

1 Scope

This standard defines a set of SCSI command descriptor blocks that are useful in accessing and controlling devices with a peripheral device type set to 5.

This command set is transport independent and may be implemented across a wide variety of environments for which a SCSI transport protocol has been defined. To date, these include Parallel SCSI, ATA/ATAPI, Serial ATA, Universal Serial Bus (USB versions 1.1 and 2.0), and High Performance Serial Bus (IEEE 1394, 1394A, and 1394B).

The command set described has been selected for correct operation when the physical interface is ATA with the ATAPI command protocol. Although some commands are also described in the SPC-3, reduced descriptions are also in this standard for the purpose of profiling mandatory and optional command features as applied to multi-media devices.

The objective of this command set is to provide for the following:

1. A definition of the command formats and functions independent of delivery, protocol/signaling or transport mechanism. Architectural constraints regarding command functions, over the various transports, are addressed in the document specific to the physical transport.
2. Standardized access to common features of devices employed in multimedia applications.
3. System software/firmware independence across device classes and physical interfaces. Provision is made for the addition of special features and functions through the use of vendor-specific options.
4. To provide compatibility such that properly conforming devices may inter-operate with subsequent devices.

The Multi-Media Commands - 5 (MMC-5) standard is divided into several clauses:

Clause 1 (this clause) is the scope.

Clause 2 contains lists of documents that may be needed by the reader for the correct understanding of this standard.

Clause 3 contains Definitions, Symbols, Abbreviations, and Conventions. This is a glossary of terminology used in this standard.

Clause 4 describes modeling for the various media oriented behaviors that the Host may witness from the device. This also provides an overview of internal drive operation to the Host application developer.

Clause 5 defines the features and profiles of MMC devices. Features describe Drive capability while profiles define a general device view.

Clause 6 defines commands that may be implemented by MMC device. Commands are described from the Host's point of view

Clause 7 defines the parameter data formats that may be implemented by a MMC devices. Inputs required by the drive are not always a part of a command. Inputs associated with mode of operation are readable and sometimes writable.

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

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2 References

2.1 Normative References

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

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

Approved References

The following are approved ANSI, approved international and approved regional publications (ISO, IEC, CEN/CENELEC, and ITUT), and may be obtained from the international and regional organizations that control them.

ANSI NCITS.336:2000	SCSI Parallel Interface 3 (SPI-3)
ANSI NCITS.351:2001	SCSI-3 Primary Commands (SPC-2)
ANSI INCITS 401:2005	SCSI-3 MultiMedia Command Set 4 (MMC-4)
ANSI NCITS.306:1998	SCSI-3 Block Command Set (SBC)
ANSI NCITS.325:1998	SCSI Serial Bus Protocol – 2 (SBP-2)
ANSI INCITS 397-2005	AT Attachment with Packet Interface 7 (ATA/ATAPI-7) Volume 1: ATA Command Set Volume 2: Parallel ATA Volume 3: Serial ATA
ISO/IEC 646:1991	Information technology - ISO 7-bit coded character set for information interchange (third edition). <i>See also: ANSI INCITS 4-1986 (R2002) Information Systems - Coded Character Sets - 7-Bit American National Standard Code for Information Interchange (7-Bit ASCII)</i>
IEC 908:1987	Compact Disc Digital Audio System.
ISO/IEC 3901:2001	International Standard Recording Code (ISRC)
ISO/IEC 10149:1995	Information Technology-Data Interchange on Read-only 120 mm Optical Data Discs (CD-ROM).
ISO/IEC 16448:2002	Information technology -- 120 mm DVD -- Read-only disk
ISO/IEC 16449:2002	Information technology - 80 mm DVD - Read-only disk
ISO/IEC 16824:1999	Information technology -- 120 mm DVD rewritable disk
ECMA 167, 3 rd Edition	Volume and File Structure for Write-Once and Rewritable Media using Non-Sequential Recording for Information Interchange
ECMA 330	120 mm (4,7 Gbytes per side) and 80 mm (1,46 Gbytes per side) DVD Rewritable Disk (DVD-RAM)
ECMA 337	120 mm 4,7GB and 80 mm 1,46 GB DVD ReWritable Disc (DVD+RW)
ECMA 338	80 mm (1,46 Gbytes per side) and 120 mm (4,70 Gbytes per side) DVD Re-recordable Disk (DVD-RW)
ANSI/IEEE Std 1394A-2000	High Performance Serial Bus

2.2 References Under Development

At the time of publication, the following referenced standards were still under development. For information on the current status of the document, or regarding availability, contact the relevant standards body or other organization as indicated.

INCITS T10/1416D	SCSI Primary Command Set – 3 (SPC-3)
INCITS T10/1417D	SCSI Block Command Set – 2 (SBC-2)
INCITS T10/1467D	SCSI Serial Bus Protocol – 3 (SBP-3)
INCITS T13/1532D	ATA Attachment with Packet Interface 8 (ATA/ATAPI-8)
	Volume 1: ATA Command Set
	Volume 2: Parallel ATA
	Volume 3: Serial ATA

For more information on the current status of the above documents, contact INCITS Secretariat, 1250 Eye Street, NW Suite 200, Washington, DC 20005, Phone Number (202) 737-8888. To obtain copies of these documents, contact Global Engineering at (303) 792-2181 or INCITS Secretariat.

2.3 Other References

The following are published by the NV Philips and Sony Corporation and are available from Philips Electronics NV (for availability, consult www.licensing.philips.com):

- System Description Compact Disc Digital Audio (aka "Red Book"), See also IEC 908:1987
- Compact Disc Read Only Memory (aka "Yellow Book"), See also ISO/IEC 10149:1995
- CD-I Full Functional Specification ("Green Book")
- System Description Compact Disc Read Only Memory eXtended Architecture (CD-ROM XA)
- Multi-session Compact Disc Specification
- System Description Recordable Compact Disc Systems, part II: CD-R
- System Description Recordable Compact Disc Systems, part II: CD-R, Volume 2: Multi-Speed
- System Description Recordable Compact Disc Systems, part III: Compact Disc ReWritable (CD-RW)
- System Description Recordable Compact Disc Systems, part III Volume 2: CD-RW

The following are published by the DVD Forum (for availability, consult www.dvdforum.org):

- DVD Specification for Read-Only Disc (DVD-ROM): part 1 Physical Specifications, Ver 1.04
- DVD Specification for Recordable Disc (DVD-R), part 1: Physical Specifications, Ver 1.0
- DVD Specifications for Recordable Disc (DVD-R) for General, part 1: Physical Specifications, Ver 2.1
- DVD Specifications for Recordable Disc (DVD-R) for Authoring, part 1: Physical Specifications, Ver 2.0
- DVD Specification for Rewritable Disc (DVD-RAM), part 1: Physical Specifications, Ver 2.2
- DVD Specification for Re-recordable Disc (DVD-RW), part 1: Physical specifications, Ver 1.0

The following are published by the DVD+RW Alliance (for availability, consult www.licensing.philips.com):

- DVD+RW 4,7 Gbytes Basic Format Specifications, Version 1.2, December 2002
- DVD+R 4,7 Gbytes Basic Format Specifications, Version 1.11, December 2002
- DVD+R 8,5 Gbytes Basic Format Specifications, Version 1.0, March 2004
- DVD+RW Dual Layer, 8,5 Gbytes Basic Format Specifications System Description part 2, volume 1; version 0.20 May 2005

The following are published by the DVD Forum (for availability, consult www.dvdforum.org):

- DVD Specifications for High Density Read-Only Disc (HD DVD-ROM), part 1: Physical Specifications, Ver 1.1

DVD Specifications for High Density Recordable Disc (HD DVD-R), part 1: Physical Specifications, Ver 1.0

DVD Specifications for High Density Rewritable Disc (HD DVD-RW), part 1: Physical Specifications, Ver 1.0

DVD Specifications for High Definition Video, Ver 0.9

The following are published by the Blu-ray Disc Founders (for availability, consult www.blu-raydisc.info):

System Description Blu-ray Disc Read-only Format, Part 1: Basic Format Specifications, Version 1.0, July 2004

System Description Blu-ray Disc Recordable Format, Part 1: Basic Format Specifications, Version 1.0, December 2004

System Description Blu-ray Disc Rewritable Format, Part 1: Basic Format Specifications, Version 2.0, November 2004

The following are published by the MRW Promoters (for availability, consult www.licensing.philips.com):

CD-MRW Defect Management & Physical Formatting Version 1.2, June 2004

DVD+MRW Defect Management & Physical Formatting, Version 1.2, October 2005

The following is published by the Small Form Factor Industry Group (SFF) (for availability, consult www.sffcommittee.org):

INF-8090i Commands for Multi-Media devices, revision 5.5, June 2003

The following is published by the Optical Storage Technology Association (OSTA) (for availability, consult www.osta.org):

Universal Disk Format (UDF), Revision 2.6, March 2005

The following are published by the USB Implementers Forum (for availability, consult www.usb.org):

Universal Serial Bus Specification, Revision 2.0, published by USB Implementers Forum

Universal Serial Bus Mass Storage Class Bulk-Only Transport, published by USB Implementers Forum

Documents describing the DVD Content Scrambling System (CSS) are published by the DVD Copy Control Association and are available only to licensees. For more information consult www.dvdcca.org.

The following is published by the 4C Content Protection Working Group and are available from CPRM-licensing@4Centity.com:

Content Protection for Recordable Media Specification: Intel, IBM, Matsushita, Toshiba, 2000

Documents describing the Advanced Access Content System (AACS) are published by the Advanced Access Content System Licensing Authority (AACS-LA) and are available only to licensees. For more information consult www.aacsla.com.

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3 Definitions, Symbols, Abbreviations, and Conventions

3.1 MMC General Terms

3.1.1 Additional Sense Code (ASC)

As defined in SPC-3, the value stored in byte 12 of the sense information is labelled the Additional Sense Code. In the case of this standard, ASC is part of a 20-bit code: SK/ASC/ASCQ that identifies a specific error or condition.

3.1.2 Additional Sense Code Qualifier (ASCQ)

As defined in SPC-3, the value stored in byte 13 of the sense information is labelled the Additional Sense Code Qualifier. In the case of this standard, ASCQ is part of a 20 bit code: SK/ASC/ASCQ that identifies a specific error or condition.

3.1.3 Advanced Access Content System (AACS)

A system for managing content stored on the prerecorded and recorded optical media for consumer use with PCs and CE devices.

3.1.4 Appendable disc

A recordable/rewritable disc that supports a track/session recording model may be either complete or appendable. An appendable disc is either a disc with no complete sessions or a disc on which a new session may be appended to the last complete session.

3.1.5 AT Attachment (ATA)

AT Attachment defines the physical, electrical, transport, and command protocols for the internal attachment of block storage devices. See AT Attachment with Packet Interface 7 (ATA/ATAPI-7)

3.1.6 AT Attachment Packet Interface (ATAPI)

A device that implements the Packet command Feature set as defined in AT Attachment with Packet Interface 7 (ATA/ATAPI-7) is referred to as an ATAPI device.

3.1.7 Authentication Grant ID (AGID)

The Authentication Grant ID is a handle used for resource control during key management. Individual key management threads are identified through the use of AGID.

3.1.8 Block (Logical Block)

A block (or logical block) consists of only the user data part of a sector.

3.1.9 Burst Cutting Area (BCA)

The Burst Cutting Area provides a unique physical identification mark for individual DVD, HD-DVD or BD media. This area is not directly addressable by the user.

3.1.10 Certification

Certification is a function defined for the Hardware Defect Management Feature. A Writable Unit is optionally written and then read. Vendor specific rules define a test for the read reliability of the writable unit. If the writable unit fails the test, the writable unit is registered into the hardware defect management system as defective. Otherwise, the writable unit is certified as good.

3.1.11 Challenge

A challenge is a data structure used during an authentication key exchange process.

3.1.12 Command Descriptor Block (CDB)

The structure of 6, 10, or 12 bytes used to communicate commands from an Initiator to a MM Drive.

3.1.13 Command Packet

Some transports package a SCSI CDB in a fixed size data structure that is used by the transport to communicate commands from an Initiator to a Drive. This structure is named a command packet.

3.1.14 Complete (Closed) session

A Complete Session is a session into which the Host is not permitted to write new user data. It may or may not be possible to append an additional session (see Finalized Disc).

3.1.15 De-icing

Most read-only CD devices locate the groove only by the presence of data. When an ECC block on a DVD+RW medium is blank, no headers are present in any sector of the ECC block.

When no data is present, a seek is unable to find a stopping point. In these cases, it is not possible to locate any sector. A seek to any address would result in a continuous "slide" across the media as if it was covered in ice.

Writing the entire surface (formatting) ensures the presence of data and headers. This makes seeking possible. The process of writing the entire surface is called De-icing.

3.1.16 Defect List (DFL).

Generically, a Defect List exists to map defective writable units to spare writable units.

When a BD-R disc is formatted with the Pseudo-Overwrite capability, the DFL is also used to map replacement Clusters.

3.1.17 Defect Management

Block addressable storage medium may have defects that render some sectors either temporarily or permanently unusable. Defect Management is a mechanism that provides a defect free address space to the host application.

3.1.18 Direct-overwrite

The process or capability of writing over previously written data without an erase cycle is direct-overwrite.

3.1.19 Disc

Within this publication, disc refers to a single disc: CD, DVD, BD, or HD-DVD.

3.1.20 Double Sided

A medium with two independently addressed sides is named double sided.

3.1.21 Drive

A Logical Unit that operates as a single MM device. e.g. a CD-ROM Drive.

3.1.22 Drive Busy

A Drive is Busy if it is executing some process and is unable to accept new commands. e.g., when the Drive is currently executing a command that had an immediate bit (IMMED) set to one in its CDB, it may be unavailable to accept and process all commands. See .

3.1.23 Dual Layer

A dual layer disc has two separate optically sensitive layers that are accessible from one side of the disc at two different focal depths. This is sometimes referred to as double layer.

3.1.24 Embossed Area

An Embossed Area is an area on the disc where information has been stored during the disc manufacturing process by means of either an High Frequency Modulated (HFM) Groove or by means of pits and lands.

The recording in an embossed area cannot be modified by a recording device.

3.1.25 Error Correction Code (ECC)

ECC is a general term for any encoding that has the purpose of detecting and correcting errors.

3.1.26 Error Detection Code (EDC)

EDC is a general term for any encoding that has the purpose of detecting data errors.

3.1.27 Feature

A feature is an atomic unit of Drive functionality. A feature associated with a given Drive defines only a small subset of related functionality normally associated with that Drive.

3.1.28 Field

A Field is a group of two or more contiguous bits. Fields containing only one bit are referred to as the "named" bit instead of the "named" field.

3.1.29 Finalized Disc

A disc is finalized when the last session is closed with no possibility of appending a new session.

3.1.30 Format

As a noun, "format" refers to a well-defined arrangement or layout of information. Within the confines of the MMC, the verb "format" refers to a format operation started by the FORMAT UNIT command.

3.1.31 Full Certification

As a part of the execution of the FORMAT UNIT command on a rewritable disc, the Drive may certify each writable unit in each of the the LBA space and all spare areas. This is Full Certification.

3.1.32 Hardware Defect Mangement

Defect Management that is implemented completely in the drive.

3.1.33 Hex

Hex is an abbreviation for the word hexadecimal. This indicates a binary value represented in base 16. The value may extend across multiple bytes.

3.1.34 Hold Track State

When a MM device enters the hold Track State the optical pick-up is maintained at an approximately constant radial position on the media.

3.1.35 Host

A Host is a SCSI device with the characteristics of a primary computing device, typically a personal computer, workstation, minicomputer, mainframe computer, or auxiliary computing device or server. A Host includes one or more SCSI initiator devices.

3.1.36 Incomplete session

An Incomplete Session is a session into which the Host is permitted to write new user data.

3.1.37 Layer

The recorded information is in layers as seen from one side of a disc. There are single and dual layer discs.

3.1.38 Lead-in

The Lead-in on a MM disc is an initial part of the physical track spiral that provides for outer to inner radius seek overshoot protection. On dual layer discs, the lead-in is always at the inner radius of its residence layer. The data content within the lead-in is different for different disc types.

3.1.39 Lead-out

The Lead-out on single layer and PTP dual layer MM discs is the final part of the physical track spiral that provides for inner to outer radius seek overshoot protection. The data content within the lead-out typically contains no unique information.

The Lead-out on an OTP dual layer MM disc is the final part of the physical track spiral that provides for outer to inner radius seek overshoot protection on layer 1.

3.1.40 Logical Block

The Initiator addressable units of data are named Logical Blocks.

3.1.41 Logical Block Address (LBA)

The LBA is the number that an Initiator uses to reference Logical Blocks on a block storage device.

3.1.42 Logical Sector Number (LSN)

A sector's LBA is referred to as LSN in some references.

3.1.43 Logical Track

Logical Track is a generic term for a logical subdivision of the address space of optical media. On CD media a Logical Track is a track.

On DVD-R/-RW and HD DVD-R media a Logical Track is an Rzone.

On DVD+R media a Logical Track is a Fragment.

On BD-R media in SRM a Logical Track is an SRR.

For all other media types where Logical Track is not defined, the entire user space of the media is viewed as a single Logical Track.

3.1.44 Logical Unit Number (LUN)

The LUN is the address of a Drive via a target.

3.1.45 Magazine

This is a term for multiple disc unit/container.

3.1.46 Medium

Within this publication, medium refers to a single disc: CD, DVD, BD, or HD-DVD.

3.1.47 Middle Area

The middle area is a transition zone at the outer radius of each layer of an OTP dual layer MM disc.

The middle area 0 is the area that follows data zone 0 and middle area 1 is the area that follows data zone 1.

3.1.48 Mount Rainier reWritable (MRW)

Mount Rainier reWritable is a general optical media format is defined specifically for rewritable media for the purpose of providing a hardware defect management scheme without ignoring potential problems with legacy devices. When used on CD-RW media, the format is named CD-MRW. When used on DVD+RW media, the format is named DVD+MRW.

3.1.49 Optimum Power Calibration (OPC)

OPC is a procedure performed by an optical storage device to calibrate laser power. Values from this calibration are used for subsequent write operations.

3.1.50 Opposite Track Path (OTP)

An opposite track path disc is dual layer disc. The Layer 0 groove begins at the inner radius with a Lead in, followed by a data zone, and finishes with a Middle area. The Layer 1 groove begins at the outer radius with a Middle area, followed by a data zone, and finishes with a lead-out.

3.1.51 output port

Some MM devices carry a means for connecting to data ports other than the Initiator interface.

3.1.52 Parallel Track Path (PTP)

A parallel track path is a dual layer disc that has a Lead in, user area and Lead-out in each layer respectively. The physical sector number in each layer increases to its respective Lead-out in parallel.

3.1.53 Physical Sector Number (PSN)

When the total number of possible sectors on a media (even those not typically accessible) is N, physical sector numbering is a one-to-one mapping of the set 0, 1, 2, ...N-1 to the entire set of sectors. No device function (e.g. defect management) may change this mapping.

3.1.54 Profile

A profile is a collection of features. The profile is a well-defined way of describing the overall capabilities of a specific Drive. More complex Drives may exhibit more than one profile.

3.1.55 Quick Certification

If a FORMAT UNIT command is issued by the Host for a BD-RE disc that was previously formatted, then the requested process is a reformat. Before starting the reformat, the DFL contains a list of Clusters that have been determined to be defective. As a part of the execution of the FORMAT UNIT command that is requesting a reformat, the Drive may certify only Clusters registered in the DFL as defective. Since this process requires significantly less execution time than Full Certification, it is called Quick Certification.

3.1.56 Quick Reformat

If a FORMAT UNIT command is issued by the Host for a BD-RE disc that was previously formatted, then the requested process is a reformat. Before starting the reformat, the DFL contains a list of Clusters that have been determined to be defective.

If a FORMAT UNIT command requests a quick reformat, the Drive shall convert each registered defective Cluster information on the disc to a re-usable Cluster status and perform no certification. The Drive shall certify a Cluster that is registered as re-usable only when executing a non-streamed write. Since this process can make a reformat execute much faster than Quick Certification, this process is called Quick Reformat.

3.1.57 Sector

In case of CD media, "Sector" refers to the data contained in one CD frame. In the CD-ROM standard (ISO/IEC 10149) the term block is used for this unit.

In the case of DVD and HD-DVD media, Sector is the smallest user addressable part of the media. The user data contained within a sector is 2 048 bytes.

A BD sector contains control information, one logical block, and logical block EDC. The user data contained within a sector is 2 048 bytes.

3.1.58 Sense Key (SK)

As defined in SPC-3, the 4-bit value stored in bits 3 - 0 of byte 2 of the sense information is labelled the Sense Key. In the case of this standard, SK is part of a 20-bit code: SK/ASC/ASCQ that identifies a specific error or condition.

3.1.59 Session

A session is a contiguous area of a CD, DVD, HD-DVD, or BD Disc into which data may be recorded.

3.1.60 Single Sided

A single sided disc has exactly one recorded or recordable side.

3.1.61 Software Defect Management

Defect Management that is implemented completely in the host.

3.1.62 Timely, Safe Recording (TSR)

A method that the Host may use to identify defective LBAs and control the timing of replacements by the Drive's Defect Management system.

3.1.63 UDF (Universal Disk Format)

The description of a file system designed for MM recordables and based upon the ECMA 167, June 1997 (see also ISO/IEC 13346:1995).

3.1.64 Uninterrupted Recording

Also known as Disc-At-Once (DAO) recording, uninterrupted is performed without any linkage sequence. This is only possible when an entire disc is recorded in a single write stream.

3.1.65 Writable Unit

A writable media has a minimum physically writable amount of data. When expressed as an integral number of logical blocks, this is a writable unit. The writable unit is an ECC block on DVD, an HD ECC block on HD DVD, and a Cluster on BD.

3.1.66 Zone

A zone is a physically contiguous region of a disc spiral. The Information Zone of a dual layer disc in OTP is considered physically contiguous.

3.2 CD Specific Terms

3.2.1 Absolute Time In Pre-groove (ATIP)

Address and recording information that is encoded in the wobble groove on CD-R/RW is named the Absolute time in pre-groove.

3.2.2 Binary Coded Decimal (BCD)

When a 4-bit entity is permitted to contain only values 0, 1, 2, ..., 9, the representation is Binary Coded Decimal. A byte using BCD representation contains two BCD digits. The high order decimal digit occupies bits 7 through 4 of the byte, while the low order decimal digit occupies the bits 3 through 0 of the byte. Only non-negative values may be represented.

3.2.3 C1, C2, C3

There are potentially 3 layers of error correction on CD media. CIRC contains two layers known as C1 and C2. C2 is layered on C1. When a sector is encoded as either mode 1 data or mode 2, form 1 data, there is a third layer of correction named C3.

3.2.4 CD-Text

A method for storing text information in the lead-in and data areas of a CD-DA disc is named CD-Text.

3.2.5 Compact Disc – Recordable/Rewritable (CD-R/RW)

This designates CD-R, CD-RW, or both.

3.2.6 Compact Disc (CD)

CD is a family of related optical storage media.

3.2.7 Compact Disc – Digital Audio (CD-DA)

The format for storing digital audio information on CD is referred to as Compact Disc – Digital Audio. See IEC 908:1987.

3.2.8 Compact Disc – Read Only Memory (CD-ROM)

Formats for storing digital data on CD is referred to as Compact Disc – Read Only Memory. See ISO/IEC 10149:1995.

3.2.9 Compact Disc – Recordable (CD-R)

A CD that is able to be written only once is named Compact Disc – Recordable.

3.2.10 Compact Disc ReWritable (CD-RW)

A CD that is able to be re-written is named Compact Disc ReWritable.

3.2.11 control field

The control field is a 4-bit field in the Q Sub-channel data on CD media indicating the type of information encoded on the current track. The information includes: audio/data, the type of audio encoding, etc.

3.2.12 Cross Interleaved Reed-Solomon Code (CIRC)

The error detection and correction technique used on all CD formats is CIRC. This is sometimes referred to as correction layer 1 (C1) and correction layer 2 (C2).

3.2.13 data mode

One byte of the header of a CD data sector contains the data mode. This indicates if data is present and if layered error correction information is present.

3.2.14 De-Icing

Most read-only CD devices locate the groove only by the presence of data. When no data is present, a seek is unable to find a stopping point. In these cases, it is not possible to locate any sector. A seek to any address would result in a continuous "slide" across the media as if it was covered in ice. This is a problem only for the random access feature.

Writing the entire surface (formatting) ensures the presence of data and headers. This makes seeking possible. The process of writing the entire surface is called De-Icing.

3.2.15 European Article Number (EAN)

EAN is a standard number registering system for CD media, controlled by the EAN International located at 145 rue Royale B, 1000 Brussels, Belgium. See MCN and UPC.

3.2.16 Fixed Packet Track

A fixed packet track is a CD track that contains only fixed length packets in its data area.

3.2.17 Frame

A CD frame is a physical CD sector. The F field unit of a MSF CD address is the frame field. For the Host, this is the smallest addressable unit on CD media.

3.2.18 Incremental Recording

Incremental recording on CD is any recording that requires a linkage sequence in the data stream. Packet, Track-At-Once (TAO), and Session-At-Once (SAO) recording are all incremental. Incremental recording is also used as a track relative term. TAO tracks are recorded uninterrupted, whereas tracks recorded in packets are recorded incrementally. This is reflected in the CONTROL field of mode 1 Q sub-channel.

3.2.19 Index

CD-DA discs may have sub-divisions of tracks identified by an index that varies from 00bcd through 99bcd. The index is recorded in the Q sub-channel of each sector of the track.

3.2.20 Layered Error Correction (L-EC)

L-EC is another name for C3 error correction. See C1, C2, C3.

3.2.21 Media Catalog Number (MCN)

This 13 BCD number is found in CD sub-channel in at least one out of every one hundred consecutive CD frames. The number is typically registered with a public or private service. See EAN and UPC.

3.2.22 Method 1 Addressing

For all CD media, method 1 addressing is a linearization of MSF addresses. If absolute location MSF is in the program area, then $LBA = 4\ 500 * M + 75 * S + F - 150$. Method 1 logical sector numbering is not defined for sectors outside of the program area.

3.2.23 Method 2 Addressing

For CD-R and CD-RW media, method 2 addressing is defined for the logical numbering of sectors on a fixed packet written disk. Link, run-in, and run-out blocks are ignored in the logical sector numbering.

3.2.24 Method 3 Addressing

Method 3 is an extension of CD method 2 addressing. It is the LBA translation method for CD-MRW formatted media. See .

3.2.25 Minute, Second, Frame address (MSF)

The physical address expressed as a sector count relative to either the beginning of the medium (absolute) or to the beginning of the current track (relative). As defined by the CD standards, each F field unit is one sector; each S field unit is 75 F field units; each M field unit is 60 S field units. Valid contents of F fields are binary values from 0 through 74. Valid contents of S fields are binary values from 0 through 59. Valid contents of M fields are binary values from 0 through 79.

3.2.26 Orange Book

The term "Orange Book" refers to any one of a collection of documents from Philips Electronics that describe recordable and rewritable CD systems and media:

System Description Recordable Compact Disc Systems, part II: CD-R,
System Description Recordable Compact Disc Systems, part II: CD-R, Volume 2: Multi-Speed,
System Description Recordable Compact Disc Systems, part III: Compact Disc ReWritable (CD-RW), and System Description Recordable Compact Disc Systems, part III Volume 2: CD-RW.

3.2.27 Packet

A packet on CD media is a set of recorded link, run-in, data, and run-out blocks.

3.2.28 packet size

On CD media the number of Data Blocks in a packet is the packet size.

3.2.29 packet track

A packet track is a CD track written as a concatenation of a pre-gap, written as one or two packets, followed by some non-zero number of user packets.

3.2.30 post-gap

The post-gap is a transition area located at the end of a CD track.

3.2.31 pre-gap

The pre-gap is a transition area located at the beginning of a CD track.

3.2.32 Program Area

The program area is the logical address space in a CD session.

3.2.33 Program Memory Area (PMA)

The PMA contains information about the recordings on a CD-R/RW disc.

3.2.34 Red Book

The term "Red Book" refers to the document: System Description Compact Disc Digital Audio. The standard IEC 908:1987, Compact Disc Digital Audio System is the preferred reference.

3.2.35 relative MSF field

See MSF address definition.

3.2.36 Sub-channel

CD media have a main channel and a Sub-channel. The Sub-channel area has eight parts called P, Q, R, S, T, U, V, and W. The Q Sub-channel contains information useful to the controller and Drive, such as the control field and MSF address. The data rate of each Sub-channel (P, Q, etc.) is 1/192nd of that of the main channel.

3.2.37 Table of Contents (TOC)

On CD media, the TOC has information on the type of session and the starting address of the tracks. This information is encoded in the Q Sub-channel in each Lead-in area.

3.2.38 Track

Track refers to a Logical Track on CD media. Track is a historical term that is often used interchangeably with Logical Track. See Logical Track.

3.2.39 Track at Once (TAO)

On CD-R/RW media when a track, including its pre-gap, is written as a single packet, the track is said to be recorded track at once (TAO).

3.2.40 Track Descriptor Block (TDB)

On CD-R/RW media, the TDB contains information on the attributes of the current track.

3.2.41 Transition area

For CD, a transition area is a sequence of sectors at the beginning or end of tracks e.g. Pause Area, Pre-Gap, Lead-out, Post-Gap.

3.2.42 Uniform Product Code (UPC)

Controlled by the UC Council, Inc., located at 1009 Lenox Drive, Suite 202 Lawrenceville, NJ 08648. See AEN and MCN.

3.2.43 Yellow book

The term "Yellow Book" refers to the Philips Electronics document: Compact Disc Read Only Memory. The preferred reference is ISO/IEC 10149, Information Technology-Data Interchange on Read-only 120 mm Optical Data Discs (CD-ROM).

3.3 DVD and HD DVD Specific Terms

3.3.1 Address In Pre-groove (ADIP)

Address and recording information encoded in the wobble pre-groove on DVD+R/+RW is named the Address in pre-groove (ADIP).

3.3.2 Block Sync Guard Area (BSGA)

On DVD-R/-RW and ECC block is recorded following a sequential recording sequence to ensure readability of subsequent ECC blocks.

3.3.3 Bordered recording

Bordered recording is the DVD-R and HD DVD-R equivalent of multi-session recording.

3.3.4 Bordered Area

A contiguous area of a disc that contains user data which is located between Lead-in/Border-in Area and Lead-out/Border-out Area.

3.3.5 Border-in Area

The area that contains the pointer to the next Border Zone and is located immediately following Border-out.

3.3.6 Border-out Area

The area that follows each Bordered Area and contains the latest RMD copies and so on. This area is used to avoid pickup overrunning for DVD/HD DVD logical units.

3.3.7 Border Zone

Border Zone is the border-out of "Session" N and the border-in of "session N+1". The Bordered Area is the part in the middle.

3.3.8 Content Protection for Prerecorded Media (CPPM)

CPPM is a system for protecting DVD-Audio content on DVD-ROM media

3.3.9 Content Protection for Recordable Media (CPRM)

CPRM is a system for protecting audio-visual content on recordable DVD media.

3.3.10 Content Scrambling System (CSS)

CSS is an encryption system for content protection of DVD-ROM mastered for video applications.

3.3.11 Control Data Zone

The Control data zone is a structure recorded in the lead-in area of a DVD and HD DVD discs that contains information concerning structure of the disc.

The DVD Control Data Zone is comprised of 192 ECC blocks in the System Lead-in Area of a DVD disc. The content of the 16 sectors in each ECC block is repeated 192 times.

The HD DVD Control Data Zone is comprised of 192 ECC blocks in the System Lead-in Area of a HD DVD disc. The content of the 32 sectors in each Block is repeated 192 times.

3.3.12 De-Icing

When an ECC block on a DVD+RW medium is blank, no headers are present in any sector of the ECC block. When no data is present, a seek is unable to find a stopping point. In these cases, it is not possible to locate any sector. A seek to any address would result in a continuous "slide" across the media as if it was covered in ice. This is a problem only for the random access feature.

Writing the entire surface (formatting) ensures the presence of data and headers. This makes seeking possible. The process of writing the entire surface is called De-Icing.

3.3.13 DVD

DVD is a family of related optical storage media and Drives.

3.3.14 DVD+R (DVD plus Recordable)

DVD+R is a wobble groove based DVD medium that is write-once.

3.3.15 DVD+RW (DVD ReWritable)

DVD+RW is a wobble groove based DVD media that is rewritable.

3.3.16 DVD-R (DVD Recordable)

DVD-R is a wobble groove based DVD medium that is write-once.

3.3.17 DVD-RAM (DVD-Random Access Memory)

DVD -RAM is rewritable DVD media. A DVD -RAM spiral has stamped headers, thereby negating the need for full format.

3.3.18 DVD-ROM (DVD-Read Only Memory)

DVD-Read Only Memory (DVD-ROM) is a standard medium defined by the "DVD -Book" for recording digital data, including Digital Video Movie data.

3.3.19 DVD-RW (DVD Re-recordable)

DVD-RW is a wobble groove based DVD media that is rewritable.

3.3.20 DVD-Video

DVD-Video is a DVD format defined for video applications as specified in the DVD Books.

3.3.21 Disc Key

The Disc Key is a general reference to a cryptographic key that exists for the protection of disc content. The exact meaning is specific to the content protection type.

3.3.22 Disc Manufacturing Information

The Disc Manufacturing Information is recorded in the Control Data Zone and contains information supplied by the disc manufacturer.

3.3.23 ECC Block

The DVD ECC block is 16 data sectors and a layered product error correction code. The HD DVD ECC block is 32 data sectors and a layered product error correction code.

3.3.24 Fragment

Fragment refers to a Logical Track on DVD+R media. See Logical Track.

3.3.25 Identification Data (ID)

The data ID field of a DVD/HD DVD sector is a 4-byte field that contains sector information and a physical sector number.

3.3.26 ID Error Detection (IED)

The IED is an EDC for detecting errors in an ID field on DVD/HD DVD media.

3.3.27 Region Playback Control (RPC)

The region playback code is used to identify one or more regions of the world for use by RPC.

3.3.28 Regional Code

The regional code is used to identify one or more regions of the world. Six regions defined.

3.3.29 Recording Management Area (RMA)

RMA is an area for recording RMD. This area starts right after the PCA and it ends at the start of the Lead-in.

3.3.30 Recording Management Data (RMD)

The data to be stored in RMA/RMZ/RDZ.

3.3.31 Recording management zone (RMZ)

RMZ is the zone for recording RMD. Three kinds of RMZ formats are defined, L-RMZ, B-RMZ and U-RMZ.

3.3.32 Rzone

Rzone refers to a Logical Track on DVD-R, DVD-RW, and HD DVD-R media. The RZone is a collection of logical blocks with a defined sequence of recording. The RZone is a structure to manage a data appendable point. See Logical Track.

3.3.33 Title Key

A value used during the encryption/decryption process of user data on DVD media.

3.4 BD Specific Terms**3.4.1 Address In Pre-groove (ADIP)**

Address and recording information encoded in the wobble pre-groove on BD-R/RE is named the Address in pre-groove (ADIP).

3.4.2 Blu-ray Disc (BD)

Blu-ray Disc is a family of related optical storage media and drives.

3.4.3 Blu-ray Disc – Recordable (BD-R)

BD-R disc is a BD disc that is write once in increments of 65 536 bytes.

3.4.4 Blu-ray Disc – Rewritable (BD-RE)

BD-RE disc is a BD disc that is Rewritable.

3.4.5 Blu-ray Disc – Read-only Memory (BD-ROM)

A BD-ROM disc is a read-only BD disc.

3.4.6 Cluster

A BD Cluster contains 32 logical sectors. The data of these 32 sectors are interleaved, scrambled, and EDC and ECC symbols are attached.

3.4.7 Disc Definition Structure (DDS)

The DDS is contained within a sector of the DMS. The DDS contains basic format information about the disc, e.g. the physical location of LSN 0, the physical location of the last LSN, and the sizes of the spare areas. On BD-R, the DDS also contains recording mode and TDMA information.

3.4.8 Disc/Defect Management Structure (DMS)

The DMS contains structures that define the disc format and that are necessary for defect management. On BD-R there are two kinds of Disc Management Structures:

1. The Temporary Disc Management Structures (TDMS), recorded in the TDMA Areas as long as the disc has not been closed.
2. Disc Management Structures (DMS), recorded in the DMA Areas when a disc is closed (to preserve all Disc Management information contained in the last Temporary Disc Management Structure).

On BD-RE the Defect Management Structure is written and updated in the DMAs of the inner and outer zones.

3.4.9 Inner Spare Area (ISA0, ISA1)

When defect management is used on BD-R or BD-RE, a spare area may be allocated in the inner radius of each layer. Each of these areas is an Inner Spare Area (ISA). The ISA on layer 0 is referenced as ISA0, while the ISA on layer 1 is referenced as ISA1.

3.4.10 Logical Overwrite (LOW)

LOW is defined in *System Description Blu-ray Disc Recordable Format, Part 1: Basic Format Specifications* as the physical description of Pseudo-Overwrite. See the Pseudo-Overwrite definition.

3.4.11 Orphan LBA(s)

When a POW is executed, the relocation occurs at the NWA, N of some SRR, T. After the POW execution, the NWA is now $N+32*K$, where K is the number of POWed Clusters. LBAs N, N+1, ..., $N+32*K-1$ cannot be used in the next appending write to T. Consequently, these LBAs may be used only by additional POW operations. However, since there is not previous data to replace, these LBAs are Orphans.

3.4.12 Outer Spare Area (OSA0, OSA1)

When defect management is used on BD-R or BD-RE, a spare area may be allocated in the outer radius of each layer. Each of these areas is an Outer Spare Area (OSA). The OSA on layer 0 is referenced as OSA0, while the OSA on layer 1 is referenced as OSA1.

3.4.13 Permanent Information & Control data (PIC) Area

This zone contains general information about the disc. The PIC is embossed on all disc types.

3.4.14 Pseudo-Overwrite (POW)

By using the Linear Replacement algorithm of the BD-R system, overwriting of a recorded Cluster is allowed. POW replacements are taken from the user data area and mapped using DFL. (POW is only defined for SRM formatted BD-R discs.)

3.4.15 Random Recording Mode (RRM)

In the BD-R Random Recording Mode, data can be randomly written at every un-recorded Cluster.

3.4.16 Sequential Recording Mode (SRM)

Sequential Recording Mode is defined for BD-R to implement the generalized track/session model defined by MMC for implementation of the Incremental Streaming Writable Feature.

3.4.17 Sequential Recording Range (SRR)

Sequential Recording Range (SRR) is the physical definition of Logical Track for a BD-R in SRM.

3.4.18 Sequential Recording Range Information (SRRI)

Information about the location and status of all SRRs is stored in the Sequential Recording Range Information (SRRI) structures. While the disc is not finalized, the SRRI shall be recorded in the Temporary Disc Management Areas (TDMAs). At finalization, the most recent version of the SRRI is recorded in the Disc Management Area (DMA).

3.4.19 Space Bit Map (SBM)

A Space Bit Map specifies the recording status for a Recording Layer a BD-R disc formatted in Random Recording Mode (RRM).

3.4.20 SRM+POW

A BD-R disc has the SRM+POW status when it has been formatted in Sequential Recording Mode with the POW feature enabled.

3.4.21 SRM-POW

A BD-R disc has the SRM-POW status when it has been formatted in Sequential Recording Mode with the POW feature disabled.

3.4.22 Temporary Disc Management Area (TDMA)

On BD-R, the defect management and recording management information needs to be updated many times during use. For this purpose special areas are available in the Lead-in/Lead-out Area called the Temporary Disc Management Area. Additional TDMA's may be defined within spare areas.

3.4.23 Temporary Disc Management Structure (TDMS)

On BD-R, the Temporary Disc Management Structure (TDMS) is a version of the DMS recorded in a TDMA. The TDMS consists of the following three elements depending on the recording mode.

For sequential recording mode the TDMS consists of:

1. Temporary Disc Definition Structure (TDDS),
2. Temporary Defect List (TDFL),
3. Sequential Recording Range Information (SRRI).

For random recording mode the TDMS consists of:

1. Temporary Disc Definition Structure (TDDS),
2. Temporary Defect List (TDFL),
3. Space Bit Maps (SBM).

3.5 Abbreviations and Acronyms

AACS	Advanced Access Content System
ADIP	Address In Pre-groove
AGID	Authentication Grant ID
ASC	Additional Sense Code
ASCQ	Additional Sense Code Qualifier
ATA	AT Attachment
ATAPI	AT Attachment Packet Interface
ATIP	Absolute Time In Pre-groove
BD	Blu-ray Disc
BD-R	Blu-ray Disc Recordable
BD-RE	Blu-ray Disc Rewritable
BD-ROM	Blu-ray Disc Read-only Memory
BCA	Burst Cutting Area
BCD	Binary Coded Decimal
BG	Background
CDB	Command Descriptor Block
CD	Compact Disc
CDZ	Control Data Zone (on DVD media)
CD-DA	CD – Digital Audio
CD-R	CD – Recordable
CD-ROM	CD – Read Only Memory
CD R/RW	a CD-R, a CD-RW, or both
CD-RW	CD ReWritable
CPPM	Content Protection for Prerecorded Media
CPRM	Content Protection for Recordable Media
CIRC	Cross Interleaved Reed-Solomon Code
DA	Data Area
DBI	Defective Block Information
DVD	Digital Versatile Disc
DVD-R	DVD Recordable
DVD-RW	DVD Re-recordable
DVD-R/-RW	DVD-R, DVD-RW or both
DVD-RAM	DVD-Random Access Memory
DVD-ROM	DVD-Read Only Memory
DVD+R	DVD Recordable
DVD+RW	DVD ReWritable
DVD+R/+RW	DVD+R, DVD+RW or both
DZ	Data Zone
EAN	European Article Number
ECC	Error Correction Code
EDC	Error Detection Code

EFM	Eight-to-Fourteen Modulation code
HD DVD	High Definition DVD
HD DVD-R	HD DVD Recordable
HD DVD-ROM	HD DVD Read-Only-Memory
HD DVD-RW	HD DVD Rewritable
ID	Identification Data
IED	ID Error Detection
ISAx	Inner Spare Area, layer x
L-EC	Layered Error Correction
LBA	Logical Block Address
LSB	Least Significant Bit
LUN	Drive Number
MCN	Media Catalog Number
MDT	Main Defect Table
MIP	Main Information Packet
MM	Multi-Media
MRW	Mount Rainier reWritable
MSB	Most Significant Bit
MSF	Minute/Second/Frame
OPC	Optimum Power Calibration
OSAx	Outer Spare Area, layer x
OTP	Opposite Track Path
PIC	Permanent Information & Control
PTP	Parallel Track Path
PMA	Program Memory Area
PSN	Physical Number
RPC	Region Playback Control
SIP	Secondary Information Packet
SK	Sense Key
TOC	Table of Contents
TAO	Track at Once
TDB	Track Descriptor Block
TSR	Timely, Safe Recording
UDF	Universal Disk Format
UPC	Uniform Product Code

3.6 Keywords

3.6.1 **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.

3.6.2 **legacy**

Bits, bytes, fields, and code values that have been defined in previous standards but have been replaced by preferred methods in this standard may be considered obsolete. If the method has a long-standing history of use, then obsoleting the method may be detrimental to many users and should then be defined as legacy rather than obsolete.

Initiators should not use legacy commands or mode pages.

Devices conforming to this standard should not support commands or mode pages defined as legacy in previous standards.

Legacy methods do not appear in the main body of this or subsequent standards.

Legacy methods that are considered important are specified in an informative annex of this standard. Devices implementing legacy commands or mode pages shall implement them according to the most recent and appropriate standard that carries a definition.

3.6.3 **may**

May indicates flexibility of choice with no implied preference (equivalent to “may or may not”).

3.6.4 **may not**

May not indicates flexibility of choice with no implied preference (equivalent to “may or may not”).

3.6.5 **shall**

A keyword indicating a mandatory requirement. Designers are required to implement all such mandatory requirements to ensure interoperability with other standard conforming products.

3.6.6 **should**

A keyword indicating flexibility of choice with a strongly preferred alternative. Equivalent to the phrase “it is recommended.”

3.6.7 **obsolete**

A keyword used to describe bits, bytes, fields, and code values that have been defined in prior standards but has been removed from this standard.

Devices conforming to this standard should not support commands or mode pages defined as obsolete in previous standards. Devices implementing obsolete commands or mode pages shall implement them according to the most recent and appropriate standard that carries a definition.

If obsolete bits, bytes, fields, or code values are not implemented, their value shall be reserved.

3.6.8 **mandatory**

A keyword indicating items required to be implemented as defined by this standard.

3.6.9 **optional**

A keyword that describes Features that are not required for compliance to this standard. However, if any optional Feature defined is implemented, it shall be implemented as defined by this standard.

3.6.10 **reserved**

A keyword referring to bits, bytes, words, fields and code values that are set aside for future standardization. A reserved bit, byte, word or field shall be set to zero, or in accordance with a future extension to this standard. 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 error.

3.7 Conventions

Various conventions are used through out this standard and are identified in this sub-clause.

Certain words and terms used in this standard have a specific meaning beyond the normal English meaning. These words and terms are defined either in 3.1 or in the text where they first appear.

Names of commands, statuses, sense keys, and additional sense codes are in all uppercase (e.g., REQUEST SENSE). Lowercase is used for words having the normal English meaning.

If there is more than one CDB length for a particular command (e.g., MODE SENSE(6) and MODE SENSE(10)) and the name of the command is used in a sentence without any CDB length descriptor (e.g., MODE SENSE), then the condition specified in the sentence applies to all CDB lengths for that command.

The names of fields are in uppercase (e.g., ALLOCATION LENGTH). 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.

The decimal sign is a comma (,) on the line between the whole and fractional numbers. Spaces are used to separate groups of three digits on either side of the decimal sign. A value less than 1 is written with a zero preceding the decimal sign. Numbers that are not immediately followed by lowercase "b," "h," or "bcd" are decimal values.

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

Numbers immediately followed by lowercase "h" (xxh) are hexadecimal values.

Numbers immediately followed by lowercase "bcd" (xxbcd) are binary coded decimal values.

Values indicated by a lower case "k" have a base value of 1 000 units.

Values indicated by an uppercase "K" have a base value of 1 024 units.

Values indicated by a lower case "m" have a base value of 1 000 000 units.

Values indicated by an uppercase "M" have a base value of 1 048 576 units.

Values indicated by a lower case "g" have a base value of 1 000 000 000 units.

Values indicated by an uppercase "G" have a base value of 1 073 741 824 units.

When the value of the bit or field is not relevant, x or xx appears in place of a specific value.

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.

Recommended error code tables defined within each command sub-clause uses the following:

Errors shown in mixed case indicate all errors, in that class, are valid.

Errors shown in uppercase refer to the identified specific error condition.

The string SK/ASC/ASCQ refers to the low order 4 bits of byte 2 and bytes 12, and 13 in the referenced Drive's sense data. SK/ASC/ASCQ is used interchangeably with the names associated with the coded values in those sense bytes. In this standard, the numeric SK value may be replaced by its equivalent text. The numeric values of ASC and ASCQ are typically replaced by a single text phrase. e.g., when the numeric values for SK/ASC/ASCQ are 03h/11h/05h, the text replacements are MEDIUM ERROR/L-EC UNCORRECTABLE ERROR.

If a reference is made to a document or standard, the document or standard name appears in italics.

Formulae appear in italics.

3.8 Bit and byte ordering

This subclause describes the representation of fields in a table that defines the format of a SCSI structure (e.g., the format of a CDB).

If a field consists of more than one bit and contains a single value (e.g., a number), the least significant bit (LSB) is shown on the right and the most significant bit (MSB) is shown on the left (e.g., in a byte, bit 7 is the MSB and is shown on the left; and bit 0 is the LSB and is shown on the right). The MSB and LSB are not labeled if the field consists of 8 or fewer bits.

If a field consists of more than one byte and contains a single value, the byte containing the MSB is stored at the lowest address and the byte containing the LSB is stored at the highest address (i.e., big-endian byte ordering). The MSB and LSB are labeled.

If a field consists of more than one byte and contains multiple fields each with their own values (e.g., a descriptor), there is no MSB and LSB of the field itself and thus there are no MSB and LSB labels. Each individual field has an MSB and LSB that are labeled as appropriate in the table (if any) that describes the format of the sub-structure having multiple fields.

If a field contains a text string (e.g., ASCII), the MSB label is the MSB of the first character and the LSB label is the LSB of the last character.

When required for clarity, multiple byte fields may be represented with only two rows in a table. This condition is represented by values in the byte number column not increasing by one in each subsequent table row, thus indicating the presence of additional bytes.

3.9 Notation conventions

When this standard requires one or more bytes to contain specific encoded character, the specific characters are enclosed in double quotation marks. The double quotation marks identify the start and end of the characters that are required to be encoded but are not themselves to be encoded. The characters that are to be encoded are shown in exactly the case that is to be encoded.

The encoded characters and the double quotation marks that enclose them are preceded by text that specifies the character encoding methodology and the number of characters required to be encoded.

Using the notation described in this subclause, stating that eleven ASCII characters "SCSI device" are to be encoded would be the same writing out the following sequence of byte values: 53h 43h 53h 49h 20h 64h 65h 76h 69h 63h 65h.