the partition to select if the CP bit is one. Refer to the sequential-access device model (see 4.2.7) and the Medium Partition mode page (see 8.3.4) for additional information about partitioning.

The logical unit position is undefined if a LOCATE(10) command fails with a sense key other than ILLEGAL REQUEST.

6.4 READ(6) command

The READ(6) command (see table 33) requests that the device server transfer one or more logical block(s) to the application client beginning with the next logical block. Prior to performing the read operation, the device server shall perform a synchronize operation (see 4.2.11).

Table 33 — READ(6) command

Bit / Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (08h)							
1	Reserved						SILI	FIXED
2	(MSB)							
3				TRANSFER LENGTH				
4								(LSB)
5	CONTROL							

The FIXED bit specifies whether fixed-block transfers or variable-block transfers are to be used. Refer to the READ BLOCK LIMITS command (see 7.5) for additional information about fixed-block transfers and variable-block transfers.

If the FIXED bit is one, the TRANSFER LENGTH specifies the number of fixed-length blocks to be transferred, using the current block length reported in the mode parameters block descriptor (see 8.3). If the FIXED bit is zero, a variable-length block is requested with the TRANSFER LENGTH specifying the maximum number of bytes allocated for the returned logical block.

A successful READ(6) command with a FIXED bit of one shall transfer the requested transfer length times the current block length in bytes to the application client. A successful READ(6) command with a FIXED bit of zero shall transfer the requested transfer length in bytes to the application client. Upon completion, the logical position shall be after the last logical block transferred (i.e., end-of-partition side).

If the suppress incorrect-length indicator (SILI) bit is one and the FIXED bit is zero, the device server shall:

a) report CHECK CONDITION status for an incorrect-length condition only if the overlength condition exists and the BLOCK LENGTH field in the mode parameter block descriptor is nonzero (see 8.3); or
b) not report CHECK CONDITION status if the only error is the underlength condition, or if the only error is the overlength condition and the BLOCK LENGTH field of the mode parameters block descriptor is zero.

Since the residual information normally provided in the INFORMATION field of the sense data may not be available when the SILI bit is set, other methods for determining the actual block length should be used (e.g., including length information in the logical block).

If the SILI bit is one and the FIXED bit is one, 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 CDB.

If the SILI bit is zero and an incorrect-length logical block is read, CHECK CONDITION status shall be returned. The ILI and VALID bits shall be set to one in the sense data and the additional sense code shall be set to NO ADDITIONAL SENSE INFORMATION. Upon termination, the logical position shall be after the incorrect-length logical block (i.e., end-of-partition side). If the FIXED bit is one, the INFORMATION field shall be set to the requested transfer length minus the actual number of logical blocks read, not including the incorrect-length logical block. If the FIXED bit is zero, the INFORMATION field shall be set to the requested transfer length minus the actual logical block length. Logical units that do not support negative values shall set the INFORMATION field to zero if the overlength condition exists.

NOTE 19 - In the above case with the FIXED bit of one, only the position of the incorrect-length logical block may be determined from the sense data. The actual length of the incorrect logical block is not reported. Other means may be used to determine its actual length (e.g., read it again with the fixed bit set to zero).

A TRANSFER LENGTH of zero specifies no logical block shall be transferred, and the logical position shall not be changed. This condition shall not be considered an error.

In the case of an unrecovered read error, if the FIXED bit is one, the sense data VALID bit shall be set to one and the INFORMATION field shall be set to the requested transfer length minus the actual number of logical blocks read, not including the unrecovered logical blocks. If the FIXED bit is zero, the sense data VALID bit shall be set to one and the INFORMATION field shall be set to the requested transfer length. Upon termination, the logical position shall be after the unrecovered logical block.

If the device server encounters a filemark during a READ(6) command, CHECK CONDITION status shall be returned and the FILEMARK and VALID bits shall be set to one in the sense data. The sense key shall be set to NO SENSE or RECOVERED ERROR, as appropriate, and the additional sense code shall be set to FILEMARK DETECTED. Upon termination, the logical position shall be after the filemark (i.e., end-of-partition side). If the FIXED bit is one, the INFORMATION field shall be set to the requested transfer length minus the actual number of logical blocks read. If the FIXED bit is zero, the INFORMATION field shall be set to the requested transfer length.

If the device server encounters early-warning during a READ(6) command and the REW bit is set to one in the Device Configuration mode page (see 8.3.3), CHECK CONDITION status shall be returned upon completion of the current logical block. The sense key shall be set to NO SENSE or RECOVERED ERROR, as appropriate, and the additional sense code shall be set to END-OF-PARTITION/MEDIUM DETECTED. The EOM and VALID bits shall be set to one in the sense data. Upon termination, the logical position shall be after the last logical block transferred (i.e., end-of-partition side). If the FIXED bit is one, the INFORMATION field in the sense data shall be set to the requested transfer length minus the actual number of logical blocks read. If the FIXED bit is zero, the INFORMATION field in the sense data shall be set to the requested transfer length minus the actual logical block length. The device server shall not return CHECK CONDITION status when early-warning is encountered if the REW bit is zero.

NOTE 20 - A REW bit of one is not recommended for most applications since read data may be present after early-warning.

If the device server encounters end-of-data during a READ(6) command, CHECK CONDITION status shall be returned, the sense key shall be set to BLANK CHECK, and the VALID bit shall be set to one in the sense data. If end-of-data is encountered at or after early-warning, the EOM bit shall also be set to one. Upon termination, the logical position shall be immediately after the last recorded logical object (i.e., end-of-partition side). If the FIXED bit is one, the INFORMATION field in the sense data shall be set to the requested transfer length minus the actual number of logical blocks read. If the FIXED bit is zero, the INFORMATION field shall be set to the requested transfer length.

If the device server encounters end-of-partition during a READ(6) command, CHECK CONDITION status shall be returned, the sense key shall be set to MEDIUM ERROR, and the EOM and VALID bits shall be set to one in the sense data. The medium position following this condition is not defined. If the FIXED bit is one, the INFORMATION field shall be set to the requested transfer length minus the actual number of logical blocks read. If the FIXED bit is zero, the INFORMATION field in the sense data shall be set to the requested transfer length.

6.5 READ REVERSE(6) command

The READ REVERSE(6) command (see table 34) requests that the device server transfer one or more logical block(s) to the application client beginning at the current logical position. Prior to performing the read reverse operation, the device server shall perform a synchronize operation (see 4.2.11).

Table 34 — READ REVERSE(6) command

Bit / Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (0Fh)							
1	Reserved					BYTORD	SILI	FIXED
2	(MSB)							
3				TRANSFER LENGTH				
4								(LSB)
5	CONTROL							

This command is similar to the READ(6) command except that medium motion is in the reverse direction. Upon completion of a READ REVERSE(6) command, the logical position shall be before the last logical block transferred (i.e., beginning-of-partition side).

A byte order (BYTORD) bit of zero specifies all logical block(s), and the byte(s) within the logical block(s), are transferred in the reverse order. The order of bits within each byte shall not be changed. A BYTORD bit of one specifies all logical block(s) are transferred in the reverse order but the byte(s) within the logical block(s) are transferred in the same order as returned by the READ(6) command. Support for either value of the BYTORD bit is optional.

Refer to the READ(6) command (see 6.4) for a description of the FIXED bit, the SILI bit, the TRANSFER LENGTH field, and any conditions that may result from incorrect usage of these fields.

Filemarks, incorrect-length logical blocks, and unrecovered read errors are handled the same as in the READ(6) command, except that upon termination the logical position shall be before the filemark, incorrect-length logical block, or unrecovered block (i.e., beginning-of-partition side).

If the device server encounters beginning-of-partition during a READ REVERSE(6) command, CHECK CONDITION status shall be returned and the EOM and VALID bits shall be set to one in the sense data. The sense key shall be set to NO SENSE or RECOVERED ERROR, as appropriate. If the FIXED bit is one, the INFORMATION field shall be set to the requested transfer length minus the actual number of logical blocks transferred. If the FIXED bit is zero, the INFORMATION field shall be set to the requested transfer length.

6.6 SPACE(6) command

The SPACE(6) command (see table 35) provides a variety of positioning functions that are determined by the CODE and COUNT fields. Both forward and reverse positioning are provided, although some logical units may only support a subset of this command. Prior to performing the space operation, except as stated in the description of the COUNT field, the device server shall perform a synchronize operation (see 4.2.11). If an application client requests an unsupported function, the command shall be terminated 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 CDB. The INFORMATION field value shall be equal to the magnitude of the COUNT

field minus the magnitude of the logical objects spaced over. A CHECK CONDITION caused by early termination of any SPACE(6) command shall not result in a negative INFORMATION field value.

Table 35 — SPACE(6) command

Bit / Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (11h)							
1	Reserved				CODE			
2	(MSB)							
3				COUNT				
4								(LSB)
5	CONTROL							

The CODE field is defined in table 36.

Table 36 — CODE field

Code	Description	Support
0000b	Logical blocks	M
0001b	Filemarks	M
0010b	Sequential filemarks	O
0011b	End-of-data	O
0100b	Obsolete	
0101b	Obsolete	
0110b-1111b	Reserved	

When spacing over logical objects, the COUNT field specifies the number of logical objects to be spaced over in the current partition. A positive value *N* in the COUNT field when the CODE field is not 0011b (i.e., end-of-data) shall cause forward positioning (i.e., toward end-of-partition) over *N* logical objects ending on the end-of-partition side of the last logical object, if they exist. A zero value in the COUNT field when the CODE field is not 0011b (i.e., end-of-data) shall cause no change of logical position. A negative value -*N*, in two's complement notation, in the COUNT field when the CODE field is not 0011b (i.e., end-of-data) shall cause reverse positioning (i.e., toward beginning-of-partition) over *N* logical objects ending on the beginning-of-partition side of the last logical object, if they exist. When the CODE field is 0011b (i.e., end-of-data), the COUNT field shall be ignored and the device server shall perform a synchronize operation before moving before the end-of-data position. When the COUNT field is zero and the CODE field is not 0011b (i.e., end-of-data), a device server is not required to perform a synchronize operation. Support of spacing in the reverse direction is optional.

If a filemark is encountered while spacing over logical blocks, the command shall be terminated. CHECK CONDITION status shall be returned, and the FILEMARK and VALID bits shall be set to one in the sense data. The sense key shall be set to NO SENSE and the additional sense code shall be set to FILEMARK DETECTED. The INFORMATION field shall be set to the requested count minus the actual number of logical blocks spaced over. The logical position shall be on the end-of-partition side of the filemark if movement was in the forward direction and on the beginning-of-partition side of the filemark if movement was in the reverse direction.

If early-warning is encountered while spacing over logical objects and the REW bit is set to one in the Device Configuration mode page (see 8.3.3), CHECK CONDITION status shall be returned, the sense key shall be set to NO SENSE, and the EOM and VALID bits shall be set to one in the sense data. The additional sense code shall be set to END-OF-PARTITION/MEDIUM DETECTED. The INFORMATION field shall be set to the requested count minus the actual number of logical objects spaced over as defined by the CODE value. If the REW bit is zero, the device server shall not report CHECK CONDITION status at the early-warning point.

NOTE 21 - Setting the REW bit to one is not recommended for most applications since data may be present after early-warning.

If end-of-data is encountered while spacing over logical objects, CHECK CONDITION status shall be returned, the sense key shall be set to BLANK CHECK, and the sense data VALID bit shall be set to one in the sense data. The additional sense code shall be set to END-OF-DATA DETECTED. The sense data EOM bit shall be set to one if end-of-data is encountered at or after early-warning. The INFORMATION field shall be set to the requested count minus the actual number of logical objects spaced over as defined by the CODE value. The medium shall be positioned such that a subsequent write operation would append to the last logical object.

If the end-of-partition is encountered while spacing forward over logical objects, CHECK CONDITION status shall be returned, and the sense key shall be set to MEDIUM ERROR. The additional sense code shall be set to END-OF-PARTITION/MEDIUM DETECTED, and the sense data EOM and VALID bit shall be set to one. The INFORMATION field shall be set to the requested count minus the actual number of logical objects spaced over as defined by the CODE value. The medium position following this condition is not defined.

If beginning-of-partition is encountered while spacing over logical objects in the reverse direction, the device server shall return CHECK CONDITION status and shall set the sense key to NO SENSE. The additional sense code shall be set to BEGINNING-OF-PARTITION/MEDIUM DETECTED. The sense data EOM and VALID bits shall be set to one, and the INFORMATION field set to the total number of logical objects not spaced over as defined by the CODE value (i.e., the requested number of logical objects minus the actual number of logical objects spaced over as defined by the CODE value). The medium position following this condition is not defined. A successfully completed SPACE(6) command shall not set EOM to one at beginning-of-partition.

When spacing over sequential filemarks, the COUNT field is interpreted as follows:

a) a positive value *N* shall cause forward movement to the first occurrence of *N* or more consecutive filemarks being logically positioned after the N^{th} filemark;
b) a zero value shall cause no change in the logical position; or
c) a negative value -*N* (2's complement notation) shall cause reverse movement to the first occurrence of *N* or more consecutive filemarks being logically positioned on the beginning-of-partition side of the N^{th} filemark.

If end-of-partition is encountered while spacing to sequential filemarks, CHECK CONDITION status shall be returned, and the sense key shall be set to MEDIUM ERROR. The additional sense code shall be set to END-OF-PARTITION/MEDIUM DETECTED, the EOM bit shall be set to one, and the VALID bit shall be set to zero in the sense data. The medium position following this condition is not defined.

If end-of-data is encountered while spacing to sequential filemarks, CHECK CONDITION status shall be returned, and the sense key shall be set to BLANK CHECK. The additional sense code shall be set to END-OF-DATA DETECTED, and the sense data VALID bit shall be set to zero. The medium shall be positioned such that a subsequent write operation would append to the last logical object. The sense data EOM bit shall be set to one if end-of-data is encountered at or after early-warning.

When spacing to end-of-data, the COUNT field is ignored. Upon successful completion, the medium shall be positioned such that a subsequent write operation would append to the last logical object.

If end-of-partition is encountered while spacing to end-of-data, CHECK CONDITION status shall be returned, and the sense key shall be set to MEDIUM ERROR. The additional sense code shall be set to END-OF-PARTITION/MEDIUM DETECTED, the EOM bit shall be set to one, and the VALID bit shall be set to zero in the sense data. The medium position following this condition is not defined.

6.7 VERIFY(6) command

The VERIFY(6) command (see table 37) requests that the device server verify one or more logical block(s) beginning at the current logical position. Prior to performing the verify operation, the device server shall perform a synchronize operation (see 4.2.11).

Table 37 — VERIFY(6) command

Bit / Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (13h)							
1	Reserved					IMMED	BYTCMP	FIXED
2	(MSB)							
3				VERIFICATION LENGTH				
4								(LSB)
5	CONTROL							

An immediate (IMMED) bit of zero specifies the command shall not return status until the verify operation has completed. An IMMED bit of one specifies status shall be returned as soon as the command descriptor block has been validated; but after all verification data has been transferred from the application client to the device server, if the BYTCMP bit is one.

In order to ensure that no errors are lost, the application client should set the IMMED bit to zero on the last VERIFY(6) command when issuing a series of VERIFY(6) commands.

A byte compare (BYTCMP) bit of zero specifies the verification shall be a verification of logical blocks on the medium (e.g., CRC, ECC). No data shall be transferred from the application client to the device server.

A BYTCMP bit of one specifies the device server shall perform a byte-by-byte compare of the data on the medium and the data transferred from the application client. Data shall be transferred from the application client to the device server as in a WRITE(6) command (see 6.8). If the BYTCMP bit is one and the byte compare option is not supported, 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 CDB.

The VERIFICATION LENGTH field specifies the amount of data to verify, in logical blocks or bytes, as specified by the FIXED bit. Refer to the READ(6) command (see 6.4) for a description of the FIXED bit and any error conditions that may result from incorrect usage. If the VERIFICATION LENGTH field is zero, no data shall be verified and the current logical position shall not be changed. This condition shall not be considered as an error.

The VERIFY(6) command shall terminate as follows:

a) when the verification length has been satisfied;
b) when an incorrect-length logical block is encountered;
c) when a filemark is encountered;
d) when end-of-data is encountered;
e) when the end-of-partition is encountered;
f) when early-warning is encountered (if the REW bit is one in the Device Configuration mode page, see 8.3.3); or
g) when an unrecoverable read error is encountered.

The status and sense data for each of the termination conditions are handled in the same manner as in the READ(6) command (see 6.4). Upon successful completion of a VERIFY(6) command, the logical position shall be after the last logical block verified.

If the data does not compare (BYTCMP bit of one), the command shall terminate with CHECK CONDITION status, the sense data VALID bit shall be set to one, the sense key shall be set to MISCOMPARE, and the

additional sense code shall be set to MISCOMPARE DURING VERIFY OPERATION. If the FIXED bit is one, the INFORMATION field shall be set to the requested verification length minus the actual number of logical blocks successfully verified. If the FIXED bit is zero, the INFORMATION field shall be set to the requested verification length minus the actual number of bytes successfully verified. This number may be larger than the requested verification length if the error occurred on a previous VERIFY(6) command with an IMMED bit of one. Upon termination, the medium shall be positioned after the logical block containing the miscompare (i.e., end-of-partition side).

6.8 WRITE(6) command

The WRITE command (see table 38) requests that the device server write the logical block that is transferred from the application client to the current logical position.

Table 38 — WRITE(6) command

Bit / Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (0Ah)							
1	Reserved							FIXED
2	(MSB)							
3				TRANSFER LENGTH				
4								(LSB)
5	CONTROL							

The FIXED bit specifies whether fixed-block transfers or variable-block transfers are to be used. See the READ BLOCK LIMITS command (see 7.5) for additional information about fixed-block transfers and variable-block transfers.

If the FIXED bit is one, the TRANSFER LENGTH value specifies the number of fixed-length blocks to be transferred, using the current block length reported in the mode parameter block descriptor (see 8.3). If the FIXED bit is zero, a single logical block is transferred with TRANSFER LENGTH specifying the logical block length in bytes.

If TRANSFER LENGTH is zero, no data shall be transferred and the current position shall not be changed. This condition shall not be considered an error.

A WRITE(6) command may be buffered or unbuffered, as specified by the BUFFERED MODE field of the mode parameter header (see 8.3). When operating in unbuffered mode (see 3.1.80), the device server shall not return GOOD status until all logical block(s) are successfully written to the medium. When operating in buffered mode (see 3.1.9), the device server may return GOOD status as soon as all logical block(s) are successfully transferred to the logical unit's object buffer.

For compatibility with devices implemented prior to this version of this International Standard, a WRITE FILEMARKS command with the IMMED bit set to zero should be issued when completing a buffered write operation to perform a synchronize operation (see 4.2.11).

If the device server enables a WRITE(6) command while positioned between EW and EOP, or encounters EW during the processing of a WRITE(6) command, an attempt to finish writing any data may be made as determined by the current settings of the REW and SEW bits in the Device Configuration mode page (see 8.3.3). The command shall terminate with CHECK CONDITION status and the additional sense code shall be set to END-OF-PARTITION/MEDIUM DETECTED. If all data that is to be written is successfully transferred to the medium, the sense key shall be set to NO SENSE or RECOVERED ERROR, as appropriate. If the device server is unable to transfer all the data to the medium, buffered or unbuffered, before end-of-partition is encountered, the sense key shall be set to VOLUME OVERFLOW. The EOM bit shall be set to one. If the SEW bit is set to one, then the VALID bit shall be set to one.

The INFORMATION field shall be set as follows:

a) if the FIXED bit is set to one, the INFORMATION field shall be set to the requested transfer length minus the actual number of logical blocks transferred to the device server; or
b) if the FIXED bit is set to zero, the INFORMATION field shall be set to the requested transfer length.

The device server should perform a synchronize operation (see 4.2.11) after the first early-warning indication has been returned to the application client (see 4.2.5).

NOTE 22 - For some application clients it is important to recognize an error if end-of-partition is encountered during the processing of a WRITE(6) command, without regard for whether all data that is to be written is successfully transferred to the medium. The VOLUME OVERFLOW sense key may always validly be returned if end-of-partition is encountered while writing, and such usage is recommended. Reporting the MEDIUM ERROR sense key may cause confusion as to whether there was really defective medium encountered during the processing of the last WRITE(6) command.

If a WRITE(6) command is terminated early, an incomplete logical block (i.e., a logical block not completely transferred to the device server from the initiator) shall be discarded. The incomplete logical block may be accessible prior to new logical block being written to the media. The device server shall be logically positioned after the last logical block that was successfully transferred.

See 4.2.6 for a description of the effect of a PEWZ on the completion of the WRITE(6) command.

6.9 WRITE FILEMARKS(6) command

The WRITE FILEMARKS(6) command (see table 39) requests that the device server write the specified number of filemarks to the current position.

Table 39 — WRITE FILEMARKS(6) command

Bit / Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (10h)							
1	Reserved						Obsolete	IMMED
2	(MSB)							
3				FILEMARK COUNT				
4								(LSB)
5	CONTROL							

An immediate (IMMED) bit of one specifies the device server shall return status as soon as the command descriptor block has been validated. An IMMED bit of one is only valid if the device is operating in buffered mode (see 3.1.9). If the IMMED bit is set to one and the device is operating in unbuffered mode the command shall be terminated 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 CDB.

An IMMED bit of zero specifies the device server shall not return status until the write operation has completed. Any buffered logical objects shall be written to the medium prior to completing the command.

The FILEMARK COUNT field specifies the number of filemarks to be written. If the FILEMARK COUNT field is set to zero, the current logical position shall not be changed. It shall not be considered an error if the FILEMARK COUNT field is set to zero.

NOTE 23 - The FILEMARK COUNT field takes the place of the TRANSFER LENGTH field normally used by medium access commands that move data from the Data-Out Buffer to the device server (see SPC-4).

NOTE 24 - Upon completion of any buffered write operation, the application client may issue a WRITE FILEMARKS(6) command with the IMMED bit set to zero and the FILEMARK COUNT field set to zero to perform a synchronize operation (see 4.2.11).

If the device server enables a WRITE FILEMARKS(6) command while positioned between EW and EOP, or encounters EW during the processing of a WRITE FILEMARKS(6) command, an attempt to finish writing any buffered logical objects may be made, as determined by the current settings of the REW and SEW bits in the Device Configuration mode page (see 8.3.3). The command shall terminate with CHECK CONDITION status and the additional sense code shall be set to END-OF-PARTITION/MEDIUM DETECTED. If all buffered logical objects to be written are successfully transferred to the medium, the sense key shall be set to NO SENSE or RECOVERED ERROR, as appropriate. If the device server is unable to transfer all the buffered logical objects to the medium before end-of-partition is encountered, the sense key shall be set to VOLUME OVERFLOW. The EOM bit shall be set to one. If the SEW bit is set to one, then the VALID bit shall be set to one.

The INFORMATION field shall be set to the FILEMARK COUNT field value minus the actual number of filemarks:

a) written to the object buffer if the IMMED bit is set to one; or
b) written to the medium if the IMMED bit is set to zero.

The device server should perform a synchronize operation (see 4.2.11) after the first early-warning indication has been returned to the application client (see 4.2.5).

See 4.2.6 for a description of the effect of a PEWZ on the completion of the WRITE FILEMARKS(6) command.

7 Common command descriptions for sequential-access devices

7.1 FORMAT MEDIUM command

The FORMAT MEDIUM command (see table 40) is used to prepare the volume for use by the logical unit. If buffered logical objects are stored by the device server when processing of a FORMAT MEDIUM command begins, the command shall be rejected with CHECK CONDITION status. The sense key shall be set to ILLEGAL REQUEST and the additional sense code shall be set to POSITION PAST BEGINNING OF MEDIUM.

Table 40 — FORMAT MEDIUM command

Bit / Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (04h)							
1	Reserved						VERIFY	IMMED
2	Reserved				FORMAT			
3	(MSB)							
4	TRANSFER LENGTH							(LSB)
5	CONTROL							

The FORMAT MEDIUM command shall be accepted only when the medium is at beginning-of-partition 0 (BOP 0). If the medium is logically at any other position, the command shall be rejected with CHECK CONDITION status. The sense key shall be set to ILLEGAL REQUEST and the additional sense code shall be set to POSITION PAST BEGINNING OF MEDIUM.

At the successful completion of a FORMAT MEDIUM command, the medium shall be positioned at BOP 0.

During the format operation, the device server shall respond to commands as follows:

a) in response to all commands except REQUEST SENSE and INQUIRY, the device server shall return CHECK CONDITION unless a reservation conflict exists. In that case RESERVATION CONFLICT status shall be returned; or
b) in response to the REQUEST SENSE command, assuming no error has occurred, the device server shall return a sense key of NOT READY and the additional sense code shall be set to LOGICAL UNIT NOT READY, FORMAT IN PROGRESS, with the sense key specific bytes set for process indication (see SPC-4).

An immediate (IMMED) bit of zero specifies the device server shall not return status until the FORMAT MEDIUM command has completed. An IMMED bit of one specifies the device server shall return status as soon as the valid medium location has been verified and the command descriptor block of the FORMAT MEDIUM command has been validated. If CHECK CONDITION status is returned for a FORMAT MEDIUM command with an IMMED bit of one, the format operation shall not be performed.

A VERIFY bit of one specifies the logical unit shall format the volume and then verify that the format was successfully accomplished. The method used to verify success of the FORMAT MEDIUM command is vendor specific. If the verify operation determines that the format was not successfully accomplished, the device server shall return a sense key of MEDIUM ERROR and the additional sense code shall be set to MEDIUM FORMAT CORRUPTED. If the VERIFY bit is zero, the logical unit shall not perform the verify check.

The FORMAT field is specified in table 41.

Table 41 — FORMAT field

Code	Description	Support
0h	Use default format	O
1h	Partition volume	O
2h	Default format then partition	O
3h-7h	Reserved	
8h-Fh	Vendor specific	

If the FORMAT field is 0h, the logical unit shall determine the format method to use. A valid FORMAT MEDIUM command with 0h in the FORMAT field shall cause all data on the entire physical volume to be lost.

If the FORMAT field is 1h, the logical unit shall partition the volume using the current mode data from the Medium Partition mode page (see 8.3.4). If none of the mode bits SDP, FDP, or IDP are set to one, the device server shall return CHECK CONDITION. The sense key shall be set to ILLEGAL REQUEST with the addition sense code set to PARAMETER VALUE INVALID. If insufficient space exists on the volume for the requested partition sizes, the device server shall return CHECK CONDITION status. The sense key shall be set to MEDIUM ERROR and the additional sense code shall be set to VOLUME OVERFLOW. A valid FORMAT MEDIUM command with 1h in the FORMAT field may cause all data on the entire physical volume to be lost.

If the FORMAT field is 2h, the logical unit shall perform the operations equivalent to a FORMAT field of 0h followed by a FORMAT field of 1h. A valid FORMAT MEDIUM command with 2h in the FORMAT field may cause all data on the entire physical volume to be lost.

When the FORMAT field contains 1h or 2h, some errors related to mode page field contents may not be detected until the FORMAT MEDIUM command is processed. Therefore, some error conditions described in 8.3.4 may be returned in response to a FORMAT MEDIUM command with 1h or 2h in the FORMAT field.

The TRANSFER LENGTH specifies the length in bytes of format information that shall transferred from the initiator. A transfer length of zero specifies no format information shall be transferred. This condition shall not be considered an error. If the FORMAT field is 0h, 1h, or 2h, the TRANSFER LENGTH shall be zero. Use of format information is restricted to vendor-specific values in the FORMAT field and the contents of the format information is vendor specific.

7.2 LOAD UNLOAD command

The LOAD UNLOAD command (see table 42) requests that the logical unit enable or disable the logical unit for further operations. This command may also be used to request a retension function. Prior to performing the LOAD UNLOAD operation, the device server shall perform a synchronize operation (see 4.2.11). If the buffered mode is not 0h (see 8.3) and a previous command was terminated with CHECK CONDITION status

and the device is unable to continue successfully writing, the logical unit shall discard any unwritten buffered logical objects prior to performing the LOAD UNLOAD operation.

Table 42 — LOAD UNLOAD command

Bit / Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (1Bh)							
1	Reserved							IMMED
2	Reserved							
3	Reserved							
4	Reserved				HOLD	EOT	RETEN	LOAD
5	CONTROL							

An immediate (IMMED) bit of zero specifies the device server shall not return status until the load or unload operation has completed. If the IMMED bit is one, the device server shall return status as soon as all buffered logical objects have been written to the medium and the command descriptor block of the LOAD UNLOAD command has been validated. If CHECK CONDITION status is returned for a LOAD UNLOAD command with an IMMED bit of one, the load or unload operation shall not be performed.

For compatibility with devices implemented prior to this version of the standard, a WRITE FILEMARKS command with an IMMED bit of zero should be used to perform a synchronize operation (see 4.2.11) prior to issuing a LOAD UNLOAD command with an IMMED bit of one.

A LOAD bit of one and a HOLD bit of zero specifies the volume in the logical unit shall be loaded and positioned to the beginning-of-partition zero. A LOAD bit of zero and a HOLD bit of zero specifies the volume in the logical unit shall be positioned for removal at the extreme position along the medium specified by the EOT bit. Following successful completion of an unload operation, the device server shall return CHECK CONDITION status with the sense key set to NOT READY for all subsequent medium access commands until a new volume is mounted or a load operation is successfully completed.

A LOAD bit of one and a HOLD bit of one specifies if the volume has not been moved into the logical unit, the volume shall be moved in but not positioned for access. The EOT and RETEN bits shall be set to zero. Following successful completion, the device server shall return GOOD status. If the device server, volume, and medium support MAM, the device server shall establish a unit attention condition for all initiators and the additional sense code shall be set to MEDIUM AUXILIARY MEMORY ACCESSIBLE.

A LOAD bit of zero and a HOLD bit of one specifies if the volume is in the logical unit, the medium shall be positioned as specified by the RETEN and EOT bits or shall be unthreaded, whichever is appropriate for the medium type, but shall not be demounted. Following successful completion, the device server shall return GOOD status.

A retension (RETEN) bit of one specifies the logical unit shall perform a retension function on the current medium. A RETEN bit of zero specifies the logical unit shall not perform a retension function on the current medium. Implementation of the retension function is vendor specific.

An end-of-tape (EOT) bit of one specifies an unload operation (LOAD bit set to zero) shall position the medium at end-of-medium for removal from the device. For devices that do not support unloading at end-of-medium 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 CDB. An EOT bit of zero specifies an unload operation shall position the medium at beginning-of-medium for removal from the device.

An EOT bit of one and a LOAD bit of one shall cause the device server to return CHECK CONDITION status and the sense key shall be set to ILLEGAL REQUEST and the additional sense code shall be set to INVALID FIELD IN CDB.

A HOLD bit of one specifies MAM shall be accessible upon completion of the command but the volume shall not be positioned for access. A HOLD bit of zero and a LOAD bit of one specifies the volume shall be positioned for access. A HOLD bit of zero and a LOAD bit of zero specifies MAM shall not be accessible upon completion of the command.

When operating in buffered mode 1h or 2h (see 8.3), the logical unit shall discard any unwritten buffered data after the LOAD UNLOAD command is validated if the device is unable to continue successfully writing (e.g., the device reported CHECK CONDITION status to a previous command, reported a write-type error, and the error has not been cleared or otherwise recovered).

7.3 LOCATE(16) command

The LOCATE(16) command (see table 43) causes the logical unit to position the medium to the logical object or logical file, as specified by the DEST_TYPE and LOGICAL IDENTIFIER fields. Upon completion, the logical position shall be as specified in table 44. Prior to performing the locate operation, the device server shall perform a synchronize operation (see 4.2.11).

Table 43 — LOCATE(16) command

Bit / Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (92h)							
1	Reserved			DEST_TYPE		Rsvd	CP	IMMED
2	Reserved							BAM
3	PARTITION							
4	(MSB)							
5								
6								
7								
8				LOGICAL IDENTIFIER				
9								
10								
11								(LSB)
12	Reserved							
13	Reserved							
14	Reserved							
15	CONTROL							

An immediate (IMMED) bit of zero specifies the device server shall not return status until the locate operation has completed. If the IMMED bit is one, the device server shall return status as soon as all buffered logical objects have been written to the medium and the command descriptor block of the LOCATE(16) command has been validated. If CHECK CONDITION status is returned for a LOCATE(16) command with an IMMED bit of one, the locate operation shall not be performed.

A change partition (CP) bit of one specifies a change to the partition specified in the PARTITION field shall occur prior to positioning to the logical object or logical file, as specified in the LOGICAL IDENTIFIER field. A CP bit of zero specifies no partition change shall occur and the PARTITION field shall be ignored.

The DEST_TYPE field shall be used in conjunction with the LOGICAL IDENTIFIER field to locate to the appropriate position of the medium. The DEST_TYPE field specifies whether the location specified is a logical object identifier or logical file identifier. The DEST_TYPE field is specified in table 44.

Table 44 — DEST_TYPE field

Code	Description	Logical position upon successful completion	Support
00b	Logical object identifier	BOP side	M
01b	Logical file identifier	BOP side of the logical file	M
10b	Obsolete		
11b	Reserved		

A block address mode type (BAM) bit of zero specifies the logical unit shall process this command as an implicit address command. A BAM bit of one specifies the logical unit shall process this command as an explicit address command.

The LOGICAL IDENTIFIER field specifies the logical identifier to which the logical unit shall position the medium based on the current setting of the DEST_TYPE field. An otherwise valid LOCATE(16) command to any position between beginning-of-data and the position immediately after the last object in the partition (i.e., position at end-of-data) shall not return a sense key of ILLEGAL REQUEST. A LOCATE(16) to a position past end-of-data shall return CHECK CONDITION status and the sense key shall be set to BLANK CHECK. Additionally, the sense data EOM bit shall be set to one if end-of-data is located at or after early-warning.

If end-of-partition is encountered, CHECK CONDITION status shall be returned, the sense key shall be set to MEDIUM ERROR, and the sense data EOM bit shall be set to one.

The PARTITION field specifies the partition to select if the CP bit is one. Refer to the sequential-access device model (see 4.2.7) and the Medium Partition mode page (see 8.3.4) for additional information about partitioning.

The logical unit position is undefined if a LOCATE(16) command fails with a sense key other than ILLEGAL REQUEST.

7.4 PREVENT ALLOW MEDIUM REMOVAL command

The PREVENT ALLOW MEDIUM REMOVAL command (see table 45) requests that the logical unit enable or disable the removal of the volume. The logical unit shall not allow volume removal if any initiator port currently has volume removal prevented.

Table 45 — PREVENT ALLOW MEDIUM REMOVAL command

Bit / Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (1Eh)							
1	Reserved							
2	Reserved							
3	Reserved							
4	Reserved							PREVENT
5	CONTROL							

Table 46 specifies the PREVENT field values and their meanings.

Table 46 — PREVENT field

Code	Description
00b	Volume removal shall be allowed.
01b	Volume removal shall be prevented.
10b	Obsolete
11b	Obsolete

The prevention of volume removal shall begin when the device server sucessfully processes a PREVENT ALLOW MEDIUM REMOVAL command with a PREVENT field of 01b (i.e., volume removal prevented). The prevention of volume removal for the logical unit shall terminate after:

a) one of the following occurs for each I_T nexus that previously had volume removal prevented:
   A) the device server sucessfully processes a PREVENT ALLOW MEDIUM REMOVAL command with a PREVENT field of 00b; or
   B) an I_T nexus loss;
b) a power on;
c) a hard reset; or
d) a logical unit reset.

If a persistent reservation or registration is being preempted by a PERSISTENT RESERVE OUT command with PREEMPT AND ABORT service action (see SPC-4), the equivalent of a PREVENT ALLOW MEDIUM REMOVAL command with the PREVENT field set to 00b shall be processed for each I_T nexus associated with the persistent reservation or registrations being preempted. This allows an application client to override the prevention of volume removal function for a SCSI initiator port that is no longer operating correctly.

While a prevention of volume removal condition is in effect, the logical unit shall inhibit mechanisms that normally allow removal of the volume by an operator.

7.5 READ BLOCK LIMITS command

The READ BLOCK LIMITS command (see table 47) requests that the READ BLOCK LIMITS DATA (see table 48) be returned. The READ BLOCK LIMITS data (see table 48) specifies the block length limits capability of the logical unit.

Table 47 — READ BLOCK LIMITS command

Bit / Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (05h)							
1	Reserved							
2	Reserved							
3	Reserved							
4	Reserved							
5	CONTROL							

Table 48 — READ BLOCK LIMITS data

Bit Byte	7	6	5	4	3	2	1	0
0	Reserved			GRANULARITY				
1	(MSB)							
2				MAXIMUM BLOCK LENGTH LIMIT				
3								(LSB)
4	(MSB)							
5				MINIMUM BLOCK LENGTH LIMIT				(LSB)

The GRANULARITY field specifies the supported block size granularity. The logical unit shall support all block sizes *n* such that *n* minus the minimum block length limit is a multiple of $2^{GRANULARITY}$ and *n* is greater than or equal to the MINIMUM BLOCK LENGTH LIMIT and less than or equal to the MAXIMUM BLOCK LENGTH LIMIT.

If the MAXIMUM BLOCK LENGTH LIMIT value equals the MINIMUM BLOCK LENGTH LIMIT value, the logical unit supports fixed-block transfers only, with the block length equal to the MINIMUM BLOCK LENGTH LIMIT value. In this case, READ and WRITE commands with the FIXED bit set to zero shall result in CHECK CONDITION status and the sense key shall be set to ILLEGAL REQUEST and the additional sense code shall be set to INVALID FIELD IN CDB.

For read and write commands with the FIXED bit set to one, block lengths are limited to multiples of four (see 8.3).

If the MAXIMUM BLOCK LENGTH LIMIT value is not equal to the MINIMUM BLOCK LENGTH LIMIT value, the logical unit supports fixed-block transfers or variable-block transfers, with the block length constrained between the given limits in either transfer mode. The transfer mode is controlled by the FIXED bit in the WRITE or READ commands. If the maximum block limit is zero, a maximum block length is not specified.

7.6 READ POSITION command

7.6.1 READ POSITION command description

The READ POSITION command (see table 49) reports the current position and provides information about logical objects contained in the object buffer. No medium movement shall occur as a result of responding to the command.

Table 49 — READ POSITION command

Bit / Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (34h)							
1	Reserved			SERVICE ACTION				
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	(MSB)							
8	ALLOCATION LENGTH							(LSB)
9	CONTROL							

The service actions defined for the READ POSITION command are shown in table 50.

Table 50 — READ POSITION service action codes

Code	Name	Description	Implementation requirements	Reference
00h	SHORT FORM – BLOCK ID	Device server shall return 20 bytes of data with the FIRST LOGICAL OBJECT LOCATION and LAST LOGICAL OBJECT LOCATION fields as logical object identifier values (see 4.2.8.2), relative to a partition.	Mandatory	7.6.2
01h	SHORT FORM – VENDOR SPECIFIC	Device server shall return 20 bytes of data with the FIRST LOGICAL OBJECT LOCATION and LAST LOGICAL OBJECT LOCATION fields as vendor-specific values.	Optional	7.6.2
02h	Reserved	Illegal request		
03h	Reserved	Illegal request		
04h	Reserved	Illegal request		
05h	Reserved	Illegal request		
06h	LONG FORM	Device server shall return 32 bytes of data.	Mandatory	7.6.3
07h	Reserved	Illegal request		
08h	EXTENDED FORM	Device server shall return 28 bytes of data up to the maximum length specified by the ALLOCATION LENGTH field.	Optional	7.6.4
09h - 1Fh	Reserved	Illegal request		

If the device server does not implement the specified service action code, then the command shall be terminated 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 CDB.

To maintain compatibility with earlier implementations, the service action codes 02h, 03h, 04h, 05h, and 07h shall not be implemented.

For service action codes of 00h, 01h, and 06h, the ALLOCATION LENGTH field in the CDB shall be zero. If it is not, then the command shall be terminated 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 CDB.

For a service action code of 08h, the ALLOCATION LENGTH field in the CDB specifies how much space has been allocated for the parameter data. If the length is not sufficient to contain the parameter data, the first portion of the parameter data shall be returned. This shall not be considered an error. If the remainder of the parameter data is required, the application client should send a new READ POSITION command with an ALLOCATION LENGTH field large enough to contain all the parameter data.

7.6.2 READ POSITION DATA format, short form

Table 51 specifies the READ POSITION data that shall be returned if the SERVICE ACTION field is 00h or 01h.

Table 51 — READ POSITION data format, short form

Bit / Byte	7	6	5	4	3	2	1	0
0	BOP	EOP	LOCU	BYCU	Rsvd	LOLU	PERR	BPEW
1	PARTITION NUMBER							
2	Reserved							
3	Reserved							
4	(MSB)							
5								
6				FIRST LOGICAL OBJECT LOCATION				
7								(LSB)
8	(MSB)							
9								
10				LAST LOGICAL OBJECT LOCATION				
11								(LSB)
12	Reserved							
13	(MSB)							
14				NUMBER OF LOGICAL OBJECTS IN OBJECT BUFFER				
15								(LSB)
16	(MSB)							
17								
18				NUMBER OF BYTES IN OBJECT BUFFER				
19								(LSB)

A beginning–of-partition (BOP) bit of one specifies the logical unit is at the beginning-of-partition in the current partition. A BOP bit of zero specifies the current logical position is not at the beginning-of-partition.

An end-of-partition (EOP) bit of one specifies the logical unit is positioned between early-warning and end-of-partition in the current partition. An EOP bit of zero specifies the current logical position is not between early-warning and end-of-partition.

A logical object count unknown (LOCU) bit of one specifies the NUMBER OF LOGICAL OBJECTS IN OBJECT BUFFER field does not represent the actual number of logical objects in the object buffer. A LOCU bit of zero specifies the NUMBER OF LOGICAL OBJECTS IN OBJECT BUFFER field is valid.

A byte count unknown (BYCU) bit of one specifies the NUMBER OF BYTES IN OBJECT BUFFER field does not represent the actual number of bytes in the object buffer. A BYCU bit of zero specifies the NUMBER OF BYTES IN OBJECT BUFFER field is valid.

A logical object location unknown (LOLU) bit of one specifies the first logical object location, last logical object location, or partition number are not currently known or not otherwise obtainable. A LOLU bit of zero specifies the FIRST LOGICAL OBJECT LOCATION, LAST LOGICAL OBJECT LOCATION, and PARTITION NUMBER fields contain valid position information.

A position error (PERR) bit of one specifies the logical unit is unable to report the correct position due to an overflow of any of the returned position data. A PERR bit of zero specifies an overflow has not occurred in any of the returned position data fields.

If the Beyond Programmable Early Warning (BPEW) bit is set to one, then the logical object location is in a PEWZ or on the EOP side of EW. If the BPEW bit is set to zero, then the logical object location is not in a PEWZ and not on the EOP side of EW. The BPEW bit shall be set to zero if the LOLU bit is set to one or if the PEWS field (see 8.3.8) is set to zero.

The PARTITION NUMBER field reports the partition number for the current logical position. If the logical unit only supports one partition for the volume, the PARTITION NUMBER field shall be set to zero.

The FIRST LOGICAL OBJECT LOCATION field specifies the logical object identifier associated with the current logical position. The value shall specify the logical object identifier of the next logical object to be transferred between an application client and the device server if a READ or WRITE command is issued.

The LAST LOGICAL OBJECT LOCATION field specifies the logical object identifier associated with the next logical object to be transferred from the object buffer to the medium. If the object buffer does not contain a complete logical object or is empty, the value reported for the last logical object location shall be equal to the value reported for the first logical object location.

NOTE 25 - The information provided by the FIRST LOGICAL OBJECT LOCATION and LAST LOGICAL OBJECT LOCATION fields may be used in conjunction with the LOCATE command to position the medium at the appropriate logical object on another device in the case of unrecoverable errors on the first device.

The NUMBER OF LOGICAL OBJECTS IN OBJECT BUFFER field specifies the number of logical objects in the object buffer of the logical unit that have not been written to the medium.

The NUMBER OF BYTES IN OBJECT BUFFER field specifies the total number of data bytes in the object buffer of the logical unit that have not been written to the medium.

7.6.3 READ POSITION data format, long form

Table 52 specifies the format of the READ POSITION data that shall be returned if the SERVICE ACTION field is 06h.

Table 52 — READ POSITION data format, long form

Bit / Byte	7	6	5	4	3	2	1	0
0	BOP	EOP	Reserved		MPU	LONU	Rsvd	BPEW
1	Reserved							
2	Reserved							
3	Reserved							
4	(MSB)							
5								
6				PARTITION NUMBER				
7								(LSB)
8	(MSB)							
9								
10								
11								
12				LOGICAL OBJECT NUMBER				
13								
14								
15								(LSB)
16	(MSB)							
17								
18								
19								
20				LOGICAL FILE IDENTIFIER				
21								
22								
23								(LSB)
24	(MSB)							
25								
26								
27								
28				Obsolete				
29								
30								
31								(LSB)

The BOP, EOP, and PARTITION NUMBER fields are as defined in the READ POSITION data format, short form (see table 51).

A mark position unknown (MPU) bit of one specifies the logical file identifier is not known or accurate reporting is not currently available. A MPU bit of zero specifies the LOGICAL FILE IDENTIFIER field contains valid position information.

A logical object number unknown (LONU) bit of one specifies the logical object number or partition number are not known or accurate reporting is not currently available. A LONU bit of zero specifies the LOGICAL OBJECT NUMBER and PARTITION NUMBER fields contain valid position information.

If the Beyond Programmable Early Warning (BPEW) bit is set to one, then the logical object location is in a PEWZ or on the EOP side of EW. If the BPEW bit is set to zero, then the logical object location is not in a PEWZ or on the EOP side of EW. The BPEW bit shall be set to zero if the LONU bit is set to one or if the PEWS field (see 8.3.8) is set to zero.

The PARTITION NUMBER field reports the partition number for the current logical position. If the logical unit only supports one partition for the volume, the PARTITION NUMBER field shall be set to zero.

The LOGICAL OBJECT NUMBER field specfies the number of logical objects between beginning-of-partition and the current logical position. A filemark counts as one logical object.

The LOGICAL FILE IDENTIFIER field specifies the number of filemarks between beginning-of-partition and the current logical position. This value is the current logical file identifier.

7.6.4 READ POSITION data format, extended form

Table 53 specifies the format of the READ POSITION data that shall be returned if the SERVICE ACTION field is 08h.

Table 53 — READ POSITION data format, extended form

Bit / Byte	7	6	5	4	3	2	1	0
0	BOP	EOP	LOCU	BYCU	Rsvd	LOLU	PERR	BPEW
1	PARTITION NUMBER							
2	(MSB)	ADDITIONAL LENGTH (1Ch)						
3								(LSB)
4	Reserved							
5	(MSB)	NUMBER OF LOGICAL OBJECTS IN OBJECT BUFFER						
6								
7								(LSB)
8	(MSB)	FIRST LOGICAL OBJECT LOCATION						
9								
10								
11								
12								
13								
14								
15								(LSB)
16	(MSB)	LAST LOGICAL OBJECT LOCATION						
17								
18								
19								
20								
21								
22								
23								(LSB)
24	(MSB)	NUMBER OF BYTES IN OBJECT BUFFER						
25								
26								
27								
28								
29								
30								
31								(LSB)

The fields are defined the same as for the corresponding fields in the READ POSITION data format, short form (see table 51).

The ADDITIONAL LENGTH field shall contain 1Ch. If the information transferred to the Data-In Buffer is truncated because of an insufficient ALLOCATION LENGTH value, the ADDITIONAL LENGTH field shall not be altered to reflect the truncation.

7.7 RECOVER BUFFERED DATA command

The RECOVER BUFFERED DATA command (see table 54) is used to recover data that has been transferred to the logical unit's object buffer but has not been successfully written to the medium. It is normally used to recover the buffered data after error or exception conditions make it impossible to write the buffered data to the medium. One or more RECOVER BUFFERED data commands may be required to recover all unwritten buffered data.

Table 54 — RECOVER BUFFERED data command

Bit / Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (14h)							
1	Reserved						SILI	FIXED
2	(MSB)							
3	TRANSFER LENGTH							
4								(LSB)
5	CONTROL							

The processing of this command is similar to the READ(6) command except that the data is transferred from the logical unit's object buffer instead of the medium. The order that logical block(s) are transferred is defined by the RBO bit in the Device Configuration mode page (see 8.3.3). If the RBO bit is not implemented, logical block(s) are transferred in the same order they would have been transferred to the medium.

Refer to the READ(6) command (see 6.4) for a description of the FIXED bit, the SILI bit, the TRANSFER LENGTH field, and any conditions that may result from incorrect usage of these fields.

If the FIXED bit is zero, no more than the requested transfer length shall be transferred to the application client. If the requested transfer length is smaller than the actual length of the logical block to be recovered, only the requested transfer length shall be transferred to the application client and the remaining data for the current logical block shall be discarded.

During recovery operations involving unknown block sizes, the application client should set the FIXED bit to zero and select the maximum block length supported by the logical unit to ensure that all buffered data is transferred.

If a buffered filemark is encountered during a RECOVER BUFFERED DATA command, CHECK CONDITION status shall be returned, the sense key shall be set to NO SENSE, and the FILEMARK and VALID bits shall be set to one in the sense data. Upon termination, the logical position shall be after the filemark. If the FIXED bit is one, the INFORMATION field shall be set to the requested transfer length minus the actual number of logical blocks transferred. If the FIXED bit is zero, the INFORMATION field shall be set to the requested transfer length.

If an attempt is made to recover more logical blocks of data than are contained in the logical unit's object buffer, CHECK CONDITION status shall be returned, the sense key shall be set to NO SENSE. The additional sense code shall be set to END-OF-DATA DETECTED, and the EOM and VALID bits shall be set to one in the sense data. If the FIXED bit is one, the INFORMATION field shall be set to the requested transfer length minus the actual number of logical blocks transferred. If the FIXED bit is zero, the INFORMATION field shall be set to the requested transfer length.

7.8 REPORT DENSITY SUPPORT command

7.8.1 REPORT DENSITY SUPPORT command description

The REPORT DENSITY SUPPORT command (see table 55) requests that information regarding the supported densities or medium type for the logical unit be sent to the application client.

Table 55 — REPORT DENSITY SUPPORT command

Bit / Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (44h)							
1	Reserved						MEDIUM TYPE	MEDIA
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	(MSB)	ALLOCATION LENGTH						
8								(LSB)
9	CONTROL							

If the MEDIA bit is set to zero, the device server shall return descriptors for densities or medium types supported by the logical unit for any supported media. If the MEDIA bit is set to one, the device server shall return descriptors for densities or the medium type supported by the mounted volume. If the MEDIA bit is set to one and the logical unit either contains no volume or contains a volume but cannot determine the medium density or the medium type, CHECK CONDITION status shall be returned. The sense key shall be set to NOT READY and the additional sense code shall specify the reason for NOT READY.

If the MEDIUM TYPE bit is set to zero, the device server shall return data as specified in 7.8.3. If the MEDIUM TYPE bit is set to one, the device server shall return data as specified in 7.8.4.

The ALLOCATION LENGTH field specifies the maximum number of bytes that the device server may return.

7.8.2 REPORT DENSITY SUPPORT header

The REPORT DENSITY SUPPORT header is specified in table 56.

Table 56 — REPORT DENSITY SUPPORT header

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)	AVAILABLE DENSITY SUPPORT LENGTH						
1								(LSB)
2	Reserved							
3	Reserved							
4	Descriptor(s)							
n								

The AVAILABLE DENSITY SUPPORT LENGTH field specifies the number of bytes in the following data that is available to be transferred. The available density support length does not include itself. If the parameter data

is truncated due to insufficient allocation length, the AVAILABLE DENSITY SUPPORT LENGTH field shall not be altered to reflect the truncation.

7.8.3 Density support report

The REPORT DENSITY SUPPORT command with a MEDIUM TYPE bit set to zero returns the REPORT DENSITY SUPPORT header (see table 56) followed by one or more density support data block descriptors (see table 57). The density support data block descriptors shall follow the REPORT DENSITY SUPPORT header. The density support data block descriptors shall be in numerical ascending order of the PRIMARY DENSITY CODE value.

Table 57 — Density support data block descriptor

Bit / Byte	7	6	5	4	3	2	1	0
0	PRIMARY DENSITY CODE							
1	SECONDARY DENSITY CODE							
2	WRTOK	DUP	DEFLT	Reserved				DLV
3	(MSB)							
4	DESCRIPTOR LENGTH							(LSB)
5	(MSB)							
6	BITS PER MM							
7								(LSB)
8	(MSB)							
9	MEDIA WIDTH							(LSB)
10	(MSB)							
11	TRACKS							(LSB)
12	(MSB)							
13								
14	CAPACITY							
15								(LSB)
16	ASSIGNING ORGANIZATION							
:								
23								
24	DENSITY NAME							
:								
31								
32	DESCRIPTION							
:								
51								

Density support data block descriptors shall be returned by ascending PRIMARY DENSITY CODE values. Multiple entries may exist for a given PRIMARY DENSITY CODE value. For all entries with equal PRIMARY DENSITY CODE values, all fields except for ASSIGNING ORGANIZATION, DENSITY NAME, and DESCRIPTION shall be identical. Density support data block descriptors with the same PRIMARY DENSITY CODE value should be ordered from most to least preferred ASSIGNING ORGANIZATION, DENSITY NAME, and DESCRIPTION.

NOTE 26 - By allowing multiple entries for a given primary and secondary density code set, multiple standard names may identify the same density code. This facilitates the remapping of density codes, if required.

The density support data block descriptor may represent a particular format in addition to giving physical density information. The information in a density support data block descriptor provides an application client with a detailed review of the recording technologies supported by a logical unit. By supplying the density code value returned in a density support data block descriptor in a MODE SELECT command (see 8.3), an application client selects the recording technology (density, format, etc.).

The PRIMARY DENSITY CODE field contains the value returned by a MODE SENSE command for the density described in the remainder of the density support data block descriptor. The device server shall accept a MODE SELECT command containing this value, for appropriate media. The value 7Fh shall be reserved. All other values are available for use. The value of 00h shall only be used for the default density of the logical unit.

When multiple density code values are assigned to the same recording technology (density, format, etc.), the SECONDARY DENSITY CODE field shall contain the equivalent density code value. When the SECONDARY DENSITY CODE is used in the mode select header with a MODE SELECT command, the device server shall accept this value as equivalent to the PRIMARY DENSITY CODE value. If no secondary density code exists, the device server shall return the PRIMARY DENSITY CODE value in this field.

A write to media ok (WRTOK) bit of zero specifies the logical unit does not support writing to the medium with this density. A WRTOK bit of one specifies the logical unit is capable of writing this density to either the currently mounted volume (i.e., MEDIA bit in command descriptor block set to one) or for some media (i.e., MEDIA bit in command descriptor block set to zero). All density code values returned by the REPORT DENSITY SUPPORT command shall be supported for read operations.

A duplicated (DUP) bit of zero specifies this primary density code has exactly one density support data block descriptor. A DUP bit of one specifies this primary density code is specified in more than one density support data block descriptor.

A default (DEFLT) bit of zero specifies this density is not the default density of the drive. A DEFLT bit of one specifies this density is the default density. If either the PRIMARY DENSITY CODE or the SECONDARY DENSITY CODE field is zero, the DEFLT bit shall be one. If neither the primary or secondary density code is zero and the DEFLT bit is one, the logical unit shall accept a MODE SELECT header with a density code of 00h as equivalent to the primary and secondary density codes.

NOTE 27 - The default density of the logical unit may vary depending on the currently mounted media. Multiple codes may return a DEFLT bit of one when the MEDIA bit is zero since more than one default may be possible.

If the descriptor length valid (DLV) bit is set to one, the DESCRIPTOR LENGTH field shall contain the length of the descriptor minus 5. If the DLV bit is set to zero, the DESCRIPTOR LENGTH field shall be set to zero and the descriptor is 52 bytes in length.

The BITS PER MM field specifies the number of bits per millimeter per track as recorded on the medium. The value in this field shall be rounded up if the fractional value of the actual value is greater than or equal to 0,5. A value of 00h specifies the number of bits per millimeter does not apply to this logical unit. Direct comparison of this value between different vendors (possibly products) is discouraged since the definition of bits may vary.

The MEDIA WIDTH field specifies the width of the medium supported by this density. This field has units of tenths of millimeters. The value in this field shall be rounded up if the fractional value of the actual value is greater than or equal to 0,5. The MEDIA WIDTH field may vary for a given density depending on the mounted volume. A value of 00h specifies the width of the medium does not apply to this logical unit.

The TRACKS field specifies the number of data tracks supported on the medium by this density. The TRACKS value may vary for a given density depending on the mounted volume. Direct comparison of this value between different vendors (possibly products) is discouraged since the definition of the number of tracks may vary. For recording formats that are neither parallel nor serpentine, the TRACKS field specifies the maximum number of data tracks that are read or recorded simultaneously.

If the MEDIA bit is zero, the CAPACITY field specifies the approximate capacity of the longest supported medium assuming recording in this density with one partition. If the MEDIA bit is one, the CAPACITY field should specify the approximate capacity of the current medium, assuming recording in this density with one partition. If the

approximate capacity of the current medium is not available for the mounted volume, the longest supported medium capacity shall be used. If a SET CAPACITY command has affected the capacity of the medium, this shall be reflected in the CAPACITY field. The capacity assumes that compression is disabled, if possible. If this density does not support an uncompressed format, the capacity assumes that compression is enabled using average data. The capacity also assumes that the media is in good condition, and that normal data and block sizes are used. This value is in units of megabytes (10^6 bytes). The logical unit does not guarantee that this space is actually available in all cases. Direct comparison of this value between different vendors (possibly products) is discouraged since the length of media and the method used to measure maximum capacity may vary. The CAPACITY field is intended to be used by the application client to determine that the correct density is being used, particularly when a lower-density format is required for interchange.

The ASSIGNING ORGANIZATION field contains eight bytes of ASCII data identifying the organization responsible for the specifications defining the values in this density support data block descriptor. The data shall be left aligned within this field. The ASCII value for a space (20h) shall be used if padding is required. The ASSIGNING ORGANIZATION field should contain a value listed in the vendor identification list (see SPC-4). The use of a specific vendor identification, other than the one associated with the device is allowed.

If vendor X defines a density and format, another vendor may use X in the ASSIGNING ORGANIZATION field. If exactly the same density and format construction later becomes known by another name, both X and the new assigning organization may be used for the density code. This is one condition that may result in multiple density support data block descriptors for a single density code value.

NOTE 28 - It is intended that the ASSIGNING ORGANIZATION field contain a unique identification of the organization responsible for the information in a density support data block descriptor. In the absence of any formal registration procedure, T10 maintains a list of vendor and assigning organization identification codes in use. Vendors are requested to voluntarily submit their identification codes to prevent duplication of codes.

The DENSITY NAME field contains eight bytes of ASCII data identifying the document (or other identifying name) that is associated with this density support data block descriptor. The data shall be left aligned within this field. The ASCII value for a space (20h) shall be used if padding is required. Two physical densities (and possibly formats) shall not have identical ASSIGNING ORGANIZATION and DENSITY NAME fields. Assigning organizations are responsible for preventing duplicate usage of one density name for multiple different densities and/or formats.

It is suggested that any document that specifies a format and density for the media contain the values to be used by a logical unit when reporting the density support. The values for the BITS PER MM, MEDIA WIDTH, and TRACKS should also be included in such a document to help maintain consistency.

The DESCRIPTION field contains twenty bytes of ASCII data describing the density. The data shall be left aligned within this field. The ASCII value for a space (20h) shall be used if padding is required.

7.8.4 Medium type support report

The REPORT DENSITY SUPPORT command with a MEDIUM TYPE bit set to one returns the REPORT DENSITY SUPPORT header (see table 56) followed by one or more medium type descriptors (see table 58).

The medium type descriptors shall follow the REPORT DENSITY SUPPORT header. The medium type descriptors shall be in numerical ascending order of the medium type value.

Table 58 — Medium type descriptor

Bit / Byte	7	6	5	4	3	2	1	0
0	MEDIUM TYPE							
1	Reserved							
2	(MSB)			DESCRIPTOR LENGTH (52)				
3								(LSB)
4	NUMBER OF DENSITY CODES							
5				PRIMARY DENSITY CODES				
:								
13								
14	(MSB)			MEDIA WIDTH				
15								(LSB)
16	(MSB)			MEDIUM LENGTH				
17								(LSB)
18	Reserved							
19	Reserved							
20	(MSB)			ASSIGNING ORGANIZATION				
:								
27								(LSB)
28	(MSB)			MEDIUM TYPE NAME				
:								
35								(LSB)
36	(MSB)			DESCRIPTION				
:								
55								(LSB)

The MEDIUM TYPE field contains the value returned by a MODE SENSE command for the medium type described in the remainder of the medium type descriptor. The device server shall accept a MODE SELECT command containing this value, for appropriate media.

The DESCRIPTOR LENGTH field contains the length of the descriptor minus 4.

The NUMBER OF DENSITY CODES field contains the number of valid density codes present in the PRIMARY DENSITY CODES value field.

The PRIMARY DENSITY CODES field contains a list of primary density code values supported by the drive for the medium type. The primary density code values shall be listed in ascending order. Any unused bytes in this field shall be set to zero.

The MEDIA WIDTH field specifies the width of the medium. This field has units of tenths of millimeters. The value in this field shall be rounded up if the fractional portion of the actual value is greater than or equal to 0,5.

The MEDIUM LENGTH field specifies the nominal length of the medium. This field has units of meters. The value in this field shall be rounded up if the fractional portion of the actual value is greater than or equal to 0,5.

The ASSIGNING ORGANIZATION field contains eight bytes of ASCII data identifying the organization responsible for the specifications defining the values in this medium type descriptor. The data shall be left aligned within this field. The ASCII value for a space (20h) shall be used if padding is required. The ASSIGNING ORGANIZATION field should contain a value listed in the vendor identification list (see SPC-4). The use of a vendor identification other than the one associated with the device is allowed.

NOTE 29 - It is intended that the ASSIGNING ORGANIZATION field contain a unique identification of the organization responsible for the information in a medium type descriptor. In the absence of any formal registration procedure, T10 maintains a list of vendor and assigning organization identification codes in use. Vendors are requested to voluntarily submit their identification codes to prevent duplication of codes.

The MEDIUM TYPE NAME field contains eight bytes of ASCII data identifying the document (or other identifying name) that is associated with this medium type descriptor. The data shall be left aligned within this field. The ASCII value for a space (20h) shall be used if padding is required. Two different medium types shall not have identical ASSIGNING ORGANIZATION and MEDIUM TYPE NAME fields. Assigning organizations are responsible for preventing duplicate usage of one medium type name for multiple different medium types.

It is suggested that any document that specifies characteristics for the media contain the values to be used by a logical unit when reporting the density support. The values for the MEDIUM WIDTH and MEDIUM LENGTH should also be included in such a document to help maintain consistency.

The DESCRIPTION field contains twenty bytes of ASCII data describing the medium type. The data shall be left aligned within this field. The ASCII value for a space (20h) shall be used if padding is required.

7.9 REWIND command

The REWIND command (see table 59) causes the logical unit to position to the beginning-of-partition in the current partition. Prior to performing the rewind operation, the device server shall perform a synchronize operation (see 4.2.11). If the buffered mode is not 0h (see 8.3) and a previous command was terminated with CHECK CONDITION status and the device is unable to continue successfully writing, the logical unit shall discard any unwritten buffered logical objects prior to performing the REWIND operation.

Table 59 — REWIND command

Bit / Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (01h)							
1	Reserved							IMMED
2	Reserved							
3	Reserved							
4	Reserved							
5	CONTROL							

An immediate (IMMED) bit of zero specifies the device server shall not return status until the rewind operation has completed. If the IMMED bit is one, the device server shall return status as soon as all buffered logical objects have been written to the medium and the command descriptor block of the REWIND command has been validated. If CHECK CONDITION status is returned for a REWIND command with an IMMED bit of one, the rewind operation shall not be performed.

NOTE 30 - For compatibility with devices implemented prior to this standard, it is suggested that a WRITE FILEMARKS command with an IMMED bit of zero be used to perform a synchronize operation (see 4.2.11) before issuing a REWIND command with an IMMED bit of one.

7.10 SET CAPACITY command

The SET CAPACITY command (see table 60) sets the available medium for the currently mounted volume to a proportion of the total capacity of that volume. Any excess space shall be unavailable on the volume after successful completion of this command until changed by a new SET CAPACITY command. This change shall persist through power cycles, logical unit resets, I_T nexus losses, and unloading or reloading of the volume. Other vendor-specific actions such as physical erasure may change the total capacity of the volume. The method for recording the available capacity and other marks needed to manage the resulting capacity for volume interchange may be specified in a recording format standard or may be vendor specific.

Table 60 — SET CAPACITY command

Bit / Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (0Bh)							
1	Reserved							IMMED
2	Reserved							
3	(MSB)	CAPACITY PROPORTION VALUE						
4								(LSB)
5	CONTROL							

If the device server does not contain a volume, then the command shall be terminated with CHECK CONDITION status. The sense key shall be set to NOT READY, and the additional sense code shall be set to MEDIUM NOT PRESENT.

The SET CAPACITY command shall be accepted only when the medium is at beginning-of-partition 0 (BOP 0). If the medium is logically at any other position, the command shall be rejected with CHECK CONDITION status. The sense key shall be ILLEGAL REQUEST and the additional sense code shall be set to POSITION PAST BEGINNING OF MEDIUM.

A valid SET CAPACITY command shall cause all data and partitioning information on the entire physical volume to be lost. If the partitioning information changes, the device server shall establish a unit attention condition for all initiators with the additional sense code set to MODE PARAMETERS CHANGED.

An immediate (IMMED) bit of zero specifies the device server shall not return status until the set capacity operation has completed. An IMMED bit of one specifies the device server shall return status as soon as the command descriptor block of the SET CAPACITY command has been validated. If CHECK CONDITION status is returned for a SET CAPACITY command with an IMMED bit set to one, the set capacity operation shall not be performed.

The CAPACITY PROPORTION VALUE field specifies the portion of the total volume capacity to be made available for use. The CAPACITY PROPORTION VALUE field is the numerator to a fraction with a denominator of 65 535. The resulting available capacity on the volume shall be equal to the total volume capacity multiplied by this fraction. The device server may round up the capacity to the next highest supported value. This rounding shall not be considered an error and shall not be reported.

NOTE 31 - Available and total volume capacities are approximate values that may be affected by defects that reduce the actual available capacity of the volume. Other factors, such as partitioning, compression, and logical block packing may also affect available capacity.

7.11 SPACE(16) command

The SPACE(16) command (see table 61) operates identically to the SPACE(6) command (see 6.6), but allows specifying a COUNT field up to eight bytes in length and has parameter data out that specifies the logical object

identifier on the medium. Following completion of a SPACE(16) command a READ POSITION command should be issued to obtain positioning information.

Table 61 — SPACE(16) command

Bit / Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (91h)							
1	Reserved				CODE			
2	Reserved							
3	Reserved							
4	(MSB)							
5								
6								
7				COUNT				
8								
9								
10								
11								(LSB)
12	(MSB)							
13				PARAMETER LENGTH				(LSB)
14	Reserved							
15	CONTROL							

The CODE field is defined in table 36 (see 6.6).

When spacing over logical objects, the COUNT field specifies the number of logical objects to be spaced over in the current partition. A positive value *N* in the COUNT field when the CODE field is not 0011b (i.e., end-of-data) shall cause forward positioning (i.e., toward end-of-partition) over *N* logical objects ending on the end-of-partition side of the last logical object, if they exist. A zero value in the COUNT field when the CODE field is not 0011b (i.e., end-of-data) shall cause no change of logical position. A negative value -*N*, in two's complement notation, in the COUNT field when the CODE field is not 0011b (i.e., end-of-data) shall cause reverse positioning (i.e., toward beginning-of-partition) over *N* logical objects ending on the beginning-of-partition side of the last logical object, if they exist. When the CODE field is 0011b (i.e., end-of-data), the COUNT field shall be ignored and the device server shall perform a synchronize operation before moving before the end-of-data position. When the COUNT field is zero and the CODE field is not 0011b (i.e., end-of-data), a device server is not required to perform a synchronize operation. Support of spacing in the reverse direction is optional.

The PARAMETER LENGTH field is used to send parameter data space positioning information specifying the position on the medium from which to start the SPACE(16) command function. For an implicit block address mode command, the PARAMETER LENGTH field shall be set to 0. For an explicit block address mode command, the PARAMETER LENGTH field shall be set to 16. If the PARAMETER LENGTH field is set to any other value, the command shall be terminated with a CHECK CONDITION status. The sense key shall be set to ILLEGAL REQUEST and the additional sense code shall be set to INVALID FIELD IN CDB.

Space positioning information is specified in table 62.

Table 62 — Space positioning information

Bit / Byte	7	6	5	4	3	2	1	0
0	Reserved							
1	Reserved							
2	Reserved							
3	PARTITION NUMBER							
4	(MSB)							
5								
6								
7								
8				LOGICAL OBJECT IDENTIFIER				
9								
10								
11								(LSB)
12	Reserved							
13	Reserved							
14	Reserved							
15	Reserved							

The LOGICAL OBJECT IDENTIFIER and PARTITION fields specify the position where the SPACE(16) command shall start. If the current logical position does not match the specified LOGICAL OBJECT IDENTIFIER and PARTITION fields, the device server shall perform a locate operation to the specified logical object identifier and partition prior to performing the space operation. If the locate operation fails, the device server shall return CHECK CONDITION status and the additional sense code shall be set to LOCATE OPERATION FAILURE. Following a locate operation failure the logical position is undefined.

NOTE 32 - Locating to the logical object identifier prior to performing the space operation is necessary for the space operation to function properly when filemarks are between the starting logical object identifier and the expected ending logical object identifier of the space operation.

If a filemark is encountered while spacing over logical blocks, the command shall be terminated. CHECK CONDITION status shall be returned, and the FILEMARK and VALID bits shall be set to one in the sense data. The sense key shall be set to NO SENSE and the additional sense code shall be set to FILEMARK DETECTED. The INFORMATION field shall be set to the requested count minus the actual number of logical blocks spaced over. The logical position shall be on the end-of-partition side of the filemark if movement was in the forward direction and on the beginning-of-partition side of the filemark if movement was in the reverse direction.

For some space operations using the SPACE(16) command, the INFORMATION field value may exceed the maximum value allowed in the fixed format sense data (see SPC-4). As such, the descriptor format sense data (see SPC-4) should be enabled (i.e., the D_SENSE bit is set to one in the Control mode page).

If early-warning is encountered while spacing over logical objects and the REW bit is set to one in the Device Configuration mode page (see 8.3.3), CHECK CONDITION status shall be returned, the sense key shall be set to NO SENSE, and the EOM and VALID bits shall be set to one in the sense data. The additional sense code shall be set to END-OF-PARTITION/MEDIUM DETECTED. The INFORMATION field shall be set to the requested count minus the actual number of logical objects spaced over as defined by the CODE value. If the REW bit is zero or the option is not supported by the logical unit, the device server shall not report CHECK CONDITION status at the early-warning point.

Setting the REW bit to one is not recommended for most applications since data may be present after early-warning.

If end-of-data is encountered while spacing over logical objects, CHECK CONDITION status shall be returned, the sense key shall be set to BLANK CHECK, and the sense data VALID bit shall be set to one in the sense data. The additional sense code shall be set to END-OF-DATA DETECTED. The sense data EOM bit shall be set to one if end-of-data is encountered at or after early-warning. The INFORMATION field shall be set to the requested count minus the actual number of logical objects spaced over as defined by the CODE value. The medium shall be positioned such that a subsequent write operation would append to the last logical object.

If the end-of-partition is encountered while spacing forward over logical objects, CHECK CONDITION status shall be returned, and the sense key shall be set to MEDIUM ERROR. The additional sense code shall be set to END-OF-PARTITION/MEDIUM DETECTED, and the sense data EOM and VALID bit shall be set to one. The INFORMATION field shall be set to the requested count minus the actual number of logical objects spaced over as defined by the CODE value. The medium position following this condition is not defined.

If beginning-of-partition is encountered while spacing over logical objects in the reverse direction, the device server shall return CHECK CONDITION status and shall set the sense key to NO SENSE. The additional sense code shall be set to BEGINNING-OF-PARTITION/MEDIUM DETECTED. The sense data EOM and VALID bits shall be set to one, and the INFORMATION field set to the total number of logical objects not spaced over as defined by the CODE value (i.e., the requested number of logical objects minus the actual number of logical objects spaced over as defined by the CODE value). The medium position following this condition is not defined. A successfully completed SPACE(16) command shall not set EOM to one at beginning-of-partition.

When spacing over sequential filemarks, the count field is interpreted as follows:

a) a positive value *N* shall cause forward movement to the first occurrence of *N* or more consecutive filemarks being logically positioned after the N^{th} filemark;
b) a zero value shall cause no change in the logical position; or
c) a negative value -*N* (2's complement notation) shall cause reverse movement to the first occurrence of *N* or more consecutive filemarks being logically positioned on the beginning-of-partition side of the N^{th} filemark.

If end-of-partition is encountered while spacing to sequential filemarks, CHECK CONDITION status shall be returned, and the sense key shall be set to MEDIUM ERROR. The additional sense code shall be set to END-OF-PARTITION/MEDIUM DETECTED, the EOM bit shall be set to one, and the VALID bit shall be set to zero in the sense data. The medium position following this condition is not defined.

If end-of-data is encountered while spacing to sequential filemarks, CHECK CONDITION status shall be returned, and the sense key shall be set to BLANK CHECK. The additional sense code shall be set to END-OF-DATA DETECTED, and the sense data VALID bit shall be set to zero. The medium shall be positioned such that a subsequent write operation would append to the last logical object. The sense data EOM bit shall be set to one if end-of-data is encountered at or after early-warning.

When spacing to end-of-data, the COUNT field is ignored. Upon successful completion, the medium shall be positioned such that a subsequent write operation would append to the last logical object.

If end-of-partition is encountered while spacing to end-of-data, CHECK CONDITION status shall be returned, and the sense key shall be set to MEDIUM ERROR. The additional sense code shall be set to END-OF-PARTITION/MEDIUM DETECTED, the EOM bit shall be set to one, and the VALID bit shall be set to zero in the sense data. The medium position following this condition is not defined.

8 Parameters for sequential-access devices

8.1 Diagnostic parameters

This subclause defines the descriptors and pages for diagnostic parameters used with sequential-access devices.

The diagnostic page codes for sequential-access devices are defined in table 63.

Table 63 — Diagnostic page codes

Page code	Description	Reference
00h	Supported diagnostic pages	SPC-4
01h - 3Fh	Reserved (for all device types)	
40h - 7Fh	Reserved	
80h - FFh	Vendor specific	

8.2 Log parameters

8.2.1 Log parameters overview

This subclause defines the descriptors and pages for log parameters used with sequential-access devices.

The log page codes for sequential-access devices are defined in table 64.

Table 64 — Log page codes

Page code	Subpage code	Log page name	Support	Reference
00h	00h	Supported Log Pages	M	SPC-4
00h	FFh	Supported Log Pages and Subpages	O	SPC-4
01h - 3Fh	FFh	Supported Subpages	O	SPC-4
01h	00h	Buffer Overrun/Underrun	O	SPC-4
02h	00h	Write Error Counter	M	SPC-4
03h	00h	Read Error Counter (read)	M	SPC-4
04h	00h	Read Reverse Error Counter	M[a]	SPC-4
05h	00h	Verify Error Counter	O	SPC-4
06h	00h	Non-Medium Error	O	SPC-4
07h	00h	Last *n* Error Events	O	SPC-4
08h - 0Ah	00h-FEh	Reserved	-	
0Bh	00h	Last *n* Deferred Error Events or Asynchronous Events	O	SPC-4
0Ch	00h	Sequential-Access Device	M	8.2.2
0Dh	00h	Temperature	O	SPC-4
0Eh	00h	Start-Stop Cycle Counter	O	SPC-4
0Fh	00h	Application Client	O	SPC-4
10h	00h	Self-Test Results	O	SPC-4

a) Mandatory only if READ REVERSE command is supported.

Table 64 — Log page codes (Continued)

Page code	Subpage code	Log page name	Support	Reference
11h	00h	DT Device Status	O	ADC-2
12h	00h	TapeAlert Response	O	ADC-2
13h	00h	Requested Recovery	O	8.2.7
14h	00h	Device Statistics	O	8.2.4
15h	00h-FEh	Reserved	-	
16h	00h	Tape Diagnostic Data	O	8.2.5
17h	00h-FEh	Reserved	-	
18h	00h-FEh	Protocol Specific Port	O	SPC-4
19h-2Dh	00h-FEh	Reserved	-	
2Dh	00h	Current Service Information	O	8.2.6
2Eh	00h	TapeAlert	M	8.2.3
2Fh	00h	Informational Exceptions	O	SPC-4
30h - 3Fh	00h-FEh	Vendor specific (does not require page format)	-	
a) Mandatory only if READ REVERSE command is supported.				

8.2.2 Sequential-Access Device log page

The Sequential-Access Device log page defines:

a) data counters associated with data bytes transferred to and from the medium and to and from the application client;
b) binary list parameters describing native capacities; and
c) a binary list parameter related to cleaning.

The default value for parameters 0 through 3 shall be zero.

NOTE 33 - The data in parameters 0 and 1 are intended to provide an indication of the compression ratio for the written data. Parameters 2 and 3 are intended to provide an indication of the compression ratio for read data.

Table 65 defines the parameter codes for the Sequential-Access Device log page.

Table 65 — Parameter codes for Sequential-Access Device log page

Parameter Code	Description	Support
0000h	Number of data bytes received from application clients during WRITE command operations.	M
0001h	Number of data bytes written to the media as a result of WRITE command operations, not counting ECC and formatting overhead.	M
0002h	Number of data bytes read from the media during READ command operations, not counting ECC and formatting overhead.	M
0003h	Number of data bytes transferred to the initiator(s) during READ command operations.	M

Table 65 — Parameter codes for Sequential-Access Device log page (Continued)

Parameter Code	Description	Support
0004h	Approximate native capacity (see 3.1.48) in megabytes (i.e., 10^6) from BOP to EOD. This is not sensitive to the current position of the medium. The approximate native capacity between EOD and EW is the difference of parameter 0005h and this parameter. Conditions may occur that reduce the amount of data that is written before reaching EW. A value of all bits set to one indicates that this information is invalid due to an unknown location of EOD (e.g., no volume is mounted, EOD information needs to be rebuilt).	M
0005h	Approximate native capacity (see 3.1.48) in megabytes (i.e., 10^6) between BOP and EW of the current partition. If no volume is mounted the device server shall set all bits in this parameter to one.	M
0006h	Minimum native capacity in megabytes (i.e., 10^6) between EW and EOP of the current partition. If no volume is mounted the device server shall set all bits in this parameter to one.	M
0007h	Approximate native capacity in megabytes (i.e., 10^6) from BOP to the current position of the medium. If no volume is mounted the device server shall set all bits in this parameter to one.	M
0008h	Maximum native capacity in megabytes (i.e., 10^6) that is currently allowed to be in the device object buffer. This value may change depending on the current position of the medium (e.g., available native capacity may decrease as the current position of the medium approaches EOP).	M
0009h - 00FFh	Reserved.	-
0100h	Cleaning requested.	O
0101h - 7FFFh	Reserved.	-
8000h - FFFFh	Vendor-specific parameters.	-

NOTE 34 - If the current partition has a native capacity of 200 GB (i.e., 200 x 10^9) with EW at 1 GB prior to EOP and the medium is positioned at EOD which is at the point that is 75 % of the native capacity between BOP and EW, then the device server would use the following to determine parameters 0004h, 0005h, and 0006h. Since 75 % of native capacity is remaining, (200 GB - 1 GB) x 75% = 149.25 GB. This equation results in parameter 0004h = 149 250 (02 4702h), parameter 0005h = 199 000 (03 0958h), and parameter 0006h = 1 000 (00 03E8h).

A non-zero value of the cleaning requested parameter indicates that the device has requested a head cleaning and a subsequent cleaning cycle has not been completed. A zero value of the cleaning requested parameter indicates that the device has not requested a head cleaning. The cleaning requested parameter value shall persist across I_T nexus losses, logical unit resets, and power cycles.

8.2.3 TapeAlert log page

The TapeAlert log page (see table 66) defines error and informational flags used for detailed device diagnostics and management (see 4.2.18 and Annex A).

Table 66 — TapeAlert log page

Bit / Byte	7	6	5	4	3	2	1	0
0	Reserved			PAGE CODE (2Eh)				
1	SUBPAGE CODE (00h)							
2	(MSB)			PAGE LENGTH (n-3)				
3								(LSB)
	TapeAlert log parameter(s)							
4				TapeAlert log parameter (first) (see table 67)				
8								
n-4				TapeAlert log parameter (last) (see table 67)				
n								

See SPC-4 for a description of the PAGE CODE field, SUBPAGE CODE field, and PAGE LENGTH field.

Table 67 specifies the format of a TapeAlert log parameter.

Table 67 — TapeAlert parameter format

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			PARAMETER CODE				
1								(LSB)
2	DU	Obsolete	TSD (1)	ETC	TMC		FORMAT AND LINKING (00b)	
3	PARAMETER LENGTH (01h)							
4	Reserved							FLAG

The value in the PARAMETER CODE field shall range from 1 to 64.

See SPC-4 for a description of the DU bit, TSD bit, ETC bit, TMC field, and FORMAT AND LINKING field. The TSD bit and FORMAT AND LINKING field shall be set to the value specified in table 67.

An active TapeAlert flag has the FLAG bit set to one. An inactive TapeAlert flag has the FLAG bit set to zero.

If processing a LOG SELECT command, the device server shall terminate the command with CHECK CONDITION status, set the sense key to ILLEGAL REQUEST, and set the additional sense code to INVALID FIELD IN PARAMETER LIST if the application client sends parameter data for the TapeALert log page with:

a) the TSD bit set to zero;
b) the DS bit set to zero;
c) the LP bit set to one;
d) the LBIN bit set to one;
e) the FLAG bit set to one; or
f) the PARAMETER LENGTH field set to a value other than 01h.

If the TASER bit is set to zero (see 8.3.8), the device server shall terminate the command with CHECK CONDITION stats, set the sense key to ILLEGAL REQUEST, and set the additional sense code to INVALID FIELD IN PARAMETER LIST upon processing a LOG SELECT command where the application client has sent parameter data for the TapeAlert log page with the ETC bit set to one.

8.2.4 Device Statistics log page

8.2.4.1 Device Statistics log page overview

The Device Statistics log page (see table 68) defines data counters associated with utilization of the tape device. A device server that implements the Device Statistics log page shall implement one or more of the defined parameters. Support for the individual parameters in the Device Statistics log page is optional. All supported parameters shall be persistent across I_T nexus loss, logical unit reset and power-on. The parameters shall not be set to zero or changed with the use of a LOG SELECT command.

Table 68 — Device Statistics log page

Bit / Byte	7	6	5	4	3	2	1	0
0	DS	SPF (0b)	PAGE CODE (14h)					
1	SUBPAGE CODE (00h)							
2	(MSB)	PAGE LENGTH (n-3)						
3								(LSB)
	Device Statistics log parameter(s)							
4	Device Statistics log parameter (first) (see table 69)							
	.							
n	Device Statistics log parameter (last) (see table 69)							

See SPC-4 for a description of the DS bit, SPF bit, PAGE CODE field, SUBPAGE CODE field and PAGE LENGTH field.

Table 69 specifies the Device Statistics log page parameter codes.

Table 69 — Device Statistics log parameter codes

Parameter Code	Description	Reference
0000h	Lifetime media loads	8.2.4.2
0001h	Lifetime cleaning operations	8.2.4.2
0002h	Lifetime power on hours	8.2.4.2
0003h	Lifetime media motion (i.e., head) hours	8.2.4.2
0004h	Lifetime meters of tape processed	8.2.4.2
0005h	Lifetime media motion (head) hours when incompatible media was last loaded	8.2.4.2
0006h	Lifetime power on hours when the last temperature condition occurred (i.e., TapeAlert code 24h)	8.2.4.2
0007h	Lifetime power on hours when the last power consumption condition occurred (i.e., TapeAlert code 1Ch)	8.2.4.2
0008h	Media motion (i.e., head) hours since last successful cleaning operation	8.2.4.2
0009h	Media motion (i.e., head) hours since second to last successful cleaning operation	8.2.4.2

Table 69 — Device Statistics log parameter codes (Continued)

Parameter Code	Description	Reference
000Ah	Media motion (i.e., head) hours since third to last successful cleaning operation	8.2.4.2
000Bh	Lifetime power on hours when the last operator initiated forced reset and/or emergency eject occurred	8.2.4.2
000Ch-0FFFh	Reserved	
1000h	Media motion (i.e., head) hours for each medium type	8.2.4.3
1001h-7FFFh	Reserved	
8000h-FFFFh	Vendor-specifc	

Parameter codes corresponding to values of time shall be reported in hours and rounded up to the next whole hour.

8.2.4.2 Device statistics data counter log parameter

The device statistics data counter log parameter format is specified in table 70.

Table 70 — Device statistics data counter log parameter format

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)							
1	PARAMETER CODE							(LSB)
2	DU	Obsolete	TSD (0b)	ETC	TMC		FORMAT AND LINKING (11b)	
3	PARAMETER LENGTH (n-3)							
4	(MSB)							
n	DEVICE STATISTICS DATA COUNTER							(LSB)

The PARAMETER CODE field is defined in table 69.

See SPC-4 for descriptions of the DU bit, TSD bit, ETC bit, TMC field and FORMAT AND LINKING field. The TSD bit and FORMAT AND LINKING field shall be set to the values specified in table 70.

The PARAMETER LENGTH field indicates the number of bytes in the DEVICE STATISTICS DATA COUNTER field that follows.

The DEVICE STATISTICS DATA COUNTER field is the value of the data counter associated with the parameter code.

8.2.4.3 Medium type log parameter

The medium type log parameter format is specified in table 71.

Table 71 — Medium type log parameter format

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)							
1	PARAMETER CODE (1000h)							(LSB)
2	DU (0b)	Obsolete	TSD (0b)	ETC (0b)	TMC (00b)		FORMAT AND LINKING (11b)	
3	PARAMETER LENGTH (*n*-3)							
	Medium type parameter(s)							
4	Medium type parameter (first) (see table 72)							
	⋮							
n	Medium type parameter (last) (see table 72)							

The PARAMETER CODE field shall be set to 1000h to indicate the Medium type log parameter.

See SPC-4 for descriptions of the DU bit, TSD bit, ETC bit, TMC field and FORMAT AND LINKING field. These fields shall be set to the values specified in table 71.

The PARAMETER LENGTH field indicates the number of bytes in the medium type parameters that follow.

The medium type parameter format is specified in table 72.

Table 72 — Medium type parameter format

Bit / Byte	7	6	5	4	3	2	1	0
0	Reserved							
1	Reserved							
2	DENSITY CODE							
3	MEDIUM TYPE							
4	(MSB)							
7	MEDIA MOTION HOURS							(LSB)

The DENSITY CODE field contains the value returned in the general mode parameter block descriptor (see SPC-4).

The MEDIUM TYPE field contains the value returned in the mode parameter header (see SPC-4).

The value returned in the MEDIUM TYPE field is vendor specific for sequential-access devices.

The MEDIA MOTION HOURS field contains the number of media motion (i.e., head) hours for the type of medium specified by the combination of the MEDIUM TYPE field and DENSITY CODE field.

8.2.5 Tape Diagnostic Data log page

The Tape Diagnostic Data log page (see table 73) provides for a number of error-event records using the list parameter format. Each error-event record contains diagnostic information for a single error type encountered by the device including data counters associated with the error event, sense data, operation code/service

action and medium type with associated media motion hours, etc. The Tape Diagnostic Data log page may be used to aid in field analysis and repair.

The Tape Diagnostic Data log page shall only include parameter entries for commands that terminated with a CHECK CONDITION status having the sense key set to MEDIUM ERROR, HARDWARE ERROR or ABORTED COMMAND.

The parameter code value associated with an error-event indicates the relative time at which a command terminated with a CHECK CONDITION status. A lower parameter code indicates that the command terminated with a CHECK CONDITION status at a more recent time. The parameter code values returned shall be numbered consecutively from 0000h (i.e., the most recent) up to *n*, where *n* is the number of current parameter entries. The number of supported parameter entries, *n,* is vendor specific.

In each parameter (see table 74) if the REPEAT bit is set to zero, then the parameter represents only one event. If the REPEAT bit is set to one, then the parameter represents more than one consecutive events that had the identical values for the MEDIUM ID NUMBER field, SENSE KEY field, ADDITIONAL SENSE CODE field and ADDITIONAL SENSE CODE QUALIFIER field in the parameter. If the REPEAT bit is set to one in the parameter, then other fields in the parameter shall be set to the values when the first of the consecutive events that had the identical values for the MEDIUM ID NUMBER field, SENSE KEY field, ADDITIONAL SENSE CODE field and ADDITIONAL SENSE CODE QUALIFIER field occurred.

All parameter codes shall be persistent across I_T nexus losses, logical unit resets, and power-on. The parameter entries shall not be set to zero or changed with the use of a LOG SELECT command.

Table 73 — Tape Diagnostic Data log page

Bit / Byte	7	6	5	4	3	2	1	0
0	DS	SPF (0b)	PAGE CODE (16h)					
1	SUBPAGE CODE (00h)							
2	(MSB)	PAGE LENGTH (*n*-3)						
3								(LSB)
	Tape diagnostic data log parameter(s)							
4	Tape diagnostic data log parameter (first) (see table 74)							
	⋮							
n	Tape diagnostic data log parameter (last) (see table 74)							

See SPC-4 for a description of the DS bit, SPF bit, PAGE CODE field, SUBPAGE CODE field and PAGE LENGTH field.

The tape diagnostic data log parameter format is specified in table 74.

Table 74 — Tape diagnostic data log parameter format

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)							
1	PARAMETER CODE							(LSB)
2	DU (0b)	Obsolete	TSD (0b)	ETC (0b)	TMC (00b)		FORMAT AND LINKING (11b)	
3	PARAMETER LENGTH (*n*-3)							
4	Reserved							
5	Reserved							
6	DENSITY CODE							
7	MEDIUM TYPE							
8	(MSB)							
11	LIFETIME MEDIA MOTION HOURS							(LSB)
12	Reserved							
13	REPEAT	Reserved			SENSE KEY			
14	ADDITIONAL SENSE CODE							
15	ADDITIONAL SENSE CODE QUALIFIER							
16	(MSB)							
19	VENDOR-SPECIFIC CODE QUALIFIER							(LSB)
20	(MSB)							
23	PRODUCT REVISION LEVEL							(LSB)
24	(MSB)							
27	HOURS SINCE LAST CLEAN							(LSB)
28	OPERATION CODE							
29	Reserved			SERVICE ACTION				
30	Reserved							
31	Reserved							
32	(MSB)							
	MEDIUM ID NUMBER							
63								(LSB)
64	Reserved						TIMESTAMP ORIGIN	
65	Reserved							
66	TIMESTAMP							
71								
72	VENDOR SPECIFIC							
n								

See SPC-4 for descriptions of the DU bit, TSD bit, ETC bit, TMC field and FORMAT AND LINKING field. These fields shall be set to the values specified in table 74.

The PARAMETER LENGTH field indicates the number of bytes in the tape diagnostic data log parameter data that follows.

The DENSITY CODE field contains the density code of the volume loaded at the time the command terminated with the CHECK CONDITION status. The DENSITY CODE field is the same value as returned in the general mode parameter block descriptor (see SPC-4). If no volume was loaded at the time the command terminated with the CHECK CONDITION status, then the DENSITY CODE field shall be set to 00h.

The MEDIUM TYPE field contains the type of volume loaded at the time the command terminated with the CHECK CONDITION status. The MEDIUM TYPE field is the same value as returned in the mode parameter header (see SPC-4). If no volume was loaded at the time the command terminated with the CHECK CONDITION status, then the MEDIUM TYPE field shall be set to 00h.

The LIFETIME MEDIA MOTION HOURS field contains the number of media motion (head) hours at the time the command terminated with the CHECK CONDITION status. The LIFETIME MEDIA MOTION HOURS field is equivalent to the value contained in the Device Statistics log page with a parameter code value of 0003h at the time the command terminated with the CHECK CONDITION status.

The REPEAT bit set to one indicates this parameter represents more than one consecutive events that had identical values for the MEDIUM ID NUMBER field, SENSE KEY field, ADDITIONAL SENSE CODE field, and ADDITIONAL SENSE CODE QUALIFIER field. The REPEAT bit set to zero indicates this parameter represents a single event.

See SPC-4 for descriptions of the SENSE KEY field, ADDITIONAL SENSE CODE field, and ADDITIONAL SENSE CODE QUALIFIER field. The SENSE KEY field, ADDITIONAL SENSE CODE field, and ADDITIONAL SENSE CODE QUALIFIER field shall contain the sense key and additional sense code values of the command that terminated with the CHECK CONDITION status.

The VENDOR-SPECIFIC CODE QUALIFIER field is vendor specific. The VENDOR-SPECIFIC CODE QUALIFIER may provide additional diagnostics information related to the command that terminated with the CHECK CONDITION status.

See SPC-4 for the descriptions of the PRODUCT REVISION LEVEL field. The PRODUCT REVISION LEVEL field shall contain the product revision level at the time the command terminated with the CHECK CONDITION status.

The HOURS SINCE LAST CLEAN field contains the time in media motion (i.e., head) hours since the last successful cleaning at the time the command terminated with the CHECK CONDITION status. The HOURS SINCE LAST CLEAN field is equivalent to the value contained in the Device Statistics log page with a parameter code of 0008h at the time the command terminated with the CHECK CONDITION status.

See SPC-4 for descriptions of the OPERATION CODE field and SERVICE ACTION field. The OPERATION CODE field and SERVICE ACTION field, if applicable, contain the operation code and service action of the command that terminated with the CHECK CONDITION status.

If a volume was present at the time the command terminated with the CHECK CONDITION status, then the MEDIUM ID NUMBER field shall contain:

1) the BARCODE field value contained in the medium auxiliary memory (see SPC-4);
2) the MEDIUM SERIAL NUMBER field value contained in the medium auxiliary memory (see SPC-4); or
3) a vendor-specific value associated with the mounted volume.

If no volume was present at the time the command terminated with the CHECK CONDITION status, the MEDIUM ID NUMBER field shall be filled with 20h (i.e., ASCII space).

See SPC-4 for descriptions of the TIMESTAMP ORIGIN and TIMESTAMP fields. The TIMESTAMP ORIGIN field and TIMESTAMP field contain the timestamp origin and timestamp maintained by the device server at the time the command terminated with the CHECK CONDITION status. If a timestamp is not supported by the device server, the TIMESTAMP ORIGIN and TIMESTAMP fields shall be set to zero.

8.2.6 Current Service Information log page

8.2.6.1 Current Service Information log page overview

The Current Service Information log page (see table 75) specifies information used for detailed device diagnostics and management.

Table 75 — Current Service Information log page

Bit / Byte	7	6	5	4	3	2	1	0
0	DS	SPF (0b)	PAGE CODE (2Dh)					
1	SUBPAGE CODE (00h)							
2	(MSB)	PAGE LENGTH (*n*-3)						
3								(LSB)
	Service information log parameter(s)							
4	Service information log parameter (first) (see table 76) (Length *x*)							
x+3								
	⋮							
x+*y*+1	Service information log parameter (last) (see table 76) (Length *y*)							
n								

See SPC-4 for a description of the DS bit, SPF bit, PAGE CODE field, SUBPAGE CODE field and PAGE LENGTH field.

The service information log parameter format is specified in table 76.

Table 76 — Service information log parameter format

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)	PARAMETER CODE						
1								(LSB)
2	DU	Obsolete	TSD	ETC (0b)	TMC (00b)		FORMAT AND LINKING (01b)	
3	PARAMETER LENGTH (*x*-3)							
4	Timestamp descriptor							
15								
16	Service information descriptor (first) (see table 77)							
r								
	⋮							
t	Service information descriptor (last) (see table 77)							
x								

See SPC-4 for descriptions of the DU bit, TSD bit, ETC bit, TMC field and FORMAT AND LINKING field. These fields shall be set to the values specified in table 76.

The PARAMETER LENGTH field indicates the number of bytes that follow.

The value in the PARAMETER CODE field shall be set to the flag number (see table 10) of the TapeAlert flag for which the information applies. When a TapeAlert flag is activated, the parameter in this log page relating to that TapeAlert flag is created. This parameter shall continue to be reported until overwritten by the next

activation of the associated TapeAlert flag or until cleared by a LOG SELECT command. The act of returning a parameter shall not clear that parameter and shall not cause deactivation of the TapeAlert flag.

The Timestamp descriptor is defined by the REPORT TIMESTAMP command parameter data format (see SPC-4) with values reflecting the time the TapeAlert flag specified by the PARAMETER CODE field was activated.

Service information descriptors are returned and provide specific information about the TapeAlert flag. At least one service information descriptor shall be returned. The format of service information descriptors is specified in table 77.

Table 77 — Service information descriptor

Bit / Byte	7	6	5	4	3	2	1	0
0	SERVICE INFORMATION DESCRIPTOR TYPE							
1	SERVICE INFORMATION DESCRIPTOR LENGTH (*n*-1)							
2	Service information descriptor specific information (see table 78)							
n								

Only one service information descriptor shall be returned for a specific value of SERVICE INFORMATION DESCRIPTOR TYPE per parameter. The SERVICE INFORMATION DESCRIPTOR TYPE field is specified in table 78.

Table 78 — SERVICE INFORMATION DESCRIPTOR TYPE field

Code	Service Information Descriptor Type	Reference
00h	Vendor-specific service information	8.2.6.2
01h	Device information	8.2.6.3
02h	Volume information	8.2.6.4
03h	TapeAlert flag specific information	8.2.6.5
04h-FEh	Reserved	

8.2.6.2 Vendor-specific service information descriptor

Table 79 specifies the vendor-specific service information descriptor format.

Table 79 — Vendor-specific service information descriptor

Bit / Byte	7	6	5	4	3	2	1	0
0	SERVICE INFORMATION DESCRIPTOR TYPE (00h)							
1	SERVICE INFORMATION DESCRIPTOR LENGTH (*n*-1)							
2	Vendor-specific information							
n								

8.2.6.3 Device information descriptor

Table 80 specifies the device information descriptor format. The device information descriptor is returned when the cause of the TapeAlert flag relating to the parameter may be related to the device. There shall be only one device information descriptor returned per service information log parameter.

Table 80 — Device information descriptor

Bit / Byte	7	6	5	4	3	2	1	0
0	SERVICE INFORMATION DESCRIPTOR TYPE (01h)							
1	SERVICE INFORMATION DESCRIPTOR LENGTH (*x*-1)							
2	DEVICE SEVERITY CODE							
3	DEC							
4	DECQ							
5	DECT LENGTH							
6	DECT							
n								
n+1	NUMBER OF DEVICE REQUESTED RECOVERIES							
n+2	DEVICE REQUESTED RECOVERY (first)							
	⋮							
x	DEVICE REQUESTED RECOVERY (last)							

The SERVICE INFORMATION DESCRIPTOR LENGTH field specifies the length of the information related to the device.

The DEVICE SEVERITY CODE field contains a severity code (see table 9).

The device element code (DEC) field is specified in table 81.

Table 81 — DEC field

Code	Description
00h	No message
10h	Device data path
20h	Mechanical
30h	Primary interface
40h	Automation interface
50h	Diagnostic interface
60h	Electronic elements
70h	Microcode
F0-FFh	Reserved

The device element code qualifier (DECQ) field is a vendor-specfic value providing more detailed information about the element specified by the DEC field.

The DECT LENGTH field specifies the length of the DECT field.

The device element code text (DECT) field is null-terminated and contains a description of what caused the TapeAlert flag to be activated.

The NUMBER OF DEVICE REQUESTED RECOVERIES field specifies the number of DEVICE REQUESTED RECOVERIES fields.

The DEVICE REQUESTED RECOVERY field values are defined in table 82 and shall be returned in prioritized order.

Table 82 — DEVICE REQUESTED RECOVERY field

Code	Description
00h	No recovery requested
01h	Retrieve device debug logs
02h	Clean device
03h	Update microcode
04h	Power off device and call service
05h	Leave the device in current state and call service
06h	Remove power from the device then apply power
07h-FFh	Reserved

8.2.6.4 Volume information descriptor

Table 83 specifies the volume information descriptor format. The volume information descriptor is returned when the cause of the TapeAlert flag relating to the parameter may be related to the volume.

Table 83 — Volume information descriptor

Bit Byte	7	6	5	4	3	2	1	0
0	SERVICE INFORMATION DESCRIPTOR TYPE (02h)							
1	SERVICE INFORMATION DESCRIPTOR LENGTH (*n*-1)							
2	VOLUME SEVERITY CODE							
3	VIC							
4	VICQ							
	Volume identification descriptor(s)							
5	Volume identification descriptor (first)							
x								
	⋮							
y	Volume identification descriptor (last)							
n								

The SERVICE INFORMATION DESCRIPTOR LENGTH field specifies the length of the information related to the volume.

The VOLUME SEVERITY CODE field contains a severity code (see table 9).

The volume information code (VIC) field is specified in table 84.

Table 84 — VIC field

Code	Description
00h	No message
01h	Good WORM volume
06h	Good encrypted volume

Table 84 — VIC field

Code	Description
0Bh	Good data volume
10h	Good cleaning volume
15h	Good microcode update volume
1Ah	Bad WORM volume
1Fh	Bad encrypted volume
25h	Bad data volume
2Ah	Bad cleaning volume
2Fh	Bad microcode update volume
All others	Reserved

The volume information code qualifier (VICQ) field is specified in table 85.

Table 85 — VICQ field

Code	Description
00h	No message
01h	Read only permitted at this logical position
06h	Logical block encryption key required
0Bh	Read only permitted for the entire volume
10h	Rewrite volume if possible
15h	Tape directory invalid, re-read volume if possible
1Ah	Cannot read or write
1Fh	Replace volume
25h	Auxiliary memory error
All others	Reserved

The volume identification descriptor format is the same as the MAM ATTRIBUTE format for medium auxiliary memory (see SPC-4). If a volume information descriptor is returned and:

1) if a MAM attribute exists for the volume identifier parameter of the device type attributes (i.e., set by the SMC device), then this attribute shall be returned as a volume identification descriptor;
2) if a MAM attribute exists for the barcode parameter of the host type attributes (i.e., set by an application client), then this attribute shall be returned as a volume identification descriptor; and
3) if a MAM attribute exists for the medium serial number parameter of the medium type attributes (i.e., set by the manufacturer), then this attribute shall be returned as a volume identification descriptor.

8.2.6.5 TapeAlert flag specific information

Table 86 specifies the TapeAlert flag information descriptor format. Table 10 specifies which flags are returned for this descriptor.

Table 86 — TapeAlert flag specific information descriptor

Bit / Byte	7	6	5	4	3	2	1	0
0	SERVICE INFORMATION DESCRIPTOR TYPE (03h)							
1	SERVICE INFORMATION DESCRIPTOR LENGTH (02h)							
2	(MSB)	CURRENT PERCENTAGE						
3								(LSB)

The current percentage field specifies a signed percentage indicating how close to operating limits the item is. The value is the signed percentage multiplied by 16 384. If the magnitude of the percentage is less than or equal to 100 %, then the device is operating within specifications. If the magnitude is greater than 100 %, then the device is outside the operating specifications. The equation that shall be used is:

$$\frac{measuredValue - \left[\frac{\langle upperLimit - lowerLimit \rangle}{2} + lowerLimit\right]}{upperLimit - \left[\frac{\langle upperLimit - lowerLimit \rangle}{2} + lowerLimit\right]} \times 16384$$

Example 1: if the power specification states the operation range is between 4.78 volts and 5.32 volts and the measured voltage is 4.70 volts, then the value returned by the equation is:

$$\frac{4{,}7 - \left[\frac{\langle 5{,}32 - 4{,}78 \rangle}{2} + 4{,}78\right]}{5{,}32 - \left[\frac{\langle 5{,}32 - 4{,}78 \rangle}{2} + 4{,}78\right]} \times 16384 = -21239 = AD09h$$

Example 2: if the media life is specified to be 260 full backups and the media has had 234 full backups performed, then the value returned by the equation is:

$$\frac{234 - \left[\frac{\langle 260 - 0 \rangle}{2} + 0\right]}{260 - \left[\frac{\langle 260 - 0 \rangle}{2} + 0\right]} \times 16384 = 13107 = 3333h$$

8.2.7 Requested Recovery log page

8.2.7.1 Requested Recovery log page overview

Table 87 specifies the Requested Recovery log page. If the device is unable to complete an action (e.g., a volume load or unload) the device server may set the RRQST bit to one in the very high frequency data log

parameter (see ADC-2) to request that the application client perform a recovery action. The application client is able to obtain a list of alternative requested recovery actions by reading the Requested Recovery log page.

Table 87 — Requested Recovery log page

Bit / Byte	7	6	5	4	3	2	1	0
0	DS	SPF (0b)	PAGE CODE (13h)					
1	SUBPAGE CODE (00h)							
2	(MSB)	PAGE LENGTH (*n*-3)						
3								(LSB)
4	Requested recovery log parameters							
n								

See SPC-4 for a description of the PAGE CODE field, the DS bit, then SPF bit, the SUBPAGE CODE field, and the PAGE LENGTH field.

Table 88 specifies the requested recovery log parameter codes.

Table 88 — Requested recovery log parameter codes

Parameter Code	Description	Reference
0000h	Recovery procedures	8.2.7.2
0001h-7FFFh	Reserved	
8000h-FFFFh	Vendor specific	

8.2.7.2 Recovery procedures log parameter

The recovery procedures log parameter format is specified in table 89.

Table 89 — Requested recovery log parameter format

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)	PARAMETER CODE (0000h)						
1								(LSB)
2	DU (1b)	Obsolete	TSD (1b)	ETC (0b)	TMC (00b)		FORMAT AND LINKING (11b)	
3	PARAMETER LENGTH (*n*-3)							
	Recovery procedures list							
4	Recovery procedure (first)							
	⋮							
n	Recovery procedure (last)							

See SPC-4 for descriptions of the DU bit, TSD bit, ETC bit, TMC field, and FORMAT AND LINKING field. These bits and fields shall be set to the values specified in table 89.

The PARAMETER LENGTH field specifies the number of recovery procedure bytes that follow.

The PARAMETER CODE field shall be set to 0000h to specify the recovery procedures log parameter.

The recovery procedures list contains recovery procedures (see table 90) listed in order from the most preferred to the least preferred procedure. If multiple recovery procedures are available, the most preferred

procedure shall be the first in the list (i.e., in byte 4), and the other procedures listed in decreasing order of preference.

Each recovery procedure consists of one or more actions to be performed. If the INTXN bit in the VHF data descriptor of the DT Device Status log page is set to one, the parameter shall report only code 00h (i.e., Recovery not requested). If a failure occurs in performing one of the actions in a procedure, an appropriate list of requested recovery procedures may be reported.

Recovery procedures do not persist across a power cycle.

Table 90 — Recovery procedures

Recovery procedure	Description
00h	Recovery not requested.
01h	Recovery requested, no recovery procedure defined.
02h	Instruct operator to push volume.
03h	Instruct operator to remove and re-insert volume.
04h	Issue UNLOAD command. Instruct operator to remove and re-insert volume.
05h	Instruct operator to power cycle target device.
06h	Issue LOAD command.
07h	Issue UNLOAD command.
08h	Issue LOGICAL UNIT RESET task management function.
09h	No recovery procedure specified. Contact service organization.
0Ah	Issue UNLOAD command. Instruct operator to remove and quarantine volume.
0Bh	Instruct operator to not insert a volume. Contact service organization.
0Ch	Issue UNLOAD command. Instruct operator to remove volume. Contact service organization.
0Dh	Request creation of a target device error log.
0Eh	Retrieve a target device error log.
0Fh	Modify configuration to allow microcode update and instruct operator to re-insert volume.
10h-7Fh	Reserved
80h-FFh	Vendor-specific procedures.

If the Requested Recovery log page is requested and the RRQST bit in the VHF data descriptor of the DT Device Status log page is set to zero, then a recovery procedure of 00h (i.e., recovery not requested) shall be reported. If the requested recovery procedure is 09h (i.e., no recovery procedure defined. Contact service organization), then the device may not be able to unload the medium via subsequent LOAD UNLOAD commands or operator panel requests until the issue is resolved (i.e., attempting to do so may damage the mechanism of the device, the medium, or both).

If the requested recovery procedure is 0Ah (i.e., Issue UNLOAD command. Instruct operator to remove and quarantine volume), then the volume should be removed from service.

If the requested recovery procedure is 0Bh (i.e., Instruct operator to not insert a volume. Contact service organization), then a nonrecoverable error has occurred and insertion of a volume may cause damage. If the 0Bh recovery procedure is requested, then the RAA bit in the VHF data descriptor of the DT Device Status log page shall be set to zero, and no other recovery procedures other than 0Dh and 0Eh shall be reported.

If the requested recovery procedure is 0Ch (i.e., Issue UNLOAD command. Instruct operator to remove volume; Contact service organization), then a non-recoverable error has occurred and insertion of a new volume may cause damage. If recovery procedure 0Ch is requested and the volume has been removed, then

the RAA bit in the VHF data descriptor of the DT Device Status log page shall be set to zero, and no other recovery procedures other than 0Dh and 0Eh shall be reported.

8.3 Mode parameters

8.3.1 Mode parameters overview

This subclause defines the descriptors and pages for mode parameters used with sequential-access devices.

The mode parameter list, including the mode parameter header and mode block descriptor, are described in SPC-4.

The MEDIUM TYPE field in the mode parameter header is vendor specific for sequential-access devices.

The value of the BLOCK LENGTH field in the mode parameter block descriptor shall be a multiple of four.

NOTE 35 - The block length field is limited to multiples of four to ensure data integrity is maintained when fixed-block transfers are performed using transports such as Fibre Channel.

The DEVICE-SPECIFIC PARAMETER field in the mode parameter header is defined in table 91 for sequential-access devices.

Table 91 — Device-specific parameter

Bit Byte	7	6	5	4	3	2	1	0
	WP	BUFFERED MODE			SPEED			

When used with the MODE SENSE command, a write protection (WP) bit of zero specifies the volume is write enabled. A WP bit of one specifies the volume is currently in the write protected state. When used with the MODE SELECT command, this field is ignored.

NOTE 36 - The write protected state may be due to logical unit internal restrictions, software write protection, or physical write protection.

Values for the BUFFERED MODE field are defined in table 92.

Table 92 — Buffered modes

Code	Description
0h	The device server shall not report GOOD status on WRITE commands until the logical blocks are actually written on the medium.
1h	The device server may report GOOD status on WRITE commands as soon as all the data specified in the WRITE command has been transferred to the logical unit's object buffer. One or more logical blocks may be buffered prior to writing the logical block(s) to the medium.
2h	The device server may report GOOD status on WRITE commands as soon as: a) all the data specified in the write command has been successfully transferred to the logical unit's object buffer; and b) all buffered logical objects from different initiators has been successfully written to the medium.
3h - 7h	Reserved

Values for the SPEED field shall be assigned as defined in table 93.

Table 93 — SPEED field

Code	Description
0h	Default (use the device's default speed).
1h	Use the device's lowest speed.
2h - Fh	Use increasing device speeds.

For the MODE SELECT command, the DENSITY CODE field of the sequential-access device block descriptor (see SPC-4) specifies the density selected by the application client for use in subsequent read and write operations. For logical units capable of automatic density recognition, the density code selected by the application client may be overridden by the logical unit for a subsequent read operation if the selected value does not match the current recorded density of the medium. If the MODE SELECT command specifies the default density code the logical unit selects the actual density code to be used in a vendor-specific manner. The value is expected to be the principal density code (or an optimal density code).

For the MODE SENSE command, the DENSITY CODE field reflects the current operating density of the logical unit. If a current operating density has not been selected, either because no volume is mounted or because the density of the installed volume has not been determined, the DENSITY CODE field should be set to the principal density code value (see 3.1.55). For some logical units, the principal density code value returned in response to a MODE SENSE command may change dynamically to match the most recently detected density. The DENSITY CODE value returned in response to a MODE SENSE command shall be determined as follows:

a) following a logical unit reset, if the logical unit is not ready, the device server shall report the principal density;
b) following a unit attention condition for a not-ready-to-ready transition or an unsuccessful read operation, the device server shall:
   A) report the principal density if no attempt has been made by the logical unit to determine the density;
   B) report the principal density if the logical unit is unable to automatically determine the density from the volume; or
   C) report the current medium density if the logical unit has determined the density from the volume.
c) following a successful read operation, the device server shall report a density code value reflecting the recorded density of the medium. For some implementations, the logical unit may automatically determine this value from the volume. For devices not capable of automatic density determination, the principal density is reported if the density code value is not provided by the preceding MODE SELECT command;
d) following a successful write operation, the device server shall report a density code value reflecting the most recently recorded density of the medium;
e) following an unsuccessful read operation or an unsuccessful write operation, while at beginning-of-partition, the device server shall report a density code value as described for item b);
f) following a successful unload operation, the device server shall report the most recent density code value as determined by items b) through e) above; or
g) following a logical unit reset, if the logical unit is ready, the device server shall retain knowledge of the density code as determined by items b) through e) above.

For a MODE SELECT command, a density code of 7Fh specifies the application client is not selecting a density. The value 7Fh shall not be returned by a MODE SENSE command. Table 94 specifies the sequential-access device density codes.

Table 94 — Sequential-access density codes

Code	Description
00h[a]	Default density.
01h - 7Eh	Density code from REPORT DENSITY SUPPORT command.

Table 94 — Sequential-access density codes

Code	Description
7Fh[b]	No change from previous density (NO-OP).
80h - FFh	Density code from REPORT DENSITY SUPPORT command.
a) Only reported by MODE SENSE commands if primary density code for the density. b) This density code value is defined for the MODE SELECT command and shall not be returned by the MODE SENSE command.	

The mode page codes and subpage codes for sequential-access devices are defined in table 95. All page code and subpage code combinations not shown in table 95 are reserved.

Table 95 — Mode page codes and subpage codes

Page code	Subpage code	Mode page name	Support	Reference
00h	not applicable	Vendor specific (does not require page format)	-	
01h	00h	Read-Write Error Recovery	M	8.3.5
02h	00h	Disconnect-Reconnect	M	SPC-4
03h - 08h	00h - FEh	Reserved	-	
09h	00h	Obsolete	-	3.3.7
0Ah	00h	Control	M	SPC-4
0Ah	01h	Control Extension	O	SPC-4
0Bh - 0Eh	00h - FEh	Reserved	-	
0Fh	00h	Data Compression	M	8.3.2
10h	00h	Device Configuration	M	8.3.3
10h	01h	Device Configuration Extension	O	8.3.8
11h	00h	Medium Partition	O	8.3.4
12h	00h	Obsolete	-	3.3.7
13h	00h	Obsolete	-	3.3.7
14h	00h	Obsolete	-	3.3.7
15h	00h	Extended	O	SPC-4
16h	00h	Extended Device-Type Specific	O	SPC-4
17h	00h - FEh	Reserved	-	
18h	00h	Protocol Specific Logical Unit	M[b]	SPC-4
18h	01h to FEh		O	SPC-4
19h	00h	Protocol Specific Port	M[c]	SPC-4
a) Valid only for MODE SENSE command. b) Mandatory only if explicit command set is supported. c) Mandatory only if supported by the SCSI transport protocol. d) See SPC-4 for support requirements.				

Table 95 — Mode page codes and subpage codes (Continued)

Page code	Subpage code	Mode page name	Support	Reference
19h	01h to FEh		O	SPC-4
1Ah	00h	Power Condition	O	SPC-4
1Bh	00h - FEh	Reserved	-	
1Ch	00h	Informational Exceptions Control	M	8.3.6
1Dh	00h	Medium Configuration	M	8.3.7
1Eh - 1Fh	00h - FEh	Reserved	-	
20h - 3Eh	00h - FEh	Vendor specific (does not require page format)	-	
3Fh	00h	Return all pages[a]	-[d]	SPC-4
3Fh	FFh	Return all pages and subpages[a]	-[d]	SPC-4
00h - 3Eh	FFh	Return all subpages[a]	-[d]	SPC-4

a) Valid only for MODE SENSE command.
b) Mandatory only if explicit command set is supported.
c) Mandatory only if supported by the SCSI transport protocol.
d) See SPC-4 for support requirements.

8.3.2 Data Compression mode page

The Data Compression mode page (see table 96) specifies the parameters for the control of data compression in a sequential-access device.

Table 96 — Data Compression mode page

Bit / Byte	7	6	5	4	3	2	1	0
0	PS	SPF(0)	PAGE CODE (0Fh)					
1	PAGE LENGTH (0Eh)							
2	DCE	DCC	Reserved					
3	DDE	RED	Reserved					
4	(MSB)							
5				COMPRESSION ALGORITHM				
6								
7								(LSB)
8	(MSB)							
9				DECOMPRESSION ALGORITHM				
10								
11								(LSB)
12	Reserved							
13	Reserved							
14	Reserved							
15	Reserved							

See SPC-4 for a description of the PS bit, SPF bit, PAGE CODE field, and PAGE LENGTH field.

A data compression enable (DCE) bit of one specifies data compression is enabled. When this bit is one, data sent to the device server by the application client shall be processed using the selected compression algorithm before being written to the medium. A DCE bit of zero specifies data compression is disabled.

A data compression capable (DCC) bit of one specifies the device supports data compression and is capable of processing data sent to it for transferal to the medium using the selected compression algorithm. A DCC bit of zero specifies the device does not support data compression. This shall be a non-changeable bit.

A data decompression enable (DDE) bit of one specifies data decompression is enabled. A DDE bit of zero specifies data decompression is disabled. Uncompressed data shall be unaffected by the setting of the DDE bit.

The report exception on decompression (RED) field specifies the response to certain boundaries detected in the data on the medium. There are a number of boundaries that may occur on the medium between compressed and uncompressed data. These boundaries are shown in table 97. Only boundaries shown in table 97 may generate a CHECK CONDITION status.

Table 97 — Possible boundaries and resulting sense keys due to data compression

Prior data	Current data	Sense Key[a,b]		
		RED field value		
		zero	one	two
Uncompressed	Compressed (unsupported algorithm)	MEDIUM ERROR	MEDIUM ERROR	MEDIUM ERROR
Uncompressed	Compressed (supported algorithm)	[none]	[none]	RECOVERED ERROR
Compressed (supported algorithm)	Uncompressed	[none]	[none]	NO SENSE
Compressed (supported algorithm)	Compressed (unsupported algorithm)	MEDIUM ERROR	MEDIUM ERROR	MEDIUM ERROR
Compressed (supported algorithm A)	Compressed (supported algorithm B)	[none]	[none]	RECOVERED ERROR
Compressed (unsupported algorithm)	Uncompressed	[none]	NO SENSE	NO SENSE
Compressed (unsupported algorithm)	Compressed (supported algorithm)	[none]	RECOVERED ERROR	RECOVERED ERROR
Compressed (unsupported algorithm A)	Compressed (unsupported algorithm B)	MEDIUM ERROR	MEDIUM ERROR	MEDIUM ERROR
All other combinations		[none]	[none]	[none]

a) [none] specifies no CHECK CONDITION status is returned given the data boundary condition and the current value of the RED field.
b) The appropriate additional sense code is specified following this table in this subclause.

If a CHECK CONDITION status is returned and the current data is compressed, the additional sense code shall be set to either DECOMPRESSION EXCEPTION SHORT ALGORITHM ID OF NN with the additional sense code qualifier set to the algorithm id or DECOMPRESSION EXCEPTION LONG ALGORITHM with no additional sense code qualifier.

If a CHECK CONDITION status is returned and the current data is uncompressed, the additional sense code shall be set to DECOMPRESSION EXCEPTION SHORT ALGORITHM ID OF NN with the additional sense code qualifier set to zero.

A RED field of zero specifies the device shall return a CHECK CONDITION status when data is encountered on the medium during a read operation that the device is unable to decompress. Data boundaries in table 97

marked other than [none] in the column for RED field values of zero shall generate CHECK CONDITION status with the specified sense key when the RED field is zero.

A RED field of one specifies the device shall return a CHECK CONDITION status when data is encountered on the medium during a read operation that requires different handling by the application client than the data most recently encountered during a prior read operation. At each of these boundaries, the data that is sent to the application client is of a fundamentally different nature from that which was previously sent. Data boundaries in table 97 marked other than [none] in the column for RED field values of one shall generate CHECK CONDITION status with the specified sense key when the RED field is one.

A RED field of two specifies the device shall return a CHECK CONDITION status when data is encountered on the medium during a read operation that has been processed using a different algorithm from that data most recently encountered during a prior read operation. Data boundaries in table 97 marked other than [none] in the column for RED field values of two shall generate CHECK CONDITION status with the specified sense key when the RED field is two.

A RED field of three is reserved. If a mode page containing a RED field of three is received, the MODE SELECT command shall be terminated 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.

Upon detection of any of the boundary conditions described in table 97 that results in a CHECK CONDITION status, the additional sense code shall be set to either DECOMPRESSION EXCEPTION SHORT ALGORITHM ID OF NN (if the algorithm identifier is less than or equal to 255) or DECOMPRESSION EXCEPTION LONG ALGORITHM ID. The device shall, in both cases, set the DECOMPRESSION ALGORITHM field to the algorithm identifier of the compression algorithm used to process the encountered data. The logical position shall be on the EOP side of the encountered data, and the INFORMATION field in the sense data shall contain a count of the number of logical blocks contained within the encountered data.

When compressed data is encountered on the medium that the device server is unable to decompress, the device server shall return a CHECK CONDITION status. The sense key shall be set to MEDIUM ERROR and the additional sense code shall be set to CANNOT DECOMPRESS USING DECLARED ALGORITHM. Undecompressed data may be returned to the application client as a single variable length logical block with the ILI bit and INFORMATION fields set accordingly. The logical position is vendor specific following this condition.

The undecompressed data may contain more than one logical object. As such, the application client should issue a READ POSTION command following this condition to re-establish positioning.

The COMPRESSION ALGORITHM field specifies the currently selected compression algorithm. The default value of the COMPRESSION ALGORITHM field shall specify the default compression algorithm for the device. The field specifies the compression algorithm the device shall use to process data sent to it by the application client when the DCE bit is set to one. If the application client selects an algorithm that the device does not support, then the device shall return a 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. Algorithm identifiers are shown in table 98. The SELECT DATA COMPRESSION ALGORITHM field in the Device Configuration mode page shall be ignored if a Data Compression mode page with the DCE bit set to one is also received by the device in the same MODE SELECT command.

For the MODE SELECT command, the DECOMPRESSION ALGORITHM field specifies the decompression algorithm selected by the application client for use in subsequent decompression of data encountered on the medium. For devices capable of the automatic recognition of the compression algorithm used to process data encountered on the medium, the decompression algorithm selected by the application client may be ignored, or overridden by the logical unit for a subsequent read operation if the selected value does not match the compression algorithm that was used to process the data encountered on the medium.

For the MODE SENSE command, the DECOMPRESSION ALGORITHM field reflects the algorithm selected by the application client. For some devices, the DECOMPRESSION ALGORITHM value returned in response to a MODE SENSE command may change dynamically to match the compression algorithm, detected by the device, that was used to process the data most recently encountered on the medium, during a read operation. A value of

zero specifies the data encountered on the medium during the most recent read operation was uncompressed. Compression algorithm identifiers are shown in table 98.

Table 98 — Compression algorithm identifiers

Algorithm identifier	Description
00h	No algorithm selected (i.e., identifies uncompressed data).
01h	Set with MODE SELECT to select the default algorithm. MODE SENSE shall return the actual compression algorithm that was selected.
02h	Reserved.
03h	IBM ALDC[a] data compression algorithm with 512 byte buffer.
04h	IBM ALDC[a] data compression algorithm with 1 024 byte buffer.
05h	IBM ALDC[a] data compression algorithm with 2 048 byte buffer.
06h - 0Fh	Reserved.
10h	IBM IDRC[b] data compaction algorithm.
11h - 1Fh	Reserved.
20h	DCLZ[c] data compression algorithm.
21h - FEh	Reserved.
FFh	Unregistered algorithm.
100h - FFFFFFFFh	Reserved.

a) Adaptive Lossless Data Compression (see ISO/IEC 15200:1996).
b) Improved Data Recording Capability
c) Data Compression according to Lempel and Ziv (see ISO/IEC 11558:1992).

8.3.3 Device Configuration mode page

The Device Configuration mode page (see table 99) is used to specify the appropriate sequential-access device configuration.

Table 99 — Device Configuration mode page

Bit / Byte	7	6	5	4	3	2	1	0
0	PS	SPF(0)	PAGE CODE (10h)					
1	PAGE LENGTH (0Eh)							
2	Rsvd	Obsolete	CAF	ACTIVE FORMAT				
3	ACTIVE PARTITION							
4	WRITE OBJECT BUFFER FULL RATIO							
5	READ OBJECT BUFFER EMPTY RATIO							
6	(MSB)	WRITE DELAY TIME						
7								(LSB)
8	OBR	LOIS	Obsolete	AVC	SOCF		ROBO	REW
9	Obsolete							
10	EOD DEFINED			EEG	SEW	SWP	BAML	BAM
11	(MSB)	OBJECT BUFFER SIZE AT EARLY WARNING						
12								
13								(LSB)
14	SELECT DATA COMPRESSION ALGORITHM							
15	WTRE		OIR	REWIND ON RESET		ASOCWP	PERSWP	PRMWP

See SPC-4 for a description of the PS bit, SPF bit, PAGE CODE field, and PAGE LENGTH field.

NOTE 37 - The change active partition (CAP) bit (byte 2, bit 6 in the Device Configuration mode page) has been obsoleted. To change active partitions refer to the LOCATE command.

A change active format (CAF) bit of one specifies the active format is to be changed to the value specified in the ACTIVE FORMAT field. A CAF bit of zero specifies no active format change is specified. For some devices, the format may only be changed when the logical unit is at beginning-of-partition.

The ACTIVE FORMAT field specifies the recording format that is in use for the selected density code when reading or writing data on a logical unit. The value of the ACTIVE FORMAT field is vendor specific.

The ACTIVE PARTITION field specifies the current logical partition number in use on the volume. This shall be a non-changeable field.

The WRITE OBJECT BUFFER FULL RATIO field, on WRITE commands, specifies to the device server how full the object buffer shall be before writing data to the medium. A value of zero specifies the value is not specified.

The READ OBJECT BUFFER EMPTY RATIO field, on READ commands, specifies to the device server how empty the object buffer shall be before retrieving additional data from the medium. A value of zero specifies the value is not specified.

The WRITE DELAY TIME field specifies the maximum time, in 100 ms increments, that the device server should wait before any buffered data that is to be written, is forced to the medium after the last buffered WRITE command that did not cause the object buffer to exceed the write object buffer full ratio. A value of zero specifies the device server shall never force buffered data to the medium under these conditions.

An object buffer recovery (OBR) bit of one specifies the logical unit supports object buffer recovery using the RECOVER BUFFERED DATA command. An OBR bit of zero specifies the logical unit does not support object buffer recovery. Most device servers consider this bit to be not changeable.

A logical object identifiers supported (LOIS) bit of zero specifies logical object identifiers are not supported in the format written on the medium. A LOIS bit of one specifies the format on the medium has recorded information about the logical object identifiers relative to a partition. Most device servers consider this bit to be not changeable.

The automatic velocity control (AVC) bit of one, specifies the device shall select the speed (if the device supports more than one speed) based on the data transfer rate that should optimize streaming activity and minimize medium repositioning. An AVC bit of zero specifies the speed chosen shall be defined by the SPEED field in the mode parameter header.

A stop on consecutive filemarks (SOCF) field of 00b specifies the device server shall pre-read data from the medium to the limits of the object buffer capacity without regard for filemarks. Values 01b, 10b, and 11b specify that the device server shall terminate the pre-read operation if one, two, or three consecutive filemarks are detected, respectively.

A recover object buffer order (ROBO) bit of one specifies logical blocks shall be returned from the object buffer of the logical unit on a RECOVER BUFFERED DATA command in LIFO order (last-in-first-out) from that they were written to the object buffer. A RBO bit of zero specifies logical blocks shall be returned in FIFO (first-in-first-out) order.

A report early-warning (REW) bit of zero specifies the device server shall not report the early-warning condition for read operations and it shall report early-warning at or before any medium-defined early-warning position during write operations. Application clients should set the REW bit to zero.

A REW bit of one specifies the device server shall return CHECK CONDITION status with the additional sense code set to END-OF-PARTITION/MEDIUM DETECTED, and the EOM bit set to one in the sense data when the early-warning position is encountered during read and write operations. If the REW bit is one and the SEW bit is zero, the device server shall return CHECK CONDITION status with the sense key set to VOLUME OVERFLOW when early-warning is encountered during write operations.

NOTE 38 - A REW bit of one is intended for compatibility with application clients using legacy formats that require an early-warning indication during read operations.

The EOD DEFINED field specifies the format type that the logical unit shall use to detect and generate the EOD area. The values for the EOD DEFINED field are specified in table 100.

Table 100 — EOD DEFINED field

Code	Description
000b	Logical unit's default EOD definition
001b	Format-defined erased area of medium
010b	As specified in the SOCF field
011b	EOD recognition and generation is not supported
100b - 111b	Reserved

An enable EOD generation (EEG) bit set to one specifies the logical unit shall generate the appropriate EOD area, as determined by the EOD field. A value of zero specifies EOD generation is disabled.

NOTE 39 - Some logical units may not generate EOD at the completion of any write-type operation.

A synchronize at early-warning (SEW) bit set to one specifies the logical unit shall cause any buffered logical objects to be transferred to the medium prior to returning status when positioned between early-warning and EOP. A SEW bit of zero specifies the logical unit may retain unwritten buffered logical objects in the object buffer when positioned between early-warning and EOP (see 5.6, 5.7, 6.8, and 6.9).

A software write protection (SWP) bit set to one specifies the device server shall perform a synchronize operation then enter the write-protected state (see 4.2.14 and 4.2.14.3). When the SWP bit is set to one, all commands requiring eventual writes to the medium shall return CHECK CONDITION status. The sense key shall be set to DATA PROTECT and the additional sense code should be set to LOGICAL UNIT SOFTWARE WRITE PROTECTED (see 4.2.14.2). A SWP bit set to zero specifies the device server may inhibit writing to the medium, dependent on other write inhibits.

A block address mode lock (BAML) bit of zero specifies the selection of the block address mode shall be determined based on the first block address mode unique command that is received after a successful load operation or a successful completion of a command that positions the medium to BOP. A BAML bit of one specifies the selection of the block address mode shall be determined based on the setting of the BAM bit. See 4.2.17 for a description of block address mode selection.

The block address mode (BAM) bit is valid only if the BAML bit is set to one. If the BAML bit is set to zero, the BAM bit shall be ignored. If the BAML bit is set to one and the BAM bit is set to zero, the logical unit shall operate using implicit address mode. If the BAML bit is set to one and the BAM bit is set to one, the logical unit shall operate using explicit address mode. See 4.2.17 for a description of block address mode selection.

The OBJECT BUFFER SIZE AT EARLY WARNING field specifies the value, in bytes, that the logical unit shall reduce its logical object buffer size to when writing in a position between its early-warning and end-of-partition. A value of zero specifies the implementation of this function is vendor specific.

NOTE 40 - The intent is to prevent the loss of data by limiting the size of the object buffer when near the end-of-partition.

The SELECT DATA COMPRESSION ALGORITHM field set to 00h specifies the logical unit shall not use a compression algorithm on any data sent to it prior to writing the data to the medium. A value of 01h specifies the data to be written shall be compressed using the logical unit's default compression algorithm. Values 02h through 7Fh are reserved. Values 80h through FFh are vendor specific. The SELECT DATA COMPRESSION ALGORITHM field shall be ignored if a Data Compression mode page with the DCE bit set to one is received by the device in the same MODE SELECT command.

NOTE 41 - New implementations use the Data Compression mode page (see 8.3.2) for specifying data compression behavior.

The WORM Tamper Read Enable (WTRE) field specifies how the device server responds to detection of compromised integrity of a WORM volume when processing a locate, read, read reverse, space, or verify operation. The WTRE field shall have no effect on the processing of a locate, read, read reverse, space, or verify operation when the device contains a non-WORM volume. The values for the WTRE field are specified in table 101.

Table 101 — WTRE field

Code	Description
00b	The device server shall respond in a vendor specific manner.
01b	Detection of compromised integrity on a WORM volume shall not affect processing of a task.
10b	The device server shall return CHECK CONDITION status. The sense key shall be set to MEDIUM ERROR and the additional sense code shall be set to WORM MEDIUM - INTEGRITY CHECK. The position of the medium may have changed.
11b	Reserved. The device server shall return CHECK CONDITION status for a MODE SELECT command with the WTRE field set to 11b. The sense key shall be set to ILLEGAL REQUEST and the additional sense code shall be set to INVALID FIELD IN PARAMETER LIST.

An application client should set the WTRE field to 01b only for the recovery of data from a WORM volume where the integrity of the stored data has been compromised.

If the only if reserved (OIR) bit is set to one, the device server shall process a command only if a reservation (see SPC-2) or persistent reservation (see SPC-4) exists that allows access via the I_T nexus from which the command was received. If the OIR bit is set to one and a command is received from an I_T nexus for which no reservation exists, the device server shall not process the command. If the OIR bit is set to one and a command is received from an I_T nexus for a logical unit upon which no reservation or persistent reservation exists, 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 NOT RESERVED. Commands that shall not be affected by the OIR bit set to one are defined as Allowed in the presence of persistent reservations in table 14 or SPC-4, or are defined in SPC-2 as Allowed in the presence of reservations. Commands that shall be affected by the OIR bit set to one are defined as Conflict in the presence of persistent reservations in table 14 or SPC-4, except for the RESERVE, RELEASE, PERSISTENT RESERVATION IN and PERSISTENT RESERVATION OUT commands, or are defined in SPC-2 as Conflict in the presence of reservations. An OIR bit set to zero specifies the device server shall process commands as specified in table 14 or SPC-4.

The REWIND ON RESET field is specified in table 102. The REWIND ON RESET field, if implemented, shall be persistent across logical unit resets.

Table 102 — REWIND ON RESET field

Code	Description
00b	Vendor specific
01b	The logical unit shall position to the beginning of the default data partition (BOP 0) on logical unit reset.
10b	The logical unit shall maintain its position on logical unit reset.
11b	Reserved

An associated write protection (ASOCWP) bit set to one specifies the logical unit shall inhibit all writing to the medium after performing a synchronize operation (see 4.2.14 and 4.2.14.4). When the ASOCWP bit is set to one, the currently mounted volume is logically write protected until the volume is demounted (see 4.2.14 and 4.2.14.4). When the ASOCWP bit is set to one, all commands requiring eventual writes to the medium shall return CHECK CONDITION status. The sense key shall be set to DATA PROTECT and the additional sense code should be set to ASSOCIATED WRITE PROTECT (see 4.2.14.2). An ASOCWP bit set to zero specifies the currently mounted volume is not write protected by the associated write protection. The ASOCWP bit shall be set to zero by the device server when the volume is demounted. This change of state shall not cause a unit attention condition. If the application client sets the ASOCWP bit to one while no volume is mounted, the device server shall terminate the MODE SELECT command with CHECK CONDITION status. The sense key shall be set to NOT READY and the additional sense code shall be set to MEDIUM NOT PRESENT. If the Device Configuration mode page is savable, the ASOCWP bit shall be saved as zero, regardless of the current setting.

A persistent write protection (PERSWP) bit set to one specifies the currently mounted volume is logically write protected (see 4.2.14 and 4.2.14.5). When the PERSWP bit is set to one, all commands requiring eventual writes to the medium shall return CHECK CONDITION status. The sense key shall be set to DATA PROTECT and the additional sense code should be set to PERSISTENT WRITE PROTECT (see 4.2.14.2). A PERSWP bit set to zero specifies the currently mounted volume is not write protected by the persistent write protection. The PERSWP bit shall be set to zero by the device server when the volume is demounted or when a volume is mounted with persistent write protection disabled. The PERSWP bit shall be set to one by the device server when a volume is mounted with persistent write protection enabled. These changes of state shall not cause a unit attention condition. If the application client sets the PERSWP bit to one while no volume is mounted, the device server shall terminate the MODE SELECT command with CHECK CONDITION status. The sense key shall be set to NOT READY and the additional sense code shall be set to MEDIUM NOT PRESENT. If the application client sets the PERSWP bit to one when the logical position is not at BOP 0, the device server shall return CHECK CONDITION status. The sense key shall be set to ILLEGAL REQUEST and the additional sense code shall be set to POSITION PAST BEGINNING OF MEDIUM. If the Device Configuration mode page is savable, the PERSWP bit shall be saved as zero, regardless of the current setting.

A permanent write protection (PRMWP) bit set to one specifies the currently mounted volume is logically write protected (see 4.2.14 and 4.2.14.6). When the PRMWP bit is set to one, all commands requiring eventual writes to the medium shall return CHECK CONDITION status. The sense key shall be set to DATA PROTECT and

the additional sense code should be set to PERMANENT WRITE PROTECT (see 4.2.14.2). A PRMWP bit set to zero specifies the currently mounted volume is not write protected by the permanent write protection. The PRMWP bit shall be set to zero by the device server when the volume is demounted or when a volume is mounted with permanent write protection disabled. The PRMWP bit shall be set to one by the device server when a volume is mounted with permanent write protection enabled. These changes of state shall not cause a unit attention condition. If the application client sets the PRMWP bit to one while no volume is mounted, the device server shall terminate the MODE SELECT command with CHECK CONDITION status. The sense key shall be set to NOT READY and the additional sense code shall be set to MEDIUM NOT PRESENT. If the application client sets the PRMWP bit to one when the logical position is not at BOP 0, the device server shall return CHECK CONDITION status. The sense key shall be set to ILLEGAL REQUEST and the additional sense code shall be set to POSITION PAST BEGINNING OF MEDIUM. If the application client attempts to change the PRMWP bit from one to zero, the device server shall terminate the MODE SELECT command with CHECK CONDITION status. The sense key shall be set to DATA PROTECT and the additional sense code shall be set to PERMANENT WRITE PROTECT. If the Device Configuration mode page is savable, the PRMWP bit shall be saved as zero, regardless of the current setting.

8.3.4 Medium Partition mode page

The Medium Partition mode page (see table 103) is used to specify the group of volume partitions. Fields in the Medium Partition mode page indicating the current state of the partitions for the volume shall be changed by the device server to the current volume state on a not ready to ready transition when the volume state changes from demounted to mounted. The physical placement and order of volume partitions are not specified by this standard.

NOTE 42 - Since defining partitions may require reformatting the volume for some implementations, an implicit write to the medium may occur as a result of a MODE SELECT command that supplies these parameters.

Table 103 — Medium Partition mode page

Bit / Byte	7	6	5	4	3	2	1	0
0	PS	SPF(0)	PAGE CODE (11h)					
1	PAGE LENGTH							
2	MAXIMUM ADDITIONAL PARTITIONS							
3	ADDITIONAL PARTITIONS DEFINED							
4	FDP	SDP	IDP	PSUM		POFM	CLEAR	ADDP
5	MEDIUM FORMAT RECOGNITION							
6	Reserved				PARTITION UNITS			
7	Reserved							
	Partition size descriptor(s)							
8	(MSB)	PARTITION SIZE						
9								(LSB)
n-1	(MSB)	PARTITION SIZE						
n								(LSB)

See SPC-4 for a description of the PS bit, SPF bit, PAGE CODE field, and PAGE LENGTH field.

The MAXIMUM ADDITIONAL PARTITIONS field is a logical unit-defined value indicating the maximum number of additional partitions supported by the logical unit. A value of zero returned by the MODE SENSE command specifies no additional partitions are present or allowed.

The ADDITIONAL PARTITIONS DEFINED field specifies the number of additional partitions to be defined for a volume when the SDP or IDP bit is set to one. The maximum value allowed is the value returned in the MAXIMUM

ADDITIONAL PARTITIONS field. The ADDITIONAL PARTITIONS DEFINED value returned by the MODE SENSE command shall report one less than the number of partitions on the media when the logical unit is ready. If the unit is not ready, the ADDITIONAL PARTITIONS DEFINED field is undefined.

A fixed data partitions (FDP) bit of one specifies the logical unit shall partition the volume based on its fixed definition of partitions. Setting this bit to one when POFM is set to zero may only be valid at beginning-of-partition and is mutually exclusive with the SDP and IDP bits. The partition size descriptors are ignored by the MODE SELECT command when the FDP bit is set to one. The logical unit may assign any number of partitions from 1 to (MAXIMUM ADDITIONAL PARTITIONS + 1).

It is recommended that the partition size descriptors be present in MODE SENSE data regardless of the settings of the FDP, SDP or IDP fields to give an estimate of the size of each partition.

A select data partitions (SDP) bit of one specifies the logical unit shall partition the volume into the number of partitions as specified by the ADDITIONAL PARTITIONS DEFINED field (*n*) using partition sizes defined by the device. The logical unit shall partition the volume into *n*+1 partitions numbered 0 through *n*. Setting this bit to one when POFM is set to zero may only be valid at beginning-of-partition and it is mutually exclusive with the FDP and IDP fields. The partition size descriptors are ignored by the MODE SELECT command when the SDP bit is set to one.

An initiator-defined partitions (IDP) bit of one specifies the logical unit shall partition the volume as defined by the ADDITIONAL PARTITIONS DEFINED field and the partition size descriptors. Setting this bit to one when POFM is set to zero may only be valid at beginning-of-partition and is mutually exclusive with the FDP and SDP fields. The number of non-zero partition size descriptors received in the Medium Partition mode page shall be one more than the ADDITIONAL PARTITIONS DEFINED value. The size of partition 0 shall be non-zero.

A logical unit is not required to retain the method used to partition the volume. The device server shall set only one of the IDP, FDP or SDP fields in the MODE SENSE data. If a volume was previously partitioned through a MODE SELECT command with FDP or SDP set to one, a device server may set IDP to one in subsequent MODE SENSE data since the volume has been initiator partitioned. However, in a MODE SELECT command, the application client cannot use IDP set to one in place of FDP or SDP set to one.

NOTE 43 - Since defining partitions may require reformatting the volume for some implementations, an implicit write to the medium may occur as a result of a MODE SELECT command that has any of the fields FDP, SDP, or IDP set to one and has a value of zero in the POFM field."

The partition size unit of measure (PSUM) field defines the units of the partition size descriptors. A logical unit is not required to retain the partition size unit of measure used to partition the volume. The PSUM field is defined in table 104.

Table 104 — PSUM field

Code	Description	Support
00b	bytes (unit of one)	O
01b	kilobytes (10^3 bytes)	O
10b	megabytes (10^6 bytes)	O
11b	$10^{(\text{PARTITION UNITS})}$ bytes	O

The PARTITION UNITS field defines the size of the partition size descriptors when the PSUM field is set to 11b. A value of *n* in the PARTITION UNITS field shall define the units of the partition size descriptors as 10^n bytes. If the PARTITION UNITS field is supported, all possible values shall be supported. A logical unit is not required to retain the partition units used to partition the volume. If PSUM is not equal to 11b, the PARTITION UNITS field is undefined. Some values of the PARTITION UNITS field may result in no legal non-zero partition size descriptors.

A partition on format (POFM) bit of one specifies the MODE SELECT command shall not cause changes to the partition sizes or user data, either recorded or buffered. If POFM is set to one, actual media partitioning occurs when the device server receives a subsequent FORMAT MEDIUM command (see 7.1). When the FORMAT MEDIUM command partitions the media, it shall do so based on the contents of the mode data for the Medium

Partition mode page. If POFM is set to one, field values specified by a MODE SELECT command for the Medium Partition mode page shall not be changed by the device server before the media is unloaded or until a logical unit reset. Some field checking may be performed by the MODE SELECT command. However, there is no guarantee that any subsequent partitioning during a FORMAT MEDIUM command will complete with no errors.

A POFM bit of zero specifies the MODE SELECT command shall alter the partition information for the volume if any of the SDP, FDP, or IDP bits are set to one.

A CLEAR bit of zero and an ADDP bit of zero specifies the logical unit may logically erase any or all partitions when one of the IDP, FDP, or SDP fields are set to one by a MODE SELECT command.

A CLEAR bit of one and an ADDP bit of zero specifies the logical unit shall logically erase every partition if one of the IDP, FDP, or SDP fields is set to one. No formatting of the volume is implied.

An additional partitions (ADDP) bit of one and a CLEAR bit of zero specifies the logical unit shall not logically erase any existing partitions, even if the size of the partition is changed. If the MODE SELECT command partition size descriptor and the current partition size differ, the logical unit shall truncate or extend the partition, whichever is appropriate. If the MODE SELECT command partition size is zero and the current partition size is non-zero, the partition shall be logically removed from the volume, resulting in the loss of all data in that partition. If the MODE SELECT command partition size is equivalent to the current partition size, no change in the partition size shall result. If the logical unit is unable to perform the operation or if such an operation would cause loss of valid data in any partition that exists both before and after the MODE SELECT or FORMAT MEDIUM command, the device server shall return CHECK CONDITION status. The sense key shall be set to ILLEGAL REQUEST with the addition sense code set to PARAMETER VALUE INVALID. If the ADDP bit is set to one and either ADDP is not supported or the FDP field is set to one the device server shall return 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. If both the ADDP and SDP fields are set to one, the logical unit shall add or remove partitions such that the resulting partition count on the volume is equal to the ADDITIONAL PARTITIONS DEFINED value plus one.

If both the ADDP and CLEAR fields are set to one, the logical unit shall logically erase all partitions that differ in size from the corresponding partition size descriptor in the MODE SELECT data. Partitions with the same size as the MODE SELECT data size shall retain all existing data. If the logical unit is incapable of supporting the changes requested without loss of data, the device server shall return CHECK CONDITION status. The sense key shall be set to ILLEGAL REQUEST and the additional sense code shall be set to PARAMETER VALUE INVALID. If setting both ADDP and CLEAR to one is not supported, the sense key shall be set to ILLEGAL REQUEST and the additional sense code shall be set to INVALID FIELD IN PARAMETER LIST.

A MODE SELECT command partition size descriptor has the equivalent (same) size as the current partition size if:

a) the mode select PARTITION SIZE, PSUM, and PARTITION UNITS fields are exactly the same as those returned by MODE SENSE command;
b) the mode select PARTITION SIZE field value is within plus or minus one of the current size when the current size is converted to the units of the mode select PSUM or PARTITION UNITS field; or
c) the mode select PARTITION SIZE is FFFFh and the current size would return FFFFh if expressed in the units of the mode select PSUM or PARTITION UNITS field.

The MEDIUM FORMAT RECOGNITION field specifies the logical unit's capability to automatically identify the volume format and volume partition information when reading a volume. The value in this field may be different following a volume change. The MEDIUM FORMAT RECOGNITION field values are shown in table 105.

Table 105 — MEDIUM FORMAT RECOGNITION field

Code	Description
00h	Logical unit is incapable of format or partition recognition.
01h	Logical unit is capable of format recognition.
02h	Logical unit is capable of partition recognition.

Table 105 — MEDIUM FORMAT RECOGNITION field

Code	Description
03h	Logical unit is capable of format and partition recognition.
04h - FFh	Reserved

If a logical unit specifies it is not capable of volume format recognition, the application client should supply all necessary parameters for the device to identify the specific format.

PARTITION SIZE fields within the partition size descriptor list define the approximate size of the respective partitions in the units specified in the PSUM and PARTITION UNITS fields. Partitions are numbered by their relative position in the partition size descriptor list, starting at 0. Only partition numbers in the range of 0 to *n* where *n* is less than or equal to 63 may have size descriptors in this mode page. Partition *n*, if present, shall be described by the partition size descriptor at mode page offsets 8+(2*n*) and 9+(2*n*). Partition 0 shall be the default partition. Partition size descriptor 0, shall contain the size of the default partition. The size of partition 0 shall be greater than 0. Up to 64 partitions may be defined using this mode page. Partitions not assigned shall have a partition size descriptor of 0. The logical unit may support more partitions than partition size descriptors. A logical unit may support more partition size descriptors than supported by the volume. All partition size descriptors representing a partition number greater than the maximum additional partition count shall be 0. The partition size descriptors are undefined if the logical unit is not ready. A MODE SELECT command partition size descriptor of FFFFh requests that the logical unit allocate all remaining partition space to that partition. A MODE SENSE command shall return a partition size descriptor of FFFFh if the partition size, in units of PSUM or PARTITION UNITS, is greater than or equal to FFFFh. If insufficient space exists on the volume for the requested partition sizes or if multiple partition size descriptors are set to FFFFh, the device server shall return 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. A device server may round, as described by the MODE SELECT command in SPC-4, any partition size to the nearest valid partition size.

It is recommended, but not required, that the number of partition size descriptors available through the Medium Partition mode page equal at least the number of maximum additional partitions + 1. This provides a mechanism for the device server to disclose the current partition sizes.

8.3.5 Read-Write Error Recovery mode page

The Read-Write Error Recovery mode page (see table 106) specifies the error recovery and reporting parameters that the device server shall use when transferring data between the device and the medium. These parameters do not affect protocol-level recovery procedures or positioning error recovery procedures.

Table 106 — Read-Write Error Recovery mode page

Bit / Byte	7	6	5	4	3	2	1	0
0	PS	SPF(0)	PAGE CODE (01h)					
1	PAGE LENGTH (0Ah)							
2	Reserved		TB	Rsvd	EER	PER	DTE	DCR
3	READ RETRY COUNT							
4	Reserved							
5	Reserved							
6	Reserved							
7	Reserved							
8	WRITE RETRY COUNT							
9	Reserved							
10	Reserved							
11	Reserved							

NOTE 44 - The parameters in the Read-Write Error Recovery mode page also apply to verify operations.

See SPC-4 for a description of the PS bit, SPF bit, PAGE CODE field, and PAGE LENGTH field.

A transfer block (TB) bit of one specifies the device server shall use its best effort to transfer a logical block that cannot be read successfully within the specified read recovery limits to the application client before CHECK CONDITION status is returned. A TB bit of zero specifies an unrecoverable logical block shall not be transferred to the application client. Logical blocks that are recoverable within the recovery limits are always transferred, regardless of the value of the TB bit.

An enable early recovery (EER) bit of one specifies the logical unit shall use the most expedient error recovery algorithm (e.g., attempt error correction prior to retries). An EER bit of zero specifies the logical unit shall use the most deliberate error recovery algorithm, within the limits established by the other error recovery parameters (e.g., attempt to recover the logical block error-free prior to using error correction).

A post error (PER) bit of one specifies the device server shall return CHECK CONDITION status to report recovered errors. A PER bit of zero specifies the device server shall not report errors recovered within the limits established by the error recovery parameters. If this bit is zero, the DTE bit shall also be set to zero.

A disable transfer on error (DTE) bit of one specifies the device server shall terminate the data transfer after a recovered read or write error occurs. All data from the recovered logical block shall be transferred prior to terminating the read or write operation. A DTE bit of zero specifies the device server shall not terminate the transfer for errors recovered within the limits established by the read-write error recovery parameters.

A disable correction (DCR) bit of one specifies the logical unit shall not use error correction codes during error recovery. A DCR bit of zero allows the use of error correction codes for error recovery.

The READ RETRY COUNT field specifies the number of times that the logical unit should attempt its recovery algorithm during a read operation before an unrecoverable error is reported. A READ RETRY COUNT of zero specifies the logical unit shall not use its recovery algorithm during read operations.

The WRITE RETRY COUNT field specifies the number of times that the logical unit should attempt its recovery algorithm during a write operation before an unrecoverable error is reported. A WRITE RETRY COUNT of zero specifies the logical unit shall not use its recovery algorithm during write operations.

8.3.6 Informational Exceptions Control mode page

In addition to support for all device types (see SPC-4), the Informational Exceptions Control mode page (see table 107) specifies the parameters for the control of TapeAlert specific informational exception conditions for a sequential-access device.

Table 107 — Informational Exceptions Control mode page

Bit Byte	7	6	5	4	3	2	1	0
0	PS	SPF (0)	PAGE CODE (1Ch)					
1	PAGE LENGTH (0Ah)							
2	PERF	Rsvd	EBF	EWASC	DEXCPT	TEST	Rsvd	LOGERR
3	Reserved				MRIE			
4	(MSB)	INTERVAL TIMER						
5								
6								
7								(LSB)
8	(MSB)	REPORT COUNT/TEST FLAG NUMBER						
9								
10								
11								(LSB)

See SPC-4 for a description of the PS bit, SPF bit, PAGE CODE field, PAGE LENGTH field, PERF bit, EBF bit, EWASC bit, LOGERR bit, and INTERVAL TIMER field.

SPC-4 defines the effect of setting the TEST bit to one if the REPORT COUNT/TEST FLAG NUMBER field is set to zero. In response to a MODE SENSE command reporting parameters from the Informational Exceptions Control mode page, the device server shall set the value of the TEST bit to zero. The device server shall not alter the value of any TapeAlert flags in response to an application client setting the TEST bit to one and the REPORT COUNT/TEST FLAG NUMBER field to zero.

Table 108 defines the effect of setting the TEST bit to one if the REPORT COUNT/TEST FLAG NUMBER field is set to a non-zero value. In response to a MODE SENSE command reporting parameters from the Informational Exceptions Control mode page, the device server shall set the value of the TEST bit to zero. If both the TEST bit and the DEXCEPT bit are set to one, the device server shall terminate the MODE SELECT command with CHECK CONDITION status, set the sense key set to ILLEGAL REQUEST, and set the additional sense code set to INVALID FIELD IN PARAMETER LIST.

Table 108 — TEST bit and TEST FLAG NUMBER field

TEST FLAG NUMBER	Description
1 to 64	Activate the TapeAlert flag specified by the TEST FLAG NUMBER field. Report the informational exception condition for the TapeAlert flag with an additional sense code of FAILURE PREDICTION THRESHOLD EXCEEDED (FALSE) and based on the DEXCPT, MRIE, INTERVAL TIMER, and REPORT COUNT values.
-1 to -64	Deactivate the TapeAlert flag specified by the absolute value of the TEST FLAG NUMBER field. Deactivating the flag in this way is equivalent to performing the specified corrective action for that flag.

Table 108 — TEST bit and TEST FLAG NUMBER field

TEST FLAG NUMBER	Description
32767	Activate all supported TapeAlert flags. Report the informational exception condition for the TapeAlert flag with an additional sense code of FAILURE PREDICTION THRESHOLD EXCEEDED (FALSE) based on the DEXCPT, MRIE, INTERVAL TIMER, and REPORT COUNT values.
all others	Return CHECK CONDITION status. Set the sense key to ILLEGAL REQUEST and the additional sense code to INVALID FIELD IN PARAMETER LIST.

SPC-4 specifies the effect of setting the TEST bit to zero.

See SPC-4 for a description of the DEXCPT bit. A device server shall not report non-TapeAlert informational exceptions with an additional sense code of FAILURE PREDICTION THRESHOLD EXCEEDED if the DEXCPT bit is set to zero and the TASER bit in the Device Configuration Extension mode page is set to zero (see 8.3.8).

See SPC-4 for a description of the MRIE field. For MRIE modes 02h to 06h, an additional sense code of FAILURE PREDICTION THRESHOLD EXCEEDED specifies a TapeAlert event has occurred on the device. Detailed information about the event is stored in the TapeAlert log page. If multiple TapeAlert flags are active simultaneously, the device server shall report a single informational exception condition.

NOTE 45 - The value of the MRIE field does not affect parameters in the TapeAlert log page or the TapeAlert Response log page.

The REPORT COUNT/TEST FLAG NUMBER field has a dual purpose:

a) SPC-4 specifies the operation of the REPORT COUNT/TEST FLAG NUMBER field if the TEST bit is set to zero. When reporting an informational exception condition associated with TapeAlert flags, upon activation of a TapeAlert flag the device server shall report to the application client the informational exception condition the number of times indicated by the value of the REPORT COUNT/TEST FLAG NUMBER field; and
b) if the TEST bit is set to one, the value of the REPORT COUNT/TEST FLAG NUMBER field represents the TEST FLAG NUMBER. In response to a MODE SENSE command reporting parameters from the Informational Exceptions Control mode page, the device server shall set the value of the REPORT COUNT/TEST FLAG NUMBER field to zero. Table 108 specifies valid values for the TEST FLAG NUMBER field. Negative numbers shall be represented using the 2's complement notation and shall be sign extended to 4 bytes.

8.3.7 Medium Configuration mode page

The Medium Configuration mode page (see table 109) specifies any special considerations the device server shall use when processing commands that access the medium.

Table 109 — Medium Configuration mode page

Bit / Byte	7	6	5	4	3	2	1	0
0	PS	SPF(0)	PAGE CODE (1Dh)					
1	PAGE LENGTH (1Eh)							
2	Reserved							WORMM
3	Reserved							
4	WORM MODE LABEL RESTRICTIONS							
5	WORM MODE FILEMARK RESTRICTIONS							
6	Reserved							
31								

See SPC-4 for a description of the PS bit, SPF bit, PAGE CODE field, and PAGE LENGTH field.

The WORM mode (WORMM) bit shall be set to one when the device server is operating in WORM mode (see 4.2.21.3). The WORMM bit shall be set to zero when the device server is not operating in WORM mode. If a MODE SELECT command is processed that attempts to change to setting of the WORMM bit, the device server shall return 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.

The WORM MODE LABEL RESTRICTIONS field specifies the restrictions against overwriting format labels when operating in WORM mode (see table 110). A series of filemarks with no interleaved logical blocks immediately preceding EOD is treated as a filemark sequence and is controlled by the WORM MODE FILEMARKS RESTRICTIONS field.

Table 110 — WORM MODE LABEL RESTRICTIONS field

Code	Description
00h	The device server shall not allow any logical blocks to be overwritten.
01h	The device server shall not allow some types of format labels to be overwritten.
02h	The device server shall allow all format labels to be overwritten.
03h - FFh	Reserved

The WORM MODE FILEMARKS RESTRICTIONS field specifies the restrictions against overwriting a series of filemarks immediately preceding EOD when operating in WORM mode (see table 111). The WORM MODE FILEMARKS RESTRICTIONS field controls only the overwriting of a series of filemarks with no interleaved logical blocks immediately preceding EOD.

Table 111 — WORM MODE FILEMARKS RESTRICTIONS field

Code	Description
00h - 01h	Reserved
02h	The device server shall allow any number of filemarks immediately preceding EOD to be overwritten except the filemark closest to BOP.
03h	The device server shall allow any number of filemarks immediately preceding EOD to be overwritten.
04h - FFh	Reserved

8.3.8 Device Configuration Extension mode page

The Device Configuration Extension mode page (see table 112), a subpage of the Device Configuration mode page (see 8.3.3), provides control of the SCSI features specific to sequential-access devices. If a device server supports the Device Configuration Extension mode page, the device server shall provide access to the mode page using the shared mode page policy (see SPC-4).

Table 112 — Device Configuration Extension mode page

Bit / Byte	7	6	5	4	3	2	1	0
0	PS	SPF(1b)	PAGE CODE (10h)					
1	SUBPAGE CODE (01h)							
2	(MSB)	PAGE LENGTH (1Ch)						
3								(LSB)
4	Reserved				TARPF	TASER	TARPC	TAPLSD
5	Reserved				SHORT ERASE MODE			

Table 112 — Device Configuration Extension mode page

Bit / Byte	7	6	5	4	3	2	1	0
6	(MSB)							
7				PEWS				(LSB)
8	Reserved							VCELBRE
9								
31				Reserved				

See SPC-4 for a description of the PS bit, SPF bit, PAGE CODE field, and PAGE LENGTH field.

A TapeAlert prevent LOG SENSE deactivation (TAPLSD) bit set to one specifies that the device server shall not alter the value of implemented TapeAlert FLAG parameters (see 8.2.3) due to processing of a LOG SENSE command with the PAGE CODE field set to 2Eh. A TAPLSD bit set to zero specifies that, as part of the processing of a LOG SENSE command with the PAGE CODE field set to 2Eh, the device server shall deactivate every supported TapeAlert flag.

A TapeAlert respect page control (TARPC) bit set to one specifies that the device server shall select the type of parameter values for the TapeAlert log page (see 8.2.3) using the value of the PC field in a LOG SELECT or LOG SENSE command (see SPC-4). A TARPC bit set to zero specifies that the device server shall select cumulative parameter values for the TapeAlert log page regardless of the value of the PC field in a LOG SELECT or LOG SENSE command.

An application client using the TapeAlert threshold usage model (see 4.2.18.2.4) should set the TARPC bit to one.

A TapeAlert Select exception reporting (TASER) bit set to one specifies that:

a) activation of a TapeAlert flag shall not result in an informational exception condition (see 8.3.6); and
b) activation or deactivation of a TapeAlert flag may result in the generation of a unit attention condition with the additional sense code set to THRESHOLD CONDITION MET depending on the value of the ETC bit in each parameter in the TapeAlert log page.

A TASER bit set to zero specifies that:

a) activation of a TapeAlert flag shall result in an informational exception condition (see 8.3.6);
b) activation or deactivation of a TapeAlert flag shall not result in the generation of a unit attention condition with the additional sense code set to THRESHOLD CONDITION MET; and
c) the device server shall set the ETC bit in each parameter of the TapeAlert log page to zero.

The device server may provide independent sets of TapeAlert log parameters for each I_T nexus (see SPC-4). If the device server does not support independent sets of TapeAlert log parameters and the processing of a MODE SELECT command with the TASER bit set to zero results in a change in the value of the ETC bit in a TapeAlert log parameter, then the device server shall establish a unit attention condition (see SAM-4) for the initiator port associated with every I_T nexus, except the I_T nexus on which the MODE SELECT command was received, with the additional sense code set to LOG PARAMETERS CHANGED.

A TapeAlert respect parameter fields (TARPF) bit set to one specifies that the device server shall select the parameters of the TapeAlert log page (see 8.2.3) to report in response to a LOG SENSE command using the values of the PPC bit and the PARAMETER POINTER field (see SPC-4). A TARPF bit set to zero specifies that the device server shall report all TapeAlert log page parameters regardless of the values of the PPC bit and the PARAMETER POINTER field.

The SHORT ERASE MODE field specifies the action to be taken by the device server when an ERASE (16) or ERASE (6) command with the LONG bit set to zero is processed. The values for the SHORT ERASE MODE field are specified in table 113. A device server shall support at least one of the specified values.

Table 113 — SHORT ERASE MODE field

Value	Description
00h	The erase operation shall be performed as specified in SSC-2.
01h	The erase operation shall have no effect on the medium.
02h	The device server shall record an EOD indication at the specified location on the medium.
03h - FFh	Reserved

The programmable early warning size (PEWS) field specifies the number of megabytes native capacity to use in establishing a PEWZ (see 3.1.56). See 4.2.6 for a description of programmable early warning.

If the volume containing encrypted logical blocks requires encryption (VCELBRE) bit is set to one and the VCELB bit in the Data Encryption Status page is set to one, then the device server shall require that any logical blocks written to the medium are encrypted (see 4.2.22). If the VCELBRE bit is set to zero, then the device server does not use the VCELB bit in the Data Encryption Status page to determine if encryption is required for writing logical blocks.

8.4 Vital product data (VPD) parameters

8.4.1 VPD parameters overview and page codes

This subclause defines the VPD pages used with sequential-access device types. See SPC-4 for VPD pages used with all device types. The VPD page codes specific to sequential-access devices are specified in table 114.

Table 114 — Sequential-access device VPD page codes

Page code	VPD page name	Reference	Support requirements
B0h	Sequential-access Device Capabilities VPD page	8.4.2	Optional
B1h	Manufacturer-assigned Serial Number VPD page	8.4.3	Optional
B2h	TapeAlert Supported Flags VPD page	8.4.4	Optional
B3h	Automation Device Serial Number VPD page	8.4.5	Optional
B4h – BFh	Reserved for this device type		

8.4.2 Sequential-access Device Capabilities VPD page

Table 115 specifies the Sequential-access Device Capabilities VPD page. This page provides the application client with the means to determine if the features specified in this page are supported by the device server.

Table 115 — Sequential-access Device Capabilities VPD page

Bit / Byte	7	6	5	4	3	2	1	0
0	PERIPHERAL QUALIFIER			PERIPHERAL DEVICE TYPE				
1	PAGE CODE (B0h)							
2	(MSB)			PAGE LENGTH (n-3)				
3								(LSB)
4	Reserved							WORM
n	Reserved							

The PERIPHERAL QUALIFIER field and the PERIPHERAL DEVICE TYPE field are defined in SPC-4.

The PAGE LENGTH field specifies the length of the following VPD page data. If the allocation length value in the INQUIRY command descriptor block is too small to transfer all of the VPD page data, the page length shall not be adjusted to reflect the truncation.

If the write once read many (WORM) bit is set to one, the device server supports WORM mode operation (see 4.2.21.3). If the WORM bit is set to zero, the device server does not support WORM mode operation.

8.4.3 Manufacturer-assigned Serial Number VPD page

Table 116 specifies the Manufacturer-assigned Serial Number VPD page.

Table 116 — Manufacturer-assigned Serial Number VPD page

Bit / Byte	7	6	5	4	3	2	1	0
0	PERIPHERAL QUALIFIER			PERIPHERAL DEVICE TYPE				
1	PAGE CODE (B1h)							
2	(MSB)			PAGE LENGTH (n-3)				
3								(LSB)
4	(MSB)			MANUFACTURER-ASSIGNED SERIAL NUMBER				
n								(LSB)

See SPC-4 for a description of the PERIPHERAL QUALIFIER field, PERIPHERAL DEVICE TYPE field, and PAGE LENGTH field. The PAGE CODE field shall be set to the value specified in table 116.

The MANUFACTURER-ASSIGNED SERIAL NUMBER field contains right-aligned ASCII data (see SPC-4) that is the manufacturer-assigned serial number. If the manufacturer-assigned serial number is not available, the device server shall return ASCII spaces (20h) in this field. If the manufacturer-assigned serial number differs from the value in the PRODUCT SERIAL NUMBER field (see SPC-4) the value in the PRODUCT SERIAL NUMBER field shall be used in building the T10 vendor ID descriptor (see SPC-4).

8.4.4 TapeAlert Supported Flags VPD page

Table 117 specifies the TapeAlert Supported Flags VPD page. The TapeAlert Supported Flags VPD page provides the application client with the means to determine the TapeAlert flags supported by the device server.

Table 117 — TapeAlert Supported Flags VPD page

Bit / Byte	7	6	5	4	3	2	1	0
0	PERIPHERAL QUALIFIER			PERIPHERAL DEVICE TYPE				
1	PAGE CODE (B2h)							
2	(MSB)	PAGE LENGTH (08h)						
3								(LSB)
4	FLAG01h	FLAG02h	FLAG03h	FLAG04h	FLAG05h	FLAG06h	FLAG07h	FLAG08h
5	FLAG09h	FLAG0Ah	FLAG0Bh	FLAG0Ch	FLAG0Dh	FLAG0Eh	FLAG0Fh	FLAG10h
6	FLAG11h	FLAG12h	FLAG13h	FLAG14h	FLAG15h	FLAG16h	FLAG17h	FLAG18h
7	FLAG19h	FLAG1Ah	FLAG1Bh	FLAG1Ch	FLAG1Dh	FLAG1Eh	FLAG1Fh	FLAG20h
8	FLAG21h	FLAG22h	FLAG23h	FLAG24h	FLAG25h	FLAG26h	FLAG27h	FLAG28h
9	FLAG29h	FLAG2Ah	FLAG2Bh	FLAG2Ch	FLAG2Dh	FLAG2Eh	FLAG2Fh	FLAG30h
10	FLAG31h	FLAG32h	FLAG33h	FLAG34h	FLAG35h	FLAG36h	FLAG37h	FLAG38h
11	FLAG39h	FLAG3Ah	FLAG3Bh	FLAG3Ch	FLAG3Dh	FLAG3Eh	FLAG3Fh	FLAG40h

The PERIPHERAL QUALIFIER field and the PERIPHERAL DEVICE TYPE field are defined in SPC-4.

The PAGE LENGTH field specifies the length of the following VPD page data. If the allocation length value in the INQUIRY command descriptor block is too small to transfer all of the VPD page data, the page length shall not be adjusted to reflect the truncation.

Each FLAGXX bit indicates whether the device server supports the corresponding TapeAlert flag or not. A supported TapeAlert flag has the corresponding FLAGXX bit set to one. A TapeAlert flag that the device server does not support has the corresponding FLAGXX bit set to zero.

8.4.5 Automation Device Serial Number VPD page

Table 118 specifies the Automation Device Serial Number VPD page.

Table 118 — Automation Device Serial Number VPD page

Bit / Byte	7	6	5	4	3	2	1	0
0	PERIPHERAL QUALIFIER			PERIPHERAL DEVICE TYPE				
1	PAGE CODE (B3h)							
2	Reserved							
3	PAGE LENGTH (n-3)							
4	(MSB)	AUTOMATION DEVICE SERIAL NUMBER						
n								(LSB)

See SPC-4 for a description of the PERIPHERAL QUALIFIER field, PERIPHERAL DEVICE TYPE field, and PAGE LENGTH field. The PAGE CODE field shall be set to the value specified in table 118.

The AUTOMATION DEVICE SERIAL NUMBER field contains the automation device serial number contained in the device entity. If configured, the automation device serial number shall be the product serial number (see

SPC-4) of the media changer containing the device entity under control of the device server (see 4.2.4). If no automation device serial number has been configured, then the device server shall return ASCII spaces (20h) in this field.

8.5 Security protocol parameters

8.5.1 Security protocol overview

This subclause describes the protocols, pages, and descriptors used by sequential-access devices with the SECURITY PROTOCOL IN and SECURITY PROTOCOL OUT commands (see SPC-4).

8.5.2 SECURITY PROTOCOL IN command specifying Tape Data Encryption security protocol

8.5.2.1 SECURITY PROTOCOL IN command specifying Tape Data Encryption security protocol overview

The SECURITY PROTOCOL IN command (see SPC-4) specifying Tape Data Encryption security protocol (i.e., 20h) requests the device server to return information about the data security methods in the device entity and on the medium. The command supports a series of pages that are requested individually. An application client requests a page by using a SECURITY PROTOCOL IN command with the SECURITY PROTOCOL field set to 20h (i.e., Tape Data Encryption) (see SPC-4) and the SECURITY PROTOCOL SPECIFIC field set to the page code requested.

A device server that supports the Tape Data Encryption protocol in the SECURITY PROTOCOL OUT command shall also support a SECURITY PROTOCOL IN command specifying the Tape Data Encryption protocol.

The SECURITY PROTOCOL SPECIFIC field (see table 119) specifies the type of report that the application client is requesting.

Table 119 — SECURITY PROTOCOL SPECIFIC field

Code	Description	Support	Reference
0000h	Tape Data Encryption In Support page	M	8.5.2.2
0001h	Tape Data Encryption Out Support page	M	8.5.2.3
0002h-000Fh	Reserved		
0010h	Data Encryption Capabilities page	E	8.5.2.4
0011h	Supported Key Formats page	E	8.5.2.5
0012h	Data Encryption Management Capabilities page	E	8.5.2.6
0013h-001Fh	Reserved		
0020h	Data Encryption Status page	E	8.5.2.7
0021h	Next Block Encryption Status page	E	8.5.2.8
0022h-002Fh	Reserved		
0030h	Random Number page	O	8.5.2.9
0031h	Device Server Key Wrapping Public Key page	O	8.5.2.10
0032h-FEFFh	Reserved		
FF00h-FFFFh	Vendor specific		

Support key:
M - mandatory for a device server that supports the Tape Data Encryption protocol
E - mandatory for a device server that supports the Set Data Encryption page (see 8.5.3.2)
O - optional for a device server that supports the Tape Data Encryption protocol

The ALLOCATION LENGTH field specifies the maximum number of bytes that the device server may return (see SPC-4).

8.5.2.2 Tape Data Encryption In Support page

Table 120 specifies the format of the Tape Data Encryption In Support page.

Table 120 — Tape Data Encryption In Support page

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			PAGE CODE (0000h)				
1								(LSB)
2	(MSB)			PAGE LENGTH (n-3)				
3								(LSB)
	Tape Data Encryption In Support page code list							
4	(MSB)			Tape Data Encryption In Support page code (first)				
5								(LSB)
n-1	(MSB)			Tape Data Encryption In Support page code (last)				
n								(LSB)

The Tape Data Encryption In Support page code list shall contain a list of all of the pages that the device server supports for the SECURITY PROTOCOL IN command specifying the Tape Data Encryption security protocol in ascending order beginning with page code 0000h.

8.5.2.3 Tape Data Encryption Out Support page

Table 121 specifies the format of the Tape Data Encryption Out Support page.

Table 121 — Tape Data Encryption Out Support page

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			PAGE CODE (0001h)				
1								(LSB)
2	(MSB)			PAGE LENGTH (n-3)				
3								(LSB)
	Tape Data Encryption Out Support page code list							
4	(MSB)			Tape Data Encryption Out Support page code (first)				
5								(LSB)
n-1	(MSB)			Tape Data Encryption Out Support page code (last)				
n								(LSB)

The Tape Data Encryption Out Support page code list shall contain a list of all of the pages that the device server supports for the SECURITY PROTOCOL OUT command specifying the Tape Data Encryption security protocol in ascending order.

8.5.2.4 Data Encryption Capabilities page

Table 122 specifies the format of the Data Encryption Capabilities page. The Data Encryption Capabilities page reports information on the set of logical block encryption algorithms supported by this device server. If external data encryption control is supported, then the set of logical block encryption algorithms reported by the device server may not include all of the algorithms in the set of logical block encryption algorithms supported by the device entity.

Table 122 — Data Encryption Capabilities page

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)							
1				PAGE CODE (0010h)				(LSB)
2	(MSB)							
3				PAGE LENGTH (n-3)				(LSB)
4	Reserved					EXTDECC		CFG_P
5								
19				Reserved				
	Logical block encryption algorithm descriptor list							
20								
43				Logical block encryption algorithm descriptor (first) (see table 125)				
n-23								
n				Logical block encryption algorithm descriptor (last) (see table 125)				

See SPC-4 for a description of the PAGE CODE field and the PAGE LENGTH field. The PAGE CODE field shall be set to the value specified in table 122.

The external data encryption control capable (EXTDECC) field specifies the external data encryption control capability of the device entity. The EXTDECC field values are specified in table 123.

Table 123 — EXTDECC field

Code	Description
00b	The external data encryption control capability is not reported.
01b	The device entity is not external data encryption control capable.
10b	The device entity is external data encryption control capable.
11b	Reserved