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Information technology – Small computer system interface (SCSI) – Part 323: SCSI Block Commands – 3 (SBC-3)



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INFORMATION TECHNOLOGY – SMALL COMPUTER SYSTEM INTERFACE (SCSI) -

Part 323: SCSI Block Commands – 3 (SBC-3)

FOREWORD

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The 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, except as described in 3.5 and 3.6.

IMPORTANT - The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

General

The purpose of this standard is to define the model and command set extensions to be used in conjunction with the SCSI Primary Command Set standard - 4 (SPC-4) to facilitate operation of SCSI direct-access block devices (e.g., hard disk drives).

SCSI standards family

Figure 0 shows the relationship of this standard to the other standards and related projects in the SCSI family of standards as of the publication of this standard.

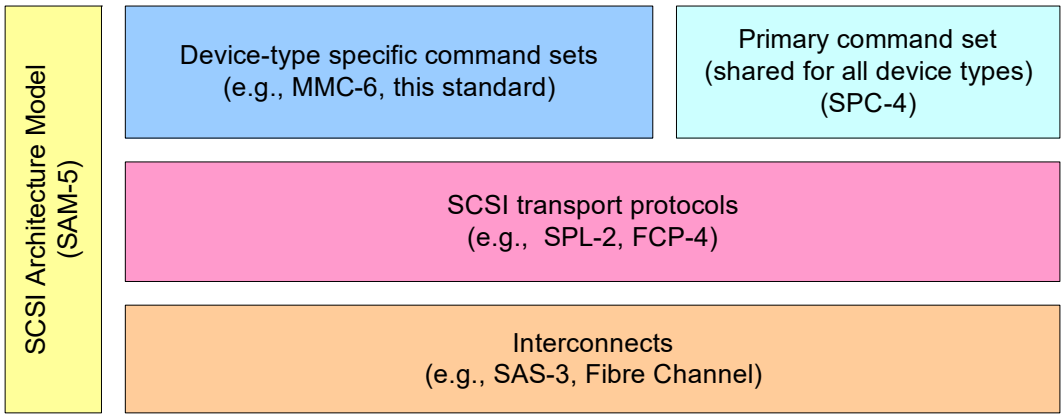


Figure 0 – SCSI document relationships

Figure 0 gives the general relationship of the documents to one another and is not intended to imply a relationship such as a hierarchy, protocol stack, or system architecture.

The set of SCSI standards specifies the interfaces, functions, and operations necessary to ensure interoperability between conforming SCSI implementations. This standard is a functional description. Conforming implementations may employ any design technique that does not violate interoperability. See SAM-5 for more information about the relationships between the SCSI standards.

This standard makes obsolete the following concepts from SBC-2:

a) linked commands;
b) the partial medium indicator (PMI) bit and the LOGICAL BLOCK ADDRESS field in the READ CAPACITY (10) command and the READ CAPACITY (16) command;
c) the READ (6) command and the WRITE (6) command;
d) the XDREAD (10) command, the XDREAD (32) command, the XDWRITE (10) command, and the XDWRITE (32) command;
e) the SYNC_NV bit in the SYNCHRONIZE CACHE commands;
f) the FUA_NV bit in read commands;
g) the FUA_NV bit in write commands;
h) the LBDATA bit and the PBDATA bit in the WRITE SAME commands;
i) the initialization pattern modifier (IP MODIFIER) field in the initialization pattern descriptor in the FORMAT UNIT command; and
j) the XOR Control mode page.

INFORMATION TECHNOLOGY – SMALL COMPUTER SYSTEM INTERFACE (SCSI) –

Part 323: SCSI Block Commands - 3 (SBC-3)

1 Scope

This part of ISO/IEC 14776 defines the command set extensions to facilitate operation of SCSI direct access block devices. The clauses in this standard, implemented in conjunction with the applicable clauses of SPC-4, specify the standard command set for SCSI direct access block devices.

The objectives of this standard are to:

a) permit an application client to communicate over a SCSI service delivery subsystem (see SAM-5) with a logical unit that declares itself to be a direct access block device in the PERIPHERAL DEVICE TYPE field of the standard INQUIRY data (see SPC-4); and
b) define commands and parameters unique to the direct access block device type.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC 14776-262, *Information Technology - Small Computer System Interface (SCSI) - Part 262: SAS Protocol Layer - 2 (SPL-2)*

ISO/IEC 14776-342, *Information Technology - Small Computer System Interface (SCSI) - Part 342: Controller Commands - 2 (SCC-2)*

INCITS 513-2015, *Information Technology - SCSI Primary Commands - 4 (SPC-4)*

INCITS 515-2016, *Information Technology - SCSI Architecture Model - 5 (SAM-5)*

INCITS 517-2015, *Information Technology - SCSI / ATA Translation - 3 (SAT-3)*

INCITS 448-2008, *Information Technology - SCSI Enclosure Services - 2 (SES-2)*

3 Terms, definitions, symbols, abbreviations, keywords, and conventions

3.1 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1.1
additional sense code
combination of the ADDITIONAL SENSE CODE field and the ADDITIONAL SENSE CODE QUALIFIER field in sense data

Note 1 to entry: See SPC-4.

3.1.2
AND
Boolean arithmetic function (see 3.1.10) on two binary input values that results in an output value of one if both of the input values are one or zero if either of the input values is zero

3.1.3
AND operation
performance of an AND (see 3.1.2) bitwise on two multiple-bit input values both having the same number of bits

Note 1 to entry: An example of multiple-bit inputs is the current content of a logical block and the content contained in the Data-Out Buffer having the same number of bytes.

3.1.4
anchored
logical block provisioning state of an LBA (see 4.7.1) in which physical capacity has been reserved for the referenced logical block (see 4.7.4.8)

3.1.5
application client
object that is the source of SCSI commands

Note 1 to entry: See SAM-5.

3.1.6
automatic read reassignment
sequence after the device server detects a recovered read error during which the device server, without intervention from an application client, performs a reassign operation on the LBA for which the error was detected

3.1.7
automatic write reassignment
sequence after the device server detects a recovered error or an unrecovered error during which the device server, without intervention from an application client, performs a reassign operation on the LBA for which the error was detected

3.1.8
background function
either a background scan operation (see 4.24) or a device specific background function (see 3.1.23)

3.1.9
bitmap buffer
temporary buffer within a device server (e.g., for one or more bytes of the result of an AND operation (see 3.1.3) or an OR operation (see 3.1.51))

3.1.10
Boolean arithmetic function
function that produces an output from one or more inputs according to the rules of AND (see 3.1.2), XOR (see 3.1.27), and OR (see 3.1.50)

3.1.11
byte
sequence of eight contiguous bits considered as a unit

3.1.12
cache
temporary data storage area that is capable of containing a subset of the logical block data stored by the logical unit and is either volatile or non-volatile

3.1.13
check data
information contained within a redundancy group (see 3.1.73) that may allow lost or destroyed XOR-protected data (see 3.1.105) to be recreated

3.1.14
command
request describing a unit of work to be performed by a device server

Note 1 to entry: See SAM-5.

3.1.15
command descriptor block
CDB
structure used to communicate commands from an application client to a device server

Note 1 to entry: See SPC-4.

3.1.16
compare operation
process by which a device server compares two sets of data for equality

3.1.17
cyclic redundancy check
CRC
error checking mechanism that checks data integrity by computing a polynomial algorithm based checksum (see 4.22.4)

3.1.18
Data-In Buffer
buffer specified by the application client to receive data from the device server during the processing of a command

Note 1 to entry: See SAM-5 and SPC-4.

3.1.19
Data-Out Buffer
buffer specified by the application client to supply data that is sent from the application client to the device server during the processing of a command

Note 1 to entry: See SAM-5 and SPC-4.

3.1.20
deallocated
logical block provisioning state of an LBA (see 4.7.1) in which physical capacity has not been reserved for the referenced logical block (see 4.7.4.7)

3.1.21
defect list
GLIST (see 4.13) or PLIST (see 4.13)

3.1.22
device server
object within a logical unit (see 3.1.43) that processes SCSI commands according to the rules of command management

Note 1 to entry: See SAM-5.

3.1.23
device specific background functions
SCSI target device specific functions that a SCSI target device may perform that have no specific association with application client-initiated operations

Note 1 to entry: See SPC-4.

3.1.24
device type
type of peripheral device (i.e., device model) implemented by the device server and indicated to the application client by the PERIPHERAL DEVICE TYPE field of the standard INQUIRY data (see SPC-4)

3.1.25
direct access block device
device that is capable of containing data stored in logical blocks that each have a unique LBA (see 4.2)

3.1.26
error correcting code
ECC
error checking mechanism that checks data integrity and enables some errors in the logical block data to be corrected

3.1.27
exclusive-or
XOR
Boolean arithmetic function on two binary input values that results in an output value of one if one and only one of the input values is one, or zero if both of the input values are either zero or one

3.1.28
extent
set of logical blocks occupying contiguous LBAs on a logical unit

3.1.29
field
group of one or more contiguous bits, a part of a larger structure (e.g., a CDB (see 3.1.15) or sense data (see SPC-4))

3.1.30
format corrupt
vendor specific condition in which the device server may not be able to perform logical block access commands (see 4.10)

3.1.31
format operation
process by which a device server initializes the medium in a logical unit

Note 1 to entry: See 4.10.

3.1.32
fully provisioned logical unit
logical unit that stores logical block data for every LBA and has assigned physical capacity for every LBA

Note 1 to entry: See 4.7.2.

3.1.33
grown defect list
GLIST
list of physical blocks that the device server has detected as containing medium defects or that the application client has specified as containing medium defects

Note 1 to entry: See 4.13.

3.1.34
hard reset
condition resulting from the events defined by SAM-5 during which the SCSI device performs the hard reset operations described in SAM-5, this standard, and other applicable command standards (see table 31)

3.1.35
I_T nexus
relationship between a SCSI initiator port and a SCSI target port

Note 1 to entry: See SAM-5.

3.1.36
I_T nexus loss
condition resulting from the events defined by SAM-5 during which the SCSI device performs the I_T nexus loss operations described in SAM-5, this standard, and other applicable command standards (see table 31)

3.1.37
LBA mapping resource
resource used by a logical unit that supports logical block provisioning management

Note 1 to entry: An example of a mapping resource is a physical block or a data structure associated with tracking resource usage.

3.1.38
logical block
set of data bytes accessed and referenced as a unit (see 4.5)

3.1.39
logical block access command
command that requests access to one or more logical blocks that may require access to the medium

Note 1 to entry: See 4.2.2.

3.1.40
logical block address
LBA
value used to reference a logical block (see 4.5)

3.1.41
logical block data
user data and protection information, if any

3.1.42
logical block length
number of bytes of user data in a logical block (see 4.5)

3.1.43
logical unit
externally addressable entity within a SCSI target device (see 3.1.76) that implements a SCSI device model

Note 1 to entry: See SAM-5.

3.1.44
logical unit reset
condition resulting from the events defined by SAM-5 in which the logical unit performs the logical unit reset operations described in SAM-5, this standard, and other applicable command standards (see table 31)

3.1.45
mapped
logical block provisioning state of an LBA (see 4.7.1) in which physical capacity has been assigned to the referenced logical block (see 4.7.4.6)

3.1.46
medium
material that is not cache on which data is stored

Note 1 to entry: The plural of medium is media.

Note 2 to entry: An example of a medium in which data is stored is a magnetic disk.

3.1.47
medium defect
area of the medium that results in a recovered error or an unrecovered error when a read medium operation or a write medium operation is performed

Note 1 to entry: See 4.13.

3.1.48
non-volatile cache
cache that retains logical block data through any power cycle

3.1.49
non-volatile medium
medium that retains logical block data through any power cycle

3.1.50
OR
Boolean arithmetic function (see 3.1.10) on two binary input values that results in an output value of one if either of the input values are one or zero if both of the input values are zero

3.1.51
OR operation
performance of an OR (see 3.1.50) bitwise on two multiple-bit input values both having the same number of bits

Note 1 to entry: An example of multiple-bit inputs is the current content of a logical block and the content contained in the Data-Out Buffer having the same number of bytes.

3.1.52
point in time ROD token
ROD token with a ROD type that is a point in time copy ROD

Note 1 to entry: See SPC-4.

3.1.53
physical block
set of data bytes accessed as a unit by the device server (see 4.6)

3.1.54
physical block length
number of bytes of logical block data in a physical block (see 4.6)

3.1.55
physical element
component that provides non-volatile storage for an associated group of logical blocks (see 4.20)

3.1.56
power cycle
sequence of power being removed followed by power being applied to a SCSI device

3.1.57
power on
condition resulting from the events defined by SAM-5 during which a SCSI device performs the power on operations described in SAM-5, this standard, and other applicable command standards (see table 31)

3.1.58
primary defect list
PLIST
list of physical blocks containing medium defects that are considered permanent

Note 1 to entry: See 4.13.

3.1.59
protection information
group of fields at the end of each logical block or at specified intervals within each logical block that contain a logical block guard, an application tag, and a reference tag

Note 1 to entry: See 4.22.

3.1.60
protection information interval
length of user data that occurs within a logical block before each protection information

3.1.61
pseudo read data
indeterminate logical block data

3.1.62
pseudo unrecovered error
simulated error (e.g., created by a WRITE LONG command (see 5.41 and 5.42)) for which a device server reports that it is unable to read or write a logical block, regardless of whether the data on the medium is valid, recoverable, or unrecoverable

3.1.63
pseudo unrecovered error with correction enabled
pseudo unrecovered error (see 3.1.62) for which a device server performs the maximum error recovery as specified in the Read-Write Error Recovery mode page (see 6.5.8)

Note 1 to entry: See 4.18.2.

3.1.64
pseudo unrecovered error with correction disabled
pseudo unrecovered error (see 3.1.62) for which a device server performs no error recovery

Note 1 to entry: See 4.18.2.

3.1.65
read cache operation
process by which a device server reads logical blocks for one or more LBAs from cache as described in 4.15

3.1.66
read command
command that requests read operations

Note 1 to entry: See 4.2.2.

3.1.67
read medium operation
process by which a device server reads logical blocks for one or more LBAs from the medium using the parameters specified in the Read-Write Error Recovery mode page (see 6.5.8)

3.1.68
read operation
process by which a device server performs operations as described in this standard

Note 1 to entry: Examples of read operations are read cache operations and read medium operations.

Note 2 to entry: See 4.2.3.

3.1.69
reassign
perform a reassign operation

3.1.70
reassign operation
operation during which the device server changes the assignment of an LBA from a specified physical block to another physical block and adds the specified physical block to the GLIST

3.1.71
recovered error
error for which a device server is able to read or write a logical block within the recovery limits specified in the Read-Write Error Recovery mode page (see 6.5.8) or the Verify Error Recovery mode page (see 6.5.9)

3.1.72
recovered read error
recovered error that occurs during a read medium operation

3.1.73
redundancy group
grouping of XOR-protected data (see 3.1.105) and associated check data (see 3.1.13) into a single type of data redundancy (see SCC-2)

3.1.74
resource provisioned logical unit
logical unit that may or may not store logical block data for every LBA and that provides enough LBA mapping resources (see 3.1.37) to map every LBA

Note 1 to entry: See 4.7.3.2.

3.1.75
sanitize operation
process by which a device server alters information on a logical unit such that recovery of previous logical block data from the cache and the medium is not possible

Note 1 to entry: See 4.11.

3.1.76
SCSI target device
SCSI device containing logical units and SCSI target ports that receives device service requests and task management requests for processing and sends device service responses and task management responses to SCSI initiator devices

Note 1 to entry: See SAM-5.

3.1.77
sense data
data describing command completed information that a device server delivers to an application client in the same I_T_L_Q nexus transaction as the status or as parameter data in response to a REQUEST SENSE command

Note 1 to entry: See SPC-4.

3.1.78
sense key
contents of the SENSE KEY field in the sense data

Note 1 to entry: See SAM-5.

3.1.79
status
one byte of response information that contains a coded value defined in SAM-5, transferred from a device server to an application client upon completion of each command

Note 1 to entry: See SAM-5.

3.1.80
stopped power condition
power condition in which a device server terminates TEST UNIT READY commands and logical block access commands

Note 1 to entry: See 4.21.4.

3.1.81
synchronize cache operation
process by which a device server synchronizes logical blocks within the volatile cache with the non-volatile cache or the medium

3.1.82
thin provisioned logical unit
logical unit that may or may not store logical block data for every LBA and that may or may not provide enough LBA mapping resources (see 3.1.37) to map every LBA

Note 1 to entry: See 4.7.3.3.

3.1.83
threshold set
set of two or more logical blocks used for tracking logical block provisioning thresholds

Note 1 to entry: See 4.7.3.7.

3.1.84
threshold set size
number of LBAs in a threshold set

Note 1 to entry: See 4.7.3.7.

3.1.85
token
representation of a collection of data

Note 1 to entry: See SPC-4.

3.1.86
unit attention condition
state that a logical unit (see 3.1.43) maintains while the logical unit has asynchronous status information to report to the SCSI initiator ports associated with one or more I_T nexuses (see 3.1.35)

Note 1 to entry: See SAM-5.

3.1.87
unmap command
command that requests an unmap operation

Note 1 to entry: See 4.2.2.

3.1.88
unmap operation
process by which a device server either deallocates or anchors a single LBA

Note 1 to entry: See 4.2.3 and 4.7.3.4.

3.1.89
unmapped
logical block provisioning state of an LBA (see 4.7.1) in which the LBA is either anchored or deallocated

3.1.90
unrecovered error
error for which a device server is unable to read a logical block or write a logical block within the recovery limits specified in the Read-Write Error Recovery mode page (see 6.5.8) and/or the Verify Error Recovery mode page (see 6.5.9)

3.1.91
unrecovered read error
unrecovered error that occurs during a read medium operation

3.1.92
unrecovered write error
unrecovered error that occurs during a write medium operation

3.1.93
user data
data contained in logical blocks that is accessible by an application client and is neither protection information nor other information that may not be accessible to the application client

3.1.94
user data segment
contiguous sequence of logical blocks

Note 1 to entry: See 4.28.

3.1.95
verify command
command that requests verify operations

Note 1 to entry: See 4.2.2.

3.1.96
verify medium operation
process by which a device server reads logical blocks for one or more LBAs from the medium using the parameters specified in the Verify Error Recovery mode page (see 6.5.9)

3.1.97
verify operation
process by which the device server performs operations as described in this standard

Note 1 to entry: An example of a verify operation is a verify medium operation.

Note 2 to entry: See 4.2.3.

3.1.98
volatile cache
cache that does not retain logical block data between power cycles

3.1.99
volatile medium
medium that does not retain logical block data between power cycles

Note 1 to entry: An example of volatile medium is a silicon memory device that loses data written to it if device power is lost.

3.1.100
write cache operation
process by which a device server writes logical blocks for one or more LBAs to the cache (see 4.7.1)

3.1.101
write command
command that requests write operations

Note 1 to entry: See 4.2.2.

3.1.102
write medium operation
process by which a device server writes logical blocks for one or more LBAs to the medium using the parameters specified in the Read-Write Error Recovery mode page (see 6.5.8)

3.1.103
write operation
process by which a device server performs operations as described in this standard

Note 1 to entry: Examples of write operations are write cache operations and write medium operations.

Note 2 to entry: See 4.2.3.

3.1.104
XOR operation
processing of an XOR bitwise on two identical-sized multiple-bit input values

Note 1 to entry: An example of multiple-bit inputs is the current content of a logical block and the content contained in the Data-Out Buffer having the same number of bytes.

3.1.105
XOR-protected data
logical blocks (i.e., including logical block data) that are part of a redundancy group

3.2 Symbols

Symbols used in this standard include:

Symbol	Meaning
+	plus
–	minus
×	multiplied by
÷	divided by
=	equals
≠	not equal to
<	less than
>	greater than

3.3 Abbreviations

Abbreviations used in this standard include:

Abbreviation	Meaning
CbCS	Capability based Command Security
CDB	command descriptor block (see 3.1.15)
CRC	cyclic redundancy check (see 3.1.17)
ECC	error correcting code (see 3.1.26)
FCP-4	Fibre Channel Protocol for SCSI, fourth version (see Bibliography)
GLIST	grown defect list (see 3.1.33)
LBA	logical block address (see 3.1.40)
LBP	logical block provisioning (see 4.7.4)
LSB	least significant bit
LUN	logical unit number
M	implementation is mandatory
MMC-6	SCSI Multimedia Commands - 6 (see Bibliography)
MSB	most significant bit
O	implementation is optional
PLIST	primary defect list (see 3.1.58)
n/a	not applicable
ROD	representation of data (see SPC-4)
SAM-5	SCSI Architecture Model - 5 (see clause 2)
SAS-3	Serial Attached SCSI-3 (see Bibliography)
SCSI	Small Computer System Interface family of standards
SCC-2	SCSI-3 Controller Commands - 2 (see clause 2)
SES-2	SCSI Enclosure Services - 2 (see clause 2)
SPC-4	SCSI Primary Commands - 4 (see clause 2)
SPL-2	SAS Protocol Layer-2 (see clause 2)
VPD	Vital product data (see 6.6)
XOR	exclusive-or (see 3.1.27)

3.4 Keywords

3.4.1
ignored
keyword used to describe an unused bit, byte, word, field or code value

Note 1 to entry: The contents or value of an ignored bit, byte, word, 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.

3.4.2
invalid
keyword used to describe an illegal or unsupported bit, byte, word, field or code value

Note 1 to entry: Receipt of an invalid bit, byte, word, field or code value shall be reported as an error.

3.4.3
mandatory
keyword indicating an item that is required to be implemented as defined in this standard

3.4.4
may
keyword that indicates flexibility of choice with no implied preference

Note 1 to entry: “May” is equivalent to “may or may not”.

3.4.5
may not
keywords that indicate flexibility of choice with no implied preference

Note 1 to entry: “May not” is equivalent to “may or may not”.

3.4.6
obsolete
keyword indicating that an item was defined in prior SCSI standards but has been removed from this standard

3.4.7
optional
keyword that describes features that are not required to be implemented by this standard; however, if any optional feature defined in this standard is implemented, then it shall be implemented as defined in this standard

3.4.8
prohibited
keyword used to describe a feature, function, or coded value that is defined in a non-SCSI standard (i.e., a standard that is not a member of the SCSI family of standards) to which this standard makes a normative reference where the use of said feature, function, or coded value is not allowed for implementations of this standard

3.4.9
reserved
keyword referring to bits, bytes, words, fields and code values that are set aside for future standardization

Note 1 to entry: A reserved bit, byte, word or field shall be set to zero, or in accordance with a future extension to this standard.

Note 2 to entry: Recipients are not required to check reserved bits, bytes, words or fields for zero values. Receipt of reserved code values in defined fields shall be reported as an error.

3.4.10
restricted
keyword referring to bits, bytes, words, and fields that are set aside for other identified standardization purposes

Note 1 to entry: A restricted bit, byte, word, or field shall be treated as a reserved bit, byte, word or field in the context where the restricted designation appears.

3.4.11
shall
keyword indicating a mandatory requirement

Note 1 to entry: Designers are required to implement all such mandatory requirements to ensure interoperability with other products that conform to this standard.

3.4.12
should
keyword indicating flexibility of choice with a strongly preferred alternative

Note 1 to entry: “Should” is equivalent to the phrase “it is strongly recommended”.

3.4.13
vendor specific
something (e.g., a bit, field, code value) that is not defined by this standard

Note 1 to entry: Specification of the referenced item is determined by the SCSI device vendor and may be used differently in various implementations.

3.5 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 this clause or in the text where they first appear.

Normal case is used for words having the normal English meaning.

Upper case is used when referring to names of commands, status codes, sense keys, and additional sense codes (e.g., REQUEST SENSE command).

If there is more than one CDB length for a particular command (e.g., ORWRITE (16) and ORWRITE (32)), and the name of the command is used in a sentence without any CDB length descriptor (e.g., ORWRITE), then the condition described in the sentence applies to all CDB lengths for that command.

Names of fields and state variables are in small uppercase (e.g. NAME). When a field or state variable name contains acronyms, uppercase letters may also be used for readability (e.g., the LOGERR bit). Normal case is used when the contents of a field or state variable are being discussed. Fields or state variables containing only one bit are usually referred to as the NAME bit instead of the NAME field.

Lists sequenced by lowercase or uppercase letters show no ordering relationship between the listed items.

EXAMPLE 1 - The following list shows no relationship between the listed items:

a) red (i.e., one of the following colors):
   A) crimson: or
   B) amber;
b) blue; or
c) green.

Lists sequenced by numbers show an ordering relationship between the listed items.

EXAMPLE 2 -The following list shows an ordered relationship between the named items:

1) top;
2) middle; and
3) bottom.

Lists are associated with an introductory paragraph or phrase, and are numbered relative to that paragraph or phrase (i.e., all lists begin with an a) or 1) entry).

In the event of conflicting information the precedence for requirements defined in this standard is:

1) text;
2) tables; then
3) figures.

Tables show data format and values. Not all tables or figures are fully described in the text.

Notes and examples do not constitute any requirements for implementers, and notes are numbered consecutively throughout this standard.

3.6 Numeric and character conventions

3.6.1 Numeric conventions

A binary number is represented in this standard by any sequence of digits comprised of only the Western-Arabic numerals 0 and 1 immediately followed by a lower-case b (e.g., 0101b). Underscores are included between characters in binary number representations to increase readability or delineate field boundaries (e.g., 0_0101_1010b).

A hexadecimal number is represented in this standard by any sequence of digits comprised of only the Western-Arabic numerals 0 to 9 and/or the upper-case English letters A to F immediately followed by a lower-case h (e.g., FA23h). Underscores are included in hexadecimal number representations to increase readability or delineate field boundaries (e.g., B_FD8C_FA23h).

A decimal number is represented in this standard by any sequence of digits comprised of only the Western-Arabic numerals 0 to 9 not immediately followed by a lower-case b or lower-case h (e.g., 25).

A range of numeric values is represented in this standard in the form “a to z”, where a is the first value included in the range, all values between a and z are included in the range, and z is the last value included in the range (e.g., the representation “0h to 3h” includes the values 0h, 1h, 2h, and 3h).

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 convention examples

ISO/IEC	United States	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

A decimal number represented in this standard with an overline over one or more digits following the decimal point is a number where the overlined digits are infinitely repeating (e.g., $666.\overline{6}$ means 666.666 666... or $666\ ^{2}/_{3}$, and $12.\overline{142\ 857}$ means 12.142 857 142 857... or $12\ ^{1}/_{7}$).

3.6.2 Units of measure

This standard represents values using both decimal units of measure and binary units of measure. Values are represented by the following formats:

a) for values based on decimal units of measure:
   1) numerical value (e.g., 100);

2) space;
3) prefix symbol and unit:
    1) decimal prefix symbol (e.g., M) (see table 2); and
    2) unit abbreviation;

and

b) for values based on binary units of measure:
    1) numerical value (e.g., 1 024);
    2) space;
    3) prefix symbol and unit:
        1) binary prefix symbol (e.g., Gi) (see table 2); and
        2) unit abbreviation.

Table 2 compares the prefix, symbols, and power of the binary and decimal units.

Table 2 – Comparison of decimal prefixes and binary prefixes

Decimal			Binary		
Prefix name	**Prefix symbol**	**Power (base-10)**	**Prefix name**	**Prefix symbol**	**Power (base-2)**
kilo	k	10^3	kibi	Ki	2^{10}
mega	M	10^6	mebi	Mi	2^{20}
giga	G	10^9	gibi	Gi	2^{30}
tera	T	10^{12}	tebi	Ti	2^{40}
peta	P	10^{15}	pebi	Pi	2^{50}
exa	E	10^{18}	exbi	Ei	2^{60}
zetta	Z	10^{21}	zebi	Zi	2^{70}
yotta	Y	10^{24}	yobi	Yi	2^{80}

3.7 State machine conventions

Figure 1 shows how state machines are described in this standard.

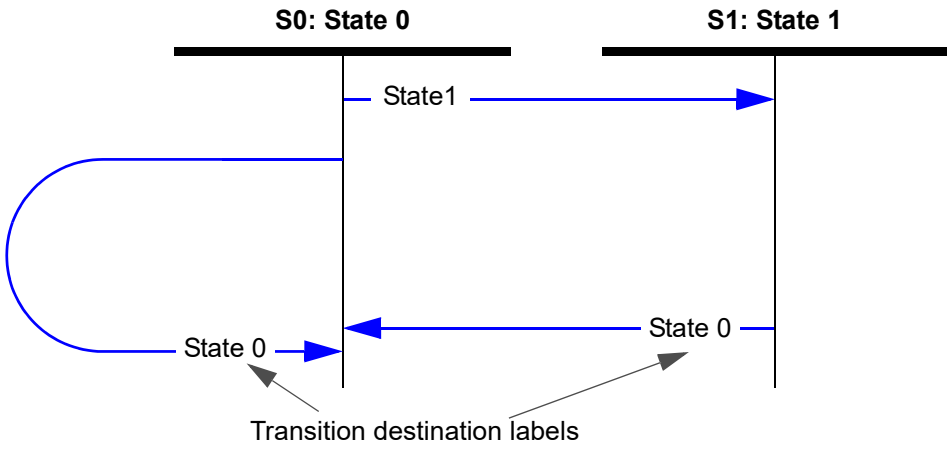


Figure 1 – Example state machine figure

The state machine figure is followed by subclauses describing the states and state transitions.

Each state and state 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.

A system specified in this manner has the following properties:

a) time elapses only within discrete states; and
b) state transitions are logically instantaneous.