WORKING DRAFT

NCITS T10 1228D

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INFORMATION TECHNOLOGY - SCSI-3 Multimedia Commands

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ABSTRACT

This working draft standard defines the SCSI-3 command set extensions to access multimedia features for all classes of SCSI-3 devices. The applicable clauses of this standard when used in conjunction with the SCSI Primary Commands specification, SCSI-3 Block Commands, and other applicable command set documents pertaining to the subject device class, define the full standard set of commands available for that device in the SCSI-3 environment.

PATENT STATEMENT

The developers of this standard have requested that holder's of patents that may be required for the implementation of the standard, disclose such patents to the publisher. However neither the developers nor the publisher have undertaken a patent search in order to identify which if any patents may apply to this standard.

No position is taken with respect to the validity of any claim or any patent rights that may have been disclosed. Details of submitted statements may be obtained from the publisher concerning any statement of patents and willingness to grant a license under these rights on reasonable and non-discriminatory terms and conditions to applicants desiring to obtain such a license.

REVISION HISTORY

Revision 0.0 Initial draft of the document

Revision 1.0 Additional commands added to document

Revision 2.0 Document structure completed, added Features clause, added annex's.

Revision 3.0 Added DVD commands, Annex P, Annex Q, and other document changes. No Change bars.

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Foreword

The Multimedia Command Set standard at present consists of seven clauses and three normative annexes. In addition there are three informative annexes. This standard now describes the CD, CD-R/RW, DVD-ROM, DVD-R, and DVD RAM devices. Also included Magnetic Disks, Tape Drives, that implement a serial bus attachment via the Serial Bus Protocol version 2. All other clauses will be applicable to any device class described in this document unless explicitly stated otherwise.

Clause 1 is the scope.

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

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

Clause 4 describes an overview of models of included device classes and the conventions used in this standard.

Clause 5 describes and identifies Feature Sets and Profile that specify the device command and status implementation.

Clause 6 describes all of the commands applicable to the included device classes.

Clause 7 describes the various parameters and mode pages used in control of device features and error recovery

Annex A describes additional sense codes for all included device classes (normative).

Annex B contains a requirements for ATAPI Compliance (normative).

Annex C contains listing of commands and behavior during Play/Scan Operation for C/DVD device classes(normative).

Annex E contains the requirements for SBP-2 Compliance (Normative)

Annex M contains Get Configuration implementation(informative)

Annex N contains listings of commands used by C/DVD device classes (informative).

Annex O describes the Event/Status Notification functions (informative)

Annex P describes the Power management functions for all included device classes (informative)

Annex Q describes the CD TEXT Format in the Lead-In Area (informative)

Other industry standards were reviewed and consulted by the committee in the development of this standard. These standards and specifications are directly related to CD-ROMs, CD-R devices, CD-R/RW devices, DVD-ROM devices, DVD-R devices, and DVD-RAM devices. The documents included Compact Disc CD-DA (RED BOOK), Compact Disc CD-ROM (YELLOW BOOK), Compact Disc CD-R, Recordable CD Systems (ORANGE BOOKS Part II and Part III), Compact Disc CD-XA, Compact Disc CD-DA Enhanced Audio CD Version 1.0, and Multi-Session Compact Disc. Where practical, this standard is consistent with the accepted industry standards that were consulted.

Introduction

This MMC-2 command set is defined independently of the physical and signaling protocol to enable its implementation in a number of environments. The NCITS T10 technical committee has seen the need to address the unique requrements for the SCSI support of multimedia in this document. This provides a central reference for both multimedia implementors and implementors of the SCSI-3 standard.

The physical transports currently being defined for SCSI-3 command sets include SCSI Parallel Interface (SPI), Serial Storage Architecture (SSA), Fibre Channel FC-4, and IEEE 1394 described in Serial Bus Protocol -2(SBP-2). Implementors may assure architectural coherency across multiple environments by implementing the applicable clauses contained within the SCSI-3 Architectural Model Specification (SAM) (X3.270-1996).

It is anticipated that this standard may be updated periodically in response to technological advances.

All standard updates are subject to the NCITS policies and procedures accredited by ANSI and involve a public review period and balloting process.

With any technical document there may arise questions of interpretation as new products are implemented. The NCITS Committee has established procedures to issue technical opinions concerning the standards developed by the NCITS organization. These procedures may result in SCSI Technical Information Bulletins being published by NCITS .

These Bulletins, while reflecting the opinion of the Technical Committee that developed the standard, are intended solely as supplementary information to other users of the standard. This standard, NCITS T10/1228D, as approved through the publication and voting procedures of the American National Standards Institute, is not altered by these bulletins. Any subsequent revision to this draft standard may or may not reflect the contents of these Technical Information Bulletins.

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1. Scope

This standard defines the multimedia command set extensions for all classes of SCSI devices. The commands specified within this standard define standard access and control to those features of the device that are used in multimedia applications (audio, video, animation). The entire standard command set available for a subject device is fully specified by the clause/clauses of this standard pertaining to that device, the applicable clauses of SCSI-3 Primary Commands, and any additional command set standards pertaining to the subject device.

The SPC command set and these extensions are transport independent and may be implemented across a wide variety of environments for which a SCSI-3 command mapping and delivery vehicle has been defined. To date these include Fibre Channel, SCSI Parallel Interface, High Performance Serial Bus, and Serial Storage Architecture.

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

1) To provide a definition of the command format and functionality independent of delivery, protocol/signaling or transport mechanism. Architectural constraints regarding command function across the various transports are addressed in the SCSI-3 Architectural Model and the document specific to the physical transport.

2) To provide standardized access to common features of SCSI-3 devices employed in multimedia applications.

3) To provide host computer software/firmware with device independence within a class of devices. Thus, different tape drives, optical media drives, and other devices can be added to host computers without requiring modifications to generic system hardware and software. Provision is made for the addition of special features and functions through the use of vendor-specific options. Reserved opcodes are provided for future standardization.

4) To provide compatibility such that properly conforming SCSI-2 devices may inter-operate with SCSI-3 devices given that the systems engineering is correctly done. SCSI-3 protocol extensions are designed to be permissive of rejections by conforming SCSI-2 devices and thus allow the SCSI-2 device to continue operation without requiring the use of the extension.

2. Normative References

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

Copies of the following documents can 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.

Additional availability contact information is provided below as needed.

2.1. Approved references

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

SCSI-3 Parallel Interface (SPI)	ANSI Standard X3.253:1995
SCSI-3 Interlocked Protocol (SIP)	ANSI Standard X3.292:1997
SCSI-3 Primary Commands (SPC)	ANSI Standard X3.301:1997

ISO/IEC 10149, Information Technology-Data Interchange on Read-only 120 mm Optical Data Discs (CD-ROM).

IEC 908:1987, Compact Disc Digital Audio System.

IEEE High Performance Serial Bus, IEEE 1394-1995.

Members of IEC and ISO maintain registers of currently valid International Standards.

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.

SCSI-3 Medium Changer Commands (SMC)	[X3T10/0999-D]
SCSI-3 MultiMedia Command Set (MMC-1)	[NCITS T10/1048D BSR # X3.304]
SCSI-3 Block Command Set (SBC)	[NCITS T10/00996D]
Serial Bus Protocol - 2 (SBP-2)	[NCITS T10/1155D]
SCSI-3 Parallel Interface - 2 (SPI-2)	[NCITS T10/1142D]
SCSI-3 Primary Command Set - 2 (SPC-2)	[NCITS T10/1236D]

IEEE P1394A High Performance Serial Bus

For more information on the current status of the above documents, contact (Secretariat). To obtain copies of these documents, contact Global Engineering or (Secretariat).

2.3. Other references

The following standards and specification were also consulted.

Compact Disc Digital Audio (CD-DA), specified in the System Description Compact Disc Digital Audio ("Red Book"), N.V. Philips and Sony Corporation. See also IEC 908:1987, Compact Disc Digital Audio System

Compact Disc Read Only Memory (CD-ROM), specified in the System Description Compact Disc Read Only Memory ("Yellow Book"), N.V. Philips and Sony Corporation. See also ISO/IEC 10149, Information Technology-Data Interchange on Read-only 120 mm Optical Data Discs (CD-ROM).

Compact Disc Interactive (CD-I), specified in the CD-I Full Functional Specification ("Green Book"), N.V. Philips and Sony Corporation.

Compact Disc Read Only Memory eXtended Architecture (CD-ROM XA), specified in the System Description CD-ROM XA, N.V. Philips and Sony Corporation.

Compact Disc Write Once (CD-WO), specified in the System Description Recordable Compact Disc Systems, part II: CD-WO (Orange Book part II), N.V. Philips and Sony Corporation

Compact Disc Rewritable (CD-RW), specified in the System Description Recordable Compact Disc Systems, part III: CD-RW (Orange Book part III), N.V. Philips and Sony Corporation

Multi-session Compact Disc, specified in the Multi-session Compact Disc Specification, N.V. Philips and Sony Corporation.

3. Definitions, abbreviations and symbols

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 the glossary or in the text where they first appear. Lower case is used for words having the normal English meaning.

Fields containing only one bit are referred to as the “named” bit instead of the “named” field.

3.1. Definitions of terms

3.1.1. Absolute MSF field - See MSF address definition.

3.1.2. algorithm type - Refers to various copy protection techniques.

3.1.3. appendable disc - A disc in which the last session has a pointer to the next possible session.

3.1.4. ATA (AT Attachment) - ATA defines the physical, electrical, transport, and command protocols for the internal attachment of block storage devices.

3.1.5. ATAPI (AT Attachment Packet Interface) - A device which complies with ANSI NCITS .***-199x, the AT Attachment Packet Interface. In this document such devices are referred to as devices implementing the Packet command feature set.

3.1.6. ATIP - Absolute Time In Pre-groove

3.1.7. AGID (Authentication Grant ID) - A value used for resource control during key management. Individual key management threads are identified through the use of AGID.

3.1.8. bcd - binary coded decimal - The number system used on the physical CD media. Numbers that use this notation have the 'bcd' suffix attached. A byte has two four-bit values each of which can have a value from 0 to 9. The maximum value is 99 bcd (99 decimal).

3.1.9. Bootable CD - a CD that is capable of providing boot records.

3.1.10. BCA (Burst cutting area) - Provides a unique physical identification mark for individual DVD medium. This area is not directly addressable by the user.

3.1.11. C/DVD Media - Term that is used when referring to media that conform either to the CD or DVD specifications.

3.1.12. Challenge key - Data used during an authentication key exchange process.

3.1.13. CDB (Command Descriptor Block) - The structure used to communicate commands from a host to C/DVD.

3.1.14. command packet - “Command Packet” is a structure used to communicate commands from a host to a C/DVD drive. See Command Descriptor Block.

3.1.15. complete session - A session that contains a written lead-in and lead-out.

3.1.16. CD-DA (Compact Disc-Digital Audio) - The standard for storing digital audio information. See IEC 908:1987.

3.1.17. CD (Compact Disc) - A family of related optical storage media or Logical Units.

3.1.18. CD-ROM (Compact Disc - Read Only Memory) - A standard for storing digitized audio and digital data. CD-ROM is used to describe media with digital data rather than discs that encode audio only.

3.1.19. CD control field - A four bit field in the Q sub-channel data indicating the type of information encoded on the current track. Indicates audio versus data and the type of audio encoding, etc. The control field is also found in the Table of Contents entries.

3.1.20. CD data mode - A byte in the header of CD data sectors. This indicates if data is present and if layered error correction information is present.

3.1.21. CD-RW (CD ReWritable) - A CD that can be re-written.

3.1.22. CD-R (CD Recordable) - A CD that can be written only once.

3.1.23. CD R/RW - either a CD-R, or a CD-RW, or both.

3.1.24. CD TEXT - A method for storing text information on CD-DA disc

3.1.25. CIRC (Cross Interleaved Reed-Solomon Code) - The error detection and correction technique used on a CD. The CIRC bytes are present in all CD modes. The error correction procedure which uses the CIRC bytes is referred to as the CIRC based algorithm.

3.1.26. Defect Management - A method for providing error free media.

3.1.27. Disc Key - A value used during the scrambling process of the title key data on DVD media.

3.1.28. Double Sided - A medium with two independently addressed sides.

3.1.29. Dual Layer - Two surfaces that can be accessed from the same side. On dual layer Discs the data is recorded using either OTP or PTP.

3.1.30. DVD - A family of related optical storage media and Logical Units.

3.1.31. DVD Control Area - The DVD Control area is comprised of 192 ECC blocks in the Lead-in Area of a DVD medium. The content of 16 sectors in each block is repeated 192 times. This area contains information concerning the disc.

3.1.32. DVD Disc Manufacturing Information - The DVD Disc Manufacturing Information is recorded in the DVD Control Area and contains information supplied by the disc manufacturer.

3.1.33. DVD ECC-Block - A self-contained block of data and error correction codes that are grouped into a sequential series of 16 DVD sectors.

3.1.34. DVD-R (DVD Recordable) - A CD that can be re-written.

3.1.35. DVD-RAM (DVD-Random Access Memory) - A CD that can be re-written.

3.1.36. DVD-ROM (DVD-Read Only Memory) - A standardized medium defined by the DVD specification for recording digital data, including digital video movie data.

3.1.37. EAN (European Article Number) - Controlled by the EAN Council located at Rue des Colonies, 54-BTE8, 1000 Brussels, Belgium.

3.1.38. ECC (Error Correction Code) - A code for detecting and correcting errors.

3.1.39. EDC (Error Detection Code) - A code for detecting an error.

3.1.40. field - A Field is a group of two or more contiguous bits.

3.1.41. Fixed Packet Track - a track that contains a TDB indicating that the track is a fixed track, and has user packets of a fixed size specified in the TDB.

3.1.42. format - The arrangement or layout of information on a medium.

3.1.43. frame - A sector on CD media. Also the F field unit of a MSF CD address. The smallest addressable unit.

3.1.44. hold track state - When a C/DVD device enters the hold track state the optical pick-up is maintained at an approximately constant radial position on the media.

3.1.45. ID - A four byte field in the header of DVD sectors which contains sector information and a physical sector number.

3.1.46. IED (ID Error Detection) - A code for detecting errors in an ID field.

3.1.47. incomplete session - A session without lead-in and lead-out written.

3.1.48. index - An index is a subdivision of a track.

3.1.49. Layer - The recorded information is in layers as seen from one side of a DVD Disc. There are single and dual layer Discs.

3.1.50. lead-in - On CD media it is the area that contains the TOC data and precedes each program area. The main channel in the lead-in area contains audio or data null information. This area is coded as track zero. The Q sub-channel in this area is coded with the Table of Contents information.
The DVD Lead-in area is the area comprising physical sectors 1.2 mm wide or more adjacent to the inside of the Data area. The area contains the Control data and precedes the Data area.

3.1.51. lead-out - On CD media it is the area that follows each program area. The main channel in the lead-out area contains audio or data null information. This area is coded as track AA h. The READ CD CAPACITY data is the first logical block address of this area minus one.
The DVD Lead-out area is the area comprising physical sectors 1.0 mm wide or more adjacent to the outside of the data area in single layered disc for PTP (Parallel Track Path) disc, or area comprising physical sectors 1.2 mm wide or more adjacent to the inside of the data area in layer 1 of OTP (Opposite Track Path) disc.

3.1.52. L-EC (Layered Error Correction) - The second level of error correction used on CD data.

3.1.53. Logical Block - A host addressable unit of data.

3.1.54. LBA (Logical Block Address) - The LBA defines a mapping mode to a linear address space.

3.1.55. Logical Unit - A physical or virtual peripheral device addressable through a target.

3.1.56. LUN (Logical Unit Number) - The address of a Logical Unit.

3.1.57. Medium - A single Disc.

3.1.58. Middle Area - Area comprising physical sectors 1.0 mm wide or more adjacent to the outside of the Data Area in OTP (Opposite Track Path) disc on both layers of DVD media.

3.1.59. MSF address (Minute/Second/Frame) - 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 74.

3.1.60. OPC (Optimum Power Calibration) - a procedure performed by the device to calibrate laser power. Values from this calibration are used for subsequent write operation.

3.1.61. OTP (Opposite Track Path) - A dual layer disc that has a Lead in, two separated user areas, Lead-out, and a Middle area. The physical sector number (PSN) of layer 0 increases to the Lead-out and the one of layer 1 that is complement of layer 0 address increases from the Lead-out to Lead-in.

3.1.62. output port - A means for connecting to data ports other than the Initiator interface.

3.1.63. PTP (Parallel Track Path) - A dual layer disc that has a Lead in, user area and Lead-out in each layer respectively. The ID sector number of both layers increases to the Lead-out in parallel.

3.1.64. Packet - a set of recorded link, run-in, data, and run-out blocks. Typical packet:

3.1.65. packet size - is the number of Data Blocks in the packet.

3.1.66. packet track - a track written as a concatenation of a pre-gap, written as one or two packets, and some non-zero number of user packets.

3.1.67. Physical Sector Number - A unique address assigned to a physical location and is not modifiable.

3.1.68. post-gap - A transition area at the end of a data track.

3.1.69. pre-gap - A transition area at the beginning of a data track.

3.1.70. Program Area(s) - a logical address space.

3.1.71. PMA (Program Memory Area) - Contains information about the recordings on a recordable disc.

3.1.72. Regional Code - A value used to identify one or more regions of the world. Currently there are only six regions defined.

3.1.73. relative MSF field - See MSF address definition.

3.1.74. Scramble Flag - An indication that there is scrambled data on the media.

3.1.75. Sector - In case of CD media, "Sector" refers to the data contained in one frame. In the CD-ROM standard (IEC/ISO 10149) the term block is used for this unit.
In the case of DVD media, Sector is the smallest user addressable part of the media. The user data contained within a sector is 2048 bytes.

3.1.76. Session - A contiguous area of a Disc that contains a lead-in, a Program Area, and a lead-out.

3.1.77. Single Layer - The single layer has singular layer per read-out side.

3.1.78. Single Sided - DVD disc structure is that the two transparent substrates joined together such that the recorded layers are on the inside. Single sided disc has one recorded side and one unrecorded side.

3.1.79. small frame - 1/98 of a frame.

3.1.80. 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 addresses. The data rate of each sub-channel (P, Q, etc.) is 1/192nd of that of the main channel.

3.1.81. TOC Table of Contents - 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 the lead-in area.

3.1.82. Title Key - A value used during the scrambling process of movie data on DVD media.

3.1.83. Track Descriptor Block (TDB) - Contains information on the attributes of the current track.

3.1.84. track - A logical sub-division of the CD media.

3.1.85. Track at Once - When a track, including its pre-gap, is written as a single packet.

3.1.86. track relative logical address - The value used to address logical blocks relative to the beginning of a track.

3.1.87. transition area - Sectors at the beginning or end of tracks e.g. Pause Area, Pre-Gap, lead-out, Post -Gap.

3.1.88. UPC (Uniform Product Code) - Controlled by the UPC Council, located at 8163 Old Yankee Road, Suite J, Dayton, Ohio 45459.

3.1.89. user packet - a packet that contains only user data blocks as the data blocks. User data blocks consist of data transferred to the device during a write command.

3.1.90. writable disc - A disc that is blank, appendable, or contains an incomplete session.

3.1.91. Yellow book - ISO/IEC 10149, Information Technology-Data Interchange on Read-only 120 mm Optical Data Discs (CD-ROM).

3.2. Abbreviations and symbols

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.

3.3. Conventions

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

3.3.1. 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.

3.4. Keywords

Several keywords are used to differentiate between levels of requirements and options, as listed below.

3.4.1. **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.

3.4.2. **may** - A keyword that indicates flexibility of choice with no implied preference.

3.4.3. **shall** - A keyword indicating a mandatory requirement. Designers are required to implement all such mandatory requirements to ensure interpretability with other standard conforming products.

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

3.4.5. **obsolete** - A keyword indicating items that were defined in prior version of this standard. These items shall be removed from future version of this standard.

3.4.6. **mandatory** - A keyword indicating items required to be implemented as defined by this standard.

3.4.7. **optional** - A keyword that describes features which are not required to be implemented as defined by this standard. However, if any optional feature defined by the standard is implemented, it shall be implemented as defined by the standard.

3.4.8. **reserved** - A keyword referring to bits, bytes, words, fields and code values that are set aside for future standardization. Their use and interpretation may be specified by future extensions to this or other standards. A reserved bit, byte, word, or field shall be set to zero, or in accordance with future extension to this standard. The recipient shall not check reserved bits, bytes, words or fields. Receipt of reserved code values in defined fields shall be treated as an error.

4. C/DVD Models

4.1. General

4.1.1. CD address reporting formats (MSF bit)

Several CD commands can report addresses either in logical block address or in MSF format (see Table 1). The READ HEADER, READ SUB-CHANNEL, and READ TOC/PMA/ATIP commands have this feature.

Table 1 - MSF Address format

Bit / Byte	7	6	5	4	3	2	1	0
0	Reserved							
1	M field							
2	S field							
3	F field							

An MSF bit of zero requests that the logical block address format be used for the CD absolute address field or for the offset from the beginning of the current track expressed as a number of logical blocks in a CD-ROM track relative address field. This track relative logical block address (TRLBA) value is reported as a negative value in twos-complement notation for transition areas that have decreasing MSF encoded relative addresses.

An MSF bit of one requests that the MSF format be used for these fields. In certain transition areas, the relative MSF addresses are decreasing positive values. The absolute MSF addresses are always increasing positive values.

The M, S, and F fields are expressed as binary numbers. The values match those on the media, except for the encoding.

NOTE: For a logical block size of 512 bytes, the MSF address returned is that for the physical block containing the specified logical blocks.

4.1.2. Logical Blocks

Blocks of data are stored on the medium along with additional information that the controller uses to manage the storage and retrieval. The format of the additional information is unique and is hidden from the Host during normal read or write operations. This additional information is often used to identify the physical location of the blocks of data and the ad-dress of the logical block, and to provide protection against the loss of the user data.

The address of the first logical block is zero. The address of the last logical block is [n-1], where [n] is the number of logical blocks available on the medium. A READ C/DVD RECORDED CAPACITY command may be issued to determine the value of [n-1]. If a command is issued that requests access to a logical block not within the capacity of the medium, the command is terminated with CHECK CONDITION.

The number of bytes of data contained in a logical block is known as the block length. Each logical block has a block length associated with it. The block length shall not be different for each logical block on the medium. The block descriptor in the MODE SENSE data describes the block length that is used on the medium. Note that the block descriptor will not be present for an ATAPI C/DVD Logical Unit. In addition the Block Descriptor for ATAPI Logical Units has been made Obsolete in this specification.

The location of a logical block on the medium does not have a relationship to the location of any other logical block. However, in a typical Logical Unit the logical blocks are located in an ascending order. The time to access the logical block at address [x] and then the logical block at address [x+1] need not be less than time to access [x] and then [x+100].

4.1.3. RESETS

Within this specification there are three resets defined. These resets will use the following names:

- Power On Reset

- Hard Reset

- Device Reset

These resets will be used differently in each physical interface used. For more information on the use in ATA/ATAPI and SCSI see the sections on implementation notes.

4.1.3.1. Power On Reset

When power is applied, the device executes a series of electrical circuitry diagnostics, resets Logical Unit specific parameters (mode pages) to default values, and if media is present, may spin up and make the logical unit ready for use. In addition power management and key management are reset to their default states.

4.1.3.2. Hard Reset

For each physical interface the detection of Hard Reset is different. The detection of Hard Reset for ATA/ATAPI and SCSI is defined in the implementation sections of this specification. The device executes a series of electrical circuitry diagnostics, resets Logical Unit specific parameters (mode pages) to default values, and if media is present, may spin up and make the logical unit ready for use. In addition power management and key management are reset to their default states. The behavior of the logical unit when Hard Reset is received is the same as for Power On Reset.

Hard Reset is used to reset devices or even a whole interface bus, not individual logical units.

4.1.3.3. Device Reset

For each physical interface the detection of Device Reset is different. The detection of Device Reset for ATA/ATAPI and SCSI is defined in the implementation sections of this specification. The Device Reset is used to bring a hung Logical Unit into a operable state. Device Reset is different from Power On or hard Reset. With the Device Reset the parameters being used by the Logical Unit are not set to the defaults. In some cases this may not be possible and the Logical Unit may need to reset to the default conditions. If a reset to default conditions occurs as a result of a Device Reset, a Unit Attention and Power Management Event Notification shall be generated. Logical Unit should:

- Reset host interface circuitry.
- Perform hardware initialization and device-internal diagnostics only if necessary.
- Do not revert to default conditions, including ATAPI master/slave address, SCSI Device Number, Logical Unit Number or TOC information.
- Stay in the current Power State.
- Persistent Prevent state is unchanged.
- Key management shall be reset to the default state.

4.1.3.4. Mapping of reset functions

Table 2 shows how the different reset functions specified in the various ATAPI and SCSI specifications are used in this specification. Note that this table is not intended to show all possible resets or their mapping.

Table 2 - Example Reset Function Mapping in ATAPI and SCSI

Reset Type	ATAPI	SCSI
Power-On Reset	Same as Power-On Reset	Same as Power-On Reset
Hard Reset	Hard Reset	TARGET RESET task management function
	ATA SRST. This is a channel reset and as such is treated as a Hard Reset. However the SRST shall not reset any mode parameters to the default state.	SAM Reset events. Note that this is SCSI protocol dependent.
		SPI Reset Signal
Device Reset	Device Reset in ATA/ATAPI-4	ABORT TASK SET task management function
	ATAPI Soft Reset in SFF8020	CLEAR TASK SET task management function

4.1.4. Error reporting

If any of the conditions in Table 3 occur during the execution of a command, the target shall return CHECK CONDITION status. The appropriate sense key and additional sense code should be set. The following list illustrates some error conditions and the applicable sense keys. The list does not provide an exhaustive enumeration of all conditions that may cause the CHECK CONDITION status.

Table 3 - Sense key responses for error reporting

Condition	Sense Key
Invalid Logical Block Address	ILLEGAL REQUEST
Unsupported option requested	ILLEGAL REQUEST
Attempt to read a blank block	ILLEGAL REQUEST
Attempt to play a data block as audio	ILLEGAL REQUEST
Target reset or medium change since last command	UNIT ATTENTION
Self diagnostic failed	HARDWARE ERROR
Un-recovered read error	MEDIUM ERROR/HARDWARE ERROR
Recovered read error	RECOVERED ERROR
Overrun or other error that might be resolved by repeating the command	ABORTED COMMAND

In the case of an invalid logical block address, the sense data information field shall be set to the logical block address of the first invalid address.

In the case of an attempt to read a blank or previously unwritten block, the sense data information field shall be set to the logical block address of the first blank block encountered. The data read up to that block shall be transferred.

There are other special error situations for CD devices. In the following cases the sense key shall be set to ILLEGAL REQUEST and the additional sense code set to END OF USER AREA ENCOUNTERED ON THIS TRACK:

a) a pre-gap area is encountered (i.e. a block with index equal to 0).

b) a post-gap area is encountered.

c) The information type (data vs. audio) changes.

When the command is other than an audio playback operation, the command shall be terminated with CHECK CONDITION status if the Logical Block Address requested is not within a data track. The sense key shall be set to

ILLEGAL REQUEST and the additional sense code set to ILLEGAL MODE FOR THIS TRACK. This applies to audio-combined and audio media.

4.1.5. Deferred Errors

Error code 70h indicates that the CHECK CONDITION status returned is the result of an error or exception condition on the I/O process that returned the CHECK CONDITION status. This includes errors generated during execution of the command by the actual execution process. It also includes errors not related to any command that are first observed during execution of a command. Examples of this latter type of error include disk servo mechanism, off track errors, and power-up test errors.

Error code 71h (deferred error) indicates that the CHECK CONDITION status returned is the result of an error or exception condition that occurred during execution of a previous command for which GOOD status has already been returned. Such commands are associated with use of the immediate bit, with some forms of caching, and with multiple command buffering. C/DVD Logical Units that implement these features are required to implement deferred error reporting.

The deferred error may be indicated by returning CHECK CONDITION status to the Host Computer as described below. The subsequent execution of a REQUEST SENSE command shall return the deferred error sense information.

If an I/O Command terminates with CHECK CONDITION status and the subsequent sense data returns a deferred error, that I/O command shall not have been executed. After the C/DVD Logical Unit detects a deferred error condition on a Logical Unit, it shall return a deferred error according to the rules described below:

1. If a deferred error can be recovered with no external system intervention, a deferred error indication shall not be posted unless required by the error handling parameters of the MODE SELECT command. The occurrence of the error may be logged if statistical or error logging is supported.

2. If a deferred error can be associated with a particular function or a particular subset of data, and the error is either un-recovered or required to be reported by the mode parameters, a deferred error indication shall be returned to the Host Computer.

Deferred errors may indicate that an operation was unsuccessful long after the command performing the data transfer returned GOOD status. If data that cannot be replicated or recovered from other sources is being stored using buffered write operations, synchronization commands should be performed before the critical data is destroyed in the host computer. This is necessary to be sure that recovery actions can be taken if deferred errors do occur in the storing of the data.

4.1.6. Removable medium

A disc has an attribute of being mounted or de-mounted on a suitable transport mechanism. A disc is mounted when the C/DVD Logical Unit is capable of performing read operations to the medium. A mounted disc may not be accessible by a host if it is reserved by another Host. A disc is de-mounted at any other time (e.g. during loading, unloading, or storage).

A host may check whether a disc is mounted by issuing a TEST UNIT READY command. In addition there now exists the MEDIA STATUS NOTIFICATION feature. This allows the host to prevent the removal of any media, as well as sensing requests from the user to remove media.

The PREVENT ALLOW MEDIUM REMOVAL command allows a host to restrict the de-mounting of the disc. This is useful in maintaining system integrity. If the C/DVD Logical Unit implements cache memory, it must ensure that all logical blocks of the medium contain the most recent data prior to permitting de-mounting of the disc. If the Host issues a START STOP UNIT command to eject the disc, and is prevented from de-mounting by the PREVENT ALLOW MEDIUM REMOVAL command, the START STOP unit command is rejected by the C/DVD Logical Unit.

4.2. CD Device Model

CD devices permit reading data from a removable rotating media. Data transfer can begin with any of the consecutively numbered logical blocks. Some CD devices support a separate information stream (e.g. audio and/or video but referred to as audio in this clause) transmitted via a connection other than the attached physical interface. This standard defines commands for controlling these other information streams.

C/DVD drives are designed to work with any disc that meets IEC. Many new drives read C/DVD data discs, digital audio discs, and audio-combined discs (i.e. some tracks are audio, some tracks are data).

The writing of a CD-R/RW disc requires the Initiator read a set of parameters from the Logical Unit, selecting the parameters to be used, setting those parameters in the write parameters of the Logical Unit and then using the normal SCSI-3 Write Command. Once the write process has begun, data is streamed from the initiator to the Logical Unit.

4.2.1. CD media organization

The formats written on the CD and CD-DA (Digital Audio) media require special interfacing considerations.

> Note: This sub-clause contains a number of terms that have special meanings peculiar to CD technology or that may be unfamiliar to many readers of this standard. The glossary, sub-clause 3.1., defines these terms.

Discs may contain either audio, data or a mixture of the two. Table 4 gives an example of a mixed mode disc to illustrate the relationship between the logical block addresses reported in SCSI and the MSF address encoded on the media.

> NOTE: The term frame is used in two different ways in the CD media standard. The intended meaning can only be determined from the context. Whenever possible, this description replaces the larger data unit with the more familiar term sector. The primary exception to this policy is the use of frame when referring to the MSF address. In the MSF context, one frame (F field unit) equals one sector. On a typical two channel CD-DA media, each frame (F field unit) is played in 1/75th of a second.

The physical format defined by the CD media standards provides 2352 bytes per sector. For usual computer data applications, 2048 bytes are used for user data, 12 bytes for a synchronization field, 4 bytes for a sector address tag field and 288 bytes - the auxiliary field - for L-EC (CD data mode 1). In less critical applications, the auxiliary field may also be used for user data (CD data mode 2). The user data portion of a CD sector contains 2048, 2332, 2340, or 2352 bytes.

Table 4 - Example of Mixed Mode CD Disc Layout

Block Description	Logical Address (Decimal)	Track Relative logical address	Absolute M/S/F Address[1]	Track / Index	Track Relative M/S/F Address	Sector Contains Info or Pause	Mode Audio or Data	CD Data Mode[2]
Lead-in Area	---	---	---	0/-	---	---	Audio	---
Pre-gap	---	---	00/00/00	1/0	00/02/00[7]	Pause	Data	Null
1st Track data	0000[4]	0	00/02/00[5]	1/1	00/00/00	Info	Data	L-EC
2nd track data	6000[4]	0	01/22/00[5]	2/1	00/00/00	Info	Data	L-EC
	7500	1500	01/42/00	2/2	00/20/00	Info	Data	L-EC
Post gap	9000	3000	02/02/00	2/3	00/40/00	Pause	Data	Null
Pause-silence	9150	-150[6]	02/04/00	3/0	00/02/00[7]	Pause	Audio	---
3rd track audio	9300[8]	0	02/04/00[9]	3/1	00/00/00	Info	Audio	---
	1400	2250	02/34/00	3/2	00/03/00	Info	Audio	---
4th track audio	21975[8]	0	04/53/00[9]	4/1	00/00/00	Info	Audio	---
Pre-gap part 1	30000	-225[6]	06/40/00	5/0	00/03/00[7]	Pause	Audio	---
Pre-gap part 2	300075	-150	06/41/00	5/0	00/02/00[7]	Pause	Data	Null
5th track data	30225	0	06/43/00	5/1	00/00/00	Info	Data	L-EC
Last Information	263999[10]	233 774	58/39/74	5/1	51/56/74	Info	Data	L-EC
Post-gap	---	233 775	58/40/00	5/2	51/57/00	Pause	Data	Null
Lead-out area	264000[11]	0	58/42/00	AA/-[13]	00/00/00	Pause	Audio	---

Notes:

1. Absolute MSF address repeated in the header field of data blocks.
2. The CD data mode is stored in the header of data tracks. This indicates that the block is part of a data pre-gap or post gap (null), that this is a data block using the auxiliary field for L-EC symbols (ECC-CD data mode one), or that this is a data block using the auxiliary field for user data (CD data mode 2.)
3. Table of Contents information is stored in the sub-channel of lead-in area. The lead-in area is coded as track zero. Track zero and the initial 150 sector pre-gap (or audio pause) are not accessible with logical addressing.
4. Exact value returned by READ TOC/PMA/ATIP Command.
5. Value stored in Table of Contents with zero tolerance.
6. Track relative logical addresses are negative in the pre-gap areas.
7. Track relative MSF value decreases to 0 in the pre-gap areas.
8. Value returned by READ TOC/PMA/ATIP Command plus or minus 75 blocks.
9. Value stored in Table of Contents plus or minus 75 sectors.
10. Minimum value returned by READ C/DVD RECORDED CAPACITY: exact value depends on encoding of this track and the lead-out track and whether this is derived from the TOC data.
11. Value returned by READ TOC/PMA/ATIP Command; exact if lead-out track is encoded as data, or plus or minus 75 blocks if encoded as audio.
12. Value stored in Table of Contents; exact if lead-out track is coded as data, or plus or minus 75 blocks if coded as audio.
13. Lead-out track number field is defined as AAh.

For data and mixed mode media (those conforming to ISO/IEC 10149), logical block address ZERO shall be assigned to the block at MSF address 00/02/00. For audio media (those conforming only to IEC 908), logical block address ZERO shall be assigned to the actual starting address of track 1. This may be approximated by using the starting address of track 1 contained in the table of contents (TOC) or by assigning logical block address ZERO to the block at MSF address 00/02/00.

Logical addressing of CD information may use any logical block length. When the specified logical block length is an exact divisor or integral multiple of the selected number of bytes per C/DVD sector, the device shall map (one to one) the bytes transferred from C/DVD sectors to the bytes of logical blocks. For instance, if 2048 bytes are transferred from each C/DVD sector, and the logical block length is 512 bytes, then each C/DVD sector shall map to exactly four logical blocks. This standard does not define the mapping of logical block lengths which do not evenly divide or are not exact multiples of the selected number of bytes per CD-ROM sector.

A track may be viewed as a partition of the CD address space. A CD media contains from one to ninety-nine tracks. All information sectors of a track are required to be of the same type (audio or data) and mode. Each change in the type of information on the disc requires a change in track number. A disc containing both audio and data would have at least two tracks, one for audio and one for data.

The tracks of a CD media are numbered consecutively with values between 1 and 99. However, the first information track may have a number greater than 1. Tracks have a minimum length of 300 sectors plus any transition area that is part of a track.

The CD media standards require transition areas between tracks encoded with different types of information. In addition, transition areas may be used at the beginning or end of any track. For audio tracks the transition areas are called pause areas. For data tracks, transition areas are called pre-gap and post-gap areas. See Table 1 for an example. The IEC 908 and ISO/IEC 10149 standards specify minimum time duration for these areas. Maximum time duration's are not specified.

Transition areas are formatted and the logical address continues to increment through transition areas. Some media (i.e. discs with only one track) may not have transition areas. The means to determine the location of the transition areas is vendor or application-specific and is addressed by other standards (e.g. ISO 9660).

C/DVD is a unique logical unit in the respect that some logical blocks on a disc may not be accessible by all commands. SEEK commands may be issued to any logical block address within the reported capacity of the disc. READ commands cannot be issued to logical blocks that occur in some transition areas. Audio commands cannot be issued to logical blocks within a data track.

CD media have lead-in and lead-out areas. These areas are outside of the user-accessible area as reported in the READ C/DVD RECORDED CAPACITY data. The lead-in area of the media is designated track zero. The lead-out area is designated track AAh. The Q sub-channel in the lead-in track contains a Table of Contents (TOC) of the disc.

NOTE: The READ C/DVD RECORDED CAPACITY command returns the logical block address of the last block prior to the lead-out area. This location may be in a transition area and therefore not a valid address for read operations.

The Table of Contents gives the absolute MSF location of the first information sector of each track. Control information (audio/data, method of audio encoding, etc.) for each track is also contained in the TOC. However, the TOC does not distinguish between the different modes of data tracks (i.e. CD data mode 1 vs. CD data mode 2).

The MSF locations pointing to the start of data tracks in the TOC are required to be accurate. However, the TOC values for audio tracks have a tolerance of plus or minus 75 sectors. Information from the TOC can be used to reply to a READ CD RECORDED CAPACITY command. When this is done, the device implementor should consider the possible tolerances and return a value that allows access to all information sectors.

An index is a partition of a track. Pre-gap areas are encoded with an index value of zero. Pause areas at the beginning of audio tracks are also encoded with an index value of zero. The first information sector of a track has an index value of one. Consecutive values up to 99 are permitted. Index information is not contained in the TOC. Not all sectors are encoded with the index value in the Q sub-channel data (the requirement is 9 out of 10). A sector without an index value is presumed to have the same index as the preceding sector.

Tracks and indexes are not defined to be any particular length, (except for a minimum track length of 300 sectors.) A CD disc may be created with a single information track that has a single index; or with 99 information tracks, each with 99 indexes.

The sub-channel information which is part of each sector includes a track relative MSF location value giving the distance from the first information sector of the track. On the media, this value decreases during the pre-gap area (sectors with index values of 0) and increases for the rest of the track. The data, returned by the READ SUB-CHANNEL command with MSF bit set to zero, converts this to a track relative logical block address (TRLBA). The TRLBA is

continually increasing over the whole track, and pre-gap areas shall return negative values. When the MSF bit in the read sub-channel command is set to one, the MSF track relative location value from the media is reported without change.

4.2.2. CD Physical Data Format

The physical format of CD-ROM and CD-DA media uses a smaller unit of synchronization than the more familiar magnetic or optical recording systems. The basic data stream synchronization unit is a small frame. This is not the same large frame (sector) as referred to in the MSF unit. Each small frame consists of 588 bits (see Figure 1). A sector on CD media consists of 98 small frames.

<table>
<tr><td>1 synchronization pattern
(24 + 3 bits)</td><td>1 byte of sub-channel data
(14 + 3 bits)</td><td>12 bytes of data
(12 x (14 + 3) bits</td><td>4 bytes of CIRC code
(4 x (14 + 3) bits)</td><td>12 bytes of data
(12 x (14 + 3) bits</td><td>4 bytes of CIRC code
(4 x (14 + 3) bits)</td></tr>
<tr><td colspan="6">588 bits</td></tr>
</table>

Figure 1 - Small Frame layout and definition

Data, sub-channel and CIRC bytes are encoded with an 8-bit to 14-bit code; then three merging bits are added. The merging bits are chosen to provide minimum low-frequency signal content and optimize phase lock loop performance.

4.2.3. Frame Format for Audio

Each small frame of an audio track on a two-channel CD-DA or CD-ROM media consists of six digitized 16-bit samples of each audio channel. These 24 bytes of data are combined with a synchronization pattern, CIRC bytes and a sub-channel byte to make a frame. Each frame takes approximately 136.05 µs to play. This gives a sampling rate of 44.1 kHz for each channel. The sub-channel information creates the higher level sector grouping for audio tracks.

4.2.4. Sector Format for Data

The data bytes of 98 small frames comprise the physical unit of data referred to as a sector. See Figure 2. (98 small frames times 24 bytes per small frame equals 2352 bytes of data per sector.)

The physical format defined by the CD-ROM media standard provides 2352 bytes per sector. For usual computer data applications, 2048 bytes are used for user data, 12 bytes for a synchronization field, 4 bytes for a sector address tag field and 288 bytes - the auxiliary field - for L-EC (CD-ROM data mode 1). In less critical applications, the auxiliary field may also be used for user data (CD-ROM data Mode 2/Form 2).

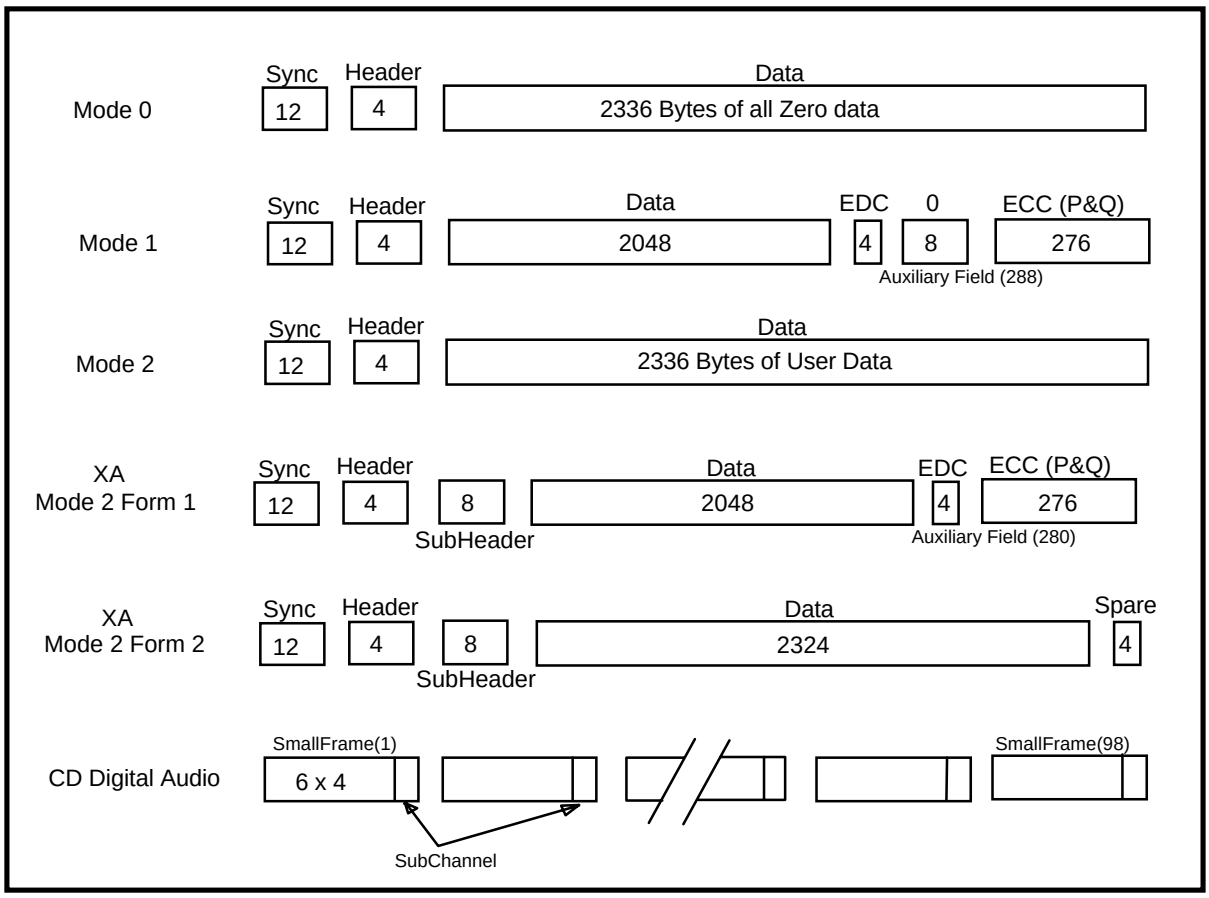

Figure 2 - CD-ROM Sector Formats

A CD physical sector size is 2048, 2052, 2056, 2324, 2336, 2340, or 2352 bytes per sector. These values correspond to the user data plus various configurations of header, sub-header and EDC/ECC.

NOTE: Many drives are capable of returning CD-ROM data Mode 1 data in a CD-ROM data Mode 2 format. This allows the user to investigate the error detection and error correction codes. However data encoded as CD-ROM data Mode 2 cannot be read as CD-ROM data Mode 1 data.

4.2.4.1. Multi Session Format

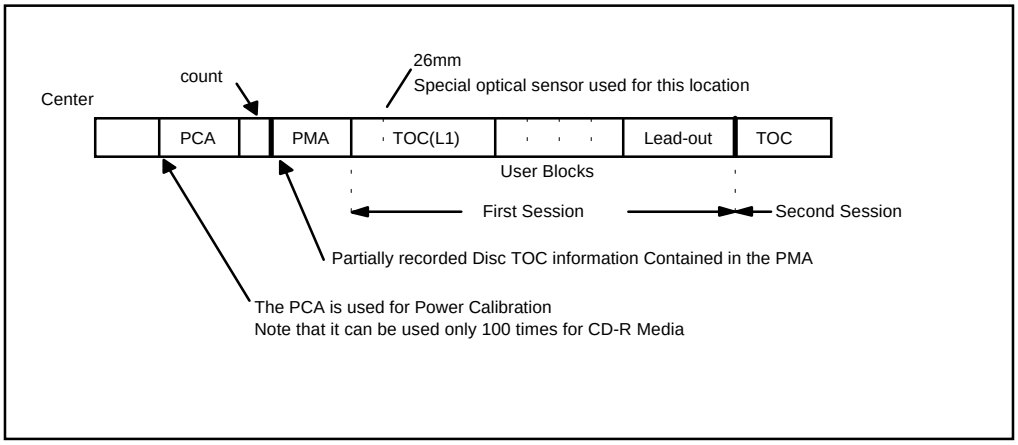

Figure 3 - CD-R/RW Disc Layout

4.2.5. Supported Block Sizes

Supported block sizes (see Table 5) include 2048, 2056, 2324, 2332, 2352, 2368, and 2448 bytes. Table 5 shows the implementation of the various block sizes. These definitions apply for reading with the Read commands.

Table 5 - Block Sizes for Read

Size	Readable block types
2048	Mode 1 or Mode 2 Form 1.
2332	Mode 2, form 1 or 2 data. The drive shall operate as specified for 2048 byte blocks except: Both forms send 2332 byte blocks. Form 1 blocks return the third layer ECC with the user data.
2336	Mode 2 data The drive shall operate as specified for 2048 byte blocks lengths. This mode will include all data, including Yellow Book Mode 2 sectors and Form 1 and Form 2.
2352	Audio or raw blocks. The drive shall operate as specified for 2048 byte blocks. Reads of data mode sectors shall return de-scrambled data.
2448 or 2368	Audio or raw blocks with raw sub-channel. The drive shall not perform the data de-scrambling operation.

4.2.6. Frame format for audio

Each small frame of an audio track on a two-channel CD-DA or CD-ROM media consists of six digitized 16-bit samples of each audio channel. These 24 bytes of data are combined with a synchronization pattern, CIRC bytes and a sub-channel byte to make a frame. Each frame takes approximately 136.05 µs (1/75th of a second) to play. This gives a sampling rate of 44.1 kHz for each channel. The sub-channel information creates the higher level sector grouping for audio tracks.

4.2.7. Q sub-channel information formats

Q sub-channel has a higher level of structure. All the Q sub-channel bits of a sector define the Q sub-channel information block. (For audio tracks, decoding the Q sub-channel is the only way to distinguish sector boundaries.)

The Control, ADR, DATA-Q, and CRC fields contain 96 bits of information defined in Figure 4.

Field name	Definitions
S0, S1	Sub-Channel Synchronization
CONTROL	The Control Field has 4 bits that define the type of information within a track: 00x0b = 2 audio channels without pre-emphasis 00x1b = 2 audio channels with pre-emphasis of 50/15 µs 10x0b = audio channels without pre-emphasis (reserved in CD-R/RW) 10x1b = audio channels with pre-emphasis of 50/15 µs (reserved in CD-R/RW) 01x0b = Data track, recorded uninterrupted 01x1b = Data track, recorded incremental 11xxb = reserved xx0xb = digital copy prohibited xx1xb = digital copy permitted The bits of the control field (except for the copy bit) can change during an actual pause (X=00) of at least 2 seconds and during the lead-in area only.
ADR	4 bits of control for DATA-Q.
DATA Q	72 bits of data
CRC	A 16 bit CRC for the Control, ADR, and DATA-Q Fields. On the disc the parity bits are inverted. The remainder has to be checked at zero. Polynomial = $P(X)=X^{16}+X^{12}+X^{5}+1$

Figure 4 - Q sub-channel Information Block

Three codes are defined for DATA-Q: MODE-1, MODE-2, and MODE-3.

4.2.7.1. Q sub-channel Mode-1

ADR = 1 (0001b)
Mode-1 occupies at least 9 out of 10 successive sub-coding blocks. Two different data formats are possible in Mode-1. The data format during the lead-in track is shown in Figure 5.

ADR	DATA-Q								
0001	TNO	POINT	MIN	SEC	FRAME	ZERO	PMIN	PSEC	PFRAME

Figure 5 - Q sub-channel Mode-1 Format recorded in lead-in

The format during the data and audio and lead-out tracks on a disc is shown in Figure 6.

ADR	DATA-Q								
0001	TNO	INDEX	MIN	SEC	FRAME	ZERO	AMIN	ASEC	AFRAME

Figure 6 - Q sub-channel Mode-1 Format recorded in Program Area and lead-out

TNO (Track number) on the media is expressed in 2 BCD digits.

00bcd	Lead-in. The end of the lead-in is at the starting diameter of the program area.
01 - 99bcd	Track numbers. A track can be preceded by a pause with the same track number. The track numbering once set, shall increment by one.
AAh	Lead-out . The lead-out starts at the end of the last track on a disc, without a preceding pause encoding.

The INDEX (Index to TNO) on the media is 2 BCD digits.

00bcd	Pause encoding.
01 - 99bcd	Sub-division numbers. During the lead-out track INDEX is 01. Within an audio track (TNO = 01 - 99 and X not equal to 00) the first value of INDEX is 01. The value of INDEX can only be incremented by one. In a data track it shall have a value of 01.

The ZERO field contains a value of ZERO. (00000000 b)

Min, Sec, Frame fields contain the running time within a track expressed in 6 BCD digits. Min, Sec, and Frame are each two digits. The time is set to zero at the start of a track. Time increases in the track and decreases in the pause/pregap, ending with the value zero at the end of the pause/pregap. In the lead-in and the lead-out tracks the time increases.

The minutes are stored in Min, the seconds in Sec. One second is subdivided into 75 Frames (running from 00 to 74).

AMIN, ASEC, AFRAME fields contain the absolute address expressed in 6 BCD digits. AMIN, ASEC, and AFRAME are each two digits. At the starting diameter of the program area the running time is set to zero and TNO takes the value of the first track on the disc.

The minutes are stored in AMIN, the seconds in ASEC. One second is subdivided into 75 AFRAMEs (running from 00 to 74).

Bytes in the Q-sub-channel that contains bcd contents may also contain illegal BCD values. Then values start with 0A0h and continue to 0FFh. No conversion of these to hex for transmission to/from the initiator is performed. Refer to Table 163 for more information.

The POINT, PMIN, PSEC, and PFRAME contain the Table of Contents during the lead-in. This Table of Contents is continuously repeated in the lead-in (TNO = 0). In each Table of Contents, the individual items are repeated three times. At the end of the lead-in, the Table of Contents can be ended with any value of point.

The value of PMIN, PSEC, and PFRAME gives the starting point of the track number pointed to by POINT. These values give the start position of the track on the absolute time scale (AMIN, ASEC, and AFRAME) with an accuracy of +/- one second. The start position of a track is the first position with the new track number and X not equal to 00.

If POINT = A0h, the value of PMIN gives the track number of the first piece of audio on the disc, PSEC and PFRAME are zero.

If POINT = A1h, the value of PMIN gives the track number of the last track on the disc, PSEC and PFRAME are zero.

If POINT = A2h, PMIN, PSEC, and PFRAME contains the starting point of the lead-out.

4.2.7.2. Q sub-channel Mode-2

ADR = 2(0010b)

If Mode-2 is present, and occupies at least 1 out of 100 successive sub-coding blocks. Mode-2 data format is shown in Figure 7 - Q sub-channel Mode-2 Format.

ADR	**DATA-Q**														
0010	N1	N2	N3	N4	N5	N6	N7	N8	N9	N10	N11	N12	N13	ZERO	AFRAME

Figure 7 - Q sub-channel Mode-2 Format

The DATA-Q field is 52 bits long and is defined as:

N1 - N13 is the Catalog number of the disc expressed in 13 BCD digits. Used in the UPC/EAN coding. The catalog number does not change on a disc. In case no catalog number is encoded according to the UPC/EAN code, N1 - N13 are all zero, or Mode-2 can be deleted from the disc.

The ZERO field contains 12 bits of zero. (000000000000b)

AFRAME is defined in Q sub-channel Mode-1 (two BCD digits running from 00 to 74). During the lead-in (TNO = 00), these 8 bits are zero.

4.2.7.3. Q sub-channel Mode-3

ADR = 3 = (0011b)

If Mode-3 is present, it occupies at least 1 out of 100 successive sub-coding blocks. Mode-3 is used to give a unique number to a audio track, This is done by means of the International Standard Recording Code (ISRC). The ISRC, as recorded on the media, is defined in Table 6. If no ISRC is used, Mode-3 must be deleted. During the lead-in and lead-out, Mode-3 is not present on the disc. The ISRC can only change immediately after the track number (TNO) has been changed. The Mode-3 data format is shown in Figure 8.

ADR	DATA-Q															
0011	I1	I2	I3	I4	I5	0	0	I6	I7	I8	I9	I10	I11	I12	ZERO	AFRAME

Figure 8 - Q sub-channel, Mode-3 Format

I1 - I12 define the ISRC, and is 60 bits in length.

The Country-Code is given in fields I1 through I2, the owner-code in fields I3 - I5, The year of recording in fields I6 - I7 and the I8 through I12 contain the serial number of the recording. The characters I1 - I5 are formatted as shown in Table 6. The characters I6 - I12 are coded in 4 bit BCD numbers.

The ZERO field contains 4 bits of zero. (0000b)

AFRAME is defined in Q sub-channel Mode-1 (two BCD digits running from 00 to 74). During the lead-in area (TNO = 00), these 8 bits are zero.

The 6 bit character coding map is shown in Table 6.

Table 6 - ISRC 6 bit character codes (in hexadecimal)

CHAR	CODE	CHAR	CODE	CHAR	CODE
0	00	G	17	W	27
1	01	H	18	X	28
2	02	I	19	Y	29
3	03	J	1A	Z	2A
4	04	K	1B		
5	05	L	1C		
6	06	M	1D		
7	07	N	1E		
8	08	O	1F		
9	09	P	20		
A	11	Q	21		
B	12	R	22		
C	13	S	23		
D	14	T	24		
E	15	U	25		
F	16	V	26		

4.2.7.4. Q sub-channel Mode-5

ADR = 5 = (0101b)

4.2.8. CD Audio error reporting

PLAY commands with the immediate bit set in the audio control mode return status as soon as the command has been validated (which may involve a seek to the starting address). The playback operation continues and may complete without notification to the initiator. Error termination of audio operations shall be reported to the initiator by returning immediate CHECK CONDITION status to the next command (except for REQUEST SENSE and INQUIRY). The deferred error sense data (reference SCSI Block Commands standard) is used to indicate that the error is not due to the current command.

The status of the play operation may be determined by issuing a REQUEST SENSE command. The sense key is set to NO SENSE and the audio status (see Table 148) is reported in the additional sense code qualifier field.

4.2.9. CD ready condition/not ready condition

The ready condition occurs after a disc is inserted and the drive has performed its initialization tasks. These tasks may include reading the Table of Contents from the media. Table 7 defines the Not Ready Error reporting for each command. A not ready condition shall occur only for the following reasons:

a) There is no medium mounted.
b) The drive is unable to load or unload the medium.
c) The drive is unable to recover the Table of Contents.
d) The controller cannot select the drive.

Table 7 - Not Ready Error Reporting (by command)

Command Name	Operation Code	Return Ready Status	Time-out	Comment
BLANK	A1h	Yes	Group 2	Recordable only
CHANGE DEFINITION	40h	No	Not Allowed	SCSI only
CLOSE AREA/SESSION	5Eh	Yes	Group 2	Recordable only
COMPARE	39H	Yes		SCSI only
COPY	18h	Yes	Group 2	SCSI only
COPY AND VERIFY	3Ah	Yes	Group 2	SCSI only
FLUSH CACHE	36h	Yes		
FORMAT UNIT	04h	Yes	Group 2	Recordable only
GET EVENT/STATUS NOTIFICATION	4Ah	Yes	Not Allowed	
INQUIRY	12h	No	Not Allowed	
LOAD/UNLOAD CD	A6h	Yes	Group 1	
LOCK/UNLOCK CACHE	38h	No	Group 2	SCSI only
LOG SELECT/SENSE	4Ch,4Dh	No	Group 1	SCSI only
MECHANISM STATUS	BDh	Yes	Group 1	
MODE SELECT	55h, 15h	No	Group 1	
MODE SENSE	5Ah, 1Ah	No	Group 1	
PAUSE/RESUME	4Bh	Yes	Group 1	
PLAY AUDIO (10)	45h	Yes	Group 1	
PLAY AUDIO (12)	A5h	Yes	Group 1	
PLAY AUDIO MSF	47h	Yes	Group 1	
PLAY CD	BCh	Yes	Group 1	
PREFETCH	34h	Yes	Group 1	
PREVENT/ALLOW MEDIUM REMOVAL	1Eh	No	Group 1	
READ (10)	28h	Yes	Group 1	
READ (12)	A8h	Yes	Group 1	
READ BUFFER	3Ch	No	Group 1	SCSI only
READ C/DVD RECORDED CAPACITY	25h	No	Group 1	
READ CD	BEh	Yes	Group 1	
READ CD MSF	B9h	Yes	Group 1	
READ DISC INFORMATION	51h	Yes	Group 1	
READ DVD STRUCTURE	A0h	Yes	Group 1	
READ FORMATTED CAPACITY	23h	No	Group 1	
READ HEADER	44h	Yes	Group 1	
READ LONG	3Eh	Yes	Group 1	SCSI only
READ SUB-CHANNEL	42h	Yes	Group 1	

Table 7 (cont.) - Not Ready Error Reporting (by command)

Command Name	Operation Code	Return Ready Status	Time-out	Comment
READ TOC/PMA/ATIP	43h	Yes	Group 1	
READ TRACK INFORMATION	52h	Yes	Group 1	
RECEIVE DIAGNOSTIC RESULTS	1Ch	No	Not Allowed	SCSI only
RELEASE	17h, 57h	No	Special	SCSI only
REPORT KEY	AAh	Yes	Group 1	
REPORT LUNS	A0h	No	Group 1	SCSI only
REQUEST SENSE	03h	No	Not Allowed	
RESERVE	16h, 56h	No	Special	SCSI only
RESERVE TRACK	53h	Yes	Group 2	Recordable only
REZERO	01h	Yes	Group 1	SCSI only
SCAN	BAh	Yes	Group 1	
SEEK	2Bh	Yes	Group 1	
SEND DIAGNOSTICS	1Dh	No	Not Allowed	SCSI only
SEND KEY	A3H	Yes	Group 1	
SEND UPC INFORMATION	54h	No	Group 1	Recordable only
SET C/DVD SPEED	B8h, BBh	No	Group 1	SCSI only
SET READ AHEAD	A7h	Yes	Group 1	
START/STOP UNIT	1Bh	Yes	Group 1	
STOP PLAY/SCAN	4Eh	Yes	Group 1	
TEST UNIT READY	00h	Yes	Group 1	
VERIFY (12)	A2h	Yes	Group 1	
WRITE (10)	2Ah	Yes	Group 2	Recordable only
WRITE (12)		Yes	Group 2	Recordable only
WRITE AND VERIFY (12)	A7h	Yes	Group 2	Recordable only

NOTE: The references to SCSI only in the table are to indicate that these commands are currently only defined in the SCSI SPC, SBC and MMC standards. As these commands are not defined in this specification the usage and actual operation of these commands is specified elsewhere, their reference here are only recommendations to provide better compatibility.

For information on the Time-out groups see section "4.15 Time-out Model" on page 54.

4.2.10. Sensing support for CD-audio commands.

If any commands related to audio operations are implemented, then the PLAY AUDIO command shall be implemented to allow a method for the initiator to determine if audio operations are supported. A target responding to a PLAY AUDIO command which has a transfer length of zero, with CHECK CONDITION status, and setting the sense key to ILLEGAL REQUEST does not support audio play operations.

4.3. DVD Model

Like CD Logical Units/Media there are three types of DVD Logical Unit/Media, Read Only (DVD-ROM), Write only Once (DVD-R) and Write Multiple times (DVD-RAM). The capacity of each of these media may be different. In addition each of these media also have the possibility of multiple layers and single or double sides.

A DVD Logical Unit may be capable of reading CD-ROM, CD-R and possibly CD-R/RW media.

Support for DVD-ROM, DVD-R, and DVD-RAM is defined by a Feature Set.

4.3.1. DVD Media Organization

The DVD media is currently specified by the Physical section of DVD Book.

- DVD Media can contain information on one side (Single Sided) or on both sides (Double Sided).

- DVD-ROM disc has two types of layer structure, single layer and double layer.

- Each Layer on either side contains a spiral track. This track contains a Lead-in, Main area, an optional Middle Area and a Lead-out.

- double layer discs have two types of track path, parallel track path and opposite track path. In the case of the Parallel Track Path, there each layer is treated separately.

- The primary Logical Block size is 2048 bytes.

- One ECC-BLOCK, having 37856 bytes, contains 16 logical blocks, ECC, headers, and parity bytes.

- There is no TOC or Sub-channel data as defined for CD function.

- Addressing used is LBA (Logical Block Address) only.

- The smallest logical block size for READ & WRITE commands is 2048 Bytes.

4.3.2. Track Structure

There are two types of track path for double layer discs, either parallel or opposite. When the path is parallel each track is treated separately and has its own lead-in and lead-out.

ED NOTE: the concept of "tracks" in CD and DVD world are different and needs to be cleared up.

There are two addresses used in the DVD system, the Block address contained in the sector headers (Physical Sector Number), and the address used to reference the blocks from the host system (LBA). The address used from the host starts at Logical Block Address 0 and progresses up through the end of the recorded information on the disc. LBA 0 shall correspond with the sector address of 030000h on the DVD media. Only the User Area is addressable using an LBA address.

ED NOTE: change "Physical Sector Number" to "Physical Block Number."

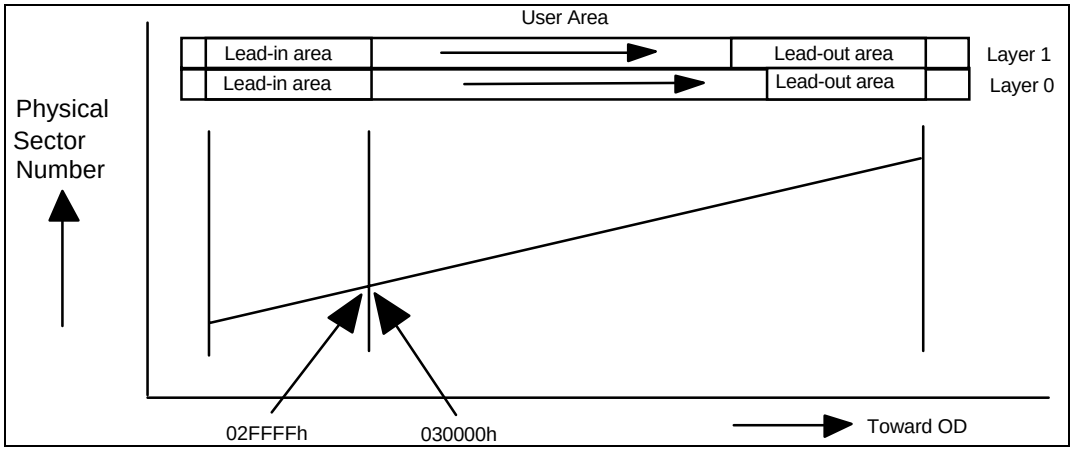

Figure 9 - Parallel Track Path Description

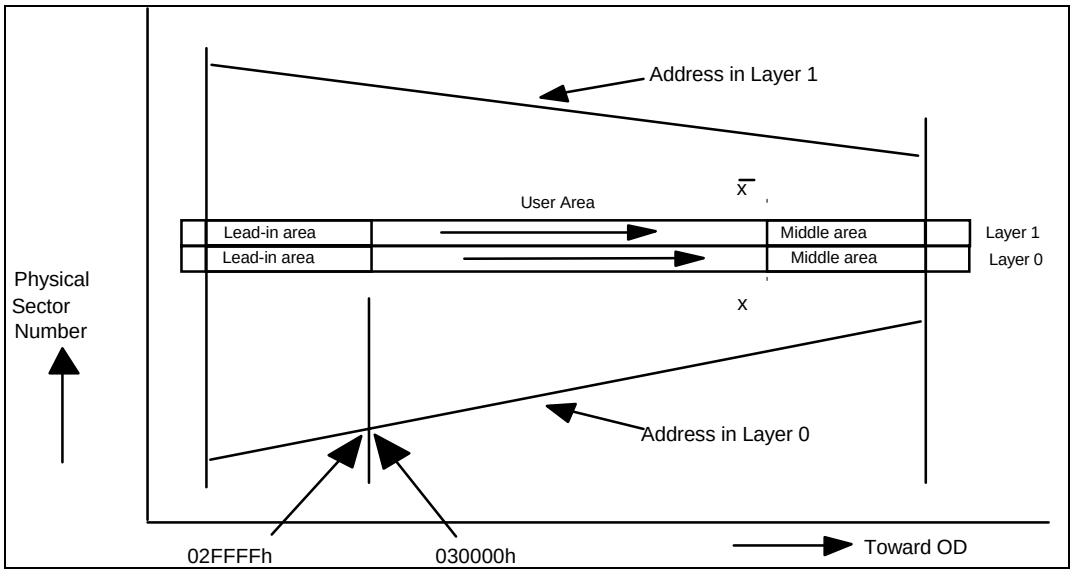

Figure 10 - Opposite Track Path Description

4.3.3. Header Layout

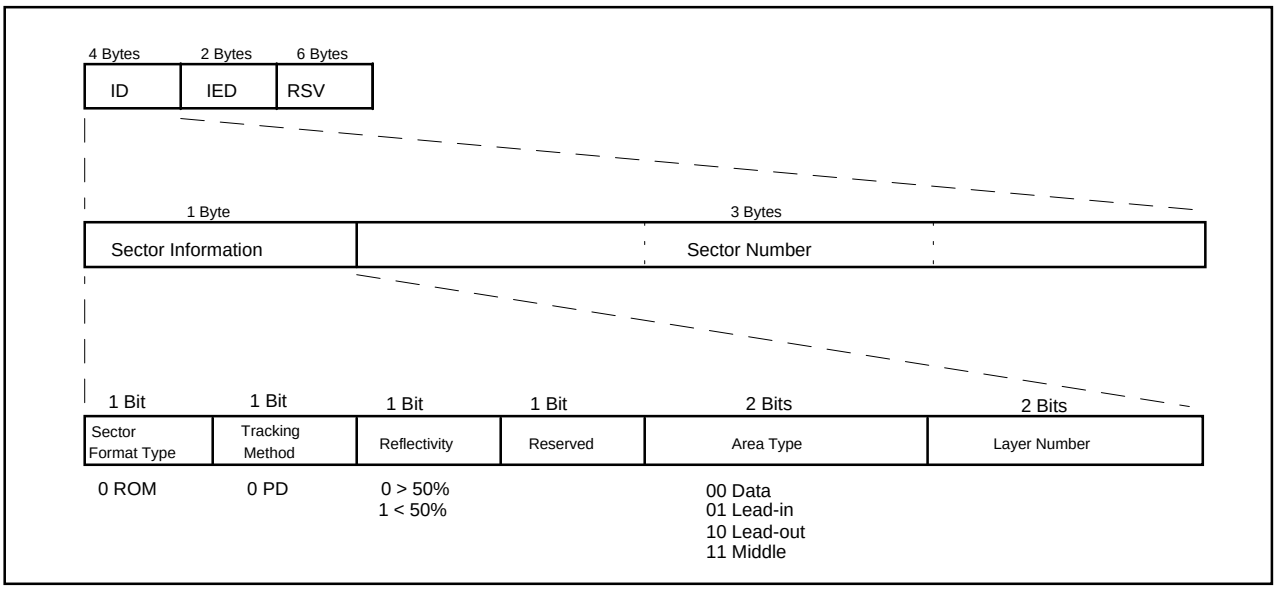

Figure 11 - Header Layout

4.3.4. Lead-in Contents

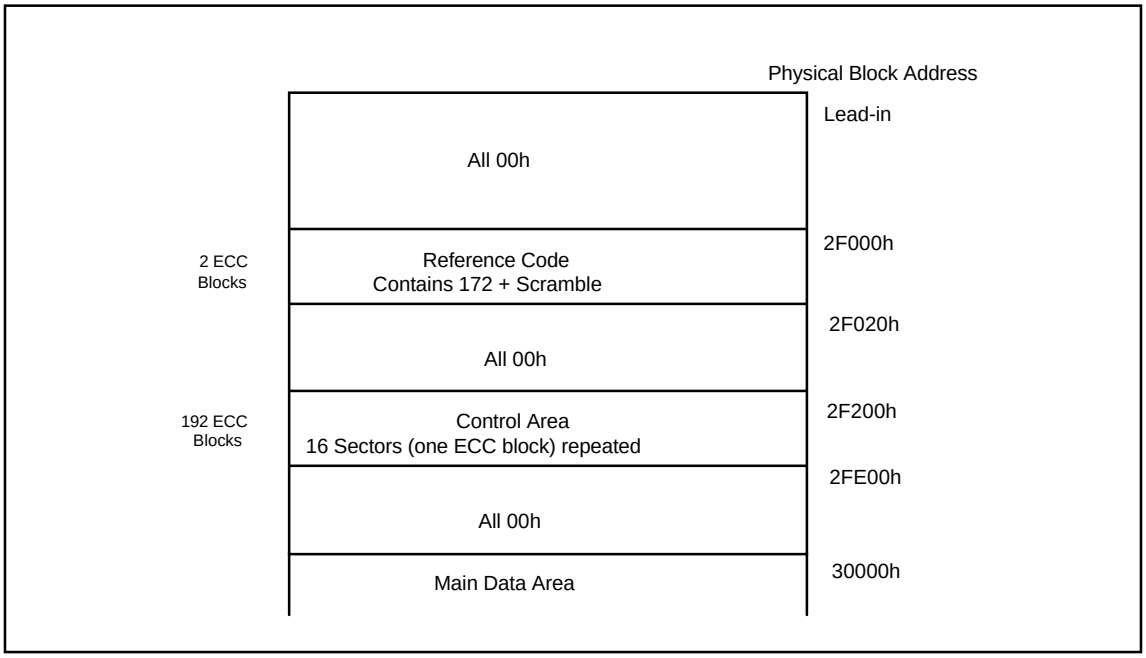

Figure 12 - Lead-in Contents

4.3.5. Sector Layout

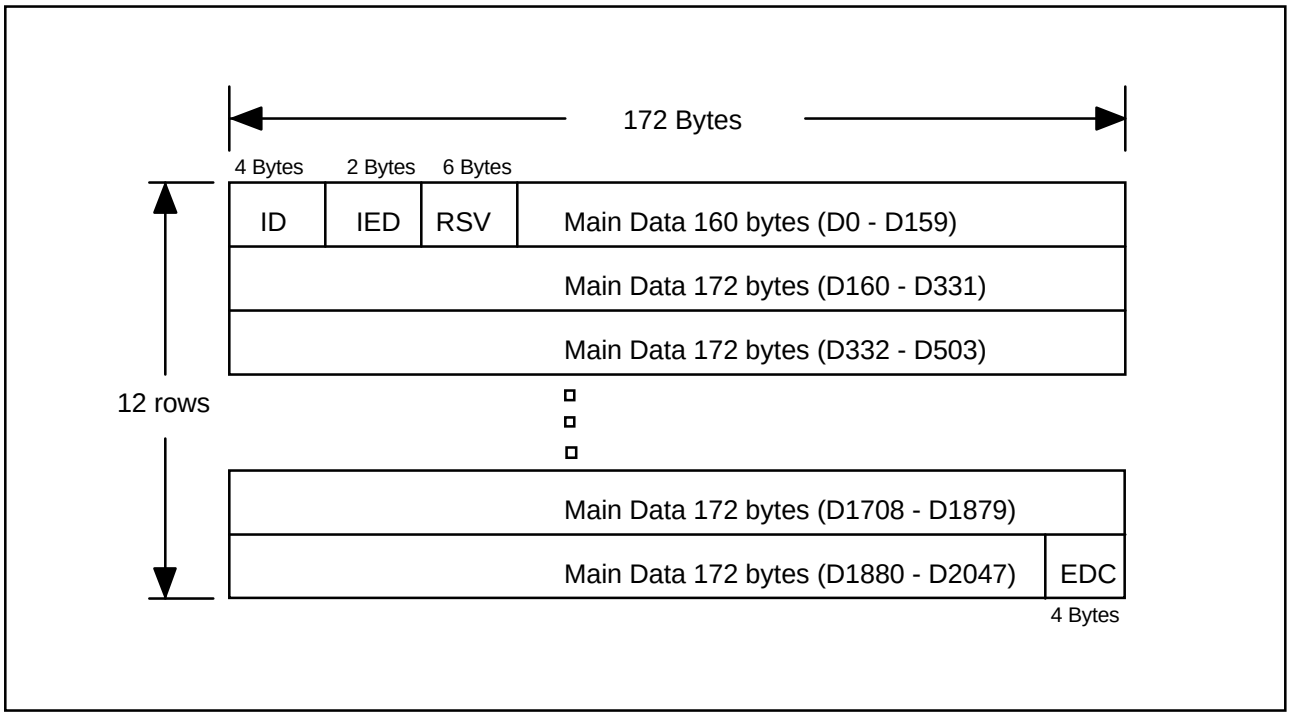

Figure 13 - Sector Layout

4.3.6. Control Area Data

Contains 192 ECC Blocks. Each of the ECC Blocks (16) Sectors contain one of three distinct type of data.

Table 8- Control Area Definition

Sector Number	Description
0	Physical Format Information
1	Disc Manufacturing Information
2	Copyright Information
:	
:	
14	
15	

4.3.7. Control Area Sector Descriptions

Table 9 - Physical Format Definition

Bit / Byte	7	6	5	4	3	2	1	0
0	Book Type				Book Version			
1	Disc Size				Minimum Rate			
2	Reserved		Number of Layers		Track Path	Layer Type		
3	Linear Density				Track Density			
4	Recorded area allocation							
5								
:								
:								
14								
15								

Table 10 - Recorded Area Allocation Definition

Byte	Single Layer	Parallel Track Path	Opposite Track Path
4	00h	00h	00g
5	Starting sector number of main data (030000h)	Starting sector number of main data (030000h)	Starting sector number of main data (030000h)
6			
7			
8	00h	00h	00h
9	End sector of main data	End sector of main data	End sector of main data
10			
11			
12	00h	00h	00h
13	000000h	000000h	End sector number in Layer 0
14			
15			

4.3.8. DVD Ready Condition/Not Ready Condition

The ready condition occurs after a disc is inserted and the Logical Unit has performed its initialization tasks. These may include reading the lead-in information from the media. A check condition status will be returned for the not ready condition only for commands that require or imply a disc access.

A not ready condition may occur for the following reasons:

1. There is no disc mounted, See “Removable medium” on page 52.
2. The Logical Unit is unable to load or unload the disc.

The Logical Unit shall spin up and make the disc ready for media accesses when a new disc is detected. Any media access that occurs when the Logical Unit is not spinning shall spin the Logical Unit up and not generate an error.

4.3.9. DVD Copy Protection

The DVD Copy Management is made up of two basic concepts. The first is to scramble the content of the data such that if it is available for copy operations, it would still be unusable. The data must be unscrambled before it can be used. The protection comes from an “Authentication” process that must exchange protected information (Keys) before the unscramble operation would be allowed. The second is to limit the playback of content to specific regions of the world. Both the scrambled content and regionalization are used only for discs that make use of the Content Scramble System (CSS).

3.7.1 Management of Protected Data

Any read by the host to a disc that contains scrambled content and a sector with a Title Key present, when the Authentication Success Flag (ASF) is set to zero shall be blocked. The command shall be terminated with a CHECK CONDITION and the Sense Key shall be set to 05 ILLEGAL COMMAND and the Sense Code and Qualifier set to 6Fh/03h READ WITHOUT VALID AUTHENTICATION.

3.7.2 Playback limitations by World Region

As part of the Authentication process the Region Code of the Media and that of the LOGICAL UNIT are checked by the LOGICAL UNIT. This process is performed during the Authentication Process. If the Regions allowed by the Media do not match the region of the LOGICAL UNIT, the authentication process will be terminated. The actual check of the region information is performed before the READ DVD STRUCTURE command with Format = 02h is completed. See

"Figure 10 - Device Key Exchange and Authentication State Diagram" on page 55. When the command is received by the Logical Unit to return a Disc Key and the Region is not allowed the command shall be terminated with a CHECK CONDITION and the Sense Key shall be set to 05 ILLEGAL COMMAND and the Sense Code and Qualifier set to 6Fh/ 04h MEDIA REGION CODE IS MISMATCH TO LOGICAL UNIT REGION.

3.7.3 Authentication Process

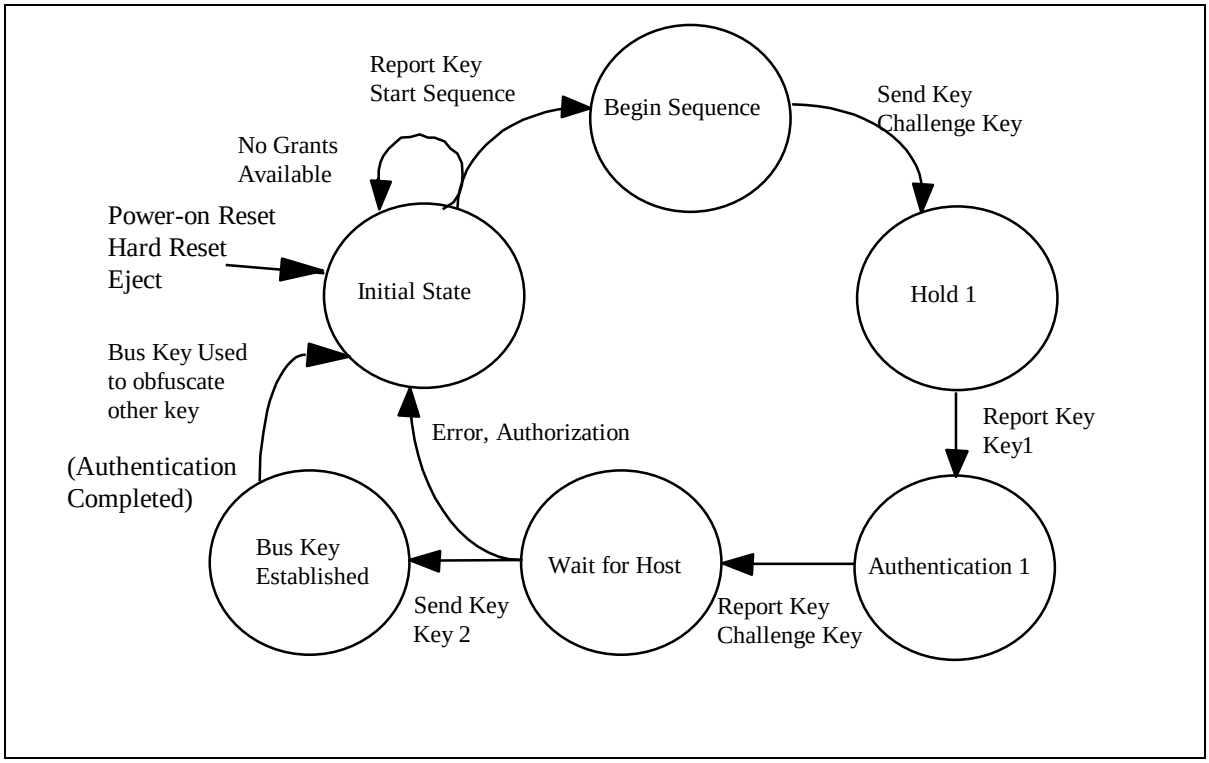

Figure 14 - Device Key Exchange and Authentication State Diagram

Note: The Initiator must reset a hung authentication process in the drive by invalidating the corresponding AGID. The Initiator may detect lost grants by refusal of the Start Authentication Process operation.

Figure 11 - Authentication Flag Sequence

4.4. Changer Model

The changer is a feature of a C/DVD device. It shall support two (2) additional commands, MECHANISM STATUS (BDh) and LOAD/UNLOAD CD (A6h).

A changer device provides a storage area for more than one CD Disc. This storage area contains multiple areas called slots. Each slot can contain just one disc. Once a disc has been placed into a given slot, it becomes locked in that position. This standard provides no capability to move a disc from one slot to another. Thus when a Disc has been moved from a given slot into the playing position, it can only be moved back into the slot that it came from. This shall be followed even if power is lost while a Disc is in the playing position or while it was being moved.

There are two basic types of changer mechanisms, one that has individually addressable eject and load capability and another that uses a cartridge to hold the discs. In the former, individual discs can be changed, while in the latter all the stored discs must be changed at one time.

Any time a disc or cartridge is removed or installed from the changer, the device shall generate an Unit Attention Condition. After the initiator detects the unit attention on a known changer device, the initiator may issue a MECHANISM STATUS Command. This will provide the initiator with information on what disc is present or was changed.

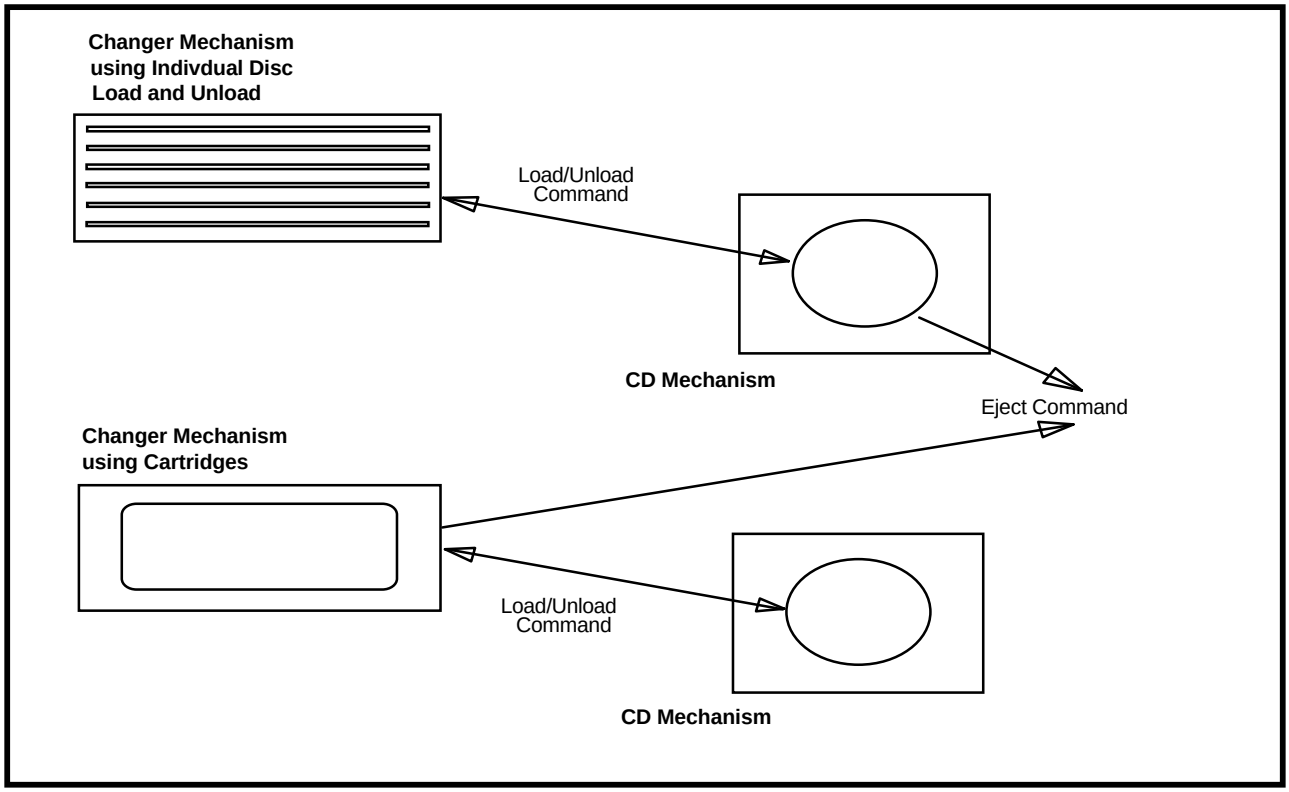

Figure 15 - Media Changer Mechanism Model

4.4.1. Side definition

As part of the DVD specifications, there is a type of media supported that includes data on more than one side of the Disc. This will allow devices that can automatically change sides to come into existence. Thus for C/DVD Devices, there is an optional capability to select each side of the Disc. Although this would not normally be thought of as a changer type of operation, the two sides to the Disc are independent and changer like functions are a good match for selecting sides. When the Logical Unit supports this functionality, each physical slot will have two logical slots. For example referencing slot 0 would be one side of the Disc, and slot 1 would then be the other side.

There are two fundamental techniques used to select each side of DVD media. The first is the most space efficient. It simply moved the Pick Up (laser unit used to read the disc) to the other side. This does add complexity to the laser mechanism to be able to position it on either the bottom or top of the media. The second approach is to actually flip the media over. This type does not exist today, although it is possible. This type of Logical Unit will pose some problems making sure that the correct side is selected after a power on or hard reset condition. Some way to remember which side was selected when the power was removed would be needed.

For a Logical Unit that supports changing sides (see section 9.1.8.7, "C/DVD Capabilities and Mechanical Status Page", on page 126, “Side Change Capable”), the number of Slots reported shall be even, and every other slot shall be an alternating side.

4.4.1.1. Side Changing Only Logical Unit

There can exist a Logical Unit that is capable of changing the side of the Disc, but does not have separate Slots from the playing position. This type of Logical Unit reports that it has a Mechanism type that is not a changer, but also reports Side Change Capable. This style of Logical Unit will still make use of the LOAD/UNLOAD C/DVD command to change the currently selected side. This style Logical Unit shall report two slots available (see section Table 52 -, "Mechanism Status Header", on page 104).

A side effect of a Logical Unit that only has the capability to change sides is that when unloading a Disc does not actually perform any action. This will appear to the host as a Logical Unit with Delayed Load type of operation (See section 6.5, "Delayed Disc load operation", on page 70).

> Note that a DVD Logical Unit that supports changing sides will not be able to report if there is actually data on both sides until each side has been read.

4.4.1.2. Attention Conditions for Sided Discs

Devices that support changing sides shall only report Unit Attention Conditions for changes that involve movement of a Disc in/out of the Logical Unit. Changes of side shall not generate Unit Attention Conditions.

4.4.1.3. Error Conditions for Sided Discs

Devices that support changing sides of a Disc shall use the NO REFERENCE POSITION FOUND, Sense Key 02h NOT READY, ASC/ASCQ 06/00 to report when the currently selected side does not contain valid data.

4.4.1.4. Initialization

The Changer shall perform its initialization routine at power on or receipt of a hardware reset from the initiator.

“Initializing Changer” is a process that refers to gathering the information that is necessary to respond to the MECHANISM STATUS Command. If a changer is in the process of initializing when it receives a MECHANISM STATUS Command, it will respond immediately and provide no slot table information (Only the Header).

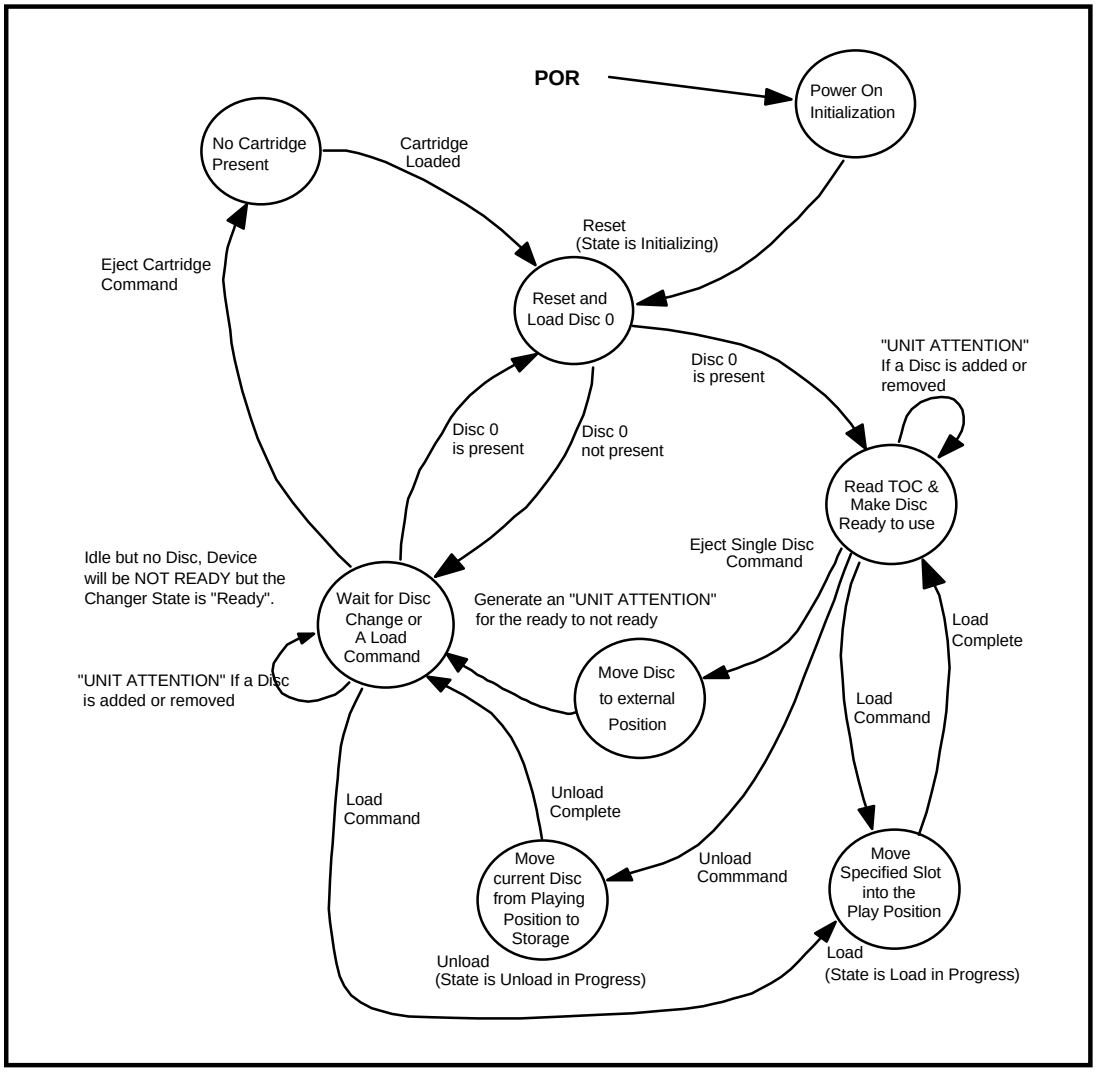

Figure 16 - Changer State Diagram

4.4.2. Changer Addressing

Several Changer specific commands use addresses called “Slots.”

If any commands related to Changer operations are implemented, then all the Changer commands shall be implemented. To determine if a drive is a changer type device, the Loading Mechanism Type field in the Capabilities page will contain one of the two changer type code (See Table 258) for individual disc or cartridge implementations.

4.4.3. Automatic Load and Unload Operations

After initialization is complete the changer shall have Disc 0 loaded into the play position. This enables drivers which are not changer aware to work with a changer device as if it were a normal single CD device. This also ensures compatibility with a Bootable CD. In support of this goal the changer shall also load and unload (Eject) default Disc 0 if

the changer supports loading and unloading (Ejecting) individual Discs unless otherwise commanded by the use of one of the changer specific Load/Unload commands.

When a LOAD Command is received and a Disc is present in the Playing position, it shall be unloaded automatically before the specified Load operation is performed.

4.4.4. Delayed Disc load operation

CD Changer Devices may either move a disc into the playing position immediately upon receipt of a LOAD command, or delay the loading of the disc until a media access command is received. It is recommended that the device not load discs into the playing position until data from a disc that is not cached is requested from the initiator.

Note that Initiator drivers should expect to encounter load mechanism delays on media accesses in addition to the spin up and seek delays normally introduced with these commands.

If the device supports delayed loading and the selected disc is not in the play position, then the commands listed in Table 11 shall move the selected disc into the play position when data that has not been cached has been requested by the initiator:

Table 11 - Commands that may cause delayed loads to occur

Command
Play Audio (10)
Play Audio MSF
Play CD
Read (10)
Read (12)
Read CD
Read CD MSF
Read CD-ROM Capacity
Read Header
Read Sub-Channel
Read TOC
Scan

If the device supports delayed loading and the selected disc is not in the play position, then the following commands shall load the selected disc into the play position before execution of the command. (See Table 12)

Table 12 - Commands that will cause delayed loads to occur

Command
Seek
Start/Stop Unit (LoEj=1)

If the device supports delayed loading and the selected disc is not in the play position, then the following commands shall not move the selected disc into the play position. (See Table 13)

Table 13 - Commands that should not cause delayed loads to occur

Command
Stop Play/Scan
Start/Stop Unit (LoEj=0)
Test Unit Ready
Inquiry
Mechanism Status
Mode Select
Mode Sense
Prevent/Allow Medium Removal
Request Sense
Set CD Speed

4.4.5. Prevent / Allow processing

There are two techniques for Prevent / Allow: either all the discs shall be prevented from being ejected by the user or each disc individually shall be prevented. If the device reports support for Software Slot Selection, then each slot shall be individually controlled by the Prevent / Allow command. Note that changer devices that use a Cartridge and not individually controlled slots should not report the Software Slot Selection capability.

4.4.6. Error Reporting for Changers

If any of the following conditions occur during the execution of a command, the Changer shall return CHECK CONDITION status. The appropriate sense key and additional sense code shall be set. Table 14 below list some error conditions and the applicable sense keys. The list does not provide an exhaustive enumeration of all conditions that may cause the CHECK CONDITION status.

Table 14 - Error Conditions and Sense Keys for Changer Mechanisms

Condition	Sense Key
Invalid Slot Number	ILLEGAL REQUEST
Unsupported option requested	ILLEGAL REQUEST
Load or Unload to invalid slot or no Disc in source location	ILLEGAL REQUEST
CD-ROM Drive reset or medium change since last command	UNIT ATTENTION
Self diagnostic failed	HARDWARE ERROR

In the case of an invalid Slot number, the sense data information field shall be set to the Slot number of the first invalid address.

Attempts to eject a Disc if the changer type is cartridge and there is a Disc in the playing position shall be rejected with a Sense Key 05, (ILLEGAL REQUEST) Sense Code 01 (MECHANICAL POSITIONING OR CHANGER ERROR).

5. Features and Profiles

5.1. Introduction

A feature is a set of commands, mode parameters and behaviors that specify the capabilities of a logical unit and its associated medium - one or more features may be supported by a particular logical unit. In general, features associated with device capabilities are static while features associated with medium capabilities are dynamic. While features are optional, the commands and mode parameters specified by a feature are mandatory. If a particular feature is reported, the logical unit or its transport shall implement all of the commands and mode parameters of that feature.

Classification by features allows logical units to report and provide layers of functionality; it also allows applications to use logical units in a precise and consistent manner. For example to illustrate layered aspect, consider two CD-ROM logical units where one particular CD-ROM logical unit may be used as both a read only block device and as a CD-Audio player. These two capabilities are reported as two separate features. Another CD-ROM logical unit may only be capable of being used as a read only block device, and it would not report the feature that specifies CD-Audio support.

Classification by features also allows applications to use devices according to the requirements of the application. For example, a CD-ROM logical unit and a hard disk drive may both be used by the same read only block device feature - the application does not need to use other features supported by the CD-ROM logical unit if the application does not them.

Another important characteristic of classification by features is its dynamic nature; a device that is capable of reading both DVD-ROM and CD-ROM medium reports different features according to whether a DVD-ROM or CD-ROM medium is loaded.

A profile is a set of features that specifies the behavior of a device class over a transport. Classification by profiles provides a means to:

1. assign the implementation of a feature (or part of a feature) between a logical unit and its transport
2. limit command fields and mode parameters based upon the capabilities of a transport
3. extend command fields and mode parameters
4. require additional commands and mode parameters as mandatory

In addition to the transport aspect, a profile enables an application: to load and initialize the appropriate modules that support the logical unit, to provide iconic representation of the logical unit, and to determine the default file system of the logical unit and its medium.

5.2. Feature Definitions

Features shall be identified by a feature code, see Table 15 The maximum number of feature sets is 65,536 and the feature code value of 0 is reserved.

Table 15 - Features

Feature Code	Feature
0	Profile List
1	Core Device
2	Microcode Upgrade
3	Random Readable Block Device
4	Random Writable Block Device
5	Format Feature
6	Power Management
7	S.M.A.R.T.
8	Event Notification
9	Embedded Changer
10	Removable Medium
11	CD-Audio Analog Output
12	CD-Audio Digital Output
13	CD READ
14	C/DVD - R
15	RESTRICTED OVERWRITE
16	DVD-READ
17	RANDOM WRITABLE
18	DVD-Video Feature

5.2.1. Core Device Feature

All logical units that conform to this specification shall implement the commands specified in “Table 16”.

Table 16 - Core Device Commands

Op Code	Command Description	Clause
12h	INQUIRY	
	GET EVENT STATUS NOTIFICATION	
55h	MODE SELECT (10)	
5Ah	MODE SENSE (10)	
	PREVENT/ALLOW	
??h	REPORT CONFIGURATION	
03h	REQUEST SENSE	
00h	TEST UNIT READY	

Note: Report configuration needs an op code.

5.2.2. Microcode Upgrade Feature

Logical units that support microcode upgrades shall implement the command specified in “Table 17”.

Table 17 - Microcode Upgrade Command

Op Code	Command Description	Clause
3Bh	WRITE BUFFER and Mode 101b (Download microcode and save)	

5.2.3. Random Readable Block Device Feature

Logical units that may be used as a random readable block device shall implement the commands specified in “Table 18”.

Table 18 - Random Readable Block Device Commands

Op Code	Command Description	Clause
28h	READ (10)	
35h	SYNCHRONIZE CACHE	

5.2.4. Random Writable Block Device Feature

Logical units that may be used as a random writable block device shall implement the commands as specified in “Table 19”.

Table 19 - Random Writable Block Device Commands

Op Code	Command Description	Clause
2Ah	WRITE (10)	
2Eh	WRITE AND VERIFY (10)	

5.2.5. FORMAT Feature

Logical units that use medium that may be formatted shall the commands specified in “Table 20”.

Table 20 - FORMAT Feature

Op Code	Command Description	Clause
04h	FORMAT UNIT	
23h	READ FORMATED CAPACITY	
2Fh	VERIFY	

5.2.6. Power Management Feature

Logical units that support power management shall implement the commands specified in “Table 21” and the mode parameters specified in “Table 22”.

Table 21 - Power Management Commands

Op Code	Command Description	Clause
4Ah	GET EVENT STATUS NOTIFICATION	
1Bh	START/STOP UNIT and the Power Conditions field	

Table 22 - Power Management Mode Parameters

Page Code	Page Description	Clause
1Ah	Power Condition	

5.2.7. S.M.A.R.T. Feature

The S.M.A.R.T. (Self-Monitoring, Analysis and Reporting Technology) is a technology developed to manage the reliability of data storage Logical Units. S.M.A.R.T.-capable PC systems have the goal of enhancing system reliability by warning users of some pending Logical Unit or media failures. With sufficient warning, users may have the opportunity to back up vital data and replace suspect Logical Units prior to data loss or unscheduled down time. S.M.A.R.T. capability is a key new element in the PC architecture that will one day provide new levels of data integrity and data availability.

Peripheral data storage Logical Units are complex electromechanical Logical Units and, as such, can suffer performance degradation or failure due to a single event or a combination of events. Some events are immediate and catastrophic while others cause a gradual degradation of the Logical Unit’s ability to perform. It is possible to predict a portion of the failures, but S.M.A.R.T. cannot and will not predict all future Logical Unit failures. S.M.A.R.T. should be treated as a feature to assist the computer user in preventing some but not all system down time due to Logical Unit failure.

S.M.A.R.T. capable Logical Units monitor a wealth of information internal to the Logical Unit to assess reliability and predict an impending Logical Unit or medium failure. This information is, in some cases, available through the interface and can be presented to end-users via drivers and supporting applications. This data should not be presented to or interpreted by system users or managers to predict the integrity or reliability of a S.M.A.R.T. Logical Unit. The predictive algorithms in a S.M.A.R.T. Logical Unit are designed to interpret internal conditions in order to detect impending failures and thus users or system managers should not attempt to predict impending Logical Unit failure from this internal data.

S.M.A.R.T. data are not linear predictors of the degrading reliability of a S.M.A.R.T. capable Logical Unit. It is the responsibility of a S.M.A.R.T. Logical Unit to predict an impending failure and report that failure via an Informational Exception Condition.

Logical units that support Self Monitoring Analysis and Reporting shall support the mode pages specified in “Table 23”.

Table 23 - S.M.A.R.T. Mode Parameters

Page Code	Page Description	Clause
1Dh	Fault/Failure Reporting	

5.2.8. Event Notification Feature

The Event Notification feature provides a means for an initiator to receive notification of events that are beyond the control of an initiator.

A logical unit that implements Event Notification shall support the commands specified in “Table 24”.

Table 24 - Event Notification Commands

Op Code	Command Description	Clause
4Ah	GET EVENT STATUS NOTIFICATION (GESN)	

In the Polling Mode of Event Notification, an initiator shall repeatedly issue GESN commands with an immediate bit of 1. The logical unit shall complete these commands upon receipt, supplying the initiator with information on the most recent event occurrences, as described in the GESN command. If an event occurrence of the class(es) requested is not in the logical unit event queue, the Logical Unit shall complete the GESN command, and shall set the NEA bit to 1. This shall not be deemed an error.

If command queuing is supported, the host may issue a GESN command with an immediate bit of 0. The command shall not complete until an event occurrence of the class(es) requested is either in the event queue, or occurs.

The logical unit shall maintain a separate queue for each class of Event Notification(s) supported. Events that are generated shall be placed at the tail of the event queue. The depth of the queue(s) is vendor specific, although it shall be at least one. If an overflow occurs, the logical unit shall maintain the most recent Events in the queue.

Each GESN command shall report only one event. If multiple Event Classes are requested and multiple events are available, the logical unit shall report the Event in the Event Class with the lowest Notification Class ordinal.

5.2.9. Embedded Changer Feature

Logical units that support an embedded changer shall implement the commands specified in “Table 25”.

Table 25 - Embedded Changer Command

Op Code	Command Description	Clause
A6h	LOAD/UNLOAD MEDIUM	
BDh	MECHANISM STATUS	

5.2.10. Removable Medium Feature

A major shortcoming of removable media Logical Units on PC platforms is their inability to report to the host when the user attempts to eject the medium. Currently most removable media Logical Units just eject the medium when the user presses the Eject button, and potentially any data the operating system has not saved to the Logical Unit is lost. Various volume tracking and locking schemes reduce this risk, but do not eliminate it. Using this feature, Logical Units will have a means of communicating to the host that the user wants to eject the medium or has inserted a new medium.

A logical unit that implements the Removable Medium Feature shall support the commands as specified in "Table 26".

Table 26 - Removable Medium Commands

Op Code	Command Description	Clause
4Ah	GET EVENT STATUS NOTIFICATION	
BDh	MECHANISM STATUS	
1Eh	PREVENT/ALLOW	
25h	READ CAPACITY	
1Bh	START/STOP UNIT and load eject (LOEJ) bit	

This section defines a protocol for providing this functionality for removable media Logical Units. The support is enabled using the PREVENT/ALLOW command (Persistent Bit), and the media status is retrieved using the GET EVENT STATUS NOTIFICATION command.

When the Persistent Prevent state is entered, the media shall remain locked in the Logical Unit, until the host issues an eject request, or a power on or hard reset condition occurs. The Persistent Prevent state shall be maintained after the eject request. New media that is inserted into the Logical Unit shall be locked in the Logical Unit after the logical unit reports the NEW MEDIA event. Prior to reporting the NEW MEDIA event, the logical unit may eject media without an explicit eject command from the host. This allows the user to remove incorrectly inserted media without having to wait for host intervention.

While in the Persistent prevent state, the logical unit shall generate Events upon receipt of a User Eject request. The logical unit shall not eject the media on receipt of these requests, if the logical unit has already reported a NEW MEDIA event for this media. When the host receives the Eject Request, and determines that it is safe to eject the medium, an eject command will be issued, at which time the logical unit shall eject the medium.

The logical unit shall only generate MSEN (EJECT REQUEST) events after reporting a MSEN (NEW MEDIA) event, and prior to reporting a MSEN (MEDIA REMOVAL) event for the given media.

To maintain compatibility with existing BIOS implementations and operating systems, the logical unit shall default to Persistent Prevent disabled. When the host enables the support using the PREVENT ALLOW command, the logical unit shall respond as described in this specification. When the host disables this feature, the logical unit must default to normal operating modes. A power on or hard reset shall cause the logical unit to the default Persistent Prevent state.

If the Logical Unit is unable to maintain media status information across a reset or power cycle, the Logical Unit shall generate a NEW MEDIA event.

Commands must be processed exactly the same as they would be if Persistent Prevent was not enabled. For compatibility reasons, UNIT ATTENTION status conditions must still be returned. However, the logical unit shall not return the UNIT ATTENTION status on a GESN command. For example, if the user inserts a new medium and the logical unit is accessed with a command, the CHECK CONDITION with UNIT ATTENTION shall be reported, but the logical unit shall also report the NEW MEDIA Event with the next available GESN (Media Status) command.

If a changer type Logical Unit uses media status operation, it shall use the following variations. If the changer Logical Unit supports individual slot load and unload capability, the slot number(s) exhibiting the media status change shall be

reported in the slot fields of the Media Status Event Data. If the changer Logical Unit uses a cartridge load mechanism, the slot fields shall be set to the start and end slot numbers present in the cartridge.

For non-immediate GESN commands, the host shall use exactly one GET EVENT STATUS NOTIFICATION request for the entire changer Logical Unit. The Logical Unit shall respond as indicated in the Asynchronous Operation section above, indicating the slot information in the Request Sense Data as described above.

5.2.11. CD-Audio Analog Output Feature

Logical units that have a CD-Audio analog output shall support the commands specified by "Table 27" and the mode pages specified in “Table 28”.

A logical unit without a CD-Audio output shall respond to a PLAY AUDIO command, which has a transfer length of zero, with CHECK CONDITION status, and set the sense key to ILLEGAL REQUEST. This behavior allows an initiator determine if a CD-Audio analog output is supported.

Table 27 - CD-Audio Analog Output Commands

OpCode	Command Description	Clause
BDh	MECHANISM STATUS	
4Bh	PAUSE/RESUME	
45h	PLAY AUDIO (10)	
47h	PLAY AUDIO MSF	
42h	READ SUBCHANNEL	
4Eh	STOP PLAY/SCAN	

Table 28 - CD-Audio Analog Output Mode Pages

Page Code	Page Description	Clause
0Eh	CD Audio Control Mode Page	

5.2.12. CD-Audio Digital Output Feature

Logical units that have a CD-Audio digital output, shall support the commands specified by “Table 29” and mode pages specified by “Table 30”.

Table 29 - CD-Audio Digital Output Commands

OpCode	Command Description	Clause
BDh	MECHANISM STATUS	
4Bh	PAUSE/RESUME	
45h	PLAY AUDIO (10)	
47h	PLAY AUDIO MSF	
4Eh	PLAY CD	
42h	READ SUBCHANNEL	
4Eh	STOP PLAY/SCAN	

Table 30 - CD-Audio Digital Output Mode Pages

Clause	Page Description	Clause
0Eh	CD Audio Control Mode Page	

5.2.13. CD READ Feature

Logical units that read CDROM media shall support the commands specified in “Table 31”.

Table 31 - CD READ Commands

Op Code	Command Description	Clause
BEh	READ CD	
51h	READ DISC INFOROMATION	
43h	READ TOC/PMA/ATIP	
52h	READ TRACK INFORMATION	

5.2.14. C/DVD-R Feature

Logical units that write and read CDR media shall support the commands specified in “Table 32”.

Table 32 - C/DVD-R Commands

Op Code	Command Description	Clause
5Bh	CLOSE TRACK/SESSION	
53h	RESERVE TRACK	

5.2.15. RESTRICTED OVERWRITE Feature

Logical units that write and read CDRW media shall support the commands specified in “Table 33”.

Table 33 - RESTRICTED OVERWRITE Feature

Op Code	Command Description	Clause
	WRITE	
A1h	BLANK	

ADD PARAMETER PAGES

5.2.16. DVD READ Feature

Logical units that read CDROM media shall support the commands specified in “Table 34”.

Table 34 - DVD READ Commands

Op Code	Command Description	Clause
51h	READ DISC INFOROMATION	
ADh	READ DVD STRUCTURE	
52h	READ TRACK INFORMATION	

5.2.17. RANDOM WRITABLE Feature

Logical units that write and read DVD-RAM media shall support the commands specified in “Table 35”.

Table 35 - RANDOM WRITABLE Feature Commands

Op Code	Command Description	Clause

5.2.18. DVD-CSS Feature

Logical units that support DVD-Video CSS (Content Scramble System) shall implement the commands specified by "Table 36".

Table 36 - DVD-CSS Feature Commands

Opcode	Command Description	Clause
A2h	REPORT KEY	
A3h	SEND KEY	
A7h	SET READ AHEAD	

5.2.19. AV Streaming

5.2.20. User input feature

5.3. Profile Definitions

5.3.1. Disk Drive Profiles

5.3.1.1. 1394 Simple Hard Disk Drive Profile

Logical units that support the 1394 Simple Hard Disk Drive Profile shall implement the features shown in “Table 37”.

Table 37 - 1394 Simple Hard Disk Drive Profile

Command/Profile/Feature	Extensions and Limitations	Type	Clause
Core Device	INQUIRY and REQUEST SENSE shall be supported by SBP-2 transport; MODE SENSE/MODE SELECT block descriptors shall not be supported	M	5.2.1.
Random Readable Block Device	Mode Page 3Eh shall be supported	M	5.2.3.
Random Writable Block Device	FUA field shall be supported in WRITE(10);	M	5.2.4.
Power Management	load eject (LOEJ) bit of START/STOP UNIT shall not be supported	M	5.2.6.
Event Notification	Asynchronous mode of GET EVENT STATUS NOTIFICATION shall be supported by SBP-2 transport	M	5.2.8.

Table 38 - Power Management Mode Parameters

Page Code	Page Description	Clause
1Ah	Power Condition	

5.3.1.2. 1394 Removable Medium Disk Drive Profile

Logical units that support the 1394 Simple Hard Disk Drive Profile shall implement the features shown in Table 39

Table 39 - 1394 Removable Medium Disk Drive Profile

Command/Profile/Feature	Extensions and Limitations	Type	Clause
Core Device	INQUIRY and REQUEST SENSE shall be supported by SBP-2 transport; MODE SENSE/MODE SELECT block descriptors shall not be supported	M	5.2.1.
Random Readable Block Device		M	5.2.3.
Random Writable Block Device	FUA field shall be supported in WRITE(10);	M	5.2.4.
Format		M	5.2.5.
Power Management		M	5.2.6.
Event Notification	Asynchronous mode of GET EVENT STATUS NOTIFICATION shall be supported by SBP-2 transport	M	5.2.8.
Removable Medium		M	5.2.10.

5.3.2. CDROM Profiles

5.3.2.1. 1394 CDROM Profile

Logical units that support the 1394 CDROM Profile shall implement the features shown in “Table 40”.

Table 40 - 1394 CDROM Profile

Command/Profile/Feature	Extensions and Limitations	Type	Clause
Core Device	INQUIRY and REQUEST SENSE shall be supported by SBP-2 transport; MODE SENSE/MODE SELECT block descriptors shall not be supported	M	5.2.1.
Random Readable Block Device		M	5.2.3.
Power Management		M	5.2.6.
Event Notification	Asynchronous mode of GET EVENT STATUS NOTIFICATION shall be supported by SBP-2 transport	M	5.2.8.
Removable Medium		M	5.2.10.
CD READ		M	5.2.13.

5.3.2.2. ATAPI CDROM Profile

Logical units that support the ATAPI CDROM Profile shall implement the features shown in “Table 41”.

Table 41 - ATAPI CDROM Profile

Command/Profile/Feature	Extensions and Limitations	Type	Clause
Core Device	MODE SENSE/MODE SELECT block descriptors shall not be supported	M	5.2.1.
Random Readable Block Device		M	5.2.3.
Removable Medium		M	5.2.10.
CD READ		M	5.2.13.

5.3.2.3. SCSI CDROM Profile

Logical units that support the ATAPI CDROM Profile shall implement the features shown in “Table 42”.

Table 42 - SCSI CDROM Profile

Command/Profile/Feature	Extensions and Limitations	Type	Clause
Core Device		M	5.2.1.
Random Readable Block Device		M	5.2.3.
Removable Medium		M	5.2.10.
CD READ		M	5.2.16.

5.3.3. CDR Profiles

5.3.3.1. 1394 CDR Profile

Logical units that support the 1394 CDR Profile shall implement the features shown in “Table 43”.

Table 43 - 1394 CDR Profile

Profile/Feature/Command	Extensions and Limitations	Type	Clause
Core Device	INQUIRY and REQUEST SENSE shall be supported by SBP-2 transport; MODE SENSE/MODE SELECT block descriptors shall not be supported	M	5.2.1.
Random Readable Block Device		M	5.2.3.
Power Management		M	5.2.6.
Event Notification	Asynchronous mode of GET EVENT STATUS NOTIFICATION shall be supported by SBP-2 transport	M	5.2.8.
Removable Medium		M	5.2.10.
C/DVD- R		M	5.2.14.

5.3.3.2. ATAPI CDR Profile

Logical units that support the ATAPI CDR Profile shall implement the features shown in “Table 44”.

Table 44 - ATAPI CDR Profile

Profile/Feature/Command	Extensions and Limitations	Type	Clause
Core Device	MODE SENSE/MODE SELECT block descriptors shall not be supported	M	5.2.1.
Random Readable Block Device		M	5.2.3.
Removable Medium		M	5.2.10.
CD READ		M	5.2.13.
C/DVD - R		M	5.2.14.

5.3.3.3. SCSI CDR Profile

Logical units that support the SCSI CDR Profile shall implement the features shown in “Table 45”.

Table 45 - SCSI CDR Profile

Profile/Feature/Command	Extensions and Limitations	Type	Clause
Core Device		M	5.2.1.
Random Readable Block Device		M	5.2.3.
Removable Medium		M	5.2.10.
CD READ		M	5.2.16.
C/DVD - R		M	5.2.14.

5.3.4. CDRW Profiles

5.3.4.1. 1394 CDRW Profile

Logical units that support the 1394 CDRW Profile shall implement the features shown in “Table 46”.

Table 46 - 1394 CDRW Profile

Command/Profile/Feature	Extensions and Limitations	Type	Clause
Core Device	INQUIRY and REQUEST SENSE shall be supported by SBP-2 transport; MODE SENSE/MODE SELECT block descriptors shall not be supported	M	5.2.1.
Random Readable Block Device		M	5.2.3.
Power Management		M	5.2.6.
Event Notification	Asynchronous mode of GET EVENT STATUS NOTIFICATION shall be supported by SBP-2 transport	M	5.2.8.
Removable Medium		M	5.2.10.
CD READ		M	5.2.13.
C/DVD- R		M	5.2.14.
RESTRICTED OVERWRITE		M	5.2.15.

5.3.4.2. ATAPI CDRW Profile

Logical units that support the ATAPI CDRW Profile shall implement the features shown in “”.

5.3.4.3. SCSI CDRW Profile

Logical units that support the ATAPI CDRW Profile shall implement the features shown in “”.

5.3.5. DVD-ROM Profiles

5.3.5.1. 1394 DVD-ROM Profile

Logical units that support the 1394 DVD-ROM Profile shall implement the features shown in “Table 47”.

Table 47 - 1394 DVD-ROM Profile

Command/Profile/Feature	Extensions and Limitations	Type	Clause
Core Device	INQUIRY and REQUEST SENSE shall be supported by SBP-2 transport; MODE SENSE/MODE SELECT block descriptors shall not be supported	M	5.2.1.
Random Readable Block Device		M	5.2.3.
Power Management		M	5.2.6.
Event Notification	Asynchronous mode of GET EVENT STATUS NOTIFICATION shall be supported by SBP-2 transport	M	5.2.8.
Removable Medium		M	5.2.10.
DVD-ROM		M	5.2.16.

5.3.5.2. ATAPI DVD-ROM Profile

Logical units that support the ATAPI DVD-ROM Profile shall implement the features shown in “Table 48”.

Table 48 - ATAPI DVD-ROM Profile

Command/Profile/Feature	Extensions and Limitations	Type	Clause
Core Device	MODE SENSE/MODE SELECT block descriptors shall not be supported	M	5.2.1.
Random Readable Block Device		M	5.2.3.
Power Management		M	5.2.6.
Event Notification		M	5.2.8.
Removable Medium		M	5.2.10.
DVD-ROM		M	5.2.16.

5.3.5.3. SCSI DVD-ROM Profile

Logical units that support the SCSI DVD-ROM Profile shall implement the features shown in “Table 49”.

Table 49 - SCSI DVD-ROM Profile

Command/Profile/Feature	Extensions and Limitations	Type	Clause
Core Device		M	5.2.1.
Random Readable Block Device		M	5.2.3.
Power Management		M	5.2.6.
Event Notification		M	5.2.8.
Removable Medium		M	5.2.10.
DVD-ROM		M	5.2.13.

5.3.6. DVD-R Profiles

5.3.6.1. 1394 DVD-R Profile

Logical units that support the 1394 DVD-R Profile shall implement the features shown in “”.

5.3.6.2. ATAPI DVD-R Profile

Logical units that support the ATAPI DVD-R Profile shall implement the features shown in “”.

5.3.6.3. SCSI DVD-R Profile

Logical units that support the SCSI DVD-R Profile shall implement the features shown in “”.

5.3.7. DVD-RAM Profiles

5.3.7.1. 1394 DVD-RAM Profile

Logical units that support the 1394 DVD-RAM Profile shall implement the features shown in “”.

5.3.7.2. ATAPI DVD-RAM Profile

Logical units that support the ATAPI DVD-RAM Profile shall implement the features shown in “”.

5.3.7.3. SCSI DVD-RAM Profile

Logical units that support the SCSI DVD-RAM Profile shall implement the features shown in “”.

5.3.8. Tape Profiles

5.3.8.1. 1394 Tape Profile

Logical units that support the 1394 Tape Profile shall implement the features shown in “”.

5.3.8.2. ATAPI Tape Profile

Logical units that support the ATAPI Tape Profile shall implement the features shown in “”.

5.3.8.3. SCSI Tape Profile

Logical units that support the SCSI Tape Profile shall implement the features shown in “”.

6. Command Descriptions for All Logical Units

Commands which may be implemented common to some or all Logical Unit types are listed in other SCSI-3 standards. For a complete description of these commands reference SCSI-3 Primary Commands, SCSI-3 Block Commands, SCSI-3 MultiMedia Commands, and others.

The commands listed in this sub-clause follow a packetize command layout. Some implementations may desire to have a common CDB length which will require the Host or Initiator to provide a padding of a number of bytes to fill the byte length requirements of the Logical Unit.

6.1. C/DVD Commands

Commands referenced for C/DVD Logical Units are listed in Table 50. These commands are described in the following sub-clauses.

Table 50 - Multimedia Commands Specific to C/DVD Devices

Command Name	Op Code	Type	Sub-clause
BLANK	A1h		6.1.1.
CLOSE TRACK/SESSION	5Bh		6.1.2.
FORMAT UNIT	04h		6.1.3.
INQUIRY	12h	M	SPC
LOAD/UNLOAD C/DVD	A6h	O	6.1.5.
MECHANISM STATUS	BDh	M	6.1.6.
MODE SELECT (6)	15h	M	SPC
MODE SENSE (10)	5Ah	M	SPC
MODE SENSE (6)	1Ah	M	SPC
PAUSE/RESUME	4Bh	A	6.1.7.
PLAY AUDIO (10)	45h	A	6.1.8.
PLAY AUDIO (12)	A5h	A	6.1.9.
PLAY AUDIO MSF	47h	A	6.1.10.
PLAY C/DVD	BCh	O	6.1.11.
PREVENT/ALLOW MEDIUM REMOVAL	1Eh	M	SPC
READ (10)	28h	M	SPC
READ BUFFER CAPACITY	5Ch		6.1.12.
READ C/DVD	BEh	O	6.1.13.
READ C/DVD MSF	B9h	O	6.1.14.
READ C/DVD RECORDED CAPACITY	25h	M	6.1.15.
READ DISC INFORMATION	51h		6.1.16.
READ DVD STRUCTURE	ADh		6.1.17.
READ HEADER	44h	M	6.1.18.
READ HEY			
READ MASTER CUE	59h		6.1.19.
READ SUB-CHANNEL	42h	M	6.1.20.
READ TOC/PMA/ATIP	43h	M	6.1.21.
READ TRACK /RZONE INFORMATION	52h		6.1.22.
RELEASE (10)	57h	M	SPC
REPAIR TRACK/RZONE	58h		
REQUEST SENSE	03h	M	SPC
RESERVE TRACK/RZONE	53h		
RESERVE(10)	56h	M	SPC
SCAN	BAh	O	6.1.26.
SEEK (10)	2Bh	M	SPC
SEEK (6)	0Bh	M	SPC
SEND CUE SHEET	5Dh		6.1.27.
SEND DIAGNOSTIC	1Dh	M	SPC
SEND EVENT			
SEND KEY	A3h		6.1.28.
SEND OPC INFORMATION	54h		6.1.29.
SET C/D SPEED	BBh	R	6.1.31.
START/STOP UNIT	1Bh	M	SPC
STOP PLAY/SCAN	4Eh	A	
SYNCHRONIZE CACHE	35h		6.1.33.
WRITE (10)	2Ah		6.1.34.
WRITE (12)			
TEST UNIT READY	00h	M	SPC

Key: M = command implementation is mandatory
O = command implementation is optional
A = mandatory command when implementing Audio
R = mandatory command for CD-R/RW Logical Units

6.1.1. BLANK Command

CD-RW discs have two properties not available with CD-R: direct-overwrite and the ability to erase. The BLANK command provides the ability to erase any part of a CD-RW disc.

Table 51 - BLANK Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code (A1h)							
1	Reserved			Reserved		Blanking Type		
2	(MSB)							
3	Start Address/Track Number							
4								
5								(LSB)
6	Reserved							
7	Reserved							
8	Reserved							
9	Reserved							
10	Reserved							
11	Control Byte							

Note: The erasing action performed in this command is a Logical Erase.

Blanking Type identifies the method and coverage of blanking. The codes for Blanking Type are defined in Table 52.

Start Address/Track Number is the LBA at which a range for erasure begins:
a) When Blanking Type is Blank a Track Tail, this field indicates the start LBA.
b) When Blanking Type is Blank a Track, this field indicates the track.

Table 52 - Blanking Types

Code	Type	Name	Description
000b	Mandatory	Blank the disc	The entire disc is to be erased. The Start Address parameter is ignored. This is used for clearing a complete disc. After completion of this command the disc is blank.
001b	Mandatory	Minimally blank the disc	Erases only the PMA, first session TOC and the pre-gap of the first track. The Start Address parameter is ignored. This is used for blanking a disc quickly. After completion of this command the disc is treated as a blank disc. Caution must be exercised when using this command as the program area still contains user data.
010b	Optional	Blank a Track	Erases the track specified in the Start Address/Track Number field. This command erases the track only, it does not erase the TOC or the PMA. The track to be erased shall be in the incomplete session.
011b	Optional	Un-reserve a Track	This is valid only when the last recorded track is incomplete, reserved, or is complete and in an incomplete session. If the last track is incomplete the track and PMA entry for incomplete track is erased. If the track is reserved or complete, the track and PMA entry of the track is erased. The Start Address/Track Number parameter is ignored.
100b	Mandatory	Blank a Track Tail	Erase the area between the LBA specified Start Address/Track Number field and the end of the track which includes the LBA specified. The LBA specified shall be the first user data block within a packet. This blank type is valid for only a Packet track. This may be used to prepare for writing a packet track to a CD-RW disc with the same write process as a CD-R. The track to be erased shall be in an incomplete session.
101b	Optional	Unclose the last session	Erases the lead-in and lead-out of the last session. The last session shall be complete when this command is issued.
110b	Optional	Erase Session	If the last session is complete, its lead-in, program area, and lead-out shall be erased. If the last session is incomplete, its program area shall be erased. If the last session is empty, the complete session immediately preceding the empty session shall be erased. If the empty session is the only session on the disc, erasing shall not be considered an error.
111b		Reserved	

Table 53 - Recommended errors for BLANK Command

Error	Reference
Deferred Errors	Sub-clause **A.1**
General Errors	Table **A.2**
Media Access Errors	Table **A.3**
Write Errors	Table **A.4**
ERASE FAILURE	Table **A.1**

6.1.2. CLOSE TRACK/SESSION Command

The CLOSE TRACK/SESSION Command allows closure of either a track or a session.

Table 54 - CLOSE TRACK/SESSION Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code (5Bh)							
1	Reserved							Immed
2	Reserved						Session	Track
3	Reserved							
4	Reserved							
5	Track Number							
6	Reserved							
7	Reserved							
8	Reserved							
9	Control Byte							

The Immed bit allows execution of the close function as an immediate operation. If Immed is zero, then the requested close operation is executed to completion prior to returning status. If Immed is one, then status is returned once the close operation has begun.

The Session and Track bits (see Table 55) have the following meanings:

Table 55 - Session and Track Bits Definitions

Session	Track	Close Actions
0	0	Reserved, not valid
0	1	Close the track associated with the track number in the CDB. If this is the incomplete track, Pad only to the minimum length of 4 seconds. No other padding is to be done. If this is the partially recorded or empty reserved track, the Logical Unit shall pad the track. In the case of an empty track, the Logical Unit shall write the track according to the write parameter page. If the write parameter page is inconsistent with the PMA, CHECK CONDITION shall be set to ILLEGAL MODE FOR THIS TRACK.
1	0	Close session. If all tracks in the last session are not complete, generate Check Condition Status.
1	1	Reserved, not valid

If a session or track is to be closed that is already closed, no error shall be reported.

If Session is set to zero and Track is set to one, byte 5 of the CDB contains the track number of the track to close. If the track number is FFh, then the incomplete track is to be closed. Byte 5 of the CDB shall be ignored if the session bit is set.

In order to close the incomplete track, the following steps are required:

1) If necessary, the track is padded to the minimum length of 4 seconds.
2) The PMA is consulted in order to locate the largest track number recorded, N.
3) The bounds of the track are determined and a PMA entry is written for track N+1.

Closing a session shall cause the lead-in and lead-out to be written for the incomplete session. Closing a session when the last session is closed shall not be considered an error. Closing a session when the last session is empty shall result in a CHECK CONDITION status and sense data set to 05/71/04.

If partially recorded, empty, or incomplete tracks exist in the incomplete session, the drive shall issue CHECK CONDITION status, sense data set to 05/71/04.

Table 56 - Recommended errors for CLOSE TRACK/SESSION Command

Error	Reference
Deferred Errors	Sub-clause **A.1**
General Errors	Table **A.2**
Media Access Errors	Table **A.3**
Write Errors	Table **A.4**
SESSION FIXATION ERROR	Table **A.1**
SESSION FIXATION ERROR WRITING LEAD-IN	Table **A.1**
SESSION FIXATION ERROR WRITING LEAD-OUT	Table **A.1**
SESSION FIXATION ERROR - INCOMPLETE TRACK IN SESSION	Table **A.1**
EMPTY OR PARTIALLY WRITTEN RESERVED TRACK	Table **A.1**

ED NOTE: this command will be replaced with the MtFuji2 format cmd

6.1.3. FORMAT UNIT command

The FORMAT UNIT Command (Table 57) formats CD-RW medium into initiator addressable logical blocks per the initiator defined options.

Table 57 - Format Unit Command

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code (04h)							
1	Reserved			Fmt	Cmp	Format Code		
2	Reserved							
3	(MSB) Interleave Value							
4	(LSB)							
5	Control Byte							

A formatted CD-RW session shall consist of a single, fixed packet track. The packet size specified in the WRITE PARAMETERS mode page defines packet size for the format operation. If the WRITE TYPE field in the WRITE PARAMETERS mode page is not packet (00b), the FORMAT UNIT command shall terminate with a CHECK CONDITION and set sense to ILLEGAL REQUEST, COMMAND SEQUENCE ERROR. If the FP bit in the WRITE PARAMETERS mode page is not set to one (Fixed Packet), the FORMAT UNIT command shall terminate with a CHECK CONDITION and set sense to ILLEGAL REQUEST, COMMAND SEQUENCE ERROR.

A FmtData bit of zero indicates that there is no parameter list. A FmtData bit of one indicates that a parameter list is available. For CD-RW, FmtData shall be set to one.

A CmpList bit of zero indicates that the parameter list provided is in addition to those already available to the Logical Unit. A CmpList bit of one indicates that the parameter list is complete and the Logical Unit is to ignore any existing parameters. For CD-RW, CmpList shall be cleared to zero.

The Format Code identifies the parameter list format. For CD-RW, the Format Code shall be set to seven (111b).

The Interleave Value identifies the interleave to be used when formatting. For CD-RW, Interleave Value shall be cleared to zero.

The FORMAT UNIT Command parameter list (Table 58) consists of three descriptors: the Format List Header, the Initialization Pattern Descriptor, and the Format Descriptor.

Table 58 - Format Unit Parameter List

Bit / Byte	7	6	5	4	3	2	1	0
0	Format List Header							
1	Initialization Pattern Descriptor							
2	Format Descriptor							

Table 59 - Format List Header

Bit Byte	7	6	5	4	3	2	1	0
0	Reserved							
1	FOV	DPRY	DCRT	STPF	IP	DSP	IMM	VS
2	(MSB) Format Descriptor Length							
3	(LSB)							

FOV is not used and shall be cleared to zero.

DPRY is not used and shall be cleared to zero.

DCRT is not used and shall be cleared to zero.

STPF is not used and shall be cleared to zero.

IP is not used and shall be cleared to zero.

DSP is not used and shall be cleared to zero.

IMM indicates that GOOD status shall be returned once the command has been decoded and the format operation has begun.

VS is not used and shall be cleared to zero.

The Format Descriptor Length shall be set to 8 when formatting CD-RW medium.

The Initialization Pattern Descriptor (Table 60) is not used for formatting CD-RW medium and shall be cleared to zeros.

Table 60 - Initialization Descriptor

Bit Byte	7	6	5	4	3	2	1	0
0	0							
1	0							
2	0							
3	0							

Table 61 - CD-RW Format Descriptor

Bit Byte	7	6	5	4	3	2	1	0
0	Sess	Grow	Reserved					
1	Reserved							
2	Reserved							
3	Reserved							
4	(MSB) Format Size							
5								
6								
7	(LSB)							

If both the Grow and Session bits are set to zero the format operation shall format (Format Size) user data blocks. Format Size must be integrally divisible by the Packet Size field in the WRITE PARAMETERS mode page. The first

formatted user data block shall be LBA 0. Existing information on the disc may be overwritten. After the format, a single session containing a single, fixed packet track will exist on the medium.

If the Grow bit is set to zero and the Session bit is set to 1 the format operation shall create a new session that contains (Format Size) user data blocks. Format Size must be integrally divisible by the Packet Size field in the WRITE PARAMETERS mode page. If the last session on the disc is not complete when this command is issued, a CHECK CONDITION status shall be generated.

A Grow bit of 1 indicates that the final session shall be "grown" to (Format Size) from its original size. This is accomplished by appending packets to the existing session, writing a new lead-out, and updating the PMA and lead-in to change the track size to reflect the new size. Data in existing packets shall not be affected. If the Format Size is smaller than the existing size, a check condition status shall be returned. The order of updating the PMA, lead-in, lead-out, and data area is not specified.

The session bit shall be ignored when the Grow bit is set.

If the Multi-Session Field (see Table 245) in the Write Parameter Page is 11b, the drive shall erase the remaining area of the disc.

Table 62 - Recommended errors for FORMAT UNIT Command

Error	Reference
Deferred Errors	Sub-clause **A.1**
General Errors	Table **A.2**
Media Access Errors	Table **A.3**
Write Errors	Table **A.4**
FORMAT COMMAND FAILED	Table **A.1**
CANNOT FORMAT MEDIUM - INCOMPATIBLE MEDIUM	Table **A.1**

6.1.4. GET EVENT STATUS NOTIFICATION

The Get Event/Status Notification Command requests the logical unit to report events and statuses as specified in the Notification Class field and provides asynchronous notification. Two modes of operation are defined here. They are polling and asynchronous modes.

In polling mode, the host will issue Get Event/Status Notification commands at periodic intervals with an IMMED (immediate) bit of 1 set. The target shall complete this command with the most recently available event status requested. The logical unit shall support polling mode.

In asynchronous mode, the host will issue a single Get Event/Status command with an IMMED (immediate) bit of 0 re-quested. If the Logical Unit supports Asynchronous event status notification (through tagged queuing) the model outlined here shall be used. If the Logical Unit does not support Asynchronous Mode, the command shall fail as an illegal request. If the host requests Asynchronous Mode using a request that is not queued or overlapped, the command shall fail as an illegal request.

When Asynchronous Event Status reporting is supported, the target shall not complete a Get Event/Status command with an IMMED bit of 0 until a change in event status of the requested class occurs. The target shall complete the Get Event/Status Notification Command as soon after the event occurs as possible. It will report the event as outlined below.

Note: Only one class of event per Get Event Status Notification Command shall be reported. The priority of event reporting shall be by event Class number. The lower the class number, the higher the priority.

This command shall not return a Unit Attention check condition.

Table 63 - GET EVENT STATUS NOTIFICATION Command

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code (4Ah)							
1	Reserved			Reserved				Immed
2	Reserved							
3	Reserved							
4	Notification Class Request							
5	Reserved							
6	Reserved							
7	(MSB) Event List Length							
8	(LSB)							
9	Control							

Note: A bit field of all 0's indicates that the target should immediately complete this command indicating No Event, and shall list the supported event class in the Event Buffer header. This Method shall be used to determine which event classes a Logical Unit supports.

Notification Class Request field requests the logical unit to report event(s) from the event classes requested in this field. Table defines the codes listed in this field.

Table 64 - Notification Class Request

Bit	Definition
0	Reserved
1	Operational Change Request/Notification
2	Power Management Class Events
3	Reserved
4	Media Status Class Events
5	Reserved
6	Device Busy Class Events
7	Reserved

If a Logical Unit does not support any of the requested event classes, the Logical Unit shall terminate the command successfully, returning only the Event Data Header, and indicating a returned Class of 0.

Host Software that manages media event status, may or may not be linked to other software that manages power states This notification field provides a way that power and media event status notifications can be independently managed by the responsible software. If a driver manages media, power management and Busy Device events, the driver can issue this command with notification field set to 0101010b to request the logical unit to report power, media, and busy events.

Table 65 - Event Status Return Data

Bit / Byte	7	6	5	4	3	2	1	0
0 - 3	Event Header							
0 - n	Event Data							

Table 66 - Event Status Header

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB) Event Data Length							
1								(LSB)
2	NEA	Reserved					Notification Class	
3	Supported Event Classes							

The Event Data Length field specifies the amount of data that follows the Event Status Notification Header. The amount of data reported shall be the number of bytes following the data length field.

NEA bit if set, indicates there are no events requested by the Notification Class field. available in the requested Notification Class(es).

Supported Event Classes field specifies the event classes that the Logical Unit supports as per the Notification Class Field (Table 64). If a Feature is supported, the corresponding bit shall be set to one.

Table 67 - Operational Change/Notification Returned Data

Bit / Byte	7	6	5	4	3	2	1	0
0	Reserved				Operational Event			
1	Operational Status							
2	(MSB) Operation Request/Report							
3								(LSB)

Operational Event field reports drive requests to change state and notifications of changes in drive state. If a persistent prevent is in place, any action request that can be reported before performing the action shall not be performed by the drive, and the drive shall notify the host of the requested action. In all other cases, the drive shall notify the host of actions that change drive state. An example of an action that must be reported after the action is taken is termination of a play operation due to an error or end of medium. Upon reporting operational change notification to the host, this field is reported as 0h on subsequent Get Event/Status Notification commands until a new change in operational state occurs.

Operational Status field reports the device's ability to respond to the host.

Operation Request/Report field reports the operation requested or operation that has been performed. The request usually originates from the unit's own user interface (i.e. front panel buttons) or from another initiator.

Table 68 - Operational Event Format

Code	Event	Description
0h	NoChg	No changes in operational state performed or requested
1h	Operational Change Request	The Logical Unit requests to change operational state
2h	Device has changed Operational State	The Logical Unit has changed operational state
3h - Fh	Reserved	

Table 69 - Operational Status Format

Code	Status	Description
0h	Allowed	Unit is ready and no persistent reserve is in place for this initiator.
1h	Prevented	Unit is ready and a persistent reserve is in place for this initiator.
2h	Temporally Busy	The Logical Unit is performing a task that will self-terminate
3h	Busy/Reserved	The Logical Unit is performing operations that will take an indefinite amount of time to terminate or is reserved by another initiator.
4h - Fh		Reserved

Table 70 - Operational Request/Report Format

Code	Event	Description
0h	NoChg	No changes in operational state performed or requested
1h	Change	An unspecified event has changed the feature list
2h	Media	A medium change has changed device operation
3h - FFh	Reserved	
100h - 1FFh	Button	A panel button was actuated or equivalent action requested by another initiator.
101h	Play	The play button was actuated or another initiator sent a play request.
102h	Rewind/back	The rewind/back button was actuated or another initiator sent a rewind/back request
103h	Fast Forward	The fast forward button was actuated or another initiator sent a fast forward request.
104h	Pause	The pause button was actuated or another initiator sent a pause request.
105h	Eject	The eject button was actuated or another initiator sent a eject request.
106h	Stop	The stop button was actuated or another initiator sent a stop request.
107h - 1FFh	Reserved	
200h - 2FFh	Medium Load	Request to load media n, where n is Code AND 0xFFh
300h - 3FFh	ASCII	ASCII code is Code AND 0xFFh
400h - EFFFh	Reserved	
F000h - FFFFh	Vendor Unique	

Table 71 - Power Management Status Returned Data

Bit / Byte	7	6	5	4	3	2	1	0
0	Reserved				Power Event			
1	Power Status							
2	Reserved							
3	Reserved							

Power Event field reports the current change in the power status. This field is set to a new power event if a change in power state occurs. Upon reporting the current power status change to the host, this field is reported as 0h on subsequent Get Event Status Notification commands until a new change in power state occurs.

If the logical unit is commanded to go the same state as the logical unit is currently in, the next Get Event Status Notification (Power Class) command shall report a Power Change Successful event.

The Power Status field shall be set to 3h (Standby) by a hard reset, power-on reset or Device reset (issued from Sleep state).

Table 72 - Power Event Format

Code	Event	Description
0h	NoChg	No changes in power state, or in power state transition
1h	PwrChg-Successful	The Logical Unit successfully changed to the specified power state
2h	PwrChg-Fail	The Logical Unit failed to enter the last requested state, and is still operating at the power state specified in the Power State field.
3h - Fh	Reserved	

Table 73 - Power Status Format

Code	Status	Description
0h	Reserved.	
1h	Active	The Logical Unit is in Active state
2h	Idle	The Logical Unit is in Idle state
3h	Busy/Reserved	The Logical Unit is in Standby state
4h - Fh	Reserved	

Table 74 - Media Event Class Returned Data

Bit / Byte	7	6	5	4	3	2	1	0
0	Reserved				Media Event			
1	Media Status							
2	Start Slot							
3	End Slot							

Start Slot field defines the first slot of a multiple slot logical unit the media status notification applies to. For logical units that do not support multiple slots, this field shall be reserved.

End Slot field defines the last slot of a multiple slot logical unit the media status notification applies to. For logical units that do not support multiple slots, this field shall be reserved.

The slot numbers are the same as those defined in the GET MECHANISM STATUS Command.

Table 75 - Power Event Format

Code	Event	Description
0h	NoEvent	Media status is unchanged.
1h	EjectRequest	The Logical Unit has received a request from the user (usually through a mechanical switch on the logical unit) to eject the specified slot or media.
2h	NewMedia	The specified slot (or the logical unit) has received new media, and is ready to access the media.
3h	MediaRemoval	The media has been removed from the specified slot, and the device is unable to access the media without user intervention.
4h - Fh	Reserved	

Table 76 - Media Status Byte Definition

Bit / Byte	7	6	5	4	3	2	1	0
0	Reserved						Media Present	Door or Tray open

The Media Present status bit indicates if there is media present in the Logical unit. A bit of 1 indicates that there is media present in the Logical unit. This bit is reported independently from the Door or Tray Open bit. If the Logical unit does not support the capability of reporting the media state while the door or tray is open shall set this bit to zero when the door or tray open bit is zero.

Door or Tray Open indicates if the Tray or Door mechanism is in the open state. A bit of 1 indicates the door/tray is open.

Table 77 - Device Busy Event Class Returned Data

Bit / Byte	7	6	5	4	3	2	1	0
0	Reserved				Device Busy Event			
1	Device Busy Status							
2	(MSB) Time							
3								(LSB)

The Time field is the predicted amount of time remaining for the device to become not busy, in units of 100ms. This type of event is usable in two environments. The first is in a queued environment. The MESN command may be issued in a non-immediate mode prior to executing commands or in the immediate mode while commands are being executed. The second environment is where immediate commands and deferred writing are performed; this command may be issued in the immediate mode to obtain status. If a normal command is issued while the device is busy, this command cannot be issued until the normal command completes. Therefore, if queuing is not used, the MESN command should precede any command that may time out. If an MESN command with the Device Busy class bit set is queued, the device shall complete the command after a time-out as defined in the time-out section has occurred. However, instead of generating a unit attention, the only action is to complete this command. If this event is to be used via polling in the immediate mode, the host should disable the device time-outs.

If Report Status Notification is not supported or not enabled, the Logical Unit shall return CHECK CONDITION (Sense

Key 05 ILLGAL REQUEST, Sense Code 24 INVALID FIELD IN COMMAND PACKET).

If the Immed bit is set to one, and if there is no Event to report the command shall return good status.

If the Immed bit is set to zero (and the Logical Unit supports tagged command queuing) and if there is NO event to report,

Table 78 - Device Busy Event Format

Code	Event	Description
0h	NoEvent	No event is available
1h	Busy Event	A time-out has occurred
2h - Fh	Reserved	

Table 79 - Device Busy Status Format

Code	Status	Description
0h	NoEvent	The Logical Unit is ready to accept any command.
1h	Power	The Logical Unit is in the process of waking up from a low-power state.
2h	Immediate	The Logical Unit is in the process of completing an earlier command.
3h	Deferred	The Logical Unit is in the process of completing a deferred operation.
4h - Fh	Reserved	

the GET EVENT STATUS NOTIFICATION command shall be queued by the target until there is an Event to report.

If the Immed bit is set to zero and the target DOES NOT support tagged command queuing, the target shall return CHECK CONDITION (Sense Key 05 ILLEGAL REQUEST, Sense Code 24 INVALID FIELD IN COMMAND PACKET).

6.1.5. LOAD/UNLOAD MEDIUM Command

The LOAD/UNLOAD MEDIUM Command (Table 80) requests the Logical Unit changer load or unload a Disc. New LOAD/UNLOAD MEDIUM commands issued before the changer enters the READY STATE (00b), see Table 86, should cause the changer to stop any LOAD/UNLOAD MEDIUM Command in progress and begin processing the new LOAD/UNLOAD MEDIUM command.

Table 80 - LOAD/UNLOAD MEDIUM command

Bit / Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (A6h)							
1	Reserved			Reserved				Immed
2	Reserved							
3	Reserved							
4	Reserved						LoUnlo	Start
5	Reserved							
6	Reserved							
7	Reserved							
8	SLOT							
9	Reserved							
10	Reserved							
11	Control							

An immediate (Immed) bit of one indicates that the Logical Unit shall return status as soon as the command descriptor block has been validated. An Immed Bit of zero indicates that the status shall not be returned until the operation has been completed.

The Load/Unload (LoUnlo) bit and the Start bit encoding is shown in Table 81

Table 81 - Load/Unload Operations

LoUnlo	Start	Operation to be Performed
0	0	Abort any prior Changer command (Stop)
0	1	Reserved
1	0	Unload media. The Slot Parameter is ignored for this operation.
1	1	Load the Media from specified Slot and initialize

The SLOT field indicated the Slot to be loaded or unloaded. Changer should always initialize (Load) Slot 0 on Power On or Bus Device Reset.

Any attempt to Load or Unload a Disc when the Device does not support that capability shall result in a Check Condition being reported to the Initiator with Sense key ILLEGAL REQUEST, Sense Code INVALID FIELD IN COMMAND DESCRIPTOR BLOCK.

Loading when the slot does not contain a Disc or the Play Position does not contain a Disc will be rejected with Sense Key ILLEGAL REQUEST, Sense Code INVALID FIELD IN COMMAND DESCRIPTOR BLOCK for the Slot Bytes. Unloading when the Play Position does not contain a Disc will be rejected with a Sense Key ILLEGAL REQUEST, Sense Code INVALID FIELD IN COMMAND DESCRIPTOR BLOCK for the Slot Bytes.

Loading when the slot does not contain a Disc will be rejected with a Sense Key NOT READY and Sense Code 3Ah MEDIUM NOT PRESENT. When this error is returned there are two possible actions by the CD Changer Device. If the Logical Unit reports Software Slot Selection (SSS) = 1, (see **Error! Reference source not found.**), then the slot

specified shall be selected for use. If the Logical Unit reports SSS = 0 then the previously used slot shall continue to be selected for use.

If the drive is capable of caching data then a delayed load of a disc into the playing position can be supported. If delayed loading of a disc into the playing position is supported, the Logical Unit shall have previously cached the TOC data from that disc. If the Logical Unit has not read the TOC for a disc that is being loaded into the playing position, then delayed loading shall not be performed and the disc shall be loaded into the playing position immediately. If Caching of TOC data has been performed and the loading of the Disc into the playing position is delayed, then the drive shall report that the Disc is ready, even though the Disc is not spinning and installed in the playing position. In all cases the behavior seen by the initiator (other than a longer subsequent media access latency) shall not be different between delayed and immediate loading of a disc.

A UNIT ATTENTION Condition shall not be generated when discs are loaded or unloaded from the playing position.

Table 82 - Recommended errors for LOAD/UNLOAD MEDIUM operation

Error	Reference
Deferred Errors	Sub-clause **A.1**
General Errors	Table **A.2**
MECHANICAL POSITIONING ERROR	Table **A.1**
INVALID ELEMENT ADDRESS	Table **A.1**
MEDIA LOAD OR EJECT FAILED	Table **A.1**

6.1.6. MECHANISM STATUS Command

The Mechanism Status command (Table 83) requests that the Logical Unit responds with the current status of the device, including any Changer Mechanism that adheres to this standard. This command is intended to provide information to the Initiator about the current operational state of the Logical Unit. The devices takes operational direction from both the Initiator and the user. Movement of media in/out of the Logical Unit as well as Play operation may be due to external controls or initiator commands. This command provides a method that allows the Initiator to know what has transpired with the changer mechanism.

Table 83 - MECHANISM STATUS Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation code (BDh)							
1	Reserved							
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	Reserved							
8	(MSB) Allocation Length							
9								(LSB)
10	Reserved							
11	Control							

The Allocation Length field specifies the maximum length in bytes of the Mechanical Status Parameter list, see Table 84 that shall be transferred from the Logical Unit to the Initiator. An Allocation Length field of zero indicates that no data shall be transferred. This condition shall not be considered an error.

The Mechanism Status Parameter list(Table 84) returned contains a header (Table 85), followed by zero or more fixed-length Slot Tables. If the Logical Unit does not support the changer commands, then the number of slot tables returned to the initiator shall be zero.

Table 84 - Mechanism Status Parameter List

Bit / Byte	7	6	5	4	3	2	1	0
0-7	Mechanism Status Header							
8-n	Slot Table(s)							

Table 85 - Mechanism Status Header

Bit / Byte	7	6	5	4	3	2	1	0
0	Fault	Changer State		Current Slot				
1	Mechanism State			Door open	Reserved			
2	(MSB)							
3	Current LBA							
4	(LSB)							
5	Reserved		Number of Slots Available					
6	(MSB)	Length of Slot Table(s)						
7	(LSB)							
8 - n	Slot Tables (0-n)							

The Fault bit, bit 7, indicates that the changer failed to complete the operation reported in the Changer State field.

The Changer State field (Table 86), indicates the current state of the changer.

Table 86 - Changer State Field

Changer State	Definition
0h	Ready
1h	Load in Progress
2h	Unload in Progress
3h	Initializing

The Current Slot field indicates the Current Slot selected. Changers compatible with a bootable device specification should always initialize (Load) Slot zero on Power On or Bus Device Reset.

The Mechanism State field (Table 87) encodes the current operation of mechanism.

Table 87 - Mechanism State Field

Mechanism State	Definition
0h	Idle
1h	Playing (Audio or Data)
2h	Scanning
3h-6h	Reserved
7h	Initializing

The slot table response data format is defined in Table 88. Each slot shall respond with the status defined.

The Door open bit when set, indicates that the Door(s) or Tray(s) is open or the cartridge is not present.

Table 88 - Slot Table Response Format

Bit / Byte	7	6	5	4	3	2	1	0
0	Disc Present (Optional)	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Change (Mandatory)
1	Reserved							
2	Reserved							
3	Reserved							

The Disc Present bit, bit 7, indicates that there is a Disc in this slot. The reporting of this information is optional after a reset or Disc change. If this feature is not supported, this bit shall be set to one after a reset condition or when a medium has been changed. When the Logical Unit is given a load command for a slot that contains no Disc, the bit corresponding to that slot shall then contain a 0 for any following response. If this bit is valid after a reset or medium change, then this capability shall be reported in the CD Capabilities and Mechanical Status Page (see Table 258).

The Change bit, bit 0, indicates that the Disc in that slot has been changed since the last time the disc was loaded.

The Number of Slots Available field indicates the number of slots available. The maximum number of slots is 32.

Table 89 - Recommended errors for Mechanism Status command

Error	Reference
Deferred Errors	Sub-clause **A.1**
General Errors	Table **A.2**

6.1.7. PAUSE/RESUME Command

The PAUSE/RESUME command (Table 90) requests that the Logical Unit stop or start a playback operation. This command is used with PLAY AUDIO and Play CD commands that are executing in immediate mode.

Table 90 - PAUSE/RESUME Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (4Bh)							
1	Reserved			Reserved				
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	Reserved							
8	Reserved							Resume
9	Control							

A Resume bit of zero causes the drive to enter the hold track state with the audio output muted after the current block is played. A Resume bit of one causes the drive to release the pause/scan and begin play at the block following the last block played/scanned.

If an audio play operation cannot be resumed and the Resume bit is one, the command is terminated with CHECK CONDITION status, COMMAND SEQUENCE ERROR. If the Resume bit is zero and an audio play operation cannot be paused, (no audio play operation has been requested, or the requested audio play operation has been completed), the command is terminated with CHECK CONDITION status, COMMAND SEQUENCE ERROR.

It shall not be considered an error to request a Pause when a pause is already in effect, or to request a Resume when a play operation is in progress.

Table 91 - Recommended errors for PAUSE/RESUME command

Error	Reference
Deferred Errors	Sub-clause **A.1**
General Errors	Table **A.2**
COMMAND SEQUENCE ERROR	Table **A.1**

6.1.8. PLAY AUDIO(10) Command

The PLAY AUDIO command (Table 92) requests that the C/DVD Logical Unit begin an audio playback operation. The command function and the output of audio signals shall be as specified by the settings of the mode parameters, including the SOTC bit.

If any commands related to audio operations are implemented then the PLAY AUDIO (10) command shall be implemented to allow a method for the Host Computer to determine if audio operations are supported. An C/DVD Logical Unit responding to a PLAY AUDIO (10) command that has a transfer length of zero with CHECK CONDITION status and setting the sense key to ILLEGAL REQUEST does not support audio play operations.

Table 92 - PLAY AUDIO(10) Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (45h)							
1	Reserved			Reserved				RELADR
2	(MSB)							
3	Starting Logical Block Address							
4								
5								(LSB)
6	Reserved							
7	(MSB)			Transfer Length				
8								(LSB)
9	Control							

The RELADR bit shall be set to zero.

The Starting Logical Block Address field specifies the logical block at which the audio playback operation shall begin. PLAY AUDIO commands with a starting logical block address of FFFF FFFFh shall implement audio play from the current location of the optics. PLAY AUDIO commands with a starting LBA address of 0000 0000h shall begin the audio play operation at 00/02/00 MSF.

The Transfer Length field specifies the number of contiguous logical blocks that shall be played. A Transfer Length field of zero indicates that no audio operation shall occur. This condition shall not be considered an error.

If the starting address is not found, the command shall be terminated with CHECK CONDITION status, LOGICAL BLOCK ADDRESS OUT OF RANGE.

If the starting address is not within an audio track, the command shall be terminated with CHECK CONDITION status, ILLEGAL MODE FOR THIS TRACK.

If the CD sub-channel mode type (data vs. audio) is other than audio or changes within the transfer length the command shall be terminated with a CHECK CONDITION and the sense key shall be set to ILLEGAL REQUEST and additional sense code set to END OF USER AREA ENCOUNTERED ON THIS TRACK.

6.1.8.1. Play Audio with Immediate Packet Commands

The PLAY AUDIO and AUDIO SCAN commands will continue to play while other commands are processed by the Logical Unit. Some commands can be accepted without disrupting the audio operations, while others will cause the Play operation to stop. The following section describes the operation of other commands while playing audio.

The C/DVD Logical Unit shall accept and perform the commands as specified. If a PLAY or SCAN operation is executing such that the IMMED bit in the Audio Control Page was set to one when the command started, execution of a new, overlapping commands takes precedence. When the new command can be executed to completion without disturbing execution of the PLAY or SCAN, it shall be done. Otherwise, the PLAY or SCAN must be terminated in

order that the new command can be executed. The following commands shall be executed without disturbing the PLAY or SCAN command:

- REQUEST SENSE
- READ SUB-CHANNEL, current position
- PAUSE/RESUME
- INQUIRY
- READ CAPACITY

All other commands that may effect the termination of PLAY or SCAN are implementation specific.

Table 93 - Recommended errors for PLAY AUDIO(10) Command

Error	Reference
Deferred Errors	Sub-clause **A.1**
General Errors	Table **A.2**
Media Access Errors	Table **A.3**

6.1.9. PLAY AUDIO(12) Command

The PLAY AUDIO command (Table 94) requests that the C/DVD Logical Unit begin an audio playback operation. The command function and the output of audio signals shall be as specified by the settings of the mode parameters, including the SOTC bit.

Table 94 - PLAY AUDIO(12) Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (A5h)							
1	Reserved			Reserved				RELADR
2	(MSB)							
3	Logical Block Address							
4								
5								(LSB)
6	(MSB)							
7	Transfer Length							
8								
9								(LSB)
10	Reserved							
11	Control							

See PLAY AUDIO (10) Command for bit and field description in the CDB.

Table 95 - Recommended errors for PLAY AUDIO(12) Command

Error	Reference
Deferred Errors	Sub-clause **A.1**
General Errors	Table **A.2**
Media Access Errors	Table **A.3**

6.1.10. PLAY AUDIO MSF Command

The PLAY AUDIO MSF command (Table 96) requests that the C/DVD Logical Unit begin an audio playback operation. The command function and the output of audio signals shall be as specified by the settings of the mode parameters including the SOTC bit described on page 120.

Table 96 - PLAY AUDIO MSF Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (47h)							
1	Reserved			Reserved				
2	Reserved							
3	Starting M Field							
4	Starting S Field							
5	Starting F Field							
6	Ending M Field							
7	Ending S Field							
8	Ending F Field							
9	Control							

The Starting M Field, the Starting S Field, and the Starting F Field specify the absolute MSF address that the audio play operation shall begin. The Ending M Field, the Ending S Field, and the Ending F Field specify the absolute MSF address where the audio play operation shall end. All contiguous audio sectors between the starting and the ending MSF address shall be played.

If the Starting Minutes, Seconds, and Frame Fields are set to FFh, the Starting address is taken from the Current Optical Head location. This allows the Audio Ending address to be changed without interrupting the current playback operation.

A starting MSF address equal to an ending MSF address causes no audio play operation to occur. This shall not be considered an error. If the starting MSF address is greater than the ending MSF address, the command shall be terminated with CHECK CONDITION status, INVALID FIELD IN CDB.

If the starting address is not found the command shall be terminated with CHECK CONDITION status, LOGICAL BLOCK OUT OF RANGE. If the address is not within an audio track the command shall be terminated with CHECK CONDITION status, ILLEGAL MODE FOR THIS TRACK OR INCOMPATIBLE MEDIUM. If a not ready condition exists, the command shall be terminated with CHECK CONDITION status.

Table 97 - Recommended errors for PLAY AUDIO MSF Command

Error	Reference
Deferred Errors	Sub-clause **A.1**
General Errors	Table **A.2**
Media Access Errors	Table **A.3**

6.1.11. PLAY CD Command (Obsolete)

The PLAY CD Command (Table 98) defines a the way digital data shall be sent to an external port.

Table 98 - PLAY CD Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (BCh)							
1	Reserved			Expected Sector Type			CMSF	Reserved
2	(MSB)							
3	Starting Logical Block Address							
4								
5								(LSB)
6	(MSB)							
7	Play Length in Blocks							
8								
9								(LSB)
10	Speed	Reserved			Port 2	Port 1	Composite	Audio
11	Control							

The Expected Sector Type field (Table 99) is used to check the sector type only. If the Requested Sector(s) do not match the specified type, the command will be terminated with a Check Condition, ILLEGAL MODE FOR THIS TRACK. The sector that does not match will not be transferred..

Table 99 - Expected Sector type field bit definitions

Sector Type	Definition	Description
000b	All types (mandatory)	No checking of the data type is performed. The Logical Unit shall always terminate a command at the sector where a transition between CD-ROM and CD-DA data occurs.
001b	CD-DA (optional)	Only IEC 908:1987 (CD-DA) (see **Error! Reference source not found.**) sectors shall be returned. All other data formats encountered return an error.
010b	Mode 1 (mandatory)	Only Yellow Book (see **Error! Reference source not found.**) sectors with a user data field of 2048 bytes shall be returned. All other data formats encountered return an error.
011b	Mode 2 formless (mandatory)	Only Yellow Book (see **Error! Reference source not found.**) sectors with the expanded user data field (2336 bytes) shall be returned. All other formats encountered will terminate the command and return CHECK condition.
100b	Mode 2 form 1 (mandatory)	Only sectors (see **Error! Reference source not found.**) which have a user data field of 2048 bytes will be returned. All other formats encountered will terminate the command and return CHECK condition.
101b	Mode 2 form 2 (mandatory)	Only sectors (see **Error! Reference source not found.**) which have a user data field of 2324 shall be returned. All other formats encountered will terminate the command and return CHECK condition. NOTE: 4 spare bytes are included making the total data length returned 2328 bytes/sector.
110b-111b	Reserved	

If the CMSF bit is set to zero, the Starting Logical Block Address field specifies the logical block at which the playback operation shall begin. If the CMSF bit is set to one, bytes 3 through 5 specify the MSF starting address and bytes 6 through 8 indicate the ending MSF address. Bytes 2 and 9 are reserved if CMSF is set to one.

PLAY CD commands with a starting LBA address of 0000 0000h shall begin the play operation at 00/02/00 MSF.

If the Starting Logical Block Address is set to 'FF FF FF FFh' (or '00 FF FF FFh' when CMSF is one) and the playback operation is in progress, or the drive is in the hold track state, the drive shall change the Transfer Length (or Ending Address when CMSF is one) without interrupting current playback operation. If there is no playback operation in progress the drive shall implement the playback operation from the current location of the optics.

The Play Length field specifies the number of contiguous logical blocks that shall be played. A Play Length field of zero indicates that no play operation shall occur. This condition shall not be considered an error.

If the starting address is not found, the command shall be terminated with CHECK CONDITION status, LOGICAL BLOCK ADDRESS OUT OF RANGE.

Byte 10 of the command descriptor block defines a group of bits that define the play operations for this command.

Table 100 defines the Field definitions for PLAY CD.

Table 100 - PLAY CD Field definition

Byte 10 bit	Value	Description
Audio	0	Analog Audio Channel is Disabled
	1	Analog Audio Channel is Enabled
Composit e	0	Composite Video port is Disabled
	1	Composite Video port is Enabled
Port 1	0	Digital Port 1 is Disabled
	1	Digital Port 1 is Enabled
Port 2	0	Digital Port 2 is Disabled
	1	Digital Port 2 is Enabled
Speed	0	Speed will be set to X1 for the operation
	1	The speed used will be the best possible

Table 101 - Recommended errors PLAY CD Command

Error	Reference
Deferred Errors	Sub-clause **A.1**
General Errors	Table **A.2**
Media Access Errors	Table **A.3**

6.1.12. READ BUFFER CAPACITY Command (Obsolete)

The READ BUFFER CAPACITY command (Table 102) checks the total length of buffer and the length of blank area.

Table 102 - READ BUFFER CAPACITY Command Descriptor Block

Bit / Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Operation Code (5Ch)							
1	Reserved			Reserved				
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	(MSB) Allocation Length							
8	(LSB)							
9	Control							

The drive reports the length of the buffer during Session at Once Recording or Track at Once Recording. If the READ BUFFER CAPACITY command is issued in a condition except Session at Once Recording or Track at Once Recording, the Blank Length of Buffer field may be invalid.

An Allocation Length of zero is not an error.

The READ BUFFER CAPACITY data (Table 103) is sent in response to this command.

Table 103 - READ BUFFER CAPACITY data

Bit / Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	(MSB) Data Length							
1	(LSB)							
2	Reserved							
3	Reserved							
4	(MSB)							
5	The Length of Buffer							
6								
7	(LSB)							
8	(MSB)							
9	Blank Length of Buffer							
10								
11	(LSB)							

The Length of Buffer indicates the whole capacity of the buffer in bytes.

The Blank Length of Buffer indicates the length of unused area of the buffer in bytes.

Table 104 - Recommended errors for READ BUFFER CAPACITY Command

Error	Reference
Deferred Errors	Sub-clause **A.1**
General Errors	Table **A.2**

6.1.13. READ CD Command

The READ CD Command described in Table 105 provides a single standard, universal way of accessing CD data. This command is generic to all types of CD data formats.

This command returns any of the defined CD data streams, including the headers, EDC, ECC, user data and CD-DA data. Each type of data is enabled via the fields in the READ CD command descriptor block (see Table 105). These fields, (byte 9) indicate which information from the CD is to be returned in the data stream. If a bit is cleared, then that particular information is not returned. If all the fields contain zero then no information is returned. This condition shall not be considered an error.

Table 105 - READ CD Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (BEh)							
1	RESERVED			Expected Sector Type			Reserved	RELADR
2	(MSB) Starting Logical Block Address							
3								
4								
5	(LSB)							
6	(MSB) Transfer Length in Blocks							
7								
8	(LSB)							
9	SYNC	Header Codes		User Data	EDC & ECC	Error Field		Reserved
10	Reserved					Sub-Channel Selection Bits		
11	Control							

The RELADR bit shall be set to zero.

The Expected Sector Type field is used as a filter or mask to select the types of data format information returned to the initiator. A transfer operation is terminated as soon as data is encountered that does not match one of those specified in the sector type field of the command. If the requested data is not of the type/types requested, the command will be terminated with a CHECK CONDITION status, ILLEGAL MODE FOR THIS TRACK . The sector/sectors which do not match will not be transferred to the initiator. .

The Sync bit, set to one, indicates that the Sync field from the sector will be included in the data stream. The Sync bit, set to zero indicates the Sync field will not be included in the data stream.

The Header Code field (Table 106) is encoded to select Header/Sub-header information that should be included in the returned data stream.

Table 106 - Header Code field definition

Header Code	Definition	Description
00b	none	no header information shall be returned
01b	header only	Only the four byte header will be returned in the data stream
10b	sub-header only	Only the mode 2 form 1 or form 2 sub-header will be returned.
11b	All headers	Return both header and sub-header information

The User data bit, when set to one, indicates that the user data part of a CD sector shall be returned in the data stream. When set to zero, user data shall not be returned to the initiator. The setting of the Mode Select Block Size does not apply to this command. If the current track is an audio track, then audio data will be returned. Otherwise, the normal user data will be returned.

The EDC and ECC bit, when set to one, indicates that the EDC and ECC (L-EC) field shall be included in the data stream. For Mode 1 CD format, this will include the 8 bytes of pad data.

The Error field(see Table 107) is an encoded field that indicates which if any of the C2 and/or Block error data will be included in the data stream. All of the field types are mandatory. If the drive does not support the C2 pointers (as reported in the mode sense capabilities page) the data returned shall be zero filled.

Table 107 - READ CD, Error field definition

Error Field	Definition	Description
00b	none	No error information is returned
01b	C2 error block data	The C2 error, Pointer bits (2352 bits or 294 bytes) will be included in the data stream. There will be one bit for each byte in error in the sector (2352 total). The bit ordering is from the most significant bit to the least significant bit in each byte. The first bytes in the sector will be the first bits/bytes in the data stream.
10b	C2 and Block Error Bits	Both the C2 error bits (2352 bits/294 bytes) and the Block Error Byte will be included in the data stream. The Block Error Byte is the logical or of all the C2 Error bit bytes. The Error Byte will be padded with a byte (undefined) to ensure an even number of bytes in the data stream. The Block error byte will be first in the data stream followed by the pad byte.
11b	Reserved	Reserved for future enhancement.

The Sub-channel data selection field (see Table 108) indicates which CD Sub-Channel information is to be included in the data stream. This may be the Q information and/or the "Raw" sub-channel information. If the field is set to a nonzero value, then that Sub-channel data will be included in the data stream to the initiator.

Table 108 - READ CD, Sub-channel Data Selection Field definition

Sub-Channel data selection value	Definition	Description	Type
000b	No sub-channel data	No sub-channel data will be returned	Mandatory
001b	RAW	RAW P-W sub-channel data will be transferred	Optional
010b	Q	Q data is transferred (see Table 109)	Optional
011b	Reserved		
100b	P-W	R-W data is transferred	Optional
101b-111b	Reserved		

In the case of R-W the drive may return the data de-interleaved and error corrected, RAW or padded with zeroes depending on the R-W supported and R-W de-interleaved and error corrected bits in the CD capabilities and Mechanism status page. In the case of RAW the drive will return the P-W sub-channel data that is not de-interleaved. See Table 113 and Table 114 for P-W data formats.

If the Starting Logical Block Address is set to FFFF FFFFh and the only information requested to be placed in the data stream is the Sub-channel data and there is currently a PLAY AUDIO command in process, the actual address used will be from the current location (of the audio play).

Table 109 - Formatted Q sub-channel response data

Byte	Description
0	Control (4 ms bits), ADR (4 Ls bits)
1	Track number
2	Index number
3	Min
4	Sec
5	Frame
6	ZERO
7	AMIN
8	ASEC
9	AFRAME
10	CRC** or 00h
11	CRC** or 00h
12	00h (pad)
13	00h (pad)
14	00h (pad)
15	MSB is P-Sub-code(optional), all others are 0h

** CRC is optional

All data returned to the initiator is converted to hex from bcd. Data stored on the media is formatted in bcd values.

The lengths of the data returned from a READ CD command vary based on the type of sector that is being read and the requested fields to be returned to the initiator. Many combinations are possible, but most are not very useful. Table 110 specifies how the Logical Unit responds to many of the requests. Requests for transfers not specified in the Table 110 shall not be supported and treated as illegal. Illegal values will cause the command to be aborted with a CHECK CONDITION status, INVALID FIELD IN CDB. See **Error! Reference source not found.** for definition of sector formats.

ED NOTE: tie byte 9 of cdb to table 39. neither MMC1 or ATAPI are very clear on the relationship.

Table 110 - Number of Bytes Returned Based on Data Selection Field

Data to be transferred	Byte[2] 9	CD-DA	Mode 1	Mode 2	Mode 2 Form 1	Mode 2 Form 2
User Data	10h	2352	2048[1]	2336[1]	2048	2328[1]
User Data + EDC/ECC	18h	(10h)[1]	2336	(10h)[1]	2328	(10h)[1]
Header	20h	(10h)[1]	4	4	4	4
Header Only + EDC/ECC	28h	(10h)[1]	Illegal	Illegal	Illegal	Illegal
Header & user data	30h	(10h)[1]	2052[1]	2340[1]	Illegal	Illegal
Header & User Data + EDC/ECC	38h	(10h)[1]	2340	(30h)[1]	Illegal	Illegal
Sub Header Only	40h	(10h)[1]	0	0	8	8
Sub Header Only + EDC/ECC	48h	(10h)[1]	Illegal	Illegal	Illegal	Illegal
Sub Header & user data	50h	(10h)[1]	(10h)[1]	(10h)[1]	2056[1]	2336[1]
Sub Header & user data + EDC/ECC	58h	(10h)[1]	(18h)[1]	(10h)[1]	2336	(50h)[1]
All Headers Only	60h	(10h)[1]	4	4	12	12
All Headers Only + EDC/ECC	68h	(10h)[1]	Illegal	Illegal	Illegal	Illegal
All Headers & user data	70h	(10h)[1]	(30h)[1]	(30h)[1]	2060[1]	2340[1]
All Headers & user data + EDC/ECC	78h	(10h)[1]	(38h)[1]	(30h)[1]	2340	2340
Sync & User Data	90h	(10h)[1]	Illegal	Illegal	Illegal	Illegal
Sync & User Data + EDC/ECC	98h	(10h)[1]	Illegal	Illegal	Illegal	Illegal
Sync & Header Only	A0h	(10h)[1]	16	16	16	16
Sync & Header Only + EDC/ECC	A8h	(10h)[1]	Illegal	Illegal	Illegal	Illegal
Sync & Header User Data	B0h	(10h)[1]	2064	2352	Illegal	Illegal
Sync & Header User Data + EDC/ECC	B8h	(10h)[1]	2352	(B0h)	Illegal	Illegal
Sync & Sub Header Only	C0h	(10h)[1]	Illegal	Illegal	Illegal	Illegal
Sync & Sub Header Only + EDC/ECC	C8h	(10h)[1]	Illegal	Illegal	Illegal	Illegal
Sync & Sub Header & User Data	D0h	(10h)[1]	Illegal	Illegal	Illegal	Illegal
Sync & Sub Header & User Data + EDC/ECC	D8h	(10h)[1]	Illegal	Illegal	Illegal	Illegal
Sync & All Headers Only	E0h	(10h)[1]	16	16	24	24
Sync & All Headers Only + EDC/ECC	E8h	(10h)[1]	Illegal	Illegal	Illegal	Illegal
Sync & All Headers & user data	F0h	(10h)[1]	2064	2352[1]	2072	2352[1]
Sync & All Headers & user data + EDC/ECC	F8h	(10h)[1]	2352[1]	(F0h)[1]	2352[1]	(F0h)[1]
Repeat 10h - F8h and Add Error Bits	02h	+294[3]	+294	+294	+294	+294
Repeat 10h - F8h and Add Block & Error Bits	04h	+296	+296	+296	+296	+296

Note:

1. These values are most useful to the initiator and shall return the number of bytes specified, if supported.
2. Byte 9 of the READ CD Command Descriptor Block
3. + indicates the addition of the specified number of bytes to the stream of the data.

For definitions of the headers of Table 110 refer to sub-clause **Error! Reference source not found.**

Values enclosed in () indicate that the amount of data is the same as the Flag byte setting specified by the contents of the parenthesis.

Table 111 - Recommended errors for READ CD command

Error	Reference
Deferred Errors	Sub-clause **A.1**
General Errors	Table **A.2**
Media Access Errors	Table **A.3**
READ ERROR - LOSS OF STREAMING	Table **A.1**

The CD-DA audio data includes 16 bits of information for each channel, and will be formatted as follows when an audio track is read. See Table 112.

Table 112 - CD-DA (Digital Audio) Data Block Format

Bit / Byte	7	6	5	4	3	2	1	0
0	Left Channel (Lower Byte)							(LSB)
1	(MSB)	Left Channel (Upper Byte)						
2	Right Channel (Lower Byte)							(LSB)
3	(MSB)	Right Channel (Upper Byte)						
2348	Left Channel (Lower Byte)							(LSB)
2349	(MSB)	Left Channel (Upper Byte)						
2350	Right Channel (Lower Byte)							(LSB)
2351	(MSB)	Right Channel (Upper Byte)						

If the CD Drive does not support the CD-DA Stream-Is-Accurate capability, See **Error! Reference source not found.**, then the digital audio data must be read as a continuous stream. If while streaming the drive must stop, there will be a non recoverable error generated READ ERROR - LOSS OF STREAMING. This is due to the 1 second uncertainty of the address. (i.e. there is no header in CD-DA data). Reissuing the command may not return exactly the same data as the previous try. When the drive supports the stream accurate capability, there will be no error, only some time delay for rotational latency.

ED NOTE: need to define stream is accurate in the model section..

The format for R-W raw data is described in Table 113.

Table 113 - R-W RAW data format

Bit / Byte	7	6	5	4	3	2	1	0
0	P-W (0)							
1	P-W (1)							
...	...							
95	P-W (95)							

R-W raw data is returned in the format and order found on the media. It is the responsibility of the Logical Unit driver to de-interleave and perform error detection and correction on the RAW data to make it usable to higher level applications.

When the Starting Logical Block Address is set to F000 0000h and P-W raw data is selected, the drive returns P-W raw data from the Lead-In area. If there is no data recorded in the Lead-In area, the command shall be terminated with CHECK CONDITION status, ILLEGAL MODE FOR THIS TRACK OR INCOMPATIBLE MEDIUM.

If the Starting Logical Block Address is set to FFFF FFFFh after the above command, the Sub-channel data will be returned from the current location within the Lead-In area. It is the responsibility of the device driver to convert this data to CD TEXT format without losing streaming.

Table 114 - P-W Data de-interleaved and error corrected

Bit yte	7	6	5	4	3	2	1	0
0	P	Q	PACK (0)					
1	P	Q	PACK (1)					
..	...							
23	P	Q	PACK (23)					
24	P	Q	PACK (0)					
25	P	Q	PACK (1)					
..	...							
47	P	Q	PACK (23)					
48	P	Q	PACK (0)					
49	P	Q	PACK (1)					
..	...							
71	P	Q	PACK (23)					
72	P	Q	PACK (0)					
73	P	Q	PACK (1)					
..	...							
03	P	Q	PACK (23)					

Drives that cannot return P or Q code with PACK data will return undefined data in the unsupported P or Q bits. Each PACK is generated after 2 contiguous Sub Channel data frames consisting of 24 bytes with 6 bits of PACK data per byte. Each 96 byte Packet consists of 4 Packs of 24 bytes each.

The basic RAW format is shown in Figure 17 below. The data is synchronized with the sub-channel sync patterns S0 and S1. Each group of 6 bits (R-W) is called a “symbol.” The symbol following the sub-channel patterns S0 and S1, is the first symbol of the first pack in a packet.

6.1.13.1. Description of Sub-Channels R-W

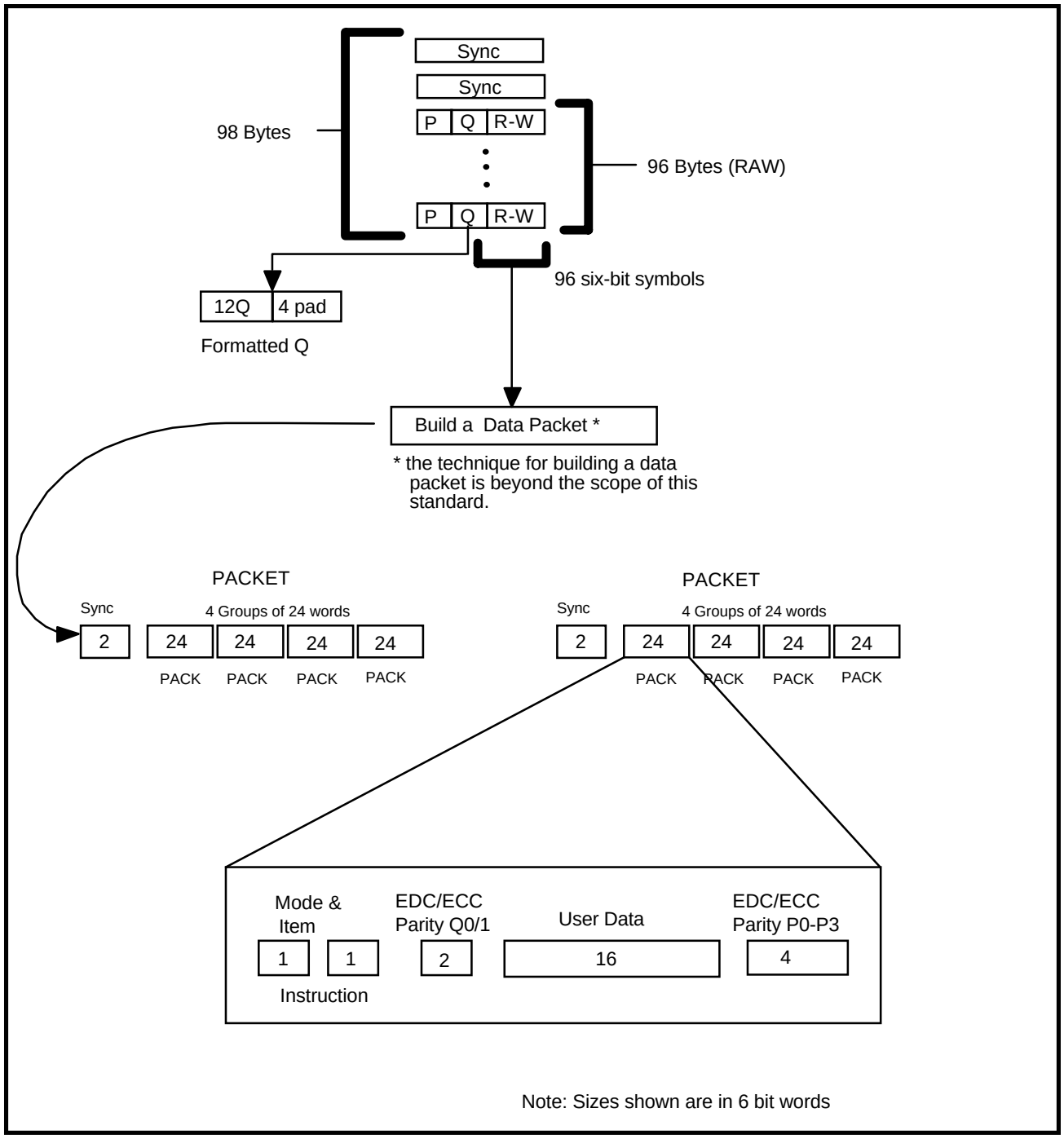

Figure 17 - Read CD Sub-Channel, R-W (100b)

To guard the data in the sub-coding channels R-W, a (24,20) Reed-Solomon Error Correction Code is used. To improve the burst error correction capability, eight way interleaving is added to this error correction system.

The first two symbols in a pack have additional protection with a (4,2) Reed Solomon Error Correction Code. The first symbol of a pack contains a mode-switch of 3 bits and a 3 bit subdivision of mode, called “item.” The defined mode-item combinations are listed in Table 115.

Table 115 - Sub-channel R-W; Allowed mode/item combinations

Mode	Item	Description
000b	000b	The Zero mode
001b	000b	The LINE GRAPHICS mode
	001b	The TV GRAPHICS mode
111b	000b	The USER mode
All others		Reserved for future use

The R-W information is returned as part of the “raw” sub-channel data. The lower 6 bits of each of the bytes contain the R-W data. This data follows the format shown in Figure 17. If the Q information needs to be taken from the raw data then it shall not be interleaved.

6.1.14. READ CD MSF Command

The READ CD MSF Command described in Table 116 provides a single standard command format for accessing CD data via MSF addressing. This command is generic to all types of CD data formats.

This command returns any of the defined CD data streams, including the headers, EDC, ECC, user data and CD-DA data. Each type of data is enabled via the fields in the READ CD MSF command descriptor block (see Table 116). These fields indicate which information from the CD is to be returned in the data stream. If the bit is cleared, then that particular information is not returned. If all the fields contain zero then no information is returned. This condition shall not be considered an error.

Table 116 - READ CD MSF Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (B9h)							
1	Reserved			Sector Type			Reserved	
2	Reserved							
3	Starting M Field							
4	Starting S Field							
5	Starting F Field							
6	Ending M Field							
7	Ending S Field							
8	Ending F Field							
9	SYNC	Header Codes		User Data	EDC & ECC	Error Fields		Reserved
10	Reserved					Sub-Channel Selection Bits		
11	Control							

The Starting M field, the Starting S field, and the Starting F field specify the absolute MSF address where the Read operation shall begin. The Ending M field, the Ending S field, and the Ending F field specify the absolute MSF address where the Read operation shall end. All contiguous sectors between the starting and ending MSF addresses shall be read.

A starting MSF address equal to an ending MSF address prevents a read operation. This shall not be considered an error. If the starting MSF address is greater than the ending MSF address, the command shall be terminated with CHECK CONDITION status, ILLEGAL REQUEST.

If the starting address is not found, or if a not ready condition exists, the command shall be terminated with CHECK CONDITION status.

For descriptions of Sector Type field see Table 99.

For a description of all fields in byte 9, and Sub-channel Selection Bits (byte 10), see sub-clause 6.1.13. Read CD Command.

Table 117 - Recommended errors for READ CD MSF Command

Error	Reference
Deferred Errors	Sub-clause **A.1**
General Errors	Table **A.2**
Media Access Errors	Table **A.3**
READ ERROR - LOSS OF STREAMING	Table **A.1**

6.1.15. READ C/DVD RECORDED CAPACITY Command (Obsolete)

The READ C/DVD RECORDED CAPACITY command (Table 118) provides a means for the initiator to request information regarding the capacity of the logical unit. This command has the same operation code (25h) as the READ CAPACITY command (see SCSI Block Commands). The general function is the same but the exact definitions of the returned logical block address is modified to allow returning a possibly inexact value (but one with a known error bound) based on the Table of Contents data.

Table 118 - READ C/DVD RECORDED CAPACITY Command Descriptor Block

Bit Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (25h)							
1	RESERVED			Reserved				RELADR
2	(MSB)							
3	Logical Block Address							
4								
5								(LSB)
6	Reserved							
7	Reserved							
8	Reserved							PMI
9	Control							

The RELADR and PMI bits shall be reserved for C/DVD Logical Units, and shall be set to zero.

READ C/DVD RECORDED CAPACITY response data shall be the logical block address and block length (in bytes) of the last valid logical block of the logical unit for seek operations. The logical block address returned shall be greater than or equal to the last readable or playable block in the last complete session. If greater, this address may be in a transition area beyond the last valid logical block for read or audio play operations. The logical block address in the command descriptor block shall be set to zero for this option.

Eight bytes of READ C/DVD RECORDED CAPACITY data (Table 119) shall be returned in response to the command.

Table 119 - READ CD RECORDED CAPACITY data format

Bit Byte	7	6	5	4	3	2	1	0
0	(MSB)							
...	Logical Block Address							
3								(LSB)
4	(MSB)							
...	Block Length in Bytes (Length reported shall be 2048d)							
7								(LSB)

The returned Logical Block Address shall be the last sector in the last complete session.

The Block Length shall be reported, in bytes, as 2048d. A block length of 512 is obsolete.

Table 120 - Recommended errors for READ CD RECORDED CAPACITY Command

Error	Reference
Deferred Errors	Sub-clause **A.1**
General Errors	Table **A.2**
Media Access Errors	Table **A.3**

ED NOTE: This command will incorporate changes from MtFuji2

6.1.16. READ DISC INFORMATION Command

It is not possible to completely characterize some incomplete CD-R/RW discs with the information from the READ TOC/PMA/ATIP command. The READ DISC INFORMATION Command (Table 121) provides information about all discs, including all incomplete CD-R/RW discs.

If a logical unit does not implement this command it shall respond with a CHECK CONDITION status.

Table 121 - READ DISC INFORMATION Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code (51h)							
1	Reserved							
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	(MSB) Allocation Length							
8								(LSB)
9	Control Byte							

The number of Disc Information Block bytes returned is limited by the Allocation Length parameter of the CDB. An Allocation Length of zero is not an error.

The Disc Information Block has two parts; a static disc information area, as shown in Table 122, and an OPC response shown in Table 126.

The number of Disc Information bytes returned (Table 122) is limited by the Allocation Length parameter of the command packet. An Allocation Length of zero shall not be considered an error. If the Allocation Length is greater than the amount of available Disc Information Data, only the available data will be transferred.

Table 122 - Disc Information Block

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB) Disc Information Length							
1								(LSB)
2	Reserved			Erasable	State of last Session		Disc Status	
3	Number of First Track on Disc							
4	Number of Sessions							
5	First Track Number in Last Session							
6	Last Track Number in Last Session							
7	DID_V	DBC_V	URU	Reserved				
8	Disc Type							
9	Reserved							
10	Reserved							
11	Reserved							
12	(MSB) Disc Identification							
13								
14								
15								(LSB)
16	(MSB) Last Session lead-in Start Time MSF							
17								
18								
19								(LSB)
20	(MSB) Last Possible Start Time for Start of lead-out MSF							
21								
22								
23								(LSB)
24	(MSB) Disc Bar Code							
...								
31								(LSB)
32	Reserved							
33	Number of OPC Table Entries							
34 - n	OPC Table Entries							

Data Length is the number of bytes available in both the recording information area and the appended OPC table. Data Length excludes itself.

Disc Status field indicates the status of the disc and is shown in Table 123

Table 123 - Disc Status

Status	Definition
00b	Empty disc
01b	Incomplete disc (Appendable)
10b	Complete (CD ROM or last session is closed and has no next session pointer)
11b	Reserved

The State of Last Session field is defined in Table 124.

Table 124 - State of Last Session

Session State	Definition
00b	Empty Session
01b	Incomplete Session
10b	Reserved
11b	Complete Session (only possible when Disc Status is Complete)

The Erasable bit, when set to one, indicates that CD-RW medium is present. Otherwise, CD-RW medium is not present.

The Number of First Track identifies the first track number in the TOC or PMA. Valid track numbers are from 01h to 63h. The first track number is not required to be one. A disc may start with any valid track number. The track numbers between the first and last track number shall be in contiguous ascending order, except for lead-out areas.

The Number of Sessions on the disc refers to all complete sessions plus any incomplete or empty sessions. A Blank Disc will always have a session count equal to one.

First Track Number in Last Session is the track number of the first track in the last session. This is inclusive of the invisible track.

Last Track Number in Last Session is the track number of the last track in the last session. This is inclusive of the invisible track.

The DID_V (Disc ID Valid) bit, when set to one, indicates that the Disc Identification field is valid.

The DBC_V (Disc Bar Code Valid bit, when set to one, indicates that the Disc Bar Code field (bytes 24 through 31) is valid.

The URU (Unrestricted Use Disc) bit, when set to one, indicates that the mounted CD-R/RW disc is defined for unrestricted use. When the Unrestricted Use Disc bit is set to zero, the mounted CD-R/RW disc is defined for restricted use. To record data to the mounted disc the appropriate Host Application code shall be set through the Write Parameters Page. A Host Application Code of zero may be used to indicate a restricted use disc - general purpose.

The Disc Type field specifies the type of data on the whole disc. A disc has only one disc type. The disc type shall be obtained from the PMA or from the A0/PSEC field in the TOC of the first session in which there is at least one data track, or is recorded together with disc ID in PMA.

In the case of a session that contains no data track (only audio), A0/PSEC field in the TOC of the session is always 00h regardless of actual disc type. For all disc, the disc type shall be determined from the following sequences:

1) Disc ID (Disc Type) as written in PMA.

2) From the first Complete Session that includes at least one data track.

3) From the first session of a Complete Disc.

4) The Disc type is NOT decided, the Disc Type field of Disc Information shall contain FF. (undefined)

Table 125 - Disc Type Field - PMA

Disc Type Code	Disc Type
00h	CD-DA or CD-ROM Disc
10h	CD-I Disc
20h	CD-ROM XA Disc
FFh	Undefined
All Other Values	Reserved

The Disc Identification number recorded in the PMA is returned. The Disc Identification Number is recorded in the PMA as a six-digit BCD number. It is returned in the Disc Information Block as a 32 bit binary integer.

The Last Session lead-in Start Time field is an address given in MSF format as defined in sub-clause 4.1.1. This field shall specify the location of the next Lead-in to be recorded. If the disc is Empty as specified in the Disc Status field or has no Complete Session, then the Lead-in Start Time is returned as specified by ATIP. If the last session, which is second or greater, is Empty or Incomplete, this field shall specify the Lead-in Start Time of the Last Session. If the Disc Status is Complete, the Lead-in Start Time shall be FF/FF/FF MSF.

The Last Possible Start Time of lead-out field is an address given in MSF format as specified in sub-clause 4.1.1. If the disc is a Complete disc, the Last Possible Start Time of Lead-out shall be FF/FF/FF MSF.

The Disc Bar Code field contains the Hex value of the bar code if the Logical Unit has the ability to read Disc Bar Code and a bar code is present. See **Error! Reference source not found.**.

An OPC (Optimum Power Calibration) Table is attached only if the values are known for the disc. Since OPC values are likely to be different for different recording speeds, each table entry is associated with a recording speed. The Number of OPC Table Entries indicates that [8 x (Number of OPC Table Entries)] bytes follow the first part of the Disc Information. This number shall be the same for all values of Allocation Length. The Number of OPC Table Entries will always be zero for CD-ROM discs and for CD-R/RW discs for which OPC have not yet been determined.

Table 126 - OPC Table Entry

Bit / Byte	7	6	5	4	3	2	1	0
0	Speed (kBytes per second)							
1								
2	OPC Values							
3								
4								
5								
6								
7								

Speed is in kBytes per second. See SEND OPC Command sub-clause 6.1.29.

The OPC Value field is associated with the speed specified in the speed field, and its content is vendor specific.

Table 127 - Recommended errors for READ DISC INFORMATION Command

Error	Reference
Deferred Errors	Sub-clause **A.1**
General Errors	Table **A.2**
Media Access Errors	Table **A.3**

ED NOT: This command will incorporate major changes from MtFuji2

6.1.17. READ DVD STRUCTURE Command

The READ DVD STRUCTURE command requests that the DVD Logical Unit transfer data from areas on the DVD Media to the Host Computer. There are several control structures on the DVD media, including the Lead-in and Burst Cutting Area (BCA). The Lead-in area for DVD media contain information about the media as well as information used by the Logical Unit to allow it to recover information from the media. The BCA for DVD media is optional which contents is specified by media manufacture.

Table 128 - READ DVD STRUCTURE Command

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code (ADh)							
1	LUN				Reserved			
2	(MSB)							
3	Reserved for RMD Block Number							
4								
5								(LSB)
6	Layer Number							
7	Format							
8	(MSB)			Allocation Length				
9								(LSB)
10	AGID		Reserved					
11	Control							

The Format field indicates the type of information that is requested be sent to the host.

The Layer Number field specifies the starting layer number for which the DVD STRUCTURE data will be returned.

The AGID field is described in the REPORT KEY command. This field is used only when the Format field contains 2h, for all other values it is reserved.

When a READ DVD STRUCTURE Command is presented for a CD media, this command shall be terminated with CHECK CONDITION status. The sense key shall be set to ILLEGAL REQUEST and the additional sense code set to INVALID COMMAND OPERATION CODE.

Table 129 - Format Code definitions for READ DVD STRUCTURE command

Format Code	Returned Data	Type or Feature	Layer Byte Usage	Description
00h	Physical	Mandatory	Layer Number	Returns information in the DVD Lead-in area
01h	Copyright	Mandatory	Layer Number	Returns the Copyright information from the DVD Lead-in area
02h	Disc Key	Key Exchange Feature	Reserved	Returns the Disc Key obfuscated by using a Bus Key
03h	ECA	Optional	Reserved	Returns the ECA information on DVD media
04h	Manufacture ’s	Mandatory	Layer Number	Returns the Disc Manufacturing information from the DVD Lead-in area
05h-FFh				Reserved

Table 130 - READ DVD STRUCTURE Data Format (Format field = 00h)

Bit Byte	7	6	5	4	3	2	1	0
0	(MSB) DVD STRUCTURE Data Length							
1								(LSB)
2	Reserved							
3	Reserved							
DVD Lead-in Structure								
1 or more Layer Descriptors								

Table 131 - Layer Descriptor(s)

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB) Length of Layer Information							
1								(LSB)
2	Book Type				Book Version			
3	Disc Size				Minimum Rate			
4	Reserved	Number of Layers		Track Path	Layer Type			
5	Linear Density				Track Density			
6	00h							
7	(MSB) Starting Sector Number of Main Data (030000h)							
8								
9								(LSB)
10	00h							
11	(MSB) End Sector of Main Data							
12								
13								(LSB)
14	00h							
15	(MSB) End Sector Number in Layer 0							
16								
17								(LSB)
18	BCA	Reserved						
19	Reserved							

The DVD STRUCTURE Data Length specifies the length in bytes of the following DVD STRUCTURE data that is available to be transferred to the Host. The DVD STRUCTURE Data Length value does not include the DVD STRUCTURE Data Length field itself.

The Length of Layer Information specifies the length in bytes of a Layer Information that follow.

This information is returned for DVD media Only. The information for the starting layer specified by the Layer Number field in the Command Packet and information for all higher layer numbers is returned. If there is only one layer then the only valid layer is layer 0. If a nonexistent layer is requested then the command shall be aborted with an INVALID FIELD IN THE COMMAND PACKET error. If the media has more than one layer, but is recorded using the Opposite Track Path method, then the same information shall be returned for all layers.

The Book Type field specifies which DVD Book this media complies with. Currently the only valid value is 0h for DVD-ROM.

The Book Version specifies the version of the specified book that this media complies with.

The Disc Size specifies the physical size of the Media. A value of 0000b specifies 120mm, a value of 0001b specifies a size of 80mm.

The Minimum Rate is used to specify to the Logical Unit the read rate to use for this media.

0000b 2.52 Mbps 0001b 5.04 Mbps 0010b 10.08 Mbps

The Number of Layers field specifies the number of layers for this side of the media. A value of 00b indicates that the media has only one layer. A value of 01b specifies that this side of the media has two layers. Currently only one and two layer discs are specified.

The Track Path bit specifies the direction of the layers when more than one layer is used. If the bit is cleared to 0 then this media uses Parallel Track Path (PTP). When PTP is used each layer is independent and has its own Lead-in and Leadoff areas on the media. If the bit is set to 1 then the media uses Opposite Track Path (OTP). With opposite track path both layers are tied together. There is only one Lead-in and Leadoff. In the middle of the media there is an area called the middle area. The addresses of blocks in one layer are mirrored in the other layer.

The Layer Type field read/writability of the layer. Only a value of 0 indicating that the media is read only is specified today.

The Linear Density field indicates the minimum/maximum pit length used for this layer.
Currently = 0000b 0.267 µm/bit 0001b 0.293 µm/bit

The Track Density field indicates the track width used for this media. Currently = 0000b 0.74 µm/track

The Starting Sector Number of Main Data field specifies the first block that contains user data. Currently the only valid value is 030000h.

The End Sector of Main Data field specifies the last sector of the user data in the last layer of the media.

The End Sector Number in Layer 0 field specifies the last sector of the user data in layer 0. If this media does not use Opposite Track Path and contain Multiple Layers, this value is set to 000000h.

The BCA flag indicates the presence of data in the Burst Cutting Area. A bit of zero indicates BCA data does not exist. a bit of one indicates BCA data does exist.

Table 132 - READ DVD STRUCTURE Data Format (Format field = 01h)

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB) DVD STRUCTURE Data Length							
1								(LSB)
2	Reserved							
3	Reserved							
DVD Copyright Information								
	Copyright Protection System Type							
	Region Management Information							
	Reserved							
	Reserved							

The DVD STRUCTURE Data Length specifies the length in bytes of the following DVD STRUCTURE data that is available to be transferred to the Host. The DVD STRUCTURE Data Length value does not include the DVD STRUCTURE Data Length field itself.

The Copyright Protection System Type field indicates the presence of data structures specific to a copyright protection system. Only two values are defined, 00h indicates there is no such data and 01h indicates a specific data structure exists. All other values are reserved.

The Region Management Information field describes the regions in which the disc can be played. Each bit represents one of eight regions. If a bit is set in this field, the disc can be played in the corresponding region. If a bit is cleared in this field the disc can not be played in the corresponding region.

Table 133 - READ DVD STRUCTURE Data Format (Format field = 02h)

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB) DVD STRUCTURE Data Length							
1								(LSB)
2	Reserved							
3	Reserved							
Disc Key Structures								
0	(MSB) DISC KEY Data							
2047								(LSB)

The DVD STRUCTURE Data Length specifies the length in bytes of the following DVD STRUCTURE data that is available to be transferred to the Host. The DVD STRUCTURE Data Length value does not include the DVD STRUCTURE Data Length field itself.

DISC KEY Value field returns the DISC KEY which is obfuscated by a Bus Key. The length of DISC KEY value is currently 2048 bytes only.

When the DISC KEY does not exist on DVD media, this command with Format = 02h shall be terminated with CHECK CONDITION status. The sense key shall be set to ILLEGAL REQUEST and the additional sense code set to COPY PROTECTION KEY EXCHANGE FAILURE - KEY NOT PRESENT.

When the DVD Logical Unit is not in the Bus Key state, this command with Format = 02h shall be terminated with CHECK CONDITION status. The sense key shall be set to ILLEGAL REQUEST and the additional sense code set to COPY PROTECTION KEY EXCHANGE FAILURE - KEY NOT ESTABLISHED.

Table 134 - READ DVD STRUCTURE Data Format (Format field =03h)

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB) DVD STRUCTURE Data Length							
1								(LSB)
2	Reserved							
3	Reserved							
DVD BCA Structure								
0	(MSB) BCA Information							
:								
:								
:								
n								(LSB)

This Information is returned from BCA recorded DVD media only. The Length of BCA Information is in the range of 12 to 188 bytes.

When a READ DVD STRUCTURE Command with a format field value of 03h is presented for a DVD media without BCA, the command shall be terminated with CHECK CONDITION status. The sense key shall be set to ILLEGAL REQUEST and the additional sense code set to INVALID FIELD IN COMMAND PACKET.

Table 135 - READ DVD STRUCTURE Data Format (Format field = 04h)

Bit Byte	7	6	5	4	3	2	1	0
0	(MSB) DVD STRUCTURE Data Length							
1								(LSB)
2	Reserved							
3	Reserved							
DVD Manufacturing's Structures								
0	Disc Manufacturing Information							
:								
:								
:								
2047								

The DVD STRUCTURE Data Length specifies the length in bytes of the following DVD STRUCTURE data that is available to be transferred to the Host. The DVD STRUCTURE Data Length value does not include the DVD STRUCTURE Data Length field itself.

The Disc Manufacturing Information is taken from the DVD media lead-in.

6.1.18. READ HEADER Command (Obsolete)

The READ HEADER command (Table 136) requests that the Logical Unit return the CD data block address header of the requested logical block.

Table 136 - READ HEADER Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (44h)							
1	RESERVED			Reserved			MSF	Reserved
2	(MSB)							
3	Logical Block Address							
4								
5								(LSB)
6	Reserved							
7	(MSB)			Allocation Length				
8								(LSB)
9	Control							

If the MSF bit is zero, the read header LBA parameter list, see Table 137 defines the CD data block address header of the requested logical block. If the MSF bit is one, the read header MSF parameter list (see Table 139) defines the CD data absolute address of the requested logical block.

The logical block address field specifies the logical block where the read header operation shall begin. If the logical block size is other than the physical block size, it shall be mapped into the appropriate physical block from which the data would have been read.

The READ HEADER data format (Table 137) defines the CD data block address header of the requested logical block.

Table 137 - READ HEADER LBA data format

Bit / Byte	7	6	5	4	3	2	1	0
0	CD Data Mode							
1	Reserved							
2	Reserved							
3	Reserved							
4	(MSB)							
5	Logical Block Address							
6								
7								(LSB)

The CD data mode field specifies the CD-ROM data mode of the logical blocks in this sector of data. The values in this field are defined in Table 138.

Table 138 - CD Data Mode field

CD Data Mode	CD Sector Formats
00h	Mode 0 or Audio
01h	Mode 1
02h	Mode 2
03h - FFh	Reserved

See **Error! Reference source not found.** for the CD sector format definition.

Table 139 - READ HEADER MSF data format

Bit / Byte	7	6	5	4	3	2	1	0
0	CD Data Mode							
1	Reserved							
2	Reserved							
3	Reserved							
4	Reserved							
5	M							
6	S							
7	F							

Table 140 - Recommended errors for READ HEADER command

Error	Reference
Deferred Errors	Sub-clause **A.1**
General Errors	Table **A.2**
Media Access Errors	Table **A.3**

6.1.19. READ MASTER CUE Command (Obsolete)

The READ MASTER CUE command reads the Mastering Information from a Master CD. Refer to RIAJ Standard, RIS 105-1994, Operation Rule of CD-R Master for CD.

Note: This document does not define any relationship between the master cue data and data sent with the Send Cue Sheet command.

Table 141 - READ MASTER CUE Command Descriptor Block

Bit / Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Operation Code (59h)							
1	Reserved			Reserved				
2	Reserved							
3	Reserved							
4	Sheet Number							
5	Reserved							
6	(MSB)							
7	Allocation Length							
8	(LSB)							
9	Control							

The Sheet Number values are shown in Table 142 below.

Table 142 - Sheet Number Values

Sheet Number	Content
00h	Disc Information
01h	Master Cue Sheet
02 ... FFh	Reserved

Allocation Length specifies the maximum number of bytes that are returned. Response data is terminated when allocation length bytes have been transferred or when all data have been transferred to the initiator, whichever is less. An Allocation Length of zero is not an error. If Allocation Length is zero, no data shall be transferred. The data read from the Master CD is transferred in the format shown in Table 143 below.

If no master cue sheet exists on the media, the Logical Unit shall return CHECK CONDITION status, INCOMPATIBLE MEDIUM INSTALLED.

Table 143 - Master CD response data format

Byte number	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
0	00h	00h	00h	00h	Sheet Length (byte)			
8	Contents of the Sheet							
...	...							

Table 144 - Recommended errors for READ MASTER CUE Command

Error	Reference
Deferred Errors	Sub-clause **A.1**
General Errors	Table **A.2**
Media Access Errors	Table **A.3**

6.1.20. READ SUB-CHANNEL Command

The READ SUB-CHANNEL command (Table 145) requests that the Logical Unit return the requested sub-channel data plus the state of audio play operations.

NOTE: Sub-channel data returned by this command may be from the last appropriate sector encountered by a current or previous media accessing operation. When there is no current audio play operation, the Logical Unit may access the media to read the sub-channel data. The Logical Unit is responsible for ensuring that the data returned is current and consistent.

Table 145 - READ SUB-CHANNEL Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (42h)							
1	RESERVED			Reserved			MSF	Reserved
2	Reserved	SUBQ	Reserved					
3	Sub-Channel Parameter List							
4	Reserved							
5	Reserved							
6	Track Number (Hex)							
7	(MSB) Allocation							
8	Length (LSB)							
9	Control							

If the MSF bit is zero, the read header LBA parameter list, see Table 137 defines the CD data block address header of the requested logical block. If the MSF bit is one, the read header MSF parameter list (see Table 139) defines the CD data absolute address of the requested logical block.

The sub Q bit set to one requests that the Logical Unit return the Q sub-channel data. The sub Q bit set to zero requests that no sub-channel data be returned. See 6.1.20.1. This shall not be considered an error.

The sub-channel parameter list (Table 146) field specifies the returned sub channel data.

Table 146 - Sub-channel parameter list codes

Format Code	Returned Data
00h	Reserved
01h	CD current position
02h	Media Catalogue number (UPC/bar code)
03h	Track International standard recording code (ISRC)
04h - EFh	Reserved
F0h - FFh	Vendor specific

The Track Number field specifies the track number from which ISRC data is read. This field shall have a value between 01h and 63h (99 bcd), and is valid only when the sub-channel parameter list field is 03h. In this case, the Logical Unit returns ISRC data for this track. This field may contain 00h when the Format code is not 03h.

6.1.20.1. Sub-Channel Data Header

The Sub-Channel data header format (Table 147) is four bytes. If the Sub Q bit is zero, in the command, the Logical Unit shall return only the sub-channel data header. In this case, the sub-channel data length is 0.

Table 147 - Sub-Q Channel Data Header Format

Bit / Byte	7	6	5	4	3	2	1	0
0	Reserved							
1	Audio Status							
2	(MSB) Sub-Channel							
3	Data Length (LSB)							

The audio status field indicates the status of audio play operations. The audio status values are defined in Table 148. Devices which do not support audio play operations shall always report 00h.

For Logical Units which support audio operations: The initial value for audio status is 15h. Audio status values 13h and 14h return information on previous audio operations. When audio play stops due to an error and the IMMED bit in the CD Audio Control Page (see **Error! Reference source not found.**) is set to one, the Logical Unit shall report 14h in this audio status byte and shall report no deferred error.

Table 148 - Audio status codes

Status	Description
00h	Audio status byte not supported or not valid
01h - 10h	Reserved
11h	Audio play operation in progress
12h	Audio play operation paused
13h	Audio play operation successfully completed
14h	Audio play operation stopped due to error
15h	No current audio status to return
16h - FFh	Reserved

The sub-channel data length field specifies the length in bytes of the following sub-channel data block. A sub-channel data length of zero indicates that no sub-channel data block is included in the returned data. Sub-channel data length does not include the sub channel header.

6.1.20.2. Sub-Channel Data Format (01h), CD current position

Table 149 defines the response data format for the CD current position data format.

Table 149 - CD current position data format

Bit / Byte	7	6	5	4	3	2	1	0
0	Sub-Channel Data Format Code (01h)							
1	ADR				CONTROL			
2	TRACK NUMBER							
3	INDEX NUMBER							
4	(MSB)							
	Absolute CD Address							
7								(LSB)
8	(MSB)							
	Track Relative CD Address							
11								(LSB)

The ADR field gives the type of information encoded in the Q sub-channel of this block, as shown in Table 150.

Table 150 - ADR Q sub-channel field

ADR Code	Description
00h	Q sub-channel mode information not supplied
01h	Q sub-channel encodes current position data (i.e., track, index, absolute address, relative address)
02h	Q sub-channel encodes media catalogue number
03h	Q sub-channel encodes ISRC
04h - 0Fh	Reserved

The control field is defined in Table 151.

The bits of the control field (except for the copy bit) can change during an actual pause (X=00) of at least 2 seconds and during the lead-in area only.

Table 151 - Q sub-channel control field

field	Definitions
00x0b	2 audio channels without pre-emphasis
00x1b	2 audio channels with pre-emphasis of 50/15 µs
10x0b	audio channels without pre-emphasis (reserved in CD-R/RW)
10x1b	audio channels with pre-emphasis of 50/15 µs (reserved in CD-R/RW)
01x0b	Data track, recorded uninterrupted
01x1b	Data track, recorded incremental
11xxb	reserved
xx0xb	digital copy prohibited
xx1xb	digital copy permitted

The Track Number field contains the current track number.

The Index Number field contains the current index number.

The Absolute CD Address field gives the current location relative to the logical beginning of the media. If the MSF bit, (Table 145) is zero, this field is an LBA. If the MSF bit is one, the address is MSF. See sub-clause 4.1.1. for a definition of the MSF field.

The Track Relative CD Address field gives the current location relative to the logical beginning of the current track. If the MSF bit is zero, this field is a track relative LBA. (If the current block is in the pre-gap area of a track, this will be a negative value, expressed as a two's-complement number.) If the MSF bit in the CDB is set to one, this field is the relative MSF address from the Q sub-channel.

The control data and current position data is obtained from the Q sub-channel information of the current block. Identification data may be reported that was obtained from a previous block. If identification data is reported, the data shall be valid for the sector addressed by the current position data.

a) If an audio play operation is proceeding in the background, position data for the last sector played shall be reported.

b) In other cases, for instance after a READ command, the Logical Unit may either report position data for the last sector processed for that operation or may report position data from the sector at the current read head position.

Note: When the type of information encoded in the Q sub-channel of the current sector is the media catalog number or ISRC, the track, index, and address fields should be extrapolated from the previous sector.

6.1.20.3. Sub-Channel Data Format (02h), Media Catalogue Number

With a Sub-channel format code of 02h the data returned is the Media Catalog Number. The Media Catalog field contains the identifying number of this media is expressed in ASCII. A value in this field of all ASCII zeros indicates that the media catalog number is not supplied. Table 152 defines the media catalogue number data format.

Table 152 - Media Catalogue Number data format

Bit / Byte	7	6	5	4	3	2	1	0
0	Sub-Channel Data Format Code (02h)							
1	Reserved							
2	Reserved							
3	Reserved							
4 ... ... **19**	Media Catalogue Number (MCN)							

If media catalogue number data is found, the MCVAL bit is set to one. If MCN data is not detected, the MCVAL bit is set to zero to indicate the media catalogue number field is invalid.

Media Catalogue Number (see Table 153) data returned in bytes 4 through 19 by this command with sub-channel data format field code 02h may be from any block that has MCN Q sub-channel data. See **Error! Reference source not found.** and sub-clause **Error! Reference source not found.**

Table 153 - MCN Format of Data Returned

Byte	Char	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0		MCVAL	Reserved						
1	N1	N1 (Most significant)							
2	N2	N2							
3	N3	N3							
...	...	...							
12	N12	N12							
13	N13	N13 (Least significant)							
14		Zero							
15		AFRAME							

All Nxx bytes are ASCII.

The MCVAL bit when set to one, indicates the Media Catalog Number field is valid.

Zero field shall return 00h.

AFRAME may return the frame number in which the MCN was found. This shall be a value from 00h to 4Ah. All other values are reserved.

6.1.20.4. Sub-Channel Data Format (03h), Track International Standard Recording Code

The track ISRC field contains the identifying number of this media according to the ISRC standards (DIN-31-621) expressed in ASCII. Table 154 defines the track international standard recording code data format. A unique ISRC may exist for each track.

Table 154 - Track International Standard Recording Code data format

Bit / Byte	7	6	5	4	3	2	1	0
0	Sub-Channel Data Format Code (03h)							
1	ADR				CONTROL			
2	Track Number							
3	Reserved							
4	(MSB) Track International Standard Recording Code (ISRC)							
19	(LSB)							

If ISRC data is detected, the TCVAL bit (see Table 155) is set to one. If ISRC data is not detected, the TCVAL bit is set to zero to indicate the ISRC field is invalid.

The ADR (Table 150) and Control fields (Table 151) shall be returned from the ADR and Control fields on the media.

The Track Number shall indicate the track for which the ISRC was requested.

Track ISRC data (see Table 155) may be from any block in the specified track that has ISRC data. When ADR field is 3 (0011), it is used to assign a unique number to an audio track. This is done by means of the ISRC which is 12 characters long (represented by I1 to I12, see Table 155.) The ISRC shall only change immediately after the TNO has been changed.

ISRC data returned is encoded as ASCII characters. The format of the data is defined in Table 155.

Table 155 - ISRC Format of Data Returned

Byte	Char	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0		TCVAL	Reserved						
1	I1	I1 (Country Code)							
2	I2	I2							
3	I3	I3 (Owner Code)							
4	I4	I4							
5	I5	I5							
6	I6	I6 (Year of Recording)							
7	I7	I7							
8	I8	I8 (Serial Number)							
9	I9	I9							
10	I10	I10							
11	I11	I11							
12	I12	I12							
13		Zero							
14		AFRAME							
15		Reserved							

All bytes are specified in ASCII. The following translation is specified for Logical Units:

ASCII	Hex	MEDIA
‘0’ - ‘9’	30h - 39h	00 - 09h
‘@’ - ‘o’	40h - 6Fh	10h - 3Fh

The following codes shall be valid for the above fields (Table 155):

a. Country Code: ‘A’ - ‘Z’ (41h - 5Ah)
b. Owner Code: ‘0’ - ‘9’ and ‘A’ - ‘Z’ (30h -39h, 41h - 5Ah)
c. Year of Recording: ‘0’ - ‘9’ (30h - 39h)
d. Serial Number: ‘0’ - ‘9’ (30h - 39h)

Zero field shall return 00h.

AFRAME may return the frame number in which the MCN was found. This shall be a value from 00h to 4Ah. All other values are reserved.

Table 156 - Recommended errors for READ SUB-CHANNEL command

Error	Reference
Deferred Errors	Sub-clause **A.1**
General Errors	Table **A.2**
Media Access Errors	Table **A.3**
AUDIO PLAY OPERATION IN PROGRESS	Table **A.1**
AUDIO PLAY OPERATION PAUSED	Table **A.1**
AUDIO PLAY OPERATION SUCCESSFULLY COMPLETED	Table **A.1**
AUDIO PLAY OPERATION STOPPED DUE TO ERROR	Table **A.1**
NO CURRENT AUDIO STATUS TO RETURN	Table **A.1**

6.1.21. READ TOC/PMA/ATIP Command

The READ TOC/PMA/ATIP Command (Table 157) requests that the Logical Unit transfer data from the Table of Contents, the Program Memory Area (PMA), and the Absolute Time in Pre-Grove (ATIP).

Table 157 - READ TOC/PMA/ATIP Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (43h)							
1	Reserved			Reserved			MSF	Reserved
2	Reserved				Format			
3	Reserved							
4	Reserved							
5	Reserved							
6	Track/Session Number (Hex)							
7	(MSB) Allocation Length							
8	(LSB)							
9	Control							

See sub-clause 4.1.1. for a description of the MSF bit.

The Format field is defined in Table 158.

Table 158 - Format Field

Format field	Return Data	Optional/ Mandatory	Description	Track/ Session field Usage
0000b	TOC	M	The Track/Session Number field specifies starting track number for which the data will be returned. For multi-session discs, this command will return the TOC data for all sessions and for Track number AAh only the lead-out area of the last complete session. See Table 160.	Track Number
0001b	Session Info	M	This format returns the first complete session number, last complete session number and last complete session starting address. In this format, the Track/Session Number field is reserved and should be set to 00h. NOTE: This format provides the initiator access to the last finalized session starting address quickly. See Table 161.	Reserved
0010b	Full TOC	M	This format returns all Q sub-code data in the lead-in(TOC) areas starting from a session number as specified in the Track/Session Number field, In this mode, the drive will support Q Sub-channel POINT field value of A0h, A1h, A2h, Track numbers, B0h, B1h, B2h, B3h, B4h, C0h, and C1h. See Table 162.	Session Number
0011b	PMA	O	This format returns all Q sub-code data in the PMA area. In this format, the Track/Session Number field is reserved and shall be set to 00h. See Table 166.	Reserved
0100b	ATIP	O	This format returns ATIP data. In this format, the Track/Session Number field is reserved and shall be set to 00h. See Table 167.	Reserved
0101b	CD TEXT	O	This format returns CD TEXT information that is recorded in the Lead-In area as R-W Sub-Channel Data	Reserved
All Other Format Codes			Reserved.	Reserved

The Track/Session Number field specifies the starting track number for which the data shall be returned. The data is returned in contiguous ascending track number order. A value of AAh requests that the starting address of the lead-out area be returned. If this value is zero, the Table of Contents data shall begin with the first track or session on the medium.

If the Track/Session Number field is not valid for the currently installed medium, the command shall be terminated with CHECK CONDITION status. The sense key shall be set to ILLEGAL REQUEST and the additional sense code set to INVALID FIELD IN CDB.

When a Read TOC/PMA/ATIP command is presented for a CD-R/RW media, where the first TOC has not been recorded (no complete session) and the Format codes 0000b, 0100b, or 1000b are specified, this command shall be rejected with an INVALID FIELD in COMMAND PACKET. Devices that are not capable of reading an incomplete session on CD-R/RW media shall report NOT READY, MEDIA FORMAT NOT COMPATIBLE.

6.1.21.1. READ TOC Response parameter list, general definition

The response parameter list (see Table 3) indicates the general description of the response data to the Read TOC/PMA/ATIP command. Each descriptor field is format specific and is defined in the appropriate format sub-clause.

Table 159 - READ TOC/PMA/ATIP parameter list, general definition

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB) Data Length							
1								(LSB)
2	First Track/Session/Reserved Field(Hex)							
3	Last Track/Session/Reserved Field(Hex)							
Parameter List Descriptor(s)								
0 : : n	Descriptor data , format specific							

The Data Length indicates the length, in bytes, of the parameter list descriptor data.

The Track/Session/Reserved Field is format specific and indicates the location, if any, of the information in the parameter list descriptors.

Descriptor data fields are format specific. The definitions of the bytes are described in each format sub-clause.

6.1.21.2. TOC/PMA/ATIP Response Data Format 0000b

The response data consist of four header bytes and zero or more track descriptors. The response data is dependent upon the format specified in the format field of the CDB. The response data returned for Format 0000b is specified in Table 160.

Table 160 - READ TOC/PMA/ATIP response data (Format = 0000b)

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB) TOC Data Length							
1								(LSB)
2	First Track Number(Hex)							
3	Last Track Number(Hex)							
	TOC Track Descriptor(s)							
0	Reserved							
1	ADR				CONTROL			
2	Track Number(Hex)							
3	Reserved							
4	(MSB) Logical Block Address							
7								(LSB)

The TOC data length indicates the length in bytes of the following TOC data. The TOC data length value does not include the TOC data length field itself. This value is not modified when the allocation length is insufficient to return all of the TOC data available.

The First Track Number field indicates the first track number in the first complete session Table of Contents.

The Last Track Number field indicates the last track number in the last complete session Table of Contents before the lead-out.

The ADR field gives the type of information encoded in the Q sub-channel of the block where this TOC entry was found. The possible ADR values are defined in Table 150.

The Control Field indicates the attributes, of the track, see Table 151.

The Track Number field indicates the track number for which the data in the TOC track descriptor is valid. A track number of AAh indicates that the track descriptor is for the start of the lead-out area.

The Logical Block Address contains the address of the first block with user information for that track number as read from the Table of Contents. An MSF bit of zero indicates that the Logical Block Address field contains a logical block address. An MSF bit of one indicates the Logical Block Address field contains an MSF address (see sub-clause 4.1.6).

6.1.21.3. TOC/PMA/ATIP Response Data Format 0001b

The response data returned for Format 0001b is specified in Table 161.

Table 161 - READ TOC/PMA/ATIP response data (Format = 0001b)

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB) TOC Data Length							
1								(LSB)
2	First Complete Session Number (Hex)							
3	Last Complete Session Number (Hex)							
TOC Track Descriptor								
0	Reserved							
1	ADR				CONTROL			
2	First Track Number In Last Complete Session (Hex)							
3	Reserved							
4	(MSB) Logical Block Address of First Track in Last Session							
7								(LSB)

The TOC Data Length specifies the length in bytes of the available session data. The TOC Data Length value does not include the TOC Data Length field itself. This value is not modified when the allocation length is insufficient to return all of the session data available.

The First Complete Session Number is set to one.

The Last Complete Session Number indicates the number of the last complete session on the disc. The Last Complete Session Number shall be set to one for a single session disc or if the Logical Unit does not support multi-session discs.

The ADR field gives the type of information encoded in the Q sub-channel of the block where this TOC entry was found. The possible ADR values are defined in Table 150.

The Control Field indicates the attributes of the track. The possible control field values are defined in Table 151.

First Track Number In Last Complete Session returns the first track number in the last complete session.

The Logical Block Address contains the address of the first block with user information for the first track of the last session, as read from the Table of Contents. An MSF bit of zero indicates that the Logical Block Address field contains a logical block address. An MSF bit of one indicates the Logical Block Address field contains an MSF address (see sub-clause 4.1.1.).

6.1.21.4. TOC/PMA/ATIP Response Data Format 0010b

The response data returned for Format 0010b is specified in Table 162.

Table 162 - READ TOC/PMA/ATIP response data (Format = 0010b)

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB) TOC Data Length							
1								(LSB)
2	First Complete Session Number (Hex)							
3	Last Complete Session Number (Hex)							
TOC Track Descriptor(s)								
0	Session Number (Hex)							
1	ADR				CONTROL			
2	TNO							
3	POINT							
4	Min							
5	Sec							
6	Frame							
7	Zero							
8	PMIN							
9	PSEC							
10	PFRAME							

Multiple TOC Track Descriptors may be returned.

For Format field of 1000b, the Logical Unit shall return TOC data for Q sub-channel modes 1 and 5 (except mode 5, point 1 through 40) in the lead-in area.

The TOC Data Length specifies the length in bytes of the available TOC data. The TOC Data Length value does not include the TOC Data Length field itself. This value is not modified when the allocation length is insufficient to return all TOC data available.

The First Complete Session Number shall be set to one.

The Last Complete Session Number indicates the number of the last complete session on the disc. The Last Complete Session Number is set to one for a single session disc or if the Logical Unit does not support multi-session discs.

The ADR field gives the type of information encoded in the Q sub-channel of the block where this TOC entry was found. The possible ADR values are defined in Table 150.

The Control Field indicates the attributes of the track. The possible control field values are defined in Table 151.

Entries in bytes 2 through 10 of the descriptors (TNO, POINT, MIN, SEC, FRAME, Zero) shall be converted to hex by the Logical Unit if the media contains a value between 0 and 99bcd. For definition of these byte see Table 163.

The returned TOC data of a multi-session disc is arranged in ascending order of the session number with duplicates removed. The TOC data within a session is arranged in the order of Q Sub-channel POINT field value of A0h, A1h, A2h, Track Numbers, B0h, B1h, B2h, B3h, B4h, C0h, and C1h.

The TOC Track Descriptor format in the lead-in area of the TOC is described in Table 163.

Table 163 - TOC Track Descriptor Format, Q sub-channel

CTRL	ADR	TNO (hex)	POINT (hex)	MIN (hex)	SEC (hex)	FRAME (hex)	ZERO (hex)	PMIN (hex)	PSEC (hex)	PFRAME (hex)
4 or 6	1	00	01-63	ATIME (Absolute time)			00	Start position of track		
4 or 6	1	00	A0	ATIME (Absolute time)			00	First Track Number	Disc Type	00
4 or 6	1	00	A1	ATIME (Absolute time)			00	Last Track Number	00	00
4 or 6	1	00	A2	ATIME (Absolute time)			00	Start position of lead-out		
4 or 6	5	00	B0	Start time of next possible program in the Recordable Area of the disc			# of pointers in Mode 5	Maximum start time of outer-most lead-out area in the Recordable Area of the disc		
4 or 6	5	00	B1	00	00	00	00	# of skip interval Pointers (N<=40)	# of skip Track Pointers (N<=21)	00
4 or 6	5	00	B2-B4	Skip #	Skip #	Skip #	Skip #	Skip #	Skip #	Skip #
4 or 6	5	00	01-40	Ending time for the interval that should be skipped			Resrv'd	Start time for interval that should be skipped on playback		
4 or 6	5	00	C0	optimum recording power	Reserved	Reserv'd	Reserved	Start time of the first lead-in Area of the disc		
4 or 6	5	00	C1	Copy of information from A1 point in ATIP.						

All of the TOC Track Descriptors, in Table 163, are further define in sub-clause found. The POINT Field (Table 164) defines various types of information within the TOC lead-in area.

Table 164 - POINT Field

ADR	POINT Field	Description
1	01-63h	Track number references
1	A0h	First Track number in the program area
1	A1h	Last Track number in the program area
1	A2h	Start location of the lead-out area
5	01-40h	Skip Interval Pointers
5	B0h	Used to Identify a Multi-session Disc (Photo CD) Contains start time of next possible program area
5	B1h	Number of skip interval pointers & Skip track assignments
5	01-40h	Skip Interval Pointers
5	B2-B4h	Skip Track Assignment Pointers
5	C0h	Start time of first lead-in area of disc (This only exists in the first lead-in area)
5	C1h	Copy of information from additional area 1 in ATIP.

The Disc Type field (see Table 165) indicates the type of disc inserted.

Table 165 - Disc Type Byte Format

Value	Description
00h	CD-DA or CD Data with first track in Mode 1
10h	CD-I disc
20h	CD data XA disc with first track in Mode 2

The definition for the Control Field in the Q sub-channel is in Table 151..

6.1.21.5. TOC/PMA/ATIP Response Data Format 0011b

The response data returned for Format 0011b is specified in Table 166.

Table 166 - READ TOC/PMA/ATIP response data (Format = 0011b)

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB) PMA Data Length							
1								(LSB)
2	Reserved							
3	Reserved							
PMA Descriptor(s)								
0	Reserved							
1	ADR				CONTROL			
2	TNO							
3	POINT							
4	Min							
5	Sec							
6	Frame							
7	Zero							
8	PMIN							
9	PSEC							
10	PFRAME							

Multiple PMA Descriptors may be returned.

The returned PMA descriptors are arranged in the order found in the PMA, with duplicates removed.

The PMA Data Length indicates the length in bytes of the available PMA data. The PMA Data Length value does not include the PMA Data Length field itself. This value is not modified when the allocation length is insufficient to return all PMA data available. This value is set to 2 plus eleven times the number of descriptors read.

Entries in bytes 2 through 10 of the descriptors (TNO, POINT, MIN, SEC, FRAME, Zero) shall be converted to hex by the Logical Unit if the media contains a value between 0 and 99bcd. For definition of these bytes see Table 163. The TOC Track Descriptors are further defined in sub-clause **Error! Reference source not found.**

6.1.21.6. TOC/PMA/ATIP Response Data Format 0100b

The response data returned for Format 0100b is specified in Table 167.

Table 167 - READ TOC/PMA/ATIP response data (Format = 0100b)

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB) ATIP Data Length							
1								(LSB)
2	Reserved							
3	Reserved							
ATIP Descriptor								
4	1	Indicative Target Writing Power			Reserved	Reference Speed		
5	0	URU	Reserved					
6	1	Disc Type	Disc Sub-Type			A1	A2	A3
7	Reserved							
8	ATIP Start Time of lead-in (Min)							
9	ATIP Start Time of lead-in (Sec)							
10	ATIP Start Time of lead-in (Frame)							
11	Reserved							
12	ATIP Last Possible Start Time of lead-out (Min)							
13	ATIP Last Possible Start Time of lead-out (Sec)							
14	ATIP Last Possible Start Time of lead-out (Frame)							
15	Reserved							
16	0	Lowest Usable CLV Recording Speed			Highest Usable CLV Recording Speed			
17	0	Power Multiplication Factor p			Target y value of the Modulation/Power function			Reserved
18	1	Recommended Erase/Write Power Ratio (P_{eo}/W_{eo})			Reserved			
19	Reserved							
20-22	A2 Values							
23	Reserved							
24-26	A3 Values							
27	Reserved							

ATIP Data Length specifies the number of bytes to be transferred in response to the command. The ATIP Data Length value does not include the data length field itself. This value is not modified when the allocation length is insufficient to return all of the ATIP data available.

Indicative Target Writing Power Field - encoded information indicating the media's recommended initial laser power setting. The meaning of these bits varies between CD-R and CD-RW media.

Reference Speed Field - encoded information indicating the recommended write speed for the media. 00h = reserved. 01h - 2X recording, 02h-07h are reserved. Valid only for CD-RW media.

The URU (Unrestricted Use Disc) bit, when set to one, indicates that the mounted CD-R/RW disc is defined for unrestricted use. When the Unrestricted Use Disc bit is set to zero, the mounted CD-R/RW disc is defined for restricted

use. To record data to the mounted disc the appropriate Host Application code shall be set through the Write Parameters Page. A Host Application Code of zero may be used to indicate a restricted use disc - general purpose.

Disc Type - zero indicates CD-R media; one indicates CD-RW media.

Disc Sub-Type - shall be set to zero.

A1 - when set to one, indicates that bytes 16-18 are valid.

A2 - when set to one, indicates that bytes 20-22 are valid.

A3 - when set to one, indicates that bytes 24-26 are valid.

ATIP Start time of Lead-in (min, sec, frame) - the start time of the lead-in. The value is read from ATIP and returned in hex format. Legal values for the M field are 50h through 63h.

ATIP Last Possible Start Time of Lead-out (min, sec, frame) - the last possible start time of lead-out. The value is read from ATIP and returned in hex format. Valid values for the M field are 0 through 4Fh.

Lowest Usable CLV Recording Speed (see Table 77) - valid only when A1 = 1.

Table 168 - Lowest CLV Recording Speeds

Value	Recording Speed
000b	Reserved
001b	2X
010b - 111b	Reserved

Highest Usable CLV Recording Speed - valid only when A1 = 1.

Table 169 - Highest CLV Recording Speeds

Value	Recording Speed
000b	Reserved
001b	2X
010b	4X
011b	6X
100b	8X
101b - 111b	Reserved

The following fields reported as recorded in ATIP, contain information that is beyond the scope of this standard.

Power Multiplication Factor p field.
Target y value of the Modulation/Power function field.
Recommended Erase/Write Power Ratio (P_{eo}/W_{eo}) field.
A2 Values - Reserved
A3 Values - Reserved

6.1.21.7. TOC/PMA/ATIP Response Data Format 0101b

The response data returned for Format 0101b is specified in Table 170.

Table 170 - READ TOC/PMA/ATIP parameter list, general definition

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB) Data Length							
1								(LSB)
2	First Track/Session/Reserved Field(Hex)							
3	Last Track/Session/Reserved Field(Hex)							
Parameter List Descriptor(s)								
0 : : n	Descriptor data , format specific							

CD TEXT Data Length specifies the number of bytes to be transferred in response to the command. The ATIP Data Length values does not include the data length field itself. This value is not modified when the allocation length is insufficient to return all of the CD TEXT data available. This length is variable depends on the number of recording Pack Data.

CD TEXT Information Descriptor(s) provides Pack Data available in the Lead-In area of the disc. Each Pack Data consists of 18 bytes of CD TEXT information. If a Pack Data is recorded repeatedly on the disc, the device should return it only once.

The detail of Pack Data and CD TEXT information is described in Annex Q.

Table 171 - Recommended errors for READ TOC/PMA/ATIP Command

Error	Reference
Deferred Errors	Sub-clause **A.1**
General Errors	Table **A.2**
Media Access Errors	Table **A.3**
AUDIO PLAY OPERATION IN PROGRESS	Table **A.1**

6.1.22. READ TRACK/RZONE INFORMATION Command

The READ TRACK/RZONE INFORMATION Command provides information about a track/RZone, regardless of its status.

Table 172 - READ RZONE(TRACK) INFORMATION Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code (52h)							
1	Reserved							Track
2	(MSB)							
3	Logical Block Address/							
4	Track Number							
5								(LSB)
6	Reserved							
7	(MSB)			Allocation Length				
8								(LSB)
9	Control Byte							

The RZone(Track) bit in byte 1 is used to specify the contents of bytes 2 through 5 of the CDB. If the RZone(Track) bit is set to zero, then bytes 2 through 5 contain a Logical Block Address. If the RZone(Track) is set to one, then bytes 2 through 5 contain a RZone(Track) number.

The Logical Block Address/RZone(Track) Number field, Bytes 2 through 5 are defined in Table 173.

Table 173 - Track/RZONE Number/LBA Field definition

Track Bit	Logical Block Address/RZone(Track) Number	RZone(Track) Number Used for Track Information
0	Logical Block Address	T_{LBA}, where T_{LBA} is the number of the track which contains the block associated with Logical Block Address.
1	00h	T_{toc}, where T_{toc} is the Lead-In area of the disc
1	T_{CDB}, a valid track number	T_{CDB}
1	FFh	T_{INV}, where T_{INV} is the RZone(track) number of the invisible RZone(track)

The number of RZone(Track) Information Block bytes returned is limited by the Allocation Length parameter of the CDB. An Allocation Length of zero is not an error.

The format and content of the RZone(Track) Information Block is shown in Table 174.

Table 174 - Track/RZone Information Block

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB) Data Length							
1								(LSB)
2	Track/RZone Number							
3	Session Number							
4	Reserved							
5	Reserved		Damage	Copy	Track Mode			
6	RT	Blank	Packet	FP	Data Mode			
7	Reserved							NWA_V
8	(MSB) Track/RZONE Start Address							
9								
10								
11								(LSB)
12	(MSB) Next Writable Address							
13								
14								
15								(LSB)
16	(MSB) Free Blocks							
17								
18								
19								(LSB)
20	(MSB) Fixed Packet Size							
21								
22								
23								(LSB)
24	(MSB) Track/RZone Size							
25								
26								
27								(LSB)

Data length field specifies the length, in bytes, of the requested data to be transferred in response to the command. The data length value does not include the data length field itself. If the Allocation length specified is less than the data length, the response shall be truncated at the allocation length specified. This truncation shall not cause a Check Condition status to be presented. The Data Length is not modified when the allocation length is insufficient to return all of the response data available.

Track Number is the track number for all of the information in this structure. If the track/RZone number is set to zero, and the P through W bit is set (see Table 258),the contents of Track Information Block shall be returned for the Lead-In area. In this case, the Track Start Address field is the start address of the Lead-In area.

Session Number is the number of the session containing this track.

The Copy bit indicates that this track is a second or higher generation copy.

The Damage bit, when set to one, and the NWA_V is set to zero, the track shall be considered "not closed due to an incomplete write." An automatic repair may be attempted by the drive when the CLOSE TRACK/SESSION command is issued. The Damage bit, when set to one, and the NWA_V is set to one, an automatic repair may be attempted by the drive when the next command that requires writing to the track is issued. If the repair is successful, the Damage bit shall be set to zero.

Track Mode is the control nibble as defined for mode 1 Q sub-channel for this track. See **Error! Reference source not found.** and Table 151

If the RT bit is zero, then the track is not reserved, otherwise the track is reserved. Reserved indicates that a PMA entry indicating the track's start and end addresses exists.

The Blank bit, when set to one, indicates that the track contains no written data. Tracks with the Track Descriptor Block recorded shall not be considered blank.

The Packet bit is valid only when the RT bit is set to one or the track indicated is the incomplete track. The Packet bit, when set to one, indicates that this track is to be written only with packets.

The FP (Fixed Packet) bit is valid only when the Packet bit is set to one. When the Packet bit is set to one and the FP bit is also set to one, then the track is to be written only with fixed packets. When the Packet bit is set to one and the FP bit is set to zero, then the track is to be written only with variable packets.

When writing, certain parameters may be set via the write parameters page. The state of the track determines what parameters must be set and which parameters in the mode page must match. Required Write Parameters are defined in Table 175.

Table 175 - Write Parameter Restrictions due to RZone(Track) State

RT	Blank	Packet	Write Parameter Restrictions(CD)	
0	0	0	Can't write to stamped disc, or during track at once on invisible track, or writing session at once mode	
0	0	1	Write type set to packet; all parameters common to READ RZONE(TRACK) INFO and the write parameters mode page must match.	
0	1	0	Write type may be set to packet or TAO. All other parameters shall be changeable. If this track is the first track of a Session, then Session at Once is allowed.	
0	1	1	Invalid State	
1	0	0	Can't write to recorded track or during track at once on reserved track.	
1	0	1	Write type set to packet; all parameters common to READ RZONE(TRACK) INFO and the write parameters mode page must match.	
1	1	0	Write type set to TAO. Track mode set to same as READ RZONE(TRACK) INFO. Copy bit may be set only if copyright bit in track mode is clear. All other common parameters must match.	
1	1	1	Write type set to Packet. Track mode set to same as READ RZONE(TRACK) INFO. Copy bit may be set only if copyright bit in track mode is clear. FP and packet size are changeable. All other common parameters must match.	

When RT, Blank and Packet bits are set to one, FP bit of a Read RZONE(Track) Information result data is set to zero.

Data Mode defines the track content. Data Mode is defined in Table 177.

Table 176 - Track Status Indications

RT	Blank	Packet	FP	Write Method	Track Status
0	0	0		Uninterrupted/TAO/SAO	Complete/During TAO/SAO
0	0	1	0	Variable	Incomplete
0	0	1	1	Fixed	Incomplete
0	1	0	0	TAO/Variable/Fixed(*)	Invisible
0	1	1	0	-	(invalid)
0	1	1	1	-	(invalid)
1	0	0		TAO	Complete/During TAO
1	0	1	0	Variable	Complete/Partially Recorded Reserve
1	0	1	1	Fixed	Complete/Partially Recorded Reserve
1	1	0	-	TAO	Empty Reserved
1	1	1	0	Variable/Fixed	Empty Reserved
1	1	1	1	-	(invalid)
* In case last session is empty, SAO is also valid.					

Table 177 - Data Mode

Value	Definition
1	Mode 1 (ISO/IEC 10149)
2	Mode 2 (ISO/IEC 10149 or CD-ROM XA)
Fh	Data Block Type unknown (no track descriptor block)
0, 3 - Eh	Reserved

If NWA_V is zero, then the next writable address field is not valid. Otherwise the next writable address field is valid. NWA_V shall be set to zero if the RZone(track) is not writable for any reason.

The RZone(Track) Start Address is the starting address for the specified RZone(track).

The Next Writable Address, if valid, is the LBA of the next writable user block in the RZone(track) specified by the LBA/RZone(Track) Number field in the CDB. Next Writable Address shall be associated with the RT, Blank, Packet and FP bits as defined in Table 178. If the write type is Raw, the Next Writable Address may be a negative number as required to point to the start of the first lead-in (see Table 230). When streaming in any write type, the Next Writable Address shall be the next user data block the drive expects to receive if no under-run occurs.

Table 178 - Next Writable Address Definition

RT	Blank	Packet	FP	NWA_V	Definition
0	0	0	-	0 *4	LBA that shall be specified by next write command *2
0	0	1	0	1 *1	LBA that shall be specified by next write command *2
0	0	1	1	1 *1	LBA that shall be specified by next write command *2, *3
0	1	0	0	1	LBA of the first data block after pre-gap *5
0	1	1	0	-	-
0	1	1	1	-	-
1	0	0	-	0 *4	LBA that shall be specified by next write command *2
1	0	1	0	1 *1	LBA that shall be specified by next write command *2
1	0	1	1	1 *1	LBA that shall be specified by next write command *2, *3
1	1	0	-	1	LBA of the first data block after pre-gap
1	1	1	0	1	LBA of the first data block after pre-gap
1	1	1	1	-	-

Notes:
*1 - When "Free Blocks" is 0 (data full), NWA_V is 0.
*2 - NWA shall be taken account of data blocks in buffer that has not yet been written to media. If the drive can write the data of next write command without interrupting of current data streaming(no underrun condition), NWA shall be contiguous to last address data in buffer. If WCE in Mode Cache Page is zero, NWA shall be taken account of Link Blocks (2 Run-out blocks, 1 Link block and 4 Run-out blocks) in case of Addressing Method-1.
*3 - NWA shall follow the Addressing Method-2 if Method-2 bit in Mode CD Capabilities and Mechanical Status Page is set to one.
*4 - During TAO (SAO), NWA_V is 1.
*5 - In the case of SAO NWA shall be the first block after lead-in for the first track of session.

The Free Blocks field represents the maximum number of user data blocks available for recording in the track. This field shall be computed as follows: First, the Available Track Space (ATS) shall be computed. For the invisible track, $ATS = (StartTimeofLastPossibleLead - out) - NWA + 5$. For a reserved track, $ATS = (PMAStopTime) - NWA + 5$. If the track is reserved for, or written with, fixed packets, $FreeBlocks = IP\left(\frac{ATS}{PacketSize + 7}\right) \bullet PacketSize$. Otherwise,

$FreeBlocks = ATS - 7$

Note: The StartTimeofLastPossibleLead-out is the last possible location of the link block at the start of the lead-out. If a disc is fully recorded, the PMA entry for the last track will be equal to the StartTimeofLastPossibleLead-out.

Addressing within fixed packet written tracks is translated by the drive for reading and writing. The NWA shall also reflect this translation: $NWA_{Method2} = NWA_{Method1} - 7 \cdot IP\left(\frac{NWA_{Method1} - TrackStartAddress}{PacketSize + 7}\right)$. Method 1 is the physical address. Method 2 is used on fixed packet written tracks to hide the link areas from the initiator. The TrackStartAddress is always a physical address, even if prior tracks are recorded with Method 2. IP( ) is the integer part of the value.

The Fixed Packet Size is valid only when the Packet and the FP bits are both set to one.

If the disc is stamped, then DAMAGE = 0, BLANK = 0, RT = 0, and NWA_V = 0.

Track Size is the number of user data blocks in the track. The track size shall be computed as follows: First, compute the Complete Track Size (CTS). For an incomplete track,
$CTS = (StartTimeofLastPossibleLeadout) - PMATrackStart + 5$. For a reserved track,

$CTS = (PMAStopTime) - PMAStartTime + 5$. If the track is reserved for, or written with, fixed packets, $TrackSize = IP\left(\frac{CTS}{PacketSize + 7}\right) \bullet PacketSize$. Otherwise, $TrackSize = CTS - 7$

NOTE: Read Track Information shall provide certain valid fields for a disc with the Unrecordable status: Track Number, Session Number, Track Mode, Data Mode, Track Start Address.

The Track Size number may not be exact for the tracks that do not have a PMA entry. The track size of tracks that do not have PMA entries is calculated as follows:

TrackSize of track n = (start of track n+1) - (start of track n)

n+1 is the Lead Out if n is the last track recorded in the TOC.

The Track Size from this calculation may include blocks from the following track and these blocks may not be readable.

Table 179 - Recommended errors for READ TRACK/RZONE INFORMATION Command

Error	Reference
Deferred Errors	A.1
General Errors	Table A.2
Media Access Errors	Table A.3

6.1.23. REPAIR TRACK/ RZONE Command (Obsolete)

A track which has been defined for packet writing may be damaged due to an incomplete packet at the end of written data. This may be caused by a RESET or a power-fail condition during a packet write. The REPAIR TRACK(Table 180) command will fill a fixed length packet to its correct user data length and add run-outs. Variable length packets will simply be completed with run-outs. The user data in the repaired packet must be rewritten as the repaired packet is not readable. The recovery indicated here only allows the track to become writable again.

Table 180 - REPAIR TRACK Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code (58h)							
1	Reserved							
2	Reserved							
3	Reserved							
4	Reserved							
5	Track Number							
6	Reserved							
7	Reserved							
8	Reserved							
9	Control Byte							

The Track Number specifies the track which requires repair.

Behavior of this command with non-packet written tracks is vendor specific.

Table 181 - Recommended errors for REPAIR TRACK Command

Error	Reference
Deferred Errors	Sub-clause **A.1**
General Errors	Table **A.2**
Media Access Errors	Table **A.3**
Write Errors	Table **A.4**

6.1.24. REPORT KEY Command

The REPORT KEY command (Table 182) requests the start of the authentication process and provides data necessary for authentication and for generating a Bus Key for the DVD Logical Unit. This command, in conjunction with SEND KEY command, is intended to perform authentication for Logical Units which conform to DVD Copy Protection scheme and to generate a Bus Key as the result of authentication.

The REPORT KEY command also requests the DVD Logical Unit to transfer TITLE KEY data, obfuscated by a Bus Key, to the Host Computer.

Table 182 - REPORT KEY Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code (A4h)							
1	LUN (Obsolete)			Reserved				
2	(MSB)							
3	Reserved or Logical Block Address							
4								
5								(LSB)
6	Reserved							
7	Reserved							
8	(MSB) Allocation Length							
9								(LSB)
10	AGID		KEY Format					
11	Control							

The KEY Format field (Table 183) indicates the type of information that is requested to be sent to the host.

The REPORT KEY command with KEY Format field of 000000b begins the authentication process. The Logical Unit, when ready to begin the authentication process, shall grant the request by returning an Authentication Grant ID (AGID). If there is no available Authentication Grant ID, the command shall be terminated with CHECK CONDITION status. The sense key shall be set to ILLEGAL REQUEST and the additional sense code set to SYSTEM RESOURCE FAILURE.

The AGID field is used to control simultaneous key exchange sequences. The AGID specified in subsequent Key Exchange commands shall match a currently active AGID. The AGID field shall be reserved when the KEY Format Field contains either 0h or 5h.

In case of KEY Format = 000100b, the Reserved / Logical Block Address field specifies the logical block address which contains the TITLE KEY to be sent to the Host obfuscated by a Bus Key. In all other cases, this field shall be reserved.

Table 183 - Key Format Code definitions for REPORT KEY Command

Key Format	Returned Data	Description	AGID Use
000000b	AGID	Returns an AUTHENTICATION GRANT ID	Reserved & N/A
000001b	Challenge Key	Returns a Challenge KEY	Valid AGID Required
000010b	KEY1	Returns a KEY1	
000100b	TITLE KEY	Returns a TITLE KEY obfuscated by a Bus Key	
000101b	ASF	Returns the current state of the Authentication Success Flag	Reserved & Ignored
001000b	RPC	Report Logical Unit region settings	
111111b	None	Invalidate Specified AGID. Invalidating an invalid AGID shall not be considered an error. An AGID that has not been granted shall be considered invalid	Valid AGID required
All other values	Reserved		

The data returned to the initiator for this command is shown in the following tables. The response for each format is defined. It should be noted that with a Key Format Code of 3Fh, no data shall be returned to the host. Table 184 defines the response data for Key Format 000000b.

Table 184 - REPORT KEY Data Format (With KEY Format = 000000b)

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			REPORT KEY Data Length				
1								(LSB)
2	Reserved							
3	Reserved							
AUTHENTICATION GRANT ID								
0	Reserved							
1	Reserved							
2	Reserved							
3	AGID		Reserved					

Table 185 defines the response data for Key Format 000001b

Table 185 - REPORT KEY Data Format (With KEY Format = 000001b)

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			REPORT KEY Data Length (0Eh)				
1								(LSB)
2	Reserved							
3	Reserved							
Challenge Key								
0	(MSB)							
:	Challenge Key Value							
9								(LSB)
10	Reserved							
11	Reserved							

Challenge Key Value field returns a value to be used to interrogate an external device to determine conformance with the DVD Copy Protection scheme. The external device then generates the corresponding KEY2.

Table 186 defines the response data for Key Format 000010b

Table 186 - REPORT KEY Data Format (With KEY Format = 000010b)

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			REPORT KEY Data Length (0Ah)				
1								(LSB)
2	Reserved							
3	Reserved							
KEY1								
0	(MSB)							
:	KEY1 Value							
4								(LSB)
5	Reserved							
6	Reserved							
7	Reserved							

KEY1 Value field returns a value used to determine the Logical Unit's conformity with DVD Copy Protection scheme by an external device. The KEY1 value will also be used as a parameter to generate a Bus Key in the Logical Unit.

When the Logical Unit is unable to produce a KEY1 value, this command with KEY Format = 000010b shall be terminated with CHECK CONDITION status. The sense key shall be set to ILLEGAL REQUEST and the additional sense code & qualifier set to COPY PROTECTION KEY EXCHANGE FAILURE - KEY NOT PRESENT.

Table 187 defines the response data for Key Format 000100b

Table 187 - REPORT KEY Data Format (With KEY Format = 000100b)

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			REPORT KEY Data Length (0Ah)				
1								(LSB)
2	Reserved							
Copyright Management Information								
3	0	CPM	CP_SEC	CGMS		Reserved		
TITLE KEY								
0	(MSB)							
:	TITLE KEY Value							
4								(LSB)
5	Reserved							
6	Reserved							
7	Reserved							

The CPM field identifies the presence of copyrighted material in this sector. If set to zero the material is not copyrighted, if set to one the material is copyrighted.

The CP_SEC field indicates that the specified sector has a specific data structure for copyright protection system. If set to zero no such data structure exists in this sector .If set to one, a specific data structure exists in this sector.

The CGMS field indicates the restrictions on copying:

00b Copying is permitted without restriction
01b Reserved
10b One generation of copies may be made
11b No copying is allowed

TITLE KEY Value field returns the TITLE KEY which is obfuscated by a Bus Key. The length of TITLE KEY value is currently 5 bytes only.

When the TITLE KEY does not exist on DVD media, this command with KEY Format = 000100b shall be terminated with CHECK CONDITION status. The sense key shall be set to ILLEGAL REQUEST and the additional sense code set to COPY PROTECTION KEY EXCHANGE FAILURE and the additional sense code qualifier shall be set to KEY NOT PRESENT.

When the Logical Unit is not in the Bus Key Established state, this command with KEY Format = 000100b shall be terminated with CHECK CONDITION status. The sense key shall be set to ILLEGAL REQUEST and the additional sense code & qualifier set to COPY PROTECTION KEY EXCHANGE FAILURE - KEY NOT ESTABLISHED.

Table 188 defines the response data for Key Format 000101b

Table 188 - REPORT KEY Data Format (With KEY Format = 000101b)

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB) REPORT KEY Data Length (0Ah)							
1								(LSB)
2	Reserved							
3	Reserved							
AUTHENTICATION SUCCESS FLAG								
0								
1	Reserved							
2	Reserved							
3	Reserved							Success Flag

For more information on the contents of the Success Flag See "Authentication Flag Sequence" on page 153.

Table 189 defines the response data for Key Format 001000b

Table 189 - REPORT KEY Data Format (With KEY Format = 001000b)

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB) REPORT KEY Data Length (06h)							
1								(LSB)
2	Reserved							
3	Reserved							
RPC State								
0	Type Code		# of Manufacturer Resets Available			# of User Controlled Resets Available		
1	Region Mask							
2	Reserved							
3	Reserved							

Type Code field specifies the current state of the Regionalization Process:

00b NONE No drive region settings
01b TEMP Drive region setting is not permanent, but is in the process of determining the permanent region. Returned Region Mask may contain one or more bits set.
10b PERM Drive region has been set permanent, but may be reset if necessary
11b FIXED Drive region cannot be changed. The Manufacturer reset has been exceeded or the drive has been set by the manufacturer to only one region.

# of Manufacturer Resets Available is a count down counter that indicates the number of times that the manufacturer can reset the region.

# of User Controlled Resets Available is a count down counter that indicates the number of times that the user/manufacturer can reset the region selection process.

The Region Mask returns a value that specifies the drive region(s) in which the Logical Unit is located. During the temporary state, the drive can be located in multiple regions. Once the drive region has been made permanent, the Logical Unit shall be located in only one region. Each bit represents one of eight regions. If a bit is Cleared in this field, the disc can be played in the corresponding region. If a bit is Set in this field, the disc cannot be played in the corresponding region.

6.1.25. RESERVE TRACK/RZONE Command

The RESERVE TRACK/RZONE Command (Table 190) allows reservation of disc space for a track/RZone. A PMA entry for the track/RZone shall be either written or cached for writing prior to disc removal.

Table 190 - RESERVE TRACK/RZONE Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code (53h)							
1	Reserved							
2	Reserved							
3	Reserved							
4	Reserved							
5	(MSB)							
6	Reservation							
7	Size							
8								(LSB)
9	Control Byte							

The Reservation Size field contains the number of user blocks desired for the track/RZONE reservation. The actual number of blocks allocated shall be according to the Write Parameters Mode Page. For DVD, when the Write type is "disc-at-once", this command is also used to specify the size of user data. For CD, the PMA start time shall reflect the appropriate pre-gap, as determined by the previous track's mode and the settings of the Write Parameters mode page. Table 191 specifies the PMA stop time, and specifies the RZone sizing.

Table 191 - Track reservation sizing (CD)

Write Parameters Mode Page Write Type Value	PMA Stop Time
Session-at-once	CHECK CONDITION status is returned and sense is set to ILLEGAL REQUEST, COMMAND SEQUENCE ERROR
Track-at-once	Reserves the number of user blocks specified. The PMA stop time shall be $PMAStart + \mathrm{Re}servationSize + 2$
Variable Packet	Reserve behaves as in track-at-once.
Fixed Packet	Set $p = \frac{\mathrm{Re}servationSize}{PacketSize}$ packets, where packet size is taken from the Write Parameters Mode Page. If p is an integer, then the reservation is performed and the PMA stop time shall be $PMAStart + (PacketSize + 7) \bullet p - 5$. Otherwise, the reservation is not performed, CHECK CONDITION status is returned, and sense is set to ILLEGAL REQUEST, INVALID FIELD IN COMMAND PACKET. Enough space for reservation size user data packets shall be reserved.

Table 192 - RZONE reservation sizing (DVD)

Write Parameters Mode Page Write Type Value	Reserved RZone Size
Disc-at-once	Reserves the number of user blocks specified. The Reserved RZone shall be *ReservedRZoneSize = ReservationSize* where *ReservationSize* is a value that is specified in the CDB
Incremental	Reserves the number of user blocks specified. The Reserved RZone Size shall be where *ReservationSize* is a value which is specified in the CDB. *NWA* is a Next Writable Address of invisible RZone. ^ means mathematical AND. *+16* means BSGLL

Note: Ceil (x) returns the least integral value greater than or equal to x.

The invisible track/RZone is known to have track/RZone number N+1 only because the track/RZone number of the track/RZone immediately preceding it has track number N. track/RZone shall only be reserved from the beginning of the invisible track/RZone. Each track/RZone prior to the invisible track/RZone has a track/RZone number defined in the PMA. After the reservation is done, the track/RZone number given to the new track/RZone is the current track/RZone number of the invisible track/RZone. The number of the invisible track/RZone is increased by one following a reservation.

For CD, if the Reservation Size is smaller than four seconds, excluding pre-gap length, the drive shall return CHECK CONDITION status.

For DVD, the actual reserved size shall be raised to ECC block unit by the device. If Reservation Size field is set to 0, no reservation is done by device and shall not be considered an error.

Reserving shall be allowed when the last track/RZone is invisible. When the last track/RZone is not invisible, shall generate a CHECK CONDITION status, ILLEGAL REQUEST, COMMAND SEQUENCE ERROR.

For CD, reserving a track when the Write Type is set to packet shall cause the TDB (Track Descriptor Block) to be written.

For DVD, maximum reserved RZones which can be reserved are limited to two at the same time. Attempting to reserve RZone when two RZones are already reserved, the command shall be terminated with CHECK CONDITION status, the sense key set to ILLEGAL REQUEST and the additional sense code set to NO MORE RESERVATION IS ALLOWED.

Attempting to reserve RZone when remaining ECC blocks in RMA are less than three, the command shall be terminated with CHECK CONDITION status, the sense key set to MEDIUM ERROR and the additional sense code set to RMA/PMA IS FULL. Because three RMD blocks are required for reservation, RZone closure and Border closure.

Reserving a track when the Write Type is set to packet (See Table 243) shall cause the TDB to be written.

Table 193 - Recommended errors for RESERVE TRACK Command

Error	Reference
Deferred Errors	Sub-clause **A.1**
General Errors	Table **A.2**
Media Access Errors	Table **A.3**
Write Errors	Table **A.4**

6.1.26. SCAN Command

The scan command requests a fast-forward or fast-reverse scan operation starting from the Scan Starting Address. The Logical Unit shall respond to this command by scanning all the way to the end of the last audio track on the media.

Like the PLAY AUDIO command, the SCAN command shall terminate the scan at the last audio track or upon receipt of a STOP PLAY/SCAN command. Upon receipt of the STOP PLAY/SCAN command the Logical Unit shall set the current address to the last address of data read from the media by the scan operation. Subsequent Audio Play commands shall cause the Logical Unit to begin playing at the location last output by the SCAN command. If the drive receives a PAUSE/RESUME Command with the resume bit clear, the drive shall pause. After that, if the drive receives a PAUSE/RESUME Command with the resume bit set, the drive shall resume audio play, not scan, from the address where the audio pause occurred.

If the drive receives a SCAN command during play or pause, the drive shall stop play or pause and perform Scan.

If the drive encounters a data track, it shall terminate the scan.

Upon receipt of a READ SUB-CHANNEL Command during scan, the drive shall return an Audio Status of 11h (Audio Play operation in Progress).

The initiator is required to issue PLAY AUDIO command immediately following a STOP PLAY/SCAN command to resume the play audio operation at normal speed.

Table 194 - SCAN Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (BAh)							
1	Reserved			Direct	Reserved			RELADR
2	(MSB)							
3	Scan Starting Address Field							
4								
5								(LSB)
6	Reserved							
7	Reserved							
8	Reserved							
9	Type			Reserved				
10	Reserved							
11	Control							

If the DIRECT bit is set to zero, the Logical Unit shall perform a fast-forward scan operation. A DIRECT bit of one causes a fast-reversed scan operation.

The RELADR bit shall be set to zero.

The Scan Starting Address specifies the address at which the audio fast scan operation shall begin. The Type field specifies the format of the address contained in the Scan Starting Address Field. Table 195 describes the type field bits.

Table 195 - Type field bit definitions

Bits 7 -6	Address Type
0 0	Logical block address format
0 1	MIN, SEC, and FRAME format (MSF)
1 0	Track Number (TNO) format
1 1	Reserved

With a Type field of 00h the Scan Starting address field specified in command bytes 2-5 are defined in Table 196.

Table 196 - Scan starting address field format-logical blocks

Bit Byte	7	6	5	4	3	2	1	0
2	(MSB)							
3	Scan Starting Logical Block Address Field							
4								
5								(LSB)

With a Type field of 01h, bytes 2-5 specify the MSF address of the starting sector. See Table 197 below.

Table 197 - Scan Starting Address format - MIN, SEC, FRAME format

Bit Byte	7	6	5	4	3	2	1	0
2	Reserved							
3	CD-Absolute Time (MIN)							
4	CD-Absolute Time (SEC)							
5	CD-Absolute Time (FRAME)							

The MIN, SEC and FRAME fields specify the relative running time from the beginning of the disc. The MIN field has a range of 00d to 99d (00h to 63h). The SEC field ranges from 00d to 59d (00h to 3Bh). The FRAME field has a range of 00h to 74d (00h to 4Ah). All MSF fields shall be binary

With a Type field of 10h, bytes 2 - 5 specify a starting address of a specific Track Number (TNO). See Table 198 below

Table 198 - Scan Starting Address Format-Track Number (TNO)

Bit Byte	7	6	5	4	3	2	1	0
2	Reserved							
3	Reserved							
4	Reserved							
5	Track Number							

The track number field specifies the track number in binary at which the scan operation will begin. This field has a range of 01h to 63h.

Table 199 - Recommended errors for SCAN operation

Error	Reference
Deferred Errors	Sub-clause **A.1**
General Errors	Table **A.2**
Media Access Errors	Table **A.3**

6.1.27. SEND CUE SHEET Command

A Session-at-once recording is written beginning with the lead-in and continuing through the lead-out. Only user data will be sent with the write commands, so a guide structure is required by the CD-R/RW Logical Unit in order to control the recording process. This guide structure is called the cue sheet. The cue sheet is constructed in the initiator and sent to the Logical Unit.

Table 200 - SEND CUE SHEET Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code (5Dh)							
1	Reserved							
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	(MSB)							
7	Cue Sheet Size							
8								(LSB)
9	Control Byte							

The Cue Sheet Size parameter is the number of bytes in the cue sheet to be sent to the Logical Unit. The entire cue sheet must be received by the Logical Unit prior to beginning the write process. If the Logical Unit cannot accept and buffer the entire cue sheet, then CHECK CONDITION is returned and sense is set to ILLEGAL REQUEST, INVALID FIELD IN COMMAND DESCRIPTOR BLOCK.

If the Write Parameters Mode Page does not have Write Type set to Session-at-once , then CHECK CONDITION status is returned and sense key is set to ILLEGAL REQUEST, COMMAND SEQUENCE ERROR.

If the Write Mode in the Write Parameter Mode page, is changed from session at once, the Q sheet may not be available.

6.1.27.1. CUE SHEET FORMAT

The Cue Sheet contains information required to specify the layout of a disc to be written, and must be sent to the drive via the SEND CUE SHEET command before writing data to the disc.

The Cue Sheet format is shown in Table 201.

Table 201 - Cue Sheet format

Byte Number	Cue Sheet Data
0	Mixture of
...	Information of absolute disc location, catalogue Code,
(m-1)* 8	and ISRC (total m lines)

If the Catalogue Code is to be recorded, it shall be described at the beginning of the Cue sheet.

If the ISRC is to be recorded, it shall be described immediately preceding each Track’s information in the Cue Sheet.

For the Cue sheet, the lead-out start time shall be the last entry.

6.1.27.2. Information of the absolute disc location

The drive writes a disc according to this information. This information defines the following parameters:

1. Generation of Sub-channel P and Q channel.
2. Format and block size of the data transferred by the WRITE command

Table 202 - Sample CUE SHEET

Byte Number (Hex)	CTL/ ADR (hex)	TNO (hex)	INDEX (hex)	DATA FORM (hex)	SCMS (hex)	ABSOLUTE TIME		
						MIN	SEC	FRAME
00 (lead-in)	01 *5	00	00 *1	01 *5	00	00 *1	00 *1	00 *1
08 (TNO:01)	01	01	00	01	00	00	00	00
10 (TNO:01) *2	01	01	01	00	00	00	02	00
18 (TNO:02)	01	02	00	C0	00	07	29	71
20 (TNO:02)	01	02	01	C0	00	07	31	71
28 (TNO:03)	01	03	01	C0	00	14	18	03
30 (TNO:04) *4	41	04	00	10	00	19	06	62
38 (TNO:04)	41	04	01	10	00	19	09	62
40 (TNO:05) *4	41	05	00	11	00	27	37	10
48 (TNO:05)	41	05	01	10	00	27	40	10
50 (TNO:06)	01	06	00	01	80 *6	38	53	23
58 (TNO:06)	01	06	01	00	80 *6	38	55	23
60 (lead-out)	01 *5	AA	01 *3	01 *5	00	56	37	46

All numbers are Hex.

NOTES:

1) Always zero for lead-in except when DATA FORM is set to 41h.
2) The first information track on a disc is preceded by a pause encoding of 2-3 seconds. (If the first track is a Data track, this track does not contain pause encoding, but always contains a "pause" of 2 seconds of pre-gap).
3) Always 01h for lead-out
4) Pre-gap
5) For the lead-out area the DATA FORM shall be one. For lead-in, DATA FORM shall be either 01h or 41h. The control mode of the first track is specified. All data for both lead-in and lead-out shall be generated by the drive except if DATA FORM 41h is selected for the lead-in.
6) Copy

This information is composed of data units of 8 bytes (1 line). The information consists of three parts:

1) The lead-in area, and contains only one data unit.
2) The Program area, that contains data units.
3) The lead-out area, and contains one or more data units.

The data units in Program Area and lead-out area are in Absolute Time order from the start time of index = 0 of the first track of the session.

Each data unit of Program area and lead-out area indicates that the value of each field (CONTROL, TNO, X, DATA FORM or ZERO) changes at the time shown in ABSOLUTE TIME field.

Table 203 - Cue Sheet Data

CTL/ ADR (hex)	TNO (hex)	INDEX (hex)	DATA FORM (hex)	SCMS (hex)	ABSOLUTE TIME		
					Min	Sec	Frame
01	02	01	C0	00	07	31	71
01	03	01	C0	00	14	18	03

The above data unit indicates that the value of TNO changes from 02 to 03 when ABSOLUTE TIME is 14/18/03 MSF.

6.1.27.2.1. Control/Address Field

The CTL/ADR byte contains the Control field in the upper 4 bits and the ADR in the lower 4 bits. Refer to Table 204.

Table 204 - CTL/ADR byte

7	6	5	4	3	2	1	0
CTL Field				ADR Field			

6.1.27.2.2. CTL Field(upper 4 bits)

The CTL (Control) field contains 4 bits that define the kind of information in a track. The definition is shown in Table 205.

Table 205 - Control Field

Bit 7	Bit 6	Bit 5	Bit 4	Definition
0	0	x	0	2 audio channels without pre-emphasis
1	0	x	0	4 audio channels without pre-emphasis
0	0	x	1	2 audio channels with pre-emphasis of 50/15 µs.
1	0	x	1	4 audio channels with pre-emphasis of 50/15 µs.
0	1	x	0	Data track
x	x	0	x	digital copy prohibited
x	x	1	x	digital copy permitted

The bits of the Control field (except for the copy bit) shall only be changed during an actual pause (Index = 00) of at least 2 seconds and during lead-in area.

6.1.27.2.3. ADR Field(lower 4 bits)

Table 206 defines the codes found in the ADR Field

Table 206 - ADR Field

Bit 3	Bit 2	Bit 1	Bit 0	Definition
0	0	0	1	start time at TNO/IDX
0	0	1	0	CATALOG CODE
0	0	1	1	ISRC CODE

All other codes are reserved for future use.

Control must be the same for each entry associated with a particular track except for first part of pre-gap.

6.1.27.2.4. TNO

The TNO field indicates track number expressed in hex. Each track has a minimum length of 4 seconds, not including the pause length preceding the track.

6.1.27.2.5. INDEX Field

The index number expressed in hex. The drive supports only 00h to 63h.

6.1.27.2.6. DATA FORM

Table 207 defines the data form byte.

Table 207 - Data Form Byte

7	6	5	4	3	2	1	0
Data Form of Sub-channel		Data Form of Main Data					

6.1.27.2.7. SCMS (Serial Copy Management System)

Bit 7 of data form of 1 indicates that Copy bit of CONTROL field alternates for Serial Copy Management System (see Table 208). The other 7 bits (Reserved) are zero This bit is effective if Copy bit of the Control Code is zero.

Table 208 - SCMS Byte

7	6	5	4	3	2	1	0
Alternate Copy bit	Reserved						

6.1.27.2.8. DATA FORM OF MAIN DATA

The DATA FORM OF MAIN DATA field specifies the format of the main data to be sent by a WRITE command to write on the disc. Currently available data formats are 1.) CD-DA, 2.) CD-ROM mode 1, 3.) CD-ROM XA, and CD-I. For lead-in and lead-out area data are generated automatically except if DATA FORM is set to 41h

6.1.27.2.9. CD-DA Data Form

Figure 18 defines a CD-DA Data Form for one frame.

Data Form	Data of One Frame	Data Size
00h	2352	2352
01h	2352	0

Figure 18 - CD (CD-DA)

The CD-DA data format, Table 209, is as follows;

Table 209 - CD-DA Data format (1 Sample)

Bit Byte	7	6	5	4	3	2	1	0
n*4+0 (L ch)	L7	L6	L5	L4	L3	L2	L1	L0
n*4+1 (L ch)	L15	L14	L13	L12	L11	L10	L9	L8
n*4+2 (R ch)	R7	R6	R5	R4	R3	R2	R1	R0
n*4+3 (R ch)	R15	R14	R13	R12	R11	R10	R9	R8

n = 0,1, .. ,587

1 Second = 75 Frames
1 Frame = 588 Samples
1 Sample = 4 bytes (16 bits L, Rch)

6.1.27.2.10. CD-ROM mode 1 Form

Figure 19 defines the form for CD-ROM mode 1.

Data Form	Sync/ Header	Data of One Frame	EDC/ECC Area	Data Size
10h	16 *2	2048 *1	288 *2	2048
11h	16 *3	2048 *1	288 *3	2352
12h	16 *2	2048 *3	288 *2	2048
13h	16 *3	2048 *3	288 *3	2352
14h	16 *2	2048 *2	288 *2	0

Figure 19 - CD-ROM mode 1

6.1.27.2.11. CD-ROM XA, CD-I Form

Figure 20 defines the form for CD-ROM XA, CD-I.

Data Form		Sync/ Header	Sub Header	Data of One Frame	EDC/ECC Area	Data Size
20h	Form 1	16 *2	8 *1	2048 *1	280 *3	2336
	Form 2	16 *2	8 *1	2324 *1	4 *3	2336
21h	Form 1	16 *3	8 *1	2048 *1	280 *3	2352
	Form 2	16 *3	8 *1	2324 *1	4 *3	2352
22h	Form 1	16 *2	8 *1	2048 *3	280 *3	2336
	Form 2	16 *2	8 *1	2324 *3	4 *3	2336
23h	Form 1	16 *3	8 *1	2048 *3	280 *3	2352
	Form 2	16 *3	8 *1	2324 *3	4 *3	2352
24h	Form 1	NA	NA	NA	NA	NA
	Form 2	16 *2	8 *2	2324 *2	4 *2	0

Figure 20 - CD-ROM XA, CD-I

Reserved Area: The Reserved Area contains 4 bytes that are reserved for quality control during the disc production process. In case of Generate Zero, the drive generates zero data of 4 bytes for this area.

6.1.27.2.12. CD-ROM mode 2

Figure 21 defines the form for CD-ROM mode 2.

Data Form	Sync/ Header	Data of One Frame	Data Size
30h	16 *2	2336 *1	2336
31h	16 *3	2336 *1	2352
32h	16 *2	2336 *3	2336
33h	16 *3	2336 *3	2352
34h	16 *2	2336 *2	0

Figure 21 - CD-ROM Mode 2

Notes for all forms:

1. Read Buffer: The data is sent by the initiator.
2. Generate Data: The drive generates the data in this area. The initiator shall not send the data for this area. All sectors in the program area shall have an associated write, even if all data for the sector is to be generated by the drive. Zero bytes shall be transferred for such sectors.
3. Ignore Buffer: The drive receives the data for this area from the initiator with Write command. However, the drive ignores the data and generates data for this area.

6.1.27.3. Data Form of Sub-Channel

The DATA FORM OF SUB-CHANNEL (Table 210) field specifies the format of the sub-channel data stored in the inner buffer by WRITE command to write on the disc.

Table 210 - Data Form of Sub-channel

Data Form		Data of One Frame				Data Size
Bit 7	Bit 6					
0	0	96 *1				0
0	1	96 *2				96
1	0	Reserved				
1	1	24 Pack *3	24 Pack *3	24 Pack *3	24 Pack *3	96

Notes:

1) Generate zero data
2) RAW Data
3) PACK DATA, Initiator sends packed data. The drive writes R-W. The drive calculates and overwrites ECC, and performs Interleaving for each PACK.

Note: When this Data Form of Sub-Channel is selected along with 01h Data Form of Main Data, this indicates that there will be attempt to write Raw P-W Sub-Channelvdata in the Lead-In. Absolute Time field should be set with the start address of the Lead-In, which can be read via a READ TRACK/RZONE command for track 0. In this case, the Data Block Type of the Write Parameters Mode Page should be set to 2,3, or 4.

The Sub-channel data is placed at the end of each Frame of main data. Figure 22 shows the relationship of Main Data and sub-channel data.

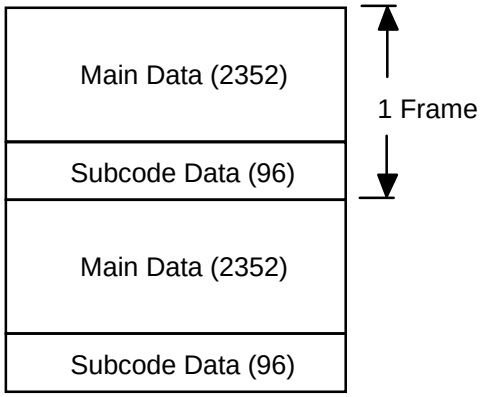

Figure 22 - Location of Sub-channel Data

The P and Q sub-channel information contained within the Sub-code Data shall be ignored. The P and Q sub-channel information is generated by the drive and based on the content of the cue sheet.

6.1.27.4. Absolute Time

The time shown at Min, Sec, and Frame gives the changing point of the CONTROL, TNO, X, DATA FORM or SCMS field. These values are given in absolute time scale.

6.1.27.5. Session Format

The Session Format is used for the identification of the type of disc. Refer to Table 247.

6.1.27.6. Pre-gap

If a Data track is preceded by a different mode of track (such as an audio track) or if the mode number of CD-ROM changes, this Data track starts with an extended pre-gap. A pre-gap is placed at the head of a Data track, also is belonging to the Data track. A pre-gap does not contain actual user data. The pre-gap is encoded as “pause.”

An extended pre-gap is divided into two parts. The first part of the extended pre-gap has a minimum 1 second of data, and it is encoded according to the data structure of previous track. The second part has a minimum 2 seconds data, and this data track is encoded according to the same data structure as the other parts.

6.1.27.7. Post-gap

If a Data track is followed by another kind of track (such as an audio track), this Data track ends with a post-gap. A post-gap is placed at the end of a Data track, and is part of the Data Track. A post-gap does not contain actual user data. The minimum length of post-gap is 2 seconds. The drive does not perform any action for a Post-gap.

6.1.27.8. Catalog Number

Table 211, Catalog Number, indicates the catalog number of a disc. The number uses UPC/EAN-code (BAR coding). If no catalog number is used, it shall be omitted. The format is as follows;

Table 211 - Catalog Number (N1..N13)

CTL/ ADR	Catalog Number						
Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
02h	N1	N2	N3	N4	N5	N6	N7
02h	N8	N9	N10	N11	N12	N13	00h

N1-N13 Catalog Number

CTL: 4 bits are zero.

ADR: 0010b

Catalog Number: ASCII 13 BYTES

6.1.27.9. ISRC

Table 212, ISRC (International Standard Recording Code), is a code that is given to CD-DA tracks. If no ISRC is used, it shall be omitted. If a track has no ISRC, it is not written in the Cue Sheet.

Table 212 - ISRC (I1..I12)

CTL/ ADR	ISRC(International Standard Recording Code)						
byte 0	byte 1	byte 2	byte 3	byte 4	byte 5	byte 6	byte 7
x3h	TNO	I1	I2	I3	I4	I5	I6
x3h	TNO	I7	I8	I9	I10	I11	I12

CTL: 4 bits of Control code are the same as that of disc location of the specified track

ADR: 0011b

TNO: Track number in HEX.

12 letters ISRC (On the Cue Sheet, I1-I12 must be described by valid ASCII characters. See **Error! Reference source not found.** for valid codes.

I1-I2: Country Code
I3-I5: Owner Code
I6-I7: Year of recording
I8-I12: Serial Number

Table 213 - Recommended Sense Key, ASC and ASCQ SEND CUE SHEET Command

Error	Reference
Deferred Errors	**A.1**
General Errors	Table **A.2**

Errors in mixed case indicate all errors in that class.

Errors in upper case refer to a specific error

6.1.28. SEND KEY Command

The SEND KEY command provides data necessary for authentication and for generating a Bus Key for the DVD Logical Unit.

This command, in conjunction with REPORT KEY command, is intended to perform authentication for Logical Units which conform to DVD Copy Protection scheme and to generate a Bus Key as the result of authentication.

Table 214 - SEND KEY Command

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code (A3h)							
1	LUN			Reserved				
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	Reserved							
8	(MSB) Parameter List Length							
9								(LSB)
10	AGID		Key Format					
11	Control							

The KEY Format field indicates the type of information that is requested to be sent to the host.

The AGID field is described in the REPORT KEY command.

Table 215 - Key Format Code definitions for SEND KEY command

Key Format	Sent Data	Description
000001b	Challenge Key	Send Challenge Key
000011b	KEY2	Send a KEY2
111111b		Invalidate Specified AGID
All other values		Reserved

Table 216 - SEND KEY Parameter List (KEY Format field =000001b)

Bit Byte	7	6	5	4	3	2	1	0
0	(MSB) SEND KEY Parameter List Length (0Eh)							
1								(LSB)
2	Reserved							
3	Reserved							
Challenge Key Value								
0	(MSB)							
:	Challenge Key Value							
9								(LSB)
10	Reserved							
11	Reserved							

Challenge Key is sent to the DVD Logical Unit to get corresponding KEY1 from the DVD Logical Unit to interrogate conformity with DVD Copy Protection scheme.

Table 217 - SEND KEY Parameter List (KEY Format field =000011b)

Bit Byte	7	6	5	4	3	2	1	0
0	(MSB) SEND KEY Parameter List Length (0Ah)							
1								(LSB)
2	Reserved							
3	Reserved							
KEY2								
0	(MSB)							
:	Challenge Key Value							
4								(LSB)
5	Reserved							
6	Reserved							
7	Reserved							

The KEY2, generated external to the DVD Logical Unit, is sent to the DVD Logical Unit to determine its conformity with DVD Copy Protection scheme. The KEY 2 value will be used for the second input to generate a Bus Key in the DVD Logical Unit.

When the KEY2 value sent does not conform with the DVD Copy Protection scheme, this command shall be terminated with an CHECK CONDITION status. The sense key shall be set to ILLEGAL REQUEST and the additional sense code & qualifier set to COPY PROTECTION KEY EXCHANGE FAILURE - AUTHENTICATION FAILURE.

Implementers Note: When the SEND KEY command with KEY Format = 000011b terminates with CHECK CONDITION status, the retry of authentication shall be performed from the beginning.

6.1.29. SEND OPC INFORMATION Command

This command is used to restore the Optimum Power Calibration (OPC) (Table 218) values to the drive for a specific disc. It is used in combination with the READ DISC INFORMATION command (sub-clause 6.1.16.).

Table 218 - SEND OPC INFORMATION Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code (54h)							
1	Reserved				Reserved			DoOpc
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	(MSB) Parameter List Length							
8	(LSB)							
9	Control							

The Parameter List Length must be set to reflect the number of the parameter bytes to be transferred. The minimum number of bytes to transfer is eight (8): 2 byte OPC Speed and 6 bytes of OPC value. This can be extended with a second OPC Speed and Value. In this case the length is 16. See sub-clause 6.1.16. for more information.

The DoOpc bit, when is set to one, indicates the drive shall perform an OPC operation to set the OPC values for the current speed. These OPC values shall become current. A Parameter List may be sent to indicate an initial value of OPC. When the bit is set to zero, the Logical Unit sets OPC values to those sent in the Parameter List.

A Parameter List Length field of zero shall not be considered an error condition.

The initiator shall transfer one or more OPC table entries(see Table 126). The transfer length shall be 8X (the number of OPC table entries).

The format of the OPC Response Data to be transferred is shown in Table 219.

Table 219 - SEND OPC INFORMATION Parameter List

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB) OPC Speed in kBytes per Second							
1	(LSB)							
2	(MSB) OPC Value							
3								
4								
5								
6								
7	(LSB)							

Table 220 - Recommended errors for SEND OPC INFORMATION Command

Error	Reference
Deferred Errors	Sub-clause **A.1**
General Errors	Table **A.2**
Media Access Errors	Table **A.3**
Write Errors	Table **A.4**

6.1.30. SET C/DVD SPEED Command (Obsolete)

The SET C/DVD SPEED (Table 221) command provides a means for the initiator to set the spindle speed to be used while reading CD data. Note that PLAY commands will not use the speed set by this command.

Table 221 - SET C/DVD SPEED Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (BBh)							
1	Reserved			Reserved				
2	(MSB) Drive Read Speed (Kbytes/sec)							
3								(LSB)
4	(MSB) Drive Write Speed (Kbytes/sec) (CD-R/RW only)							
5	(Reserved for CD-ROM)							(LSB)
6	Reserved							
7	Reserved							
8	Reserved							
9	Reserved							
10	Reserved							
11	Control							

The Drive Read Speed and Write Speed parameters contain the requested Data rates the drive should use. The Logical Unit may choose to select the speed specified or any slower rate. A value of FFFFh will set the Drive Read Speed or the Drive Write Speed to the maximum supported. Requesting a speed faster than the drive supports shall not generate an error. The actual speed set is returned in the Capabilities Mode Sense page. (See **Error! Reference source not found.**).

Table 222 - Recommended errors for SET C/DVD SPEED Command

Error	Reference
Deferred Errors	Sub-clause **A.1**
General Errors	Table **A.2**
Media Access Errors	Table **A.3**

6.1.31. SET READ AHEAD Command

The SET READ AHEAD command (Table 223) requests that the C/DVD Logical Unit perform Read Ahead Caching operations from the Read-Ahead Logical Block Address when the drive encounters the Trigger Logical Block Address during its internal Read Ahead Caching operation.

If this command is received by the DVD Logical Unit when data after the Trigger Logical Block Address and before the Read Ahead Logical Block Address is contained in its cache, that data should be discarded and Read Ahead Caching restarted from the specified Read Ahead Logical Block Address.

Sectors after the Trigger LBA (Not including the Trigger LBA) should be skipped. The data for both the Trigger and Read Ahead LBAs will normally be read by the host. The sectors between these addresses (exclusive) are normally not read by the host.

The Read-Ahead operation shall be performed in background, i.e. the C/DVD Logical Unit shall accept a command during the Read-Ahead operation.

Table 223 - SET READ AHEAD Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (A7h)							
1	Reserved			Reserved				
2	(MSB)							
3	Trigger Logical Block Address							
4								
5								(LSB)
6	(MSB)							
7	Read Ahead Logical Block Address							
8								(LSB)
9								(LSB)
10	Reserved							
11	Control							

Table 224 - Recommended errors for SET READ AHEAD Command

Error	Reference
Deferred Errors	Sub-clause **A.1**
General Errors	Table **A.2**
Media Access Errors	Table **A.3**

6.1.32. STOP PLAY/SCAN Command

The STOP PLAY/SCAN (Table 225) Command stops playback of CD audio commands.

Table 225 - STOP PLAY/SCAN Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (4Eh)							
1	Reserved			Reserved				
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	Reserved							
8	Reserved							
9	Control							

Issuing a Stop Play/Scan command while the drive is scanning shall result in continuation of the play command. Issuing a Stop Play/Scan command while the drive is paused shall stop the play command.

Issuing a Stop Play/Scan command when no play operation is in progress shall not be considered an error.

Figure 23 provides an overview of the terminate sequences performed by the Stop Play commands.

Table 226 - Recommended errors for STOP PLAY/SCAN Command

Error	Reference
Deferred Errors	Sub-clause **A.1**
General Errors	Table **A.2**
Media Access Errors	Table **A.3**

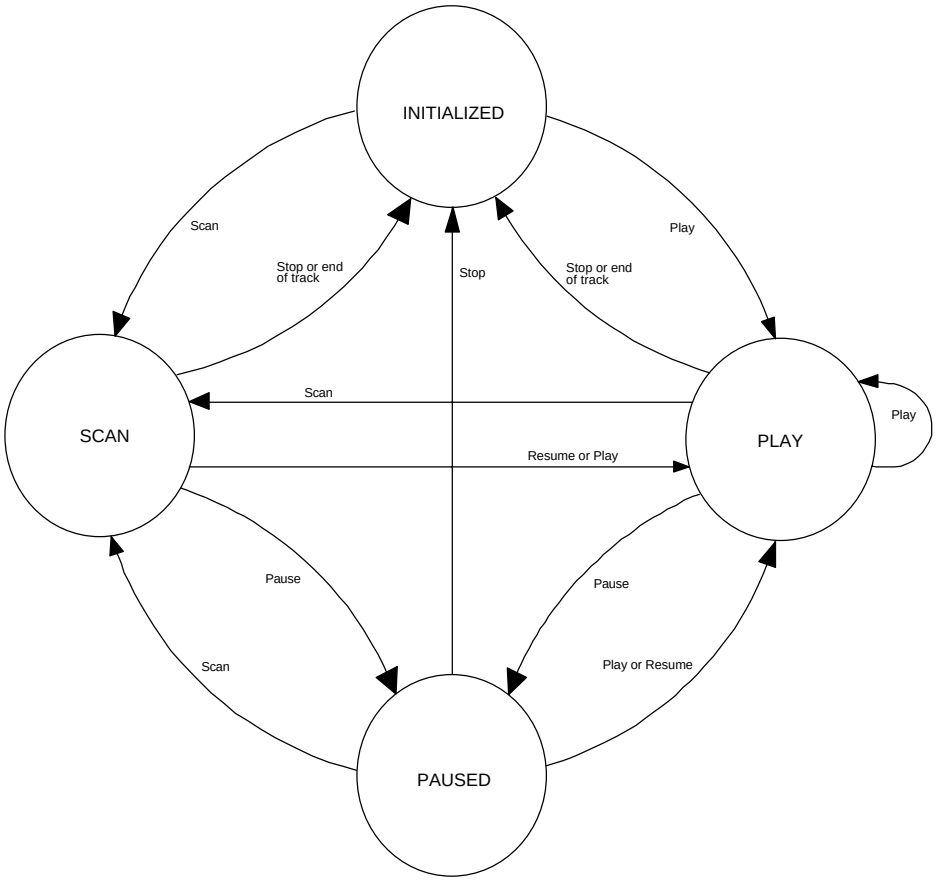

Figure 23 - Stop Play/Play Audio/Audio Scan/Pause/Resume Sequencing

6.1.33. SYNCHRONIZE CACHE Command

The SYNCHRONIZE CACHE command is shown in Table 227.

In reference to this command set, this command provides a normal sequence to terminate a Write process, and assures all remaining data in the data buffer has been written to the media.

If the data buffer is empty, issuing this command will result in no data being written to the physical media. This action will not be considered an error. Normal status shall be presented at the completion of the action.

Table 227 - SYNCHRONIZE CACHE Command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (35h)							
1	Reserved			Reserved			Immed	RELADR
2	(MSB)							
3	Logical Block Address							
4								
5								(LSB)
6	Reserved							
7	(MSB)			Number of Blocks				
8								(LSB)
9	Control							

An Immed (Immediate) bit of one indicates that the Logical Unit shall return status when the command descriptor block has been validated. An Immediate bit of zero indicates that the status shall not be returned until the operation has been completed. If the Immediate bit is one and the Logical Unit does not support immediate operation, then the command shall terminate 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 RELADR bit shall be set to zero.

The Logical Block Address field may be ignored by the drive.

The Number of Blocks field specifies the total number of contiguous logical blocks within the range. A Number of Blocks field, equal to 0, indicates that all remaining logical blocks on the logical unit shall be within the range. This field may be ignored by the drive.

A logical block within the specified range that is not in cache memory is not considered an error.

Table 228 - Recommended errors for SYNCHRONIZE CACHE Command

Error	Reference
Deferred Errors	Sub-clause **A.1**
General Errors	Table **A.2**
Media Access Errors	Table **A.3**
Write Errors	Table **A.4**

6.1.34. WRITE (10) Command

The Write (10) command (Table 229) shall use the WRITE Parameters mode page to determine its operating behavior.

Table 229 identifies the fields and information necessary to perform the WRITE operation. This command definition is identical to the WRITE Command defined in the SCSI-3 Block Command document. Bit definitions supplied in this document are for reference.

Table 229 - WRITE (10) command

Bit / Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (2Ah)							
1	Reserved			DPO	FUA	Reserved		RELADR
2	(MSB)							
3	Logical Block Address							
4								
5								(LSB)
6	Reserved							
7	(MSB)			Transfer Length				
8								(LSB)
9	Control							

A DPO (Disable Page Out) bit, set to one, indicates that the Logical Unit shall assign the logical blocks accessed by this command the lowest priority for being fetched into or retained by the cache. A DPO bit, of one, overrides any retention priority specified in the cache page. A DPO bit of zero indicates the priority shall be determined by the retention priority fields in the cache page. All other aspects of the algorithm implementing the cache replacement strategy are not defined by this International Standard. The drive may ignore this bit.

> **NOTE**: The DPO bit is used to control replacement of logical blocks in the cache memory when the initiator has information on the future usage of the logical blocks. If the DPO bit is set to one, the initiator knows the logical blocks accessed by the command are not likely to be accessed again in the near future and should not be put in the cache memory nor retained by the cache memory. If the DPO bit is zero, the initiator expects that logical blocks accessed by this command are likely to be accessed again in the near future.

A FUA (force unit access) bit, set to one, indicates that the Logical Unit shall access the media in performing the command prior to returning GOOD status. In the case where the cache contains a more recent version of a logical block than the media, the logical block shall first be written to the media. WRITE commands shall not return GOOD status until the logical blocks have actually been written on the media, and the Write process is complete. This mode may not work with a sequence of writes intended to produce a continuos stream unless command queuing is implemented

An FUA bit of zero indicates that the Logical Unit may satisfy the command by accessing the cache memory. For WRITE operations, logical blocks may be transferred directly to the cache memory. GOOD status may be returned to the initiator prior to writing the logical blocks to the medium. Any error that occurs after the GOOD status is returned is a deferred error, and information regarding the error is not reported until the following command.

The Logical Block Address field specifies the logical block where the write operation shall begin. In case of WCE=1(see [ED NOTE: include this page in clause 7 ===] Write Cache page in SCSI-3 Block Commands) and FUA=0 with variable packet writing, and if the LBA is equal to the Next Writable Address in the same track as a previous Write, then writing should continue without interruption of streaming. If , during streaming, a WRITE command is issued for packet writing with an LBA = NWA+7 the drive shall begin a new packet. If the LBA is equal to the NWA in another track, a synchronize cache may be performed before executing the write command. If the LBA is not any next writable address or a writable CD- E address, the status shall be set to CHECK CONDITION, ILLEGAL REQUEST, INVALID ADDRESS FOR WRITE.

LBA in the range of -45150 (FFFF4FA2h) to -1 (FFFFFFFFh) shall be encoded as a two's complement negative number. Values in the range 0 through ffff4fa1h shall be considered positive values. Values -45150 through 404849 are valid for CD media. Table 230 shows the MSF to LBA mapping.

Table 230- LBA to MSF translation

Condition	Formulae
-150 ≤ LBA ≤ 404849	$M = IP\left(\frac{LBA+150}{60\cdot 75}\right)$ $S = IP\left(\frac{LBA+150-M\cdot 60\cdot 75}{75}\right)$ $F = IP\left(LBA+150-M\cdot 60\cdot 75-S\cdot 75\right)$
-45150 ≤ LBA ≤ -151	$M = IP\left(\frac{LBA+450150}{60\cdot 75}\right)$ $S = IP\left(\frac{LBA+450150-M\cdot 60\cdot 75}{75}\right)$ $F = IP\left(LBA+450150-M\cdot 60\cdot 75-S\cdot 75\right)$
00/00/00 ≤ MSF ≤ 89/59/74	$LBA = \left(M\cdot 60+S\right)\cdot 75+F-150$
90/00/00 ≤ MSF ≤ 99/59/74	$LBA = \left(M\cdot 60+S\right)\cdot 75+F-450150$

The RELADR bit shall be set to zero.

The transfer length field specifies the number of contiguous logical blocks of data that shall be transferred. A transfer length of zero indicates that no logical blocks shall be transferred. This condition shall not be considered an error. Any other value indicates the number of logical blocks that shall be transferred. The block size shall be determined by the write parameters mode page (if in track at once, packet, or raw mode) or by the cue sheet (session at once mode).

Once actual writing to the media has started, the data stream must be uninterrupted until the recording is done. Interruptions of data are called "underrun." The underrun condition may also be forced with the "Synchronize Cache" command. The drive shall behave as follows in an underrun condition.

1) Session at Once mode (see Table 243) for more information)

The drive shall generate and write a lead-out (the lead-in was generated and written before any data). The drive shall update the PMA.

2) Track at Once mode:

The drive shall pad the track (if reserved or not minimum length) and update the PMA.

3) Variable Packet:

The drive shall write run-out and link blocks.

4) Fixed Packet:

The drive shall pad the packet.

5) Raw mode

The drive shall write run-out and link blocks. The drive shall read the TOC and track information from the session just written and update the PMA. It is assumed that the initiator has written the lead-out.

Note: "Update the PMA" means to update the PMA on the disc or to update the PMA Cache, which shall be written to the PMA on the disc prior to the removing the disc from the drive. PMA Caching is vendor specific.

If the block number specified by the LBA field is already written on CD-R media, the drive shall return a CHECK CONDITION status, ILLEGAL REQUEST, INVALID ADDRESS FOR WRITE. This error will indicate that an underrun may have occurred, as the run-out and link blocks occupy logical addresses. On CD-RW media, the LBA shall specify an address that is an appendable point (according to CD-R rules) or is the first user data block of an existing packet or track.

While writing is occurring, the drive may not be able to process all SCSI commands. The following is a list of commands that shall function during writing without causing a flush cache.

1) TEST UNIT READY

2) REQUEST SENSE

3) INQUIRY

4) READ TRACK INFO (for current track). If the LBA or track number specified is not within the current track, the drive may return CHECK CONDITION status , ILLEGAL COMMAND, Invalid Field in CDB.

5) READ BUFFER CAPACITY

6) WRITE with the NWA in the current track.

All other commands may force a flush cache before executing normally. This shall not be considered an error.

Table 231 - Recommended errors for WRITE Command

Error	Reference
Deferred Errors	Sub-clause A.1
General Errors	Table A.2
Media Access Errors	Table A.3
Write Errors	Table A.4

6.1.35. WRITE (12) Command

The WRITE(12) command requests that the Device write the data transferred from the Host to the medium. The WRITE(12) command shall use the WRITE Parameters Mode Page to determine its operating behavior.

Table 232 - WRITE(12) Command

Bit / Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (AAh)							
1	Reserved			DPO (0)	FUA	EBP (0)	Reserved	RELADR
2	(MSB)							
3	Logical Block Address							
4								
5								(LSB)
6	(MSB)			Transfer Length				
7								
8								
9								(LSB)
10	Reserved							
11	Control							

The RELADR bit shall be set to zero.

The Erase By-pass (EBP) bit is not used by C/DVD devices and shall be set to zero. An EBP bit of zero indicates that the device will default to the normal write operation. An EBP bit of one indicates that the device is allowed to by-pass the erase operation.

A Force Unit Access (FUA) bit of one indicates that the C/DVD device shall access the media in performing the command.

The Disable Page Out (DPO) bit is not used by C/DVD devices and shall be set to zero. A DPO bit of zero indicates the priority shall be determined by the retention priority fields in the cache page if supported. All other aspects of the algorithm implementing the cache memory replacement strategy are vender specific.

Write commands shall access the specified logical blocks on the media. In the case where the cache contains a more recent version of a logical block than the media, the logical block shall first be written to the media.

A FUA bit of zero indicates that the C/DVD device may satisfy the command by writing to the cache memory.

The Logical Block Address field specifies the logical block where the write operation shall begin. For DVD-R, FUA=0 with incremental writing, and if the LBA is equal to the Next Writable Address in the same RZone as a previous Write, then writing should continue without interruption of streaming. If the LBA is equal to the NWA in another RZone, a flush cache may be performed before executing the write command. If the LBA is not any Next Writable Address, the status shall be set to CHECK CONDITION, ILLEGAL REQUEST, INVALID ADDRESS FOR WRITE.

For CD-R, LBA in the range of -45150 (FFFF4FA2h) to -1 (FFFFFFFFh) shall be encoded as a two's complement negative number. Values in the range 0 through ffff4fa1h shall be considered positive values. Values -45150 through 404849 are valid for CD media. Table 230 shows the LBA to MSF translation.

Table 233- LBA to MSF translation

Condition	Formulae
-150 ≤ LBA ≤ 404849	$M = IP\left(\frac{LBA+150}{60\cdot 75}\right)$ $S = IP\left(\frac{LBA+150-M\cdot 60\cdot 75}{75}\right)$ $F = IP\left(LBA+150-M\cdot 60\cdot 75-S\cdot 75\right)$
-45150 ≤ LBA ≤ -151	$M = IP\left(\frac{LBA+450150}{60\cdot 75}\right)$ $S = IP\left(\frac{LBA+450150-M\cdot 60\cdot 75}{75}\right)$ $F = IP\left(LBA+450150-M\cdot 60\cdot 75-S\cdot 75\right)$
00/00/00 ≤ MSF ≤ 89/59/74	$LBA = \left(M\cdot 60+S\right)\cdot 75+F-150$
90/00/00 ≤ MSF ≤ 99/59/74	$LBA = \left(M\cdot 60+S\right)\cdot 75+F-450150$

The Transfer Length field specifies the number of contiguous logical blocks of data that shall be transferred. A transfer length of zero indicates that no data shall be transferred. This condition shall not be considered an error and no data shall be written. Any other value indicates the number of logical blocks that shall be transferred.

Note: The block size is determined by the write parameters mode page (if in track at once, packet, or raw mode) or by the cue sheet (session at once mode).

Once actual writing to the media has started, the data stream must be uninterrupted until the recording is completed. Interruptions of data are called “underrun.” The underrun condition may also be forced with the “Synchronize Cache” command. The drive shall behave as follows in an underrun condition.

1) Session at Once mode (see **((((send cue sheet reference here))))** for more information)

   The drive shall generate and write a lead-out (the lead-in was generated and written before any data). The drive shall update the PMA.

2) Track at Once mode:

   The drive shall pad the track (if reserved or not minimum length) and update the PMA.

3) Variable Packet:

   The drive shall write run-out and link blocks.

4) Fixed Packet:

   The drive shall pad the packet.

5) Raw mode

   The drive shall write run-out and link blocks. The drive shall read the TOC and track information from the session just written and update the PMA. It is assumed that the initiator has written the lead-out.

Note: “Update the PMA” means to update the PMA on the disc or to update the PMA Cache, which shall be written to the PMA on the disc prior to the removing the disc from the drive. PMA Caching is vendor specific.

If the block number specified by the LBA field is already written on Write-Once media, the drive shall return a CHECK CONDITION status, ILLEGAL REQUEST, INVALID ADDRESS FOR WRITE. With CD-R media this error will indicate that an underrun may have occurred, as the run-out and link blocks occupy logical addresses. On CD-RW media, the LBA shall specify an address that is an appendable point (according to CD-R rules) or is the first user data block of an existing packet or track.

While writing is occurring, the drive may not be able to process all SCSI commands. The following is a list of commands that shall function during writing without causing a synchronize cache.

1) TEST UNIT READY

2) REQUEST SENSE

3) INQUIRY

4) READ TRACK INFO (for current track). If the LBA or track number specified is not within the current track, the drive may return CHECK CONDITION status , ILLEGAL COMMAND, Invalid Field in CDB.

5) READ BUFFER CAPACITY

All other commands may force a synchronize cache before executing. . This shall not be considered an error.

Table 234 identifies the appropriate sub-clauses that define the various error responses for this command.

Table 234 - Recommended errors for WRITE Command

Error	Reference
Deferred Errors	Sub-clause A.1
General Errors	Table A.2
Media Access Errors	Table A.3
Write Errors	Table A.4

7. Parameters for all Logical Unit types

This clause defines and lists the specified parameters that a host system or logical unit would require to perform at a desired level.

Parameters uniquely required to implement a specific feature set are defined within the sub-clause defining that feature set. Other parameters that are unique to a specific command are listed in the specific sub-clause defining that command

7.1. Mode Pages

Mode Pages are used to provide information to or from the logical unit. MODE SELECT (used to set parameters) and MODE SENSE (used to interrogate capabilities) commands move the pages (Table 235) to/from the logical units. The page definitions are provided in the following sub-clauses.

Each mode page (Table 235) contains a page code, a page length, and a set of mode parameters.

Table 235- Mode Page Codes for C/DVD

Page Code	Description	Section	Status
00h	Vendor-specific (does not require page format)		
01h	C/DVD Read/Write error recovery page	9.1.3.1 on page 114	
02h - 04h	Reserved		
05h	Write Parameter page		
06h	Reserved		
07h	Verify error recovery page		
08h - 0Ah	Reserved		
0Bh	Medium types supported page		
0Ch	Reserved		
0Dh	CD Page		
0Eh	CD audio control page	9.1.3.3 on page 120	Audio Feature set
0Fh - 17h	Reserved		
18h	Feature Set Support & Version page	9.1.3.4 on page 122	
19h	Reserved		
1Ah	Power Condition Page	9.1.3.2 on page 119	
1Bh	Reserved		
1Ch	Fault/Failure Reporting Page	9.1.3.5 on page 123	Smart Feature set
1Dh	C/DVD Inactivity page	9.1.3.6 on page 125	
1Eh - 1Fh	Reserved		
2Ah	C/DVD Capabilities & Mechanical Status Page	9.1.3.F on page 126	
20h - 29H 2Bh - 3Eh	Vendor - specific (page format required)		
3Fh	Return all pages (valid only for the Mode Sense command		

7.1.1. Mode Select/Sense Parameters

This section describes the pages used with MODE SELECT and MODE SENSE commands.

The Mode Parameter List (Table 236) contains a header, followed by zero or more variable length pages.

Table 236- Mode Parameter List

Bit Byte	7	6	5	4	3	2	1	0
0 - n	Mode Parameter Header							
0 - n	Page(s)							

Table 237 - Mode Page Format

Bit Byte	7	6	5	4	3	2	1	0
0	PS/ Reserved	Reserved	Page Code					
1	Page Length (n - 1)							
2	Mode Parameter							
n								

When using the MODE SENSE command, a Parameters Savable (PS) bit of one indicates that the mode page can be saved by the C/DVD Logical Unit in a non-volatile, vendor-specific location. A PS bit of zero indicates that the supported parameters cannot be saved. When using the MODE SELECT command, the PS bit is reserved.

The Page Code field identifies the format and parameters defined for that mode page.

When using the MODE SENSE command, if Page Code 00h (vendor-specific page) is implemented, the C/DVD Logical Unit shall return that page last in response to a request to return all pages (page code 3Fh). When using the MODE SELECT command, this page shall be sent last.

The Page Length field specifies the length in bytes of the mode parameters that follow. If the Host Computer does not set this value to the value that is returned for the page by the MODE SENSE command, the C/DVD Logical Unit shall terminate the command with CHECK CONDITION status. The sense key shall be set to ILLEGAL REQUEST with the additional sense code set to INVALID FIELD IN PARAMETER LIST. The C/DVD Logical Unit is permitted to implement a mode page that is less than the full page length defined in this Specification, provided no field is truncated and the Page Length field correctly specifies the actual length implemented.

The mode parameters for each page are defined here. Mode parameters not implemented by the C/DVD Logical Unit shall be set to zero.

Table 238 - Mode Parameter Header

Bit Byte	7	6	5	4	3	2	1	0
0	(MSB) Mode Data Length							
1	(LSB)							
2	Reserved Obsolete (Medium Type Code)							
3	Reserved							
4	Reserved							
5	Reserved							
6	Block Descriptor Length 0 (8 for legacy SCSI logical units)							
7								

When using the MODE SENSE command, the mode data length field specifies the length in bytes of the following data that is available to be transferred. The mode data length is the total byte count of all data following the mode data length field. When using the MODE SELECT command, this field is reserved.

The block descriptor associated with the Mode Select and Mode Sense commands is used for legacy system support for SCSI systems. If supported, block sizes (see “Block Descriptor Block Sizes for Read” on page 114.) shall include 2048 and may include 512, 2056, 2324, 2332, 2336, 2340, 2352, 2368, and 2448 bytes. The Table of Block Sizes for Read shows the implementation of the various block sizes. These definitions apply for reading with the Read commands. Other block sizes are allowed and the contents of those blocks is not specified by this specification.

In a SCSI Logical Unit, if the block descriptor is not supported and the DBD bit in the Mode Sense command Packet is set to zero, the device shall respond with CHECK CONDITION status, ILLEGAL FIELD IN COMMAND PACKET.

Table 239 - Block Descriptor Block Sizes for Read

Size	Readable block types
512	Mode 1 or Mode 2 Form 1 sectors divided into four blocks each
2048	Mode 1, Mode2 Form1, or DVD
2056	Mode 2 Form 1 with subheader. Equivalent to READ CD, Flag = 50h.
2324	Mode 2 Form 2 with no subheader. Note: There is no mapping to READ CD, as the 4 spare bytes are not returned.
2332	Mode 2, Form1 or 2 data. The drive shall operate as specified for 2048 byte blocks except that both forms send 2332 byte blocks. Form 1 blocks return the third layer ECC with the user data. There is no mapping to READ CD, as the 4 spare bytes are not returned.
2336	Mode 2 data. The drive shall operate as specified for 2048 byte block lengths. This mode will include all data including Yellow Book Mode 2 sectors and Form1 & 3. Equivalent to READ CD, Flag = 58h.
2340	All bytes except the synchronization field. Equivalent to READ CD, Flag = 78h.
2352	Audio or raw blocks. The drive shall operate as specified for 2048 byte block lengths. Reads of data mode sectors shall return descrambled data. Equivalent to READ CD, Flag = F8h
2448 or 2368	Audio or raw blocks with raw sub-channel. The drive shall not perform the data descrambling operation. Equivalent to READ CD, Flag = F8. Sub-channel data selection = 010b (2448) or sub-channel data selection = 001b (2368).

7.1.2. Read/Write Error Recovery Parameters Page

The Read/Write Error Recovery Parameters Page specifies the error recovery parameters the C/DVD Logical Unit shall use during any command that performs a data read operation from the media (e.g. READ, READ TOC/PMA/ATIP, etc.).

Table 240 - Read/Write Error Recovery Parameters Page Format

Bit / Byte	7	6	5	4	3	2	1	0
0	PS (Optional) Default 0	Reserved	Page Code (01h)					
1	Page Length (0Ah)							
2	Error Recovery Parameter, Default 0							
	AWRE	ARRE	TB	RC	Reserved	PER	DTE	DCR
3	Read Retry Count							
4	Reserved (Correction Span in SCSI SBC)							
5	Reserved (Head Offset Count in SCSI SBC)							
6	Reserved (Data Strobe Offset Count in SCSI SBC)							
7	Reserved							
8	Write Retry Count							
9	Reserved							
10	(MSB) Recovery Time Limit (0)							
11	(LSB)							

The Parameters Savable (PS) bit is only used with the MODE SENSE command. This bit is reserved with the MODE SELECT command. A PS bit of one indicates that the C/DVD Logical Unit is capable of saving the page in a non-volatile vendor-specific location. The PS bit is optional.

NOTE The implementation of error recovery procedures for C/DVD Logical Units is markedly different from those used for magnetic medium disk drives. At least one level of error correction is required to transfer the data stream. Therefore, the performance of the Logical Unit may differ substantially from what would be expected by sending the same error recovery parameters to a magnetic medium Logical Unit.

An automatic write reallocation enabled (AWRE) bit of one indicates that the Logical Unit shall enable automatic reallocation to be performed during write operations. An AWRE bit of zero indicates that the Logical Unit shall not perform automatic reallocation of defective data blocks during write operations.

An automatic read reallocation enabled (ARRE) bit of one indicates that the Logical Unit shall enable automatic reallocation of defective data blocks during read operation. An ARRE bit of zero indicates that the Logical Unit shall not perform automatic reallocation of defective data blocks during read operation. When ARRE is enabled other error recovery modes shall not be used. The Disable Correction and Read Continuous shall not be enabled while ARRE is enabled.

A Transfer Block (TB) bit of one indicates that a data block that is not recovered within the recovery limits specified, shall be transferred to the Host Computer before CHECK CONDITION status is returned. A TB bit of zero indicates that such a data block shall not be transferred to the Host Computer. The TB bit does not affect the action taken for recovered data.

A Read Continuous (RC) bit of one indicates that the Logical Unit shall transfer the entire requested length of data without adding delays to perform error recovery procedures. This implies that the Logical Unit may send data that is erroneous or fabricated in order to maintain a continuous flow of data. A RC bit of zero indicates that error recovery operations that cause delays are acceptable during the data transfer.

A Post Error (PER) bit of one indicates that the Logical Unit shall report recovered errors. A PER bit of zero indicates that the Logical Unit shall not report recovered errors. Error recovery procedures shall be performed within the limits

established by the error recovery parameters. This capability is very different for DVD media. To be able to recover the data from DVD media, error correction must be used. Thus it is not reasonable to report when ECC is used to recover the data. This bit for DVD media shall only be used to report when auto reallocation of a logical block has been performed. For CD media this capability is used to report when the Layered Error correction has been used to recover the data. Again as the CIRC is mandatory for recovery of data it shall not cause recovered errors to be reported.

A Disable Transfer on Error (DTE) bit of one indicates that the Logical Unit shall terminate the data transfer to the Host upon detection of a recovered error. A DTE bit of zero indicates that the Logical Unit shall not terminate the data transfer upon detection of a recovered error.

A Disable Correction (DCR) bit of one indicates that error correction codes shall not be used for data error recovery. A DCR bit of zero allows the use of error correction codes for data error recovery.

The interpretation of the bits 5-0 in the Error Recovery Parameter byte for C/DVD Logical Units is given in "Table 66 - C/ DVD Error Recovery Descriptions (CD Media)" on page 116. If the error recovery parameter is set to any other value, the command shall be terminated with CHECK CONDITION status. The sense key shall be set to ILLEGAL REQUEST and the additional sense code set to INVALID FIELD IN PARAMETER LIST.

The Read Retry Count field specifies the number of times that the controller shall attempt its read recovery algorithm.

The Write Retry Count field specifies the number of times that the controller shall attempt its write recovery algorithm. This may not have any affect if the Logical Unit does not support read after write operations.

A CIRC Recovered Data Error is defined as a block for which the CIRC based error correction algorithm was unsuccessful for a read attempt, but on a subsequent read operation no error was reported. The number of subsequent read operations is limited to the read retry count. Layered error correction was not used.

A CIRC Un-recovered Data Error is defined as a block for which the CIRC based error correction algorithm was unsuccessful on all read attempts up to the read retry count. Layered error correction was not used.

An L-EC Recovered Data Error is defined as a block for which the CIRC based error correction algorithm was unsuccessful, but the layered error correction was able to correct the block within the read retry count.

An L-EC Un-correctable Data Error is defined as a block which could not be corrected by layered error correction within the read retry count.

The correlation of the error recovery parameter and the bit settings defined for CD devices is given in Table 241. The interpretation of these codes for CD devices is given in Table 242. If the error recovery parameter is set to any other value, the command shall be terminated with CHECK CONDITION status. The sense key shall be set to ILLEGAL REQUEST and the additional sense code set to INVALID FIELD IN PARAMETER LIST.

Table 241 - Error Recovery Parameter Bit Settings

Error Recovery Parameter	Bit Settings 7 6 5 4 3 2 1 0	Error Recovery Parameter	Bit Settings 7 6 5 4 3 2 1 0
00h	R R 0 0 R 0 0 0	20h	R R 1 0 R 0 0 0
01h	R R 0 0 R 0 0 1	21h	R R 1 0 R 0 0 1
04h	R R 0 0 R 1 0 0	24h	R R 1 0 R 1 0 0
05h	R R 0 0 R 1 0 1	25h	R R 1 0 R 1 0 1
06h	R R 0 0 R 1 1 0	26h	R R 1 0 R 1 1 0
07h	R R 0 0 R 1 1 1	27h	R R 1 0 R 1 1 1
10h	R R 0 1 R 0 0 0	30h	R R 1 1 R 0 0 0
11h	R R 0 1 R 0 0 1	31h	R R 1 1 R 0 0 1
14h	R R 0 1 R 1 0 0	34h	R R 1 1 R 1 0 0
15h	R R 0 1 R 1 0 1	35h	R R 1 1 R 1 0 1

R = Reserved and shall be set to zero

Table 242 - CD Devices, error recovery description

error code	description
00h	The maximum error recovery procedures available are used. If an error occurs which is uncorrectable with the error correction codes (ECC) on the media, data transfer is terminated with CHECK CONDITION status. The block with the error is not transferred. The sense key is set to MEDIUM ERROR. The information bytes give the address of the block where the unrecovered error was detected. Recovered errors are not reported.
01h	Only retries of the read operation and CIRC are used (layered error correction is not used). Only CIRC unrecovered data errors are reported. If an CIRC unrecovered data error occurs, data transfer is terminated with CHECK CONDITION status. The block with the error is not transferred. The sense key is set to MEDIUM ERROR. The information bytes give the address of the block where the unrecovered error was detected. Recovered errors are not reported.
04h	The maximum error recovery procedures available are used. Recovered data errors are reported. If a recovered data error occurs, data transfer is not terminated. However, when the data transfer has completed CHECK CONDITION status is reported. The sense key is set to RECOVERED ERROR. The information bytes give the address of the last block where a recovered data error was detected. If a data error occurs that is uncorrectable with the ECC information available on the media, data transfer is terminated and CHECK CONDITION status is reported. The block with the error is not transferred. The sense key is set to MEDIUM ERROR. The information bytes give the address of the block where the uncorrectable error was detected.
05h	Only retries of the read operation and CIRC are used (layered error correction is not used). Recovered data errors are reported. If a recovered data error occurs, data transfer is not terminated. However, when the data transfer has completed CHECK CONDITION status is reported. The sense key is set to RECOVERED ERROR. The information bytes give the address of the last block where a CIRC recovered data error was detected. If an unrecovered data error occurs, data transfer is terminated and CHECK CONDITION status is reported. The block with the error is not transferred. The sense key is set to MEDIUM ERROR. The information bytes give the address of the block where the unrecovered error was detected.
06h	The maximum error recovery procedures are used. Recovered data errors are reported. If a recovered data error occurs data transfer is terminated and CHECK CONDITION status is reported. The block with the recovered error is not transferred. The sense key is set to RECOVERED ERROR. The information bytes give the address of the block where the recovered data error was detected. If a data error occurs that is uncorrectable with the ECC information on the medium, data transfer is terminated with CHECK CONDITION status. The block with the error is not transferred. The sense key is set to MEDIUM ERROR. The information bytes give the address of the block where the uncorrectable error was detected.

Table 242 (cont.) - CD Devices, error recovery description

error code	description
07h	Only retries of the read operation are used (layered error correction is not used). CIRC recovered data errors are reported. If a CIRC recovered data error occurs, data transfer is terminated with CHECK CONDITION status. The block with the recovered error is not transferred. The sense key is set to RECOVERED ERROR. The information bytes give the address of the block where the recovered data error was detected. If an CIRC unrecovered data error occurs, data transfer is terminated with CHECK CONDITION status. The block with the error is not transferred. The sense key is set to MEDIUM ERROR. The information bytes give the address of the block where the uncorrectable error was detected.
10h	If data transfer can be maintained, the maximum error recovery procedures available are used. (RC=1.) If an error occurs which is uncorrectable with the error codes (ECC) on the media, or is uncorrectable in time to maintain data transfer, the data transfer is not terminated. However, when the data transfer has completed, CHECK CONDITION status is reported. The sense key is set to MEDIUM ERROR. The information bytes give the address of the block where the first unrecovered error was detected. Recovered errors are not reported.
11h	If data transfer can be maintained, retries of the read operation and CIRC are used (layered error correction is not used). (RC=1.) Only CIRC unrecovered data errors are reported. If a CIRC unrecovered data error occurs, data transfer is not terminated. However, when data transfer has completed, CHECK CONDITION status is reported. The sense key is set to MEDIUM ERROR. The information bytes give the address of the block where the first unrecovered error was detected. Recovered errors are not reported. If a data error occurs that is uncorrectable with the ECC information available on the media, data transfer is terminated and CHECK CONDITION status is reported. The block with the error is not transferred. The sense key is set to MEDIUM ERROR. The information bytes give the address of the block where the uncorrectable error was detected.
14h	If data transfer can be maintained, the maximum error recovery procedures available are used. (RC=1.) Recovered data errors are reported. If a recovered data error occurs, data transfer is not terminated. However, when the data transfer has completed, CHECK CONDITION status is reported. The sense key is set to RECOVERED ERROR. The information bytes give the address of the block where a recovered data error was detected. If an data error occurs that is uncorrectable with the ECC information available on the media, or is uncorrectable in time to maintain data transfer, the data is not terminated. However, when the data transfer has completed, CHECK CONDITION status is reported. The sense key is set to MEDIUM ERROR. The information bytes give the address of the block where the first unrecovered error was detected. Reporting unrecovered errors takes precedence over reporting recovered errors.
15h	If data transfer can be maintained, retries of the read operation and CIRC are used (layered error correction is not used). (RC=1.) Recovered data errors are reported. If a recovered data error occurs, data transfer is not terminated. However, when the data transfer has completed CHECK CONDITION status is reported. The sense key is set to RECOVERED ERROR. The information bytes give the address of the block where a CIRC recovered data error was detected. If an unrecovered data error occurs, data transfer is not terminated. However, when the data transfer has completed CHECK CONDITION status is reported. The sense key is set to MEDIUM ERROR. The information bytes give the address of the block where the unrecovered error was detected. Recovered errors are not reported.

Table 242 (cont.) - CD Devices, error recovery description

error code	description
20h	The maximum error recovery procedures available are used. If an error occurs which is uncorrectable with the error correction codes (ECC) on the media, data transfer is terminated with CHECK CONDITION status. The block with the error is transferred. The sense key is set to MEDIUM ERROR. The information bytes give the address of the block where the unrecovered error was detected. Recovered errors are not reported.
21h	Only retries of the read operation and CIRC are used (layered error correction is not used). Only CIRC unrecovered data errors are reported. If an CIRC unrecovered data error occurs, data transfer is terminated with CHECK CONDITION status. The block with the error is transferred. The sense key is set to MEDIUM ERROR. The information bytes give the address of the block where the unrecovered error was detected. Recovered errors are not reported.
24h	The maximum error recovery procedures available are used. Recovered data errors are reported. If a recovered data error occurs, data transfer is not terminated. However, when the data transfer has completed, CHECK CONDITION status is reported. The sense key is set to RECOVERED ERROR. The information bytes give the address of the last block where a recovered data error was detected. If a data error occurs that is uncorrectable with the ECC information available on the media, data transfer is terminated and CHECK CONDITION status is reported. The block with the error is transferred. The sense key is set to MEDIUM ERROR. The information bytes give the address of the block where the uncorrectable error was detected.
25h	Only retries of the read operation and CIRC are used (layered error correction is not used). Recovered data errors are reported. If a recovered data error occurs, data transfer is not terminated. However, when the data transfer has completed CHECK CONDITION status is reported. The sense key is set to RECOVERED ERROR. The information bytes give the address of the last block where a CIRC recovered data error was detected. If an unrecovered data error occurs, data transfer is terminated and CHECK CONDITION status is reported. The block with the error is transferred. The sense key is set to MEDIUM ERROR. The information bytes give the address of the block where the unrecovered error was detected.
26h	The maximum error recovery procedures are used. Recovered data errors are reported. If a recovered data error occurs data transfer is terminated and CHECK CONDITION status is reported. The block with the recovered error is transferred. The sense key is set to RECOVERED ERROR. The information bytes give the address of the block where the recovered data error was detected. If a data error occurs that is uncorrectable with the ECC information on the medium, data transfer is terminated with CHECK CONDITION status. The block with the error is transferred. The sense key is set to MEDIUM ERROR. The information bytes give the address of the block where the uncorrectable error was detected.

Table 242 (cont.) - CD Devices, error recovery description

error code	description
27h	Only retries of the read operation are used (layer error correction is not used). CIRC recovered data errors are reported. If a CIRC recovered data error occurs, data transfer is terminated with CHECK CONDITION status. The block with the recovered error is transferred. The sense key is set to RECOVERED ERROR. The information bytes give the address of the block where the recovered data error was detected. If a CIRC unrecovered data error occurs, data transfer is terminated with CHECK CONDITION status. The block with the error is transferred. The sense key is set to MEDIUM ERROR. The information bytes give the address of the block where the unrecovered error was detected.
30h	Same as code 10h
31h	Same as code 11h
34h	Same as code 14h
35h	Same as code 15h

7.1.3. Write Parameters Mode Page

The Write Parameters Mode Page (see Table 243) contains parameters needed for the correct execution of write commands.

The values in this page do not necessarily reflect the status on a given track. They will be used as applicable when a write operation occurs. If any parameters have values incompatible with the current track, a check condition status shall occur when a write is attempted.

The PS bit (parameters savable) (see Table 243) is only used with the MODE SENSE command. This bit is reserved with the MODE SELECT command. A PS bit of one indicates that the target is capable of saving the page in a non-volatile, vendor-specific location. If the PS bit is set to one in MODE SENSE data, then the page shall be savable by issuing a MODE SELECT command with SP set to one.

Table 243 - Write Parameters Mode Page

Bit / Byte	7	6	5	4	3	2	1	0
0	PS	Reserved	Page Code (05h)					
1	Page Length (32h)							
2	Reserved			Test Write	Write Type			
3	Multi-session		FP	Copy	Track Mode			
4	Reserved				Data Block Type			
5	Reserved							
6	Reserved							
7	Reserved		Host Application Code					
8	Session Format							
9	Reserved							
10	(MSB) Packet Size							
11								
12								
13								(LSB)
14	(MSB) Audio Pause Length							
15								(LSB)
16	(MSB) Media Catalog Number							
17	...							
...								
30	...							
31								(LSB)
32	(MSB) International Standard Recording Code							
33	...							
...								
46	...							
47								(LSB)
48	Sub-header Byte 0							
49	Sub-header Byte 1							
50	Sub-header Byte 2							
51	Sub-header Byte 3							
52	Vendor Specific							
53	Vendor Specific							
54	Vendor Specific							
55	Vendor Specific							

The Test Write bit (see Table 243) is valid only for Write Type 1 or 2 (Track at Once or Session at Once). When the Test Write bit is set to one, it indicates that the device performs the write process, but does not write data to the media. When the bit is set to zero the Write laser power is set such that user data is transferred to the CD media. In addition, all track and disc information collected, during test write mode, shall be cleared. It should be noted that the number of tracks reserved or written may be limited in test write mode.

Write Type Field (Table 244) specifies the CD-R/RW stream type to be used during writing. Write Type values are shown in Table 244.

Table 244 - Write Type Field

Value	Definition
00h	Packet
01h	Track-at-once
02h	Session-at-once
03h	Raw
04h - 0Fh	Reserved

Packet - the device shall perform packet writing when write commands are issued.

Track at Once - the device shall perform track at once recording when write commands are issued.

Session at Once - the device shall perform session at once recording. This mode requires that a cue sheet be sent prior to sending write commands.

Raw - the device shall write data as received from the initiator. In this mode, the initiator sends the lead-in. As the initiator must provide Q sub-channel in this mode, the only valid Data Block Types are 1, 2, and 3. The Next Writable Address starts at the beginning of the lead-in (which shall be a negative LBA on a blank disc).

NOTE: In RAW record mode the drive shall not generate run-in and run-out blocks (main and sub-channel 1 data) but shall generate and record the link block.

The Multi-session field defines how session closure affects the opening of the next session. See Table 245.

Table 245 - Multi-session Field Definition

Multisession Field	Action Upon Session Closure
00b	No B0 pointer. Next Session not allowed
01b	B0 pointer = FF:FF:FF. Next session not allowed
10b	Reserved
11b	Next session allowed. B0 pointer = next possible program area.

The FP bit, when set to one indicates that the packet type is fixed. Otherwise, the packet type is variable. This bit is ignored unless the write type is set to 0 (Packet).

Track Mode is the Control nibble in all mode 1 Q sub-channel in the track.

A Copy bit with value one indicates that this is the first or higher generation copy of a copyright protected track. When set to one, the copyright bit in the control nibble of each mode 1 Q sub-channel shall alternate between 1 and 0 at 9.375 Hz. The duty cycle is 50%, changing every 4 blocks. The initial value on the medium is zero.

Data Block Type defines both the specific data fields in a user data block and its size. The Data Block Type is as defined in Table 246. This size is used for writing instead of the block size set in the mode select header.

Table 246 - Data Block Type Codes

Value	Block Size	Definition	Requirement
0	2352	Raw data 2352 bytes of raw data (not valid for write type = packet)	Optional
1	2368	Raw data with P and Q sub-channel 2352 bytes of raw data, 16 bytes buffer for Q sub-channel: Bytes 0..9 are Q sub-channel data Bytes 10..11 are Q sub-channel EDC Bytes 12..14 are zero Byte 15, most significant bit has state of P sub-channel bit (not valid for write type = packet)	Optional
2	2448	Raw data with P-W sub-channel appended: 2352 bytes of raw data. 96 bytes of pack form R-W sub-channel in the low order 6 bits of each byte. Bit 7 of each byte contains the P sub-channel state and bit 6 of each byte contains the Q sub-channel bit. (not valid for write type = packet)	Optional
3	2448	Raw data with raw P-W sub-channel appended: 2352 bytes of raw data. 96 bytes of raw P-W sub-channel. (not valid for write type = packet)	Optional
4 - 6		Reserved values	
7	NA	Vendor Specific	Optional
8	2048	Mode 1 (ISO/IEC 10149): 2048 bytes of user data	Mandatory
9	2336	Mode 2 (ISO/IEC 10149): 2336 bytes of user data	Optional
10	2048	Mode 2 (CD-ROM XA, form 1): 2048 bytes of user data, sub-header from write parameters	Mandatory
11	2056	Mode 2 (CD-ROM XA, form 1): 8 bytes of sub-header, 2048 bytes of user data	Optional
12	2324	Mode 2 (CD-ROM XA, form 2): 2324 bytes of user data, sub-header from write parameters	Optional
13	2332	Mode 2 (CD-ROM XA, form 1, form 2, or mixed form): 8 bytes of sub-header 2324 bytes of user data	Mandatory
14	-	Reserved values	
15	NA	Vendor Specific	Optional

NOTES:

1. When a track has been designated for packet writing, the device shall ensure that the TDB is written upon receipt of the write command.
2. With the exceptions of data block types 1, 2, and 3, the device shall generate all P sub-channel and all mode 1, mode 2, and mode 3 Q sub-channel.
3. For data block types 8 through 13, the device shall generate all sync fields and all headers.

4. For data blocks of mode 1 or of mode 2, form 1, the device shall generate EDC and L-EC parity.
5. For data block types 0, 1, 2, and 3, the device shall perform no data scrambling per ISO/IEC 10149.
6. For data block types 8 through 13, the device shall perform data scrambling per ISO/IEC 10149.

The Host Application Code is typically zero. When the unrestricted Use Disc bit in Disc Information Block (see Table 122) is one, the Host Application Code shall be ignored by the device. If the Unrestricted Use Disc bit is zero, then the Host Application Code shall be set to the appropriate value for the medium in order that writing be allowed. A Host Application Code of zero is used for a Restricted Use - General Purpose Disc.

The Session Format code is to be written in the TOC of the session containing this track. The Session Format code is the PSEC byte of the mode 1, point A0 TOC entry. See Table 247.

Table 247 - Session Format Codes

Disc Type Code	Session Format
00h	CD-DA or CD-ROM Disc
10h	CD-I Disc
20h	CD-ROM XA Disc
All Other Values	Reserved

The Packet Size field specifies the number of User Data Blocks per fixed packet.

Audio Pause Length is the number of blocks from the beginning of the track for which the mode 1 Q sub-channel INDEX shall be zero. If this number is zero, then there is no period where the Mode 1 Q sub-channel INDEX shall be zero. The default value shall be 150. This field is valid only for audio tracks, otherwise it is ignored.

The Media Catalog Number (MCN) is formatted as in Table 153. The MCN will be written in a mode 2 Q sub-channel in at least one out of every 100 blocks in the program area.

The International Standard Recording Code (ISRC) is formatted as in Table 155.

7.1.4. Verify error recovery page (Page Code 07h)

The verify error recovery parameters page (Table 248) specifies the error recovery parameter the target shall use during verify operations.

Table 248 - Verify error recovery parameters page

Bit Byte	7	6	5	4	3	2	1	0
0	PS	Reserved	Page Code (07h)					
1	Parameter Length (06h)							
2	Error Recovery Parameter							
3	Verify Retry Count							
4	Reserved							
5	Reserved							
6	Reserved							
7	Reserved							

The page savable (PS) bit is only used with the MODE SENSE command. This bit is reserved with the MODE SELECT command. A PS bit of one indicates that the target is capable of saving the page in a non-volatile vendor-specific location. The error recovery parameters for verify operations are as defined by the read error recovery parameters (see ***Error! Reference source not found.***).

7.1.4.1. CD device parameters

The CD parameters page (Table 249) specifies parameters that affect all CD-ROM data types.

Table 249 - CD parameters page

Bit / Byte	7	6	5	4	3	2	1	0
0	PS	Reserved	Page Code (0Dh)					
1	Parameter Length (06h)							
2	Reserved							
3	Reserved				Inactivity Timer Multiplier			
4	(MSB) Number Of MSF - S Units Per MSF - M Unit							
5	(LSB)							
6	(MSB) Number Of MSF - F Units Per MSF - S Unit							
7	(LSB)							

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

The inactivity timer value specifies the length of time that the drive shall remain in the hold track state after completion of a seek or read operation (Table 250).

Table 250 - Inactivity timer multiplier values

Inactivity timer value	minimum time in hold track state	Inactivity timer value	Minimum time in hold track state
0	Vendor-specific	8	16 s
1	125 ms	9	32 s
2	250 ms	Ah	1 min.
3	500 ms	Bh	2 min.
4	1 s	Ch	4 min.
5	2 s	Dh	8 min.
6	4 s	Eh	16 min.
7	8 s	Fh	32 min.

The number of S units per M unit field gives the ratio of these MSF address values. For media conforming to the CD data and CD-DA standard, this value is 60.

The number of F units per S unit field gives the ratio of these MSF address values. For media conforming to the CD data and CD-DA standard, this value is 75.

7.1.5. CD Audio Control Parameters Page (Page Code 0Eh)

The CD Audio Control Parameters Page (Table 251) sets the playback modes and output controls for subsequent PLAY AUDIO commands and any current audio playback operation.

Table 251 - CD Audio Control Mode Page Format

Bit / Byte	7	6	5	4	3	2	1	0
0	PS (Optional)	Reserved	Page Code (0Eh)					
1	Page Length (0Eh)							
2	Reserved					Immed Mandatory Always 1	SOTC Mandatory Default 0	Reserved
3	Reserved							
4	Reserved							
5	Reserved							
6	Obsolete (75)							
7								
8	Reserved				CDDA Output Port 0 Channel Selection			
9	Output Port 0 Volumne (Mandatory) Default FFh							
10	Reserved				CDDA Output Port 1 Channel Selection			
11	Output Port 1 Volumne (Mandatory) Default FFh							
12	Reserved				CDDA Output Port 2 Channel Selection			
13	Output Port 2 Volumne (Mandatory) Default FFh							
14	Reserved				CDDA Output Port 3 Channel Selection			
15	Output Port 3 Volumne (Mandatory) Default FFh							

The Parameters Savable (PS) bit is only used with the MODE SENSE command. The PS bit is optional. This bit is reserved with the MODE SELECT command. A PS bit of one indicates that the C/DVD Logical Unit is capable of saving the page in a non-volatile vendor-specific location.

The Immediate Bit (IMMED) is used for information purposes only; the audio commands will always send completion status as soon as the playback operation has been started. This bit shall always be set to 1.

A Stop On Track Crossing (SOTC) bit of zero indicates the C/DVD Logical Unit shall terminate the audio playback operation when the transfer length is satisfied. Multiple tracks shall be played as necessary. Periods of time encoded as audio pause/silence at the beginning of tracks, (index 0) shall also be played. A SOTC bit of one indicates the C/DVD Logical Unit shall terminate the audio playback operation when the beginning of a following track is encountered. The SOTC bit is mandatory.

The CDDA Output Port Channel Selection field specifies the Red Book audio channels from the disc to which a specific output port shall be connected. More than one output port may be connected to an audio channel. More than one audio channel may be connected to an output port.

Table 252 - CDDA Output Port Channel Selection Codes

Code	Description
0000b	Output port muted
0001	Connect audio channel 0 to this output port
0010b	Connect audio channel 1 to this output port
0011b	Connect audio channel 0 and audio channel 1 to this output port
0100b	Connect audio channel 2 to this output port
1000b	Connect audio channel 3 to this output port

The Output Port Volume Control indicates the relative volume level for this audio output port. The value used is specified as an attenuation of the normal volume level. A value of zero indicates the minimum volume level (Mute), and a value of FFh indicates maximum volume (No attenuation) level. It is recommended that the MUTE and volume functions should be supported on a per channel basis. The attenuation used shall be as specified in "Table 71 - Attenuation Levels for Audio". All values not shown in the table shall be valid, with the attenuation selected by interpolating using the known table values.

It is recommended that the Logical Unit support at least 16 volume levels. The actual attenuation levels for any given Binary attenuation value shall be given by the following equation: 20 Log (Binary Level / 256)

Note: Audio channel volume control regarding channel selection of MUTE vs. Volume Level setting of 0. It is recommend that Logical Units allow the setting of the Channel Selection fields to MUTE and also allow the setting of the Volume Level field to 0. It is up to the Logical Unit to determine how to shut off the volume, either via muting circuitry or via the volume control.

Table 253 - Attenuation Levels for Audio

Binary Level	Attenuation
FFh	0db (0n)
F0h	-0.56
E0h	-1.16
C0h	-2.50
80h	-6.00
40h	-12.0
20h	-18.0
10h	-24.0
0Fh	-24.6
0Eh	-25.2
0Ch	-26.6
08h	-30.0
04h	-36.0
02h	-42.1
01h	-48.0
00h	Mute (Off)

7.1.6. Feature Set Support & Version page (Page Code 18h)

7.1.7. Power Condition Page (Page Code 1Ah)

The power condition page (Table 254) provides the application client the means to control the length of time a logical unit will delay before changing its power requirements. There are notification events to the host that a logical unit has entered into one of the power conditions.

Table 254 - Power Condition Mode Page Format

Bit / Byte	7	6	5	4	3	2	1	0
0	PS (Optional)	Reserved	Page Code (1Ah)					
1	Page Length (0Ah)							
2	Reserved							
3	Reserved						Idle	Standby
4	(MSB) Idle Timer							
5								
6								
7								(LSB)
8	(MSB) Standby Timer							
9								
10								
11								(LSB)

On the receipt of a command the Logical Unit shall adjust itself to the power condition which allows the command to execute. The timer which maps to this power condition and any lower power condition timers shall be reset on receipt of the command. On completion of the command the timer associated with this power condition shall be restarted.

An Idle bit of one indicates a logical unit shall use the Idle Timer to determine the length of inactivity time to wait before entering the Idle condition.

If the Idle bit is zero, or a value of zero in the Idle Timer indicates the logical unit shall disable the Idle Timer.

The Idle Timer field indicates the inactivity time in 100 millisecond increments that the logical unit shall wait before entering the Idle condition.

A Standby bit of one indicates a logical unit shall use the Standby Timer to determine the length of inactivity time to wait before entering the Standby condition.

The Standby Timer field indicates the inactivity time in 100 millisecond increments that the logical unit shall wait before entering the Standby condition.

If the Standby bit is zero or a value of zero in the Standby Timer indicates the logical unit shall disable the Standby Timer.

For more information on these timers see section 7.1.2, "Timers", on page 77.

7.1.8. Fault / Failure Reporting Control Page

The Fault / Failure Reporting Control page (Table 255) defines the methods used by the target to control the reporting and the operations of specific informational exception conditions. This page shall only apply to informational exception that report an additional sense code of FAILURE PREDICTION THRESHOLD EXCEEDED to the application client.

Informational exception conditions occur as a result of vendor specific events within a target. An informational exception condition may occur asynchronous to any commands issued by an application client.

Table 255 - Fault/ Failure Reporting Control Page

Bit / Byte	7	6	5	4	3	2	1	0
0	PS (Optional) Default 0	Reserved	Page Code (1Ch)					
1	Page Length (0Ah)							
2	Perf	Reserved			DExcept	Test	Reserved	LogErr (0)
3	Reserved				MRIE			
4	(MSB)							
5	Interval Timer							
6								
7								(LSB)
8	(MSB)							
9	Report Count							
10								
11								(LSB)

The log errors bit (LogErr) of zero indicates that the logging of informational exception conditions within a Logical Unit is vendor specific.

A disable exception control (DExcpt) bit of zero indicates information exception operations shall be enabled. The reporting of informational exception conditions when the DExcpt bit is set to zero is determined from the method of reporting informational exception field. A DExcpt bit of one indicates the Logical Unit shall disable all information exception operations. The method of reporting Fault / Failure Reporting field is ignored when DExcpt is set to one.

A Test bit of one shall create a false Logical Unit failure at the next interval time (as specified by the Interval timer field), if the DExcpt bit is not set. When the Test bit is one, the MRIE and Report count fields shall apply as if the Test bit were zero. The false Logical Unit failure shall be reported with an additional sense code of FAILURE PREDICTION THRESHOLD EXCEEDED (FALSE). If both the Test and the DExcpt bits are one, the Logical Unit shall terminate the MODE SELECT command with CHECK CONDITION status. The sense key shall be set to ILLEGAL REQUEST with the additional sense code set to INVALID FIELD IN PARAMETER LIST. A Test bit of zero shall instruct the Logical Unit not to generate any false Logical Unit failure notifications.

A Performance bit (Perf) of zero indicates that informational exception operations that are the cause of delays are acceptable. A Perf bit of one indicates the Logical Unit shall not cause delays while doing informational exception operations. A Perf bit set to one may cause the Logical Unit to disable some or all of the informational exception operations, thereby limiting the reporting of informational exception conditions.

The Method of Reporting Fault / Failure Reporting field (MRIE) indicates the methods that shall be used by the Logical Unit to report informational exception conditions *(see Table 74 - on page 124*). The priority of reporting multiple information exceptions is vendor specific.

Table 256 - Method of Reporting Fault/Failure Reporting Field

MRIE	Description
0h	No reporting of informational exception condition: This method instructs the target to not report information exception conditions.
1h - 3h	Reserved
4h	Unconditionally generate recovered error: This method instructs the target to report informational exception conditions, regardless of the value of the Perf bit of the error recovery parameters mode page, by returning a CHECK CONDITION status on any command. The sense key shall be set to RECOVERED ERROR and the additional sense code shall be set to FAILURE PREDICTION THRESHOLD - Predicted Logical Unit Failure or FAILURE PREDICTION THRESHOLD EXCEEDED - Predicted Media Failure. The command that has the CHECK CONDITION shall complete without error before any informational exception condition may be reported.
5h - Bh	Reserved
Ch - Fh	Vendor specific

The Interval Timer field indicates the period in 100 millisecond increments that a informational exception condition has occurred. The Logical Unit shall not report informational exception conditions more frequently than the time specified by the Interval Timer field and as soon as possible after the timer interval has elapsed. After the informational exception condition has been reported the interval timer shall be restarted. A value of zero in the Interval Timer field indicates that the Logical Unit shall only report the informational exception condition one time.

The Report Count field indicates the number of times to report an informational exception condition to the application client. A value of zero in the Report Count field indicates there is no limit on the number of times the Logical Unit shall report an informational exception condition.

The maintaining of the Interval Timer and the Report Count field across power cycles and/or resets by the Logical Unit shall be vendor specific.

7.1.9. C/DVD Time-out & Protect Page

The C/DVD Time-out & Protect page (Table 257) specifies parameters that affect C/DVD operation.

Table 257 - C/DVD Time-out & Protect Page

Bit / Byte	7	6	5	4	3	2	1	0
0	PS (Optional) Default 0	Reserved	Page Code (1Dh)					
1	Page Length (08h)							
2	Reserved							
3	Reserved							
4	Reserved						DISP (Optional) Default 0	SW PP (Optional) Default 0
5	Reserved							
6	(MSB) Group 1 Minimum Time-out (Seconds)							
7								(LSB)
8	(MSB) Group 2 Minimum Time-out (Seconds)							
9								(LSB)

The Parameters Savable (PS) bit is only used with the MODE SENSE command. This bit is reserved with the MODE SELECT command. A PS bit of one indicates that the C/DVD Logical Unit is capable of saving the page in a non-volatile vendor-specific location. The PS bit is optional.

The DISP bit when set to 1 shall make the Logical Unit unavailable until power has been removed and then reapplied. The Logical Unit shall report not ready for all media access after this bit has been set to 1.

The SWPP bit provides a Software Write Protect until Power down. When this bit is set to 1 the Logical Unit shall prevent writes to the media. When the bit is set to 1, the Logical Unit shall flush any data in the Cache to the media before preventing any further writes.

See the Time-out model for more information on the Group 1 & 2 Minimum Time-out fields.

7.1.10. C/DVD Capabilities and Mechanical Status Page

The C/DVD Capabilities and Mechanical Status Page (Table 258) is read only and may not be set with Mode Select.

Table 258 - CD Capabilities and Mechanical Status Page

Bit / Byte	7	6	5	4	3	2	1	0
0	PS	Reserved	Page Code (2Ah)					
1	Page Length (14h)							
2	Reserved		DVD-RAM Read	DVD-R Read	DVD-ROM Read	Method 2	CD-RW Read	CD-R Read
3	Reserved		DVD-RAM Write	DVD-R Write	Reserved	Test Write	CD-RW Write	CD-R Write
4	Reserved	Multi Session	Mode 2 Form 2	Mode 2 Form 1	Digital Port (2)	Digital Port (1)	Composite	Audio Play
5	Read Bar Code	UPC	ISRC	C2 Pointers supported	R-W De-interleaved & corrected	R-W Supported	CD-DA Stream is Accurate	CD-DA Commands Supported
6	Loading Mechanism Type			Reserved	Eject (Individual or Cartridge)	Prevent Jumper	Lock State	Lock
7	Reserved		P through W in Lead-In	Side Change Capable	S/W Slot Selection (SSS)	Changer Supports Disc Present reporting	Separate Channel Mute Supported	Separate volume levels per channel
8	(MSB) Obsolete - Reserved							
9	(LSB)							
10	(MSB) Number of Volume Levels Supported							
11	(LSB)							
12	(MSB) Buffer Size supported by Logical Unit (in kBytes)							
13	(LSB)							
14	(MSB) Obsolete - Reserved							
15	(LSB)							
16	Reserved							
17	Reserved		Length		LSBF	RCK	BCK	Reserved
18	Optional Reserved							
19	Optional Reserved							
20	(MSB) Copy Management Revision Supported							
21	(LSB)							
22	Reserved							
23	Reserved							

The Page Length field shall be set to 14h

If DVD-RAM Read bit (read only field) is set to one, the Logical Unit shall support the read function of DVD-RAM disc.

If DVD-R Read bit (read only field) is set to one, the Logical Unit shall support the read function of DVD-R disc.

If DVD-ROM Read bit (read only field) is set to one, the Logical Unit shall support the read function of DVD-ROM disc.

If Method 2 is set to one, the Logical Unit shall support the read function of CD-R media written using fixed packet tracks using Addressing Method 2.

If CD-R/RW Read Field is set to one, the Logical Unit shall support the read function of CD-R/RW disc (Orange Book Part III).

If CD-R Read Field is set to one, the Logical Unit shall support the read function of CD-R disc (Orange Book Part II).

If DVD-RAM Write bit (read only field) is set to one, the Logical Unit shall support the write function of DVD-RAM disc.

If DVD-R Write bit (read only field) is set to one, the Logical Unit shall support the write function of DVD-R disc.

If the Test Write bit is set to one, the Logical Unit shall only accept data from the host and not write to the media.

If CD-R/RW Write Field is set to one, the Logical Unit shall support the write function of CD-R/RW disc (Orange Book Part III).

If CD-R Write Field is set to one, the Logical Unit shall support the write function of CD-R disc (Orange Book Part II).

The individual capabilities of the Logical Unit are specified by bytes 4 through 7. Each of the bits indicate if that specific capability is supported. A value of zero indicates that the capability is NOT supported; a value of one indicates the capability IS supported.

Bit 0 - Audio Play - The Logical Unit is capable of Audio Play operation. This also indicates that the Logical Unit is capable of overlapping Play and other commands such as reading of the Sub-channel information.

Bit 1 - Composite - The Logical Unit is capable of delivering a composite Audio and Video data stream.

Bit 2 - Digital Port(1) - The Logical Unit supports digital output (IEC958) on port 1

Bit 3 - Digital Port(2) - The Logical Unit supports digital output(IEC958) on port 2

Bit 4 - Mode 2 Form 1 - The Logical Unit is capable of reading sectors in Mode 2 Form 1 (XA) format.

Bit 5 - Mode 2 Form 2 - The Logical Unit is capable of reading sectors in Mode 2 Form 2 format. Bit 6 Multi Session The Logical Unit is capable of reading multiple session or Photo CD discs.

Bit 8 - CD-DA Commands Supported - Red Book audio can be read using the READ-CD command.

Bit 9 - CD-DA Stream is Accurate - This bit indicates that the Logical Unit supports an advanced feature that allows it to return to an audio location without losing place to continue the READ CD-DA command. 0 The Logical Unit is incapable of accurately restarting the CD-DA read operation, and a BUFFER OVERFLOW error shall be reported whenever a loss of streaming occurs. This error will be fatal and the command will have to be repeated from the beginning. 1 The Logical Unit can continue from a loss of streaming condition and no error will be generated.

Bit 10 - R-W Supported - The commands that return Sub-channel data can return the combined R-W information.

Bit 11 - R-W De-interleaved & Corrected - This indicates that the R-W sub-channel data will be returned de-interleaved and error corrected.

Bit 12 - C2 Pointers are Supported - This indicates that the Logical Unit supports the C2 Error Pointers. This also indicates that the Logical Unit is capable of returning the C2 Error Pointers and C2 Block Error flags in the READ CD command. Bit 13 ISRC The Logical Unit can return the International Standard Recording Code Information.

Bit 14 - UPC - The Logical Unit can return the Media Catalog Number (UPC)

Bit 15 - Read Bar Code - The Logical Unit is capable of reading the disc bar code.

Bit 16 - Lock - The PREVENT/ALLOW command is capable of actually locking the media into the Logical Unit.

Bit 17 - Lock State - This indicates the current state of the Logical Unit. 0 The Logical Unit is currently in the allow (Unlocked) state. Media may be inserted or ejected. 1 The Logical Unit is currently in the prevent (Locked) state. Media

loaded in the Logical Unit may not be removed via a soft or hard eject. If the Logical Unit is empty, media may not be inserted if the Prevent Jumper is not present. If the jumper is present, then media may be inserted.

Bit 18 - Prevent Jumper - This indicates the state of the (Optional) Prevent/Allow Jumper. 0 Jumper is present. Logical Unit will power up to the allow state. Locking the Logical Unit with the Prevent/Allow Command shall NOT prevent the insertion of media. 1 Jumper is not present. Logical Unit will power up to the Prevent State (Locked). The Logical Unit will not accept new media or allow the ejection of media already loaded until an allow command is issued.

Bit 19 - Eject Command - The Logical Unit can eject the disc via the normal START/STOP command with the LoEj bit set. If the mechanism is a Changer that uses a Cartridge, then this bit indicates that the Cartridge can be ejected.

Bit 20 - Reserved

Bit 21-23 - Loading Mechanism Type - This field specifies the type of disc loading the Logical Unit supports.

0 0 0 Caddy type loading mechanism
0 0 1 Tray type loading mechanism
0 1 0 Popup type loading mechanism
0 1 1 Reserved
1 0 0 Changer with individually changeable discs
1 0 1 Changer using a Cartridge Mechanism
1 1 0 Reserved
1 1 1 Reserved

Bit 24 - Separate Volume Levels - The audio level for each channel can be controlled independently.

Bit 25 - Separate Channel Mute - The mute capability for each channel can be controlled independently.

Bit 26 - Supports Disc Present (SDP) - This bit indicates that the Logical Unit contains an embedded changer, and that after a reset condition or if a cartridge is changed, it can report the exact contents of the slots. The response to the MECHANISM STATUS command will contain valid Disc is Present status information for all slots.

Bit 27 - Software Slot Selection (SSS) - This bit controls the behavior of the LOAD/UNLOAD command when trying to load a Slot with no Disc present (see "Table 48 - Load/Unload or Optional Selection Operations" on page 101).

Bit 28 - Side Change Capable - This bit indicates that the Logical Unit is capable of selecting both sides of the Discs. This capability can be reported for Logical Units that have changer functions.

Bit 29 - P through W in Lead-In - This bit indicates that the Logical Units is capable of reading the raw R-W Sub-Channel information from the lead-in.

Bytes 8 & 9 are identified as obsolete in this standard. It was used in previous versions of this standard and should not be used in future developments.

The Number of Volume Levels Supported field returns the number of discrete levels. If the Logical Unit only supports turning audio on and off, the Number of Volume Levels field shall be set to 2.

The Buffer Size Supported field returns the number of bytes of buffer dedicated to the data stream returned to the Host Computer. This value is returned in Kbytes (Size/1024). If the Logical Unit does not have a buffer cache, the value returned shall be zero.

Byte 17 - is used to describe the format of the Logical Units digital output.

Bit 1 - BCKF Set if data valid on the falling edge of the BCK signal. Clear if data valid on the rising edge of the BCK signal

Bit 2 - RCK Set if HIGH on LRCK indicates left channel. Clear if HIGH on LRCK indicates right channel.

Bit 3 - LSBF Set if LSB first. Clear if MSB first.

Bit 4-5 - Length 00 32 BCKs 01 16 BCKs 10 24 BCKs 11 24 BCKs (I^2S)

The Copy Management Revision Supported Field indicates the version of the DVD Copy Protection scheme that is supported by the Logical Unit. This shall be 0001h to comply with this specification.

Annex A Additional Sense Codes for CD (normative)

This annex lists error codes expected to be generated by CD devices. Specific commands specify that certain errors occur in response to certain conditions, but each command does not contain a comprehensive list of possible error conditions.

A.1. Error Reporting

Any error may be reported in response to any command due to the occurrence of a deferred error. For example, a write error may occur due to a cached write command and that error shall be reported in response to the next command.

Errors listed in Table A.2 are not caused by any specific commands but by actions outside the control of the initiator.

Table A.1 lists all errors that may be generated by CD devices. Not all errors are applicable to all devices.

Table A.1 - CD Device Sense Key, ASC and ASCQ Assignments

Sense Key	ASC	ASCQ	Type	Description
0	00	00	R	NO ADDITIONAL SENSE INFORMATION
b	00	06	R	I/O PROCESS TERMINATED
5	00	11	R	AUDIO PLAY OPERATION IN PROGRESS
4	00	17	R	CLEANING REQUESTED
3	02	00	R	NO SEEK COMPLETE
2	04	00	R	LOGICAL UNIT NOT READY, CAUSE NOT REPORTABLE
2	04	01	R	LOGICAL UNIT IS IN PROCESS OF BECOMING READY
2	04	02	R	LOGICAL UNIT NOT READY, INITIALIZING CMD. REQUIRED
2	04	03	R	LOGICAL UNIT NOT READY, MANUAL INTERVENTION REQUIRED
2	04	04	++R	LOGICAL UNIT NOT READY, FORMAT IN PROGRESS
2	04	07	R	LOGICAL UNIT NOT READY, OPERATION IN PROGRESS
2	04	08	R	LOGICAL UNIT NOT READY, LONG WRITE IN PROGRESS
4	05	00	R	LOGICAL UNIT DOES NOT RESPOND TO SELECTION
3	06	00	R	NO REFERENCE POSITION FOUND
5	07	00	R	MULTIPLE PERIPHERAL DEVICES SELECTED
4	08	00	R	LOGICAL UNIT COMMUNICATION FAILURE
4	08	01	R	LOGICAL UNIT COMMUNICATION TIME-OUT
4	08	02	R	LOGICAL UNIT COMMUNICATION PARITY ERROR
4	09	00	R	TRACK FOLLOWING ERROR
4	09	01	R	TRACKING SERVO FAILURE
4	09	02	R	FOCUS SERVO FAILURE
4	09	03	R	SPINDLE SERVO FAILURE
4	09	04	R	HEAD SELECT FAULT
6	0A	00	R	ERROR LOG OVERFLOW
1	0B	00	R	WARNING
1	0B	01	R	WARNING - SPECIFIED TEMPERATURE EXCEEDED
1	0B	02	R	WARNING - ENCLOSURE DEGRADED
3	0C	00	R	WRITE ERROR
3	0C	07	R	WRITE ERROR - RECOVERY NEEDED
3	0C	08	R	WRITE ERROR - RECOVERY FAILED
3	0C	09	R	WRITE ERROR - LOSS OF STREAMING
3	0C	0A	R	WRITE ERROR - PADDING BLOCKS ADDED

All values are in hex

Table A.1 (cont.) - CD Device Sense Key, ASC and ASCQ Assignments

Sense Key	ASC	ASCQ	Type	Description
3	11	00	R	UNRECOVERED READ ERROR
3	11	01	++R	READ RETRIES EXHAUSTED
3	11	02	++R	ERROR TOO LONG TO CORRECT
3	11	05	R	L-EC UNCORRECTABLE ERROR
3	11	06	R	CIRC UNRECOVERED ERROR
3	11	0F	R	ERROR READING UPC/EAN NUMBER
3	11	10	R	ERROR READING ISRC NUMBER
b	11	11	++R	READ ERROR - LOSS OF STREAMING
3	15	00	R	RANDOM POSITIONING ERROR
3	15	01	R	MECHANICAL POSITIONING ERROR
3	15	02	R	POSITIONING ERROR DETECTED BY READ OF MEDIUM
1	17	00	R	RECOVERED DATA WITH NO ERROR CORRECTION APPLIED
1	17	01	R	RECOVERED DATA WITH RETRIES
1	17	02	R	RECOVERED DATA WITH POSITIVE HEAD OFFSET
1	17	03	R	RECOVERED DATA WITH NEGATIVE HEAD OFFSET
1	17	04	R	RECOVERED DATA WITH RETRIES AND/OR CIRC APPLIED
1	17	05	R	RECOVERED DATA USING PREVIOUS SECTOR ID
1	17	07	++R	RECOVERED DATA WITHOUT ECC - RECOMMEND REASSIGNMENT
1	17	08	++R	RECOVERED DATA WITHOUT ECC - RECOMMEND REWRITE
1	17	09	++R	RECOVERED DATA WITHOUT ECC - DATA REWRITTEN
1	18	00	R	RECOVERED DATA WITH ERROR CORRECTION APPLIED
1	18	01	R	RECOVERED DATA WITH ERROR CORR. & RETRIES APPLIED
1	18	02	R	RECOVERED DATA - DATA AUTO-REALLOCATED
1	18	03	R	RECOVERED DATA WITH CIRC
1	18	04	R	RECOVERED DATA WITH L-EC
1	18	05	R	RECOVERED DATA - RECOMMEND REASSIGNMENT
1	18	06	R	RECOVERED DATA - RECOMMEND REWRITE
5	1A	00	R	PARAMETER LIST LENGTH ERROR
4	1B	00	R	SYNCHRONOUS DATA TRANSFER ERROR
a	1D	00	++R	MISCOMPARE DURING VERIFY OPERATION
5	20	00	R	INVALID COMMAND OPERATION CODE
5	21	00	R	LOGICAL BLOCK ADDRESS OUT OF RANGE
5	21	01	R	INVALID ELEMENT ADDRESS
5	24	00	R	INVALID FIELD IN CDB
5	25	00	R	LOGICAL UNIT NOT SUPPORTED

All values are in hex

Table A.1 (cont.) - CD Device Sense Key, ASC and ASCQ Assignments

Sense Key	ASC	ASCQ	Type	Description
5	26	00	R	INVALID FIELD IN PARAMETER LIST
5	26	01	R	PARAMETER NOT SUPPORTED
5	26	02	R	PARAMETER VALUE INVALID
5	26	03	R	THRESHOLD PARAMETERS NOT SUPPORTED
5	26	04	R	INVALID RELEASE OF ACTIVE PERSISTENT RESERVATION
5	27	00	++R	WRITE PROTECTED
5	27	01	++R	HARDWARE WRITE PROTECTED
5	27	02	++R	LOGICAL UNIT SOFTWARE WRITE PROTECTED
5	27	03	++R	ASSOCIATED WRITE PROTECT
5	27	04	++R	PERSISTENT WRITE PROTECT
5	27	05	++R	PERMANENT WRITE PROTECT
6	28	00	R	NOT READY TO READY CHANGE, MEDIUM MAY HAVE CHANGED
6	28	01	R	IMPORT OR EXPORT ELEMENT ACCESSED
6	29	00	R	POWER ON, RESET, OR BUS DEVICE RESET OCCURRED
6	29	01	R	POWER ON OCCURRED
6	29	02	R	SCSI BUS RESET OCCURRED
6	29	03	R	BUS DEVICE RESET FUNCTION OCCURRED
6	29	04	R	DEVICE INTERNAL RESET
6	2A	00	R	PARAMETERS CHANGED
6	2A	01	R	MODE PARAMETERS CHANGED
6	2A	02	R	LOG PARAMETERS CHANGED
6	2A	03	R	RESERVATIONS PREEMPTED
5	2B	00	R	COPY CANNOT EXECUTE SINCE HOST CANNOT DISCONNECT
5	2C	00	R	COMMAND SEQUENCE ERROR
5	2C	03	R	CURRENT PROGRAM AREA IS NOT EMPTY
5	2C	04	R	CURRENT PROGRAM AREA IS EMPTY
6	2F	00	R	COMMANDS CLEARED BY ANOTHER INITIATOR
2	30	00	R	INCOMPATIBLE MEDIUM INSTALLED
2	30	01	R	CANNOT READ MEDIUM - UNKNOWN FORMAT
2	30	02	R	CANNOT READ MEDIUM - INCOMPATIBLE FORMAT
2	30	03	++R	CLEANING CARTRIDGE INSTALLED
2	30	04	R	CANNOT WRITE MEDIUM - UNKNOWN FORMAT
2	30	05	R	CANNOT WRITE MEDIUM - INCOMPATIBLE FORMAT
2	30	06	++R	CANNOT FORMAT MEDIUM - INCOMPATIBLE MEDIUM
2	30	07	R	CLEANING FAILURE
5	30	08	R	CANNOT WRITE - APPLICATION CODE MISMATCH
5	30	09	R	CURRENT SESSION NOT FIXATED FOR APPEND

All values are in hex

Table A.1 (cont.) - CD Device Sense Key, ASC and ASCQ Assignments

Sense Key	ASC	ASCQ	Type	Description
3	31	00	R	MEDIUM FORMAT CORRUPTED
3	31	01	R	FORMAT COMMAND FAILED
	34	00	R	ENCLOSURE FAILURE
	35	00	R	ENCLOSURE SERVICES FAILURE
	35	01	R	UNSUPPORTED ENCLOSURE FUNCTION
	35	02	R	ENCLOSURE SERVICES UNAVAILABLE
	35	03	R	ENCLOSURE SERVICES TRANSFER FAILURE
	35	04	R	ENCLOSURE SERVICES TRANSFER REFUSED
1	37	00	R	ROUNDED PARAMETER
5	39	00	R	SAVING PARAMETERS NOT SUPPORTED
2	3A	00	R	MEDIUM NOT PRESENT
2	3A	01	++R	MEDIUM NOT PRESENT - TRAY CLOSED
2	3A	02	++R	MEDIUM NOT PRESENT - TRAY OPEN
6	3B	0D	R	MEDIUM DESTINATION ELEMENT FULL
6	3B	0E	R	MEDIUM SOURCE ELEMENT EMPTY
6	3B	0F	R	END OF MEDIUM REACHED
6	3B	11	R	MEDIUM MAGAZINE NOT ACCESSIBLE
6	3B	12	R	MEDIUM MAGAZINE REMOVED
6	3B	13	R	MEDIUM MAGAZINE INSERTED
6	3B	14	R	MEDIUM MAGAZINE LOCKED
6	3B	15	R	MEDIUM MAGAZINE UNLOCKED
5	3D	00	R	INVALID BITS IN IDENTIFY MESSAGE
2	3E	00	R	LOGICAL UNIT HAS NOT SELF-CONFIGURED YET
4	3E	01	++R	LOGICAL UNIT FAILURE
4	3E	02	++R	TIMEOUT ON LOGICAL UNIT
6	3F	00	R	TARGET OPERATING CONDITIONS HAVE CHANGED
6	3F	01	R	MICROCODE HAS BEEN CHANGED
6	3F	02	R	CHANGED OPERATING DEFINITION
6	3F	03	R	INQUIRY DATA HAS CHANGED
4	40	NN	R	DIAGNOSTIC FAILURE ON COMPONENT NN (80H-FFH)
5	43	00	R	MESSAGE ERROR
4	44	00	R	INTERNAL TARGET FAILURE
b	45	00	R	SELECT OR RESELECT FAILURE
4	46	00	R	UNSUCCESSFUL SOFT RESET
4	47	00	R	SCSI PARITY ERROR
b	48	00	R	INITIATOR DETECTED ERROR MESSAGE RECEIVED
b	49	00	R	INVALID MESSAGE ERROR

All values are in hex

Table A.1 (cont.) - CD Device Sense Key, ASC and ASCQ Assignments

Sense Key	ASC	ASCQ	Type	Description
4	4A	00	R	COMMAND PHASE ERROR
4	4B	00	R	DATA PHASE ERROR
4	4C	00	R	LOGICAL UNIT FAILED SELF-CONFIGURATION
b	4D	NN	R	TAGGED OVERLAPPED COMMANDS (NN = QUEUE TAG)
b	4E	00	R	OVERLAPPED COMMANDS ATTEMPTED
3	51	00	++R	ERASE FAILURE
4	53	00	R	MEDIA LOAD OR EJECT FAILED
5	53	02	R	MEDIUM REMOVAL PREVENTED
3	57	00	R	UNABLE TO RECOVER TABLE-OF-CONTENTS
6	5A	00	R	OPERATOR REQUEST OR STATE CHANGE INPUT
6	5A	01	R	OPERATOR MEDIUM REMOVAL REQUEST
6	5A	02	++R	OPERATOR SELECTED WRITE PROTECT
6	5A	03	++R	OPERATOR SELECTED WRITE PERMIT
6	5B	00	R	LOG EXCEPTION
6	5B	01	R	THRESHOLD CONDITION MET
6	5B	02	R	LOG COUNTER AT MAXIMUM
6	5B	03	R	LOG LIST CODES EXHAUSTED
6	5D	00	R	FAILURE PREDICTION THRESHOLD EXCEEDED
6	5D	FF	R	FAILURE PREDICTION THRESHOLD EXCEEDED (FALSE)
6	5E	00	R	LOW POWER CONDITION ON
6	5E	01	R	IDLE CONDITION ACTIVATED BY TIMER
6	5E	02	R	STANDBY CONDITION ACTIVATED BY TIMER
6	5E	03	R	IDLE CONDITION ACTIVATED BY COMMAND
6	5E	04	R	STANDBY CONDITION ACTIVATED BY COMMAND
5	63	00	R	END OF USER AREA ENCOUNTERED ON THIS TRACK
5	63	01	R	PACKET DOES NOT FIT IN AVAILABLE SPACE
5	64	00	R	ILLEGAL MODE FOR THIS TRACK
5	64	01	R	INVALID PACKET SIZE
4	65	00	R	VOLTAGE FAULT

All values are in hex

Table A.1 (cont.) - CD Device Sense Key, ASC and ASCQ Assignments

Sense Key	ASC	ASCQ	Type	Description
3	72	00	R	SESSION FIXATION ERROR
3	72	01	R	SESSION FIXATION ERROR WRITING LEAD-IN
3	72	02	R	SESSION FIXATION ERROR WRITING LEAD-OUT
5	72	03	R	SESSION FIXATION ERROR - INCOMPLETE TRACK IN SESSION
5	72	04	R	EMPTY OR PARTIALLY WRITTEN RESERVED TRACK
3	73	00	R	CD CONTROL ERROR
1	73	01	R	POWER CALIBRATION AREA ALMOST FULL
3	73	02	R	POWER CALIBRATION AREA IS FULL
3	73	03	R	POWER CALIBRATION AREA ERROR
3	73	04	R	PROGRAM MEMORY AREA UPDATE FAILURE
3	73	05	R	PROGRAM MEMORY AREA IS FULL

All values are in hex

Table A.2 lists errors that may occur at any time, typically in response to a protocol or hardware error or user intervention.

Table A.2 - CD General Errors

Sense Key	ASC	ASCQ		Description
0	00	00	R	NO ADDITIONAL SENSE INFORMATION
b	00	06	R	I/O PROCESS TERMINATED
2	04	00	R	LOGICAL UNIT NOT READY, CAUSE NOT REPORTABLE
2	04	01	R	LOGICAL UNIT IS IN PROCESS OF BECOMING READY
2	04	02	R	LOGICAL UNIT NOT READY, INITIALIZING CMD. REQUIRED
2	04	03	R	LOGICAL UNIT NOT READY, MANUAL INTERVENTION REQUIRED
2	04	04	++R	LOGICAL UNIT NOT READY, FORMAT IN PROGRESS
2	04	07	R	LOGICAL UNIT NOT READY, OPERATION IN PROGRESS
2	04	08	R	LOGICAL UNIT NOT READY, LONG WRITE IN PROGRESS
4	05	00	R	LOGICAL UNIT DOES NOT RESPOND TO SELECTION
5	07	00	R	MULTIPLE PERIPHERAL DEVICES SELECTED
4	08	00	R	LOGICAL UNIT COMMUNICATION FAILURE
4	08	01	R	LOGICAL UNIT COMMUNICATION TIME-OUT
4	08	02	R	LOGICAL UNIT COMMUNICATION PARITY ERROR
6	0A	00	R	ERROR LOG OVERFLOW
1	0B	00	R	WARNING
1	0B	01	R	WARNING - SPECIFIED TEMPERATURE EXCEEDED
1	0B	02	R	WARNING - ENCLOSURE DEGRADED
5	1A	00	R	PARAMETER LIST LENGTH ERROR
4	1B	00	R	SYNCHRONOUS DATA TRANSFER ERROR
5	20	00	R	INVALID COMMAND OPERATION CODE
5	24	00	R	INVALID FIELD IN CDB
5	25	00	R	LOGICAL UNIT NOT SUPPORTED
5	26	00	R	INVALID FIELD IN PARAMETER LIST
5	26	01	R	PARAMETER NOT SUPPORTED
5	26	02	R	PARAMETER VALUE INVALID
6	28	00	R	NOT READY TO READY CHANGE, MEDIUM MAY HAVE CHANGED
6	29	00	R	POWER ON, RESET, OR BUS DEVICE RESET OCCURRED
6	29	01	R	POWER ON OCCURRED
6	29	02	R	SCSI BUS RESET OCCURRED
6	29	03	R	BUS DEVICE RESET FUNCTION OCCURRED
6	29	04	R	DEVICE INTERNAL RESET
6	2A	00	R	PARAMETERS CHANGED
6	2A	01	R	MODE PARAMETERS CHANGED
6	2A	02	R	LOG PARAMETERS CHANGED
6	2F	00	R	COMMANDS CLEARED BY ANOTHER INITIATOR

All values are in hex

Table A.2 (cont.) - CD General Errors

Sense Key	ASC	ASCQ		Description
	34	00	R	ENCLOSURE FAILURE
	35	00	R	ENCLOSURE SERVICES FAILURE
	35	01	R	UNSUPPORTED ENCLOSURE FUNCTION
	35	02	R	ENCLOSURE SERVICES UNAVAILABLE
	35	03	R	ENCLOSURE SERVICES TRANSFER FAILURE
	35	04	R	ENCLOSURE SERVICES TRANSFER REFUSED
5	3D	00	R	INVALID BITS IN IDENTIFY MESSAGE
2	3E	00	R	LOGICAL UNIT HAS NOT SELF-CONFIGURED YET
4	3E	01	++R	LOGICAL UNIT FAILURE
4	3E	02	++R	TIMEOUT ON LOGICAL UNIT
6	3F	00	R	TARGET OPERATING CONDITIONS HAVE CHANGED
6	3F	01	R	MICROCODE HAS BEEN CHANGED
6	3F	02	R	CHANGED OPERATING DEFINITION
6	3F	03	R	INQUIRY DATA HAS CHANGED
4	40	NN	R	DIAGNOSTIC FAILURE ON COMPONENT NN (80H-FFH)
5	43	00	R	MESSAGE ERROR
4	44	00	R	INTERNAL TARGET FAILURE
b	45	00	R	SELECT OR RESELECT FAILURE
4	46	00	R	UNSUCCESSFUL SOFT RESET
4	47	00	R	SCSI PARITY ERROR
b	48	00	R	INITIATOR DETECTED ERROR MESSAGE RECEIVED
b	49	00	R	INVALID MESSAGE ERROR
4	4A	00	R	COMMAND PHASE ERROR
4	4B	00	R	DATA PHASE ERROR
4	4C	00	R	LOGICAL UNIT FAILED SELF-CONFIGURATION
b	4D	NN	R	TAGGED OVERLAPPED COMMANDS (NN = QUEUE TAG)
b	4E	00	R	OVERLAPPED COMMANDS ATTEMPTED
6	5A	00	R	OPERATOR REQUEST OR STATE CHANGE INPUT
6	5A	01	R	OPERATOR MEDIUM REMOVAL REQUEST
6	5B	00	R	LOG EXCEPTION
6	5B	01	R	THRESHOLD CONDITION MET
6	5B	02	R	LOG COUNTER AT MAXIMUM
6	5B	03	R	LOG LIST CODES EXHAUSTED
6	5D	00	R	FAILURE PREDICTION THRESHOLD EXCEEDED
6	5D	FF	R	FAILURE PREDICTION THRESHOLD EXCEEDED (FALSE)
4	65	00	R	VOLTAGE FAULT

Note: All values are in hex

Table A.3 lists errors that may be generated by media access commands of any type (read of control or user data or writing of control or data area).

Table A.3 - CD Media Access Errors

Sense Key	ASC	ASCQ		Description
4	00	17	R	CLEANING REQUESTED
3	02	00	R	NO SEEK COMPLETE
3	06	00	R	NO REFERENCE POSITION FOUND
4	09	00	R	TRACK FOLLOWING ERROR
4	09	01	R	TRACKING SERVO FAILURE
4	09	02	R	FOCUS SERVO FAILURE
4	09	03	R	SPINDLE SERVO FAILURE
4	09	04	R	HEAD SELECT FAULT
3	11	00	R	UNRECOVERED READ ERROR
3	11	01	++R	READ RETRIES EXHAUSTED
3	11	02	++R	ERROR TOO LONG TO CORRECT
3	11	05	R	L-EC UNCORRECTABLE ERROR
3	11	06	R	CIRC UNRECOVERED ERROR
3	11	0F	R	ERROR READING UPC/EAN NUMBER
3	11	10	R	ERROR READING ISRC NUMBER
3	15	00	R	RANDOM POSITIONING ERROR
3	15	01	R	MECHANICAL POSITIONING ERROR
3	15	02	R	POSITIONING ERROR DETECTED BY READ OF MEDIUM
1	17	00	R	RECOVERED DATA WITH NO ERROR CORRECTION APPLIED
1	17	01	R	RECOVERED DATA WITH RETRIES
1	17	02	R	RECOVERED DATA WITH POSITIVE HEAD OFFSET
1	17	03	R	RECOVERED DATA WITH NEGATIVE HEAD OFFSET
1	17	04	R	RECOVERED DATA WITH RETRIES AND/OR CIRC APPLIED
1	17	05	R	RECOVERED DATA USING PREVIOUS SECTOR ID
1	17	07	++R	RECOVERED DATA WITHOUT ECC - RECOMMEND REASSIGNMENT
1	17	08	++R	RECOVERED DATA WITHOUT ECC - RECOMMEND REWRITE
1	17	09	++R	RECOVERED DATA WITHOUT ECC - DATA REWRITTEN
1	18	00	R	RECOVERED DATA WITH ERROR CORRECTION APPLIED
1	18	01	R	RECOVERED DATA WITH ERROR CORR. & RETRIES APPLIED
1	18	02	R	RECOVERED DATA - DATA AUTO-REALLOCATED
1	18	03	R	RECOVERED DATA WITH CIRC
1	18	04	R	RECOVERED DATA WITH L-EC
1	18	05	R	RECOVERED DATA - RECOMMEND REASSIGNMENT
1	18	06	R	RECOVERED DATA - RECOMMEND REWRITE
5	21	00	R	LOGICAL BLOCK ADDRESS OUT OF RANGE

Note: All values are in hex

Table A.3 (cont.) - CD Media Access Errors

Sense Key	ASC	ASCQ		Description
2	30	00	R	INCOMPATIBLE MEDIUM INSTALLED
2	30	01	R	CANNOT READ MEDIUM - UNKNOWN FORMAT
2	30	02	R	CANNOT READ MEDIUM - INCOMPATIBLE FORMAT
2	30	03	++R	CLEANING CARTRIDGE INSTALLED
2	30	07	R	CLEANING FAILURE
3	31	00	R	MEDIUM FORMAT CORRUPTED
2	3A	00	R	MEDIUM NOT PRESENT
2	3A	01	++R	MEDIUM NOT PRESENT - TRAY CLOSED
2	3A	02	++R	MEDIUM NOT PRESENT - TRAY OPEN
3	57	00	R	UNABLE TO RECOVER TABLE-OF-CONTENTS
6	5E	00	R	LOW POWER CONDITION ON
6	5E	01	R	IDLE CONDITION ACTIVATED BY TIMER
6	5E	02	R	STANDBY CONDITION ACTIVATED BY TIMER
6	5E	03	R	IDLE CONDITION ACTIVATED BY COMMAND
6	5E	04	R	STANDBY CONDITION ACTIVATED BY COMMAND
5	63	00	R	END OF USER AREA ENCOUNTERED ON THIS TRACK
5	64	00	R	ILLEGAL MODE FOR THIS TRACK
3	73	00	R	CD CONTROL ERROR

Note: All values are in hex

Table A.4 describes errors that may be generated by commands that cause user or control data to be written to the medium.

Table A.4 - CD Write Errors

Sense Key	ASC	ASCQ		Description
3	0C	00	R	WRITE ERROR
3	0C	07	R	WRITE ERROR - RECOVERY NEEDED
3	0C	08	R	WRITE ERROR - RECOVERY FAILED
3	0C	09	R	WRITE ERROR - LOSS OF STREAMING
3	0C	0A	R	WRITE ERROR - PADDING BLOCKS ADDED
5	27	00	++R	WRITE PROTECTED
5	27	01	++R	HARDWARE WRITE PROTECTED
5	27	02	++R	LOGICAL UNIT SOFTWARE WRITE PROTECTED
5	27	03	++R	ASSOCIATED WRITE PROTECT
5	27	04	++R	PERSISTENT WRITE PROTECT
5	27	05	++R	PERMANENT WRITE PROTECT
2	30	04	R	CANNOT WRITE MEDIUM - UNKNOWN FORMAT
2	30	05	R	CANNOT WRITE MEDIUM - INCOMPATIBLE FORMAT
5	30	08	R	CANNOT WRITE - APPLICATION CODE MISMATCH
5	30	09	R	CURRENT SESSION NOT FIXATED FOR APPEND
6	5A	02	++R	OPERATOR SELECTED WRITE PROTECT
6	5A	03	++R	OPERATOR SELECTED WRITE PERMIT
1	73	01	R	POWER CALIBRATION AREA ALMOST FULL
3	73	02	R	POWER CALIBRATION AREA IS FULL
3	73	03	R	POWER CALIBRATION AREA ERROR
3	73	04	R	PROGRAM MEMORY AREA UPDATE FAILURE
3	73	05	R	PROGRAM MEMORY AREA IS FULL

Note: All values are in hex

Table A.5 describes errors that may be generated by commands that cause the CD session to be closed.

Table A.5 - CD Fixation Errors

Sense Key	ASC	ASCQ		Description
5	2C	03	R	CURRENT PROGRAM AREA IS NOT EMPTY
5	2C	04	R	CURRENT PROGRAM AREA IS EMPTY
3	72	00	R	SESSION FIXATION ERROR
3	72	01	R	SESSION FIXATION ERROR WRITING LEAD-IN
3	72	02	R	SESSION FIXATION ERROR WRITING LEAD-OUT
5	72	03	R	SESSION FIXATION ERROR - INCOMPLETE TRACK IN SESSION
5	72	04	R	EMPTY OR PARTIALLY WRITTEN RESERVED TRACK

Note: All values are in hex

Annex B ATAPI Compliance (normative)

B.1. Introduction

This section describes the implementation of the MultiMedia Commands in ATAPI devices. The intent is to make the command sets highly compatible. It is desired that a common driver may be written to control both SCSI and ATAPI devices.

B.2. General

ATAPI devices implement a subset of SCSI behavior. Certain errors and conditions that exist in SCSI don't exist in ATAPI. In addition, certain terms are used in ATAPI instead of related SCSI terms. The mechanisms for transporting the commands, data, and status are unique to each transport. Addressing of units is also unique to each transport. MMC does not directly specify any of these mechanisms; the command and data layer definition may be layered on either transport.

B.2.1. Terms

B.2.1.1. Host - the ATAPI equivalent for the SCSI term "Initiator."

B.2.1.2. Device - the ATAPI equivalent for the SCSI term "Target" or "Logical Unit."

B.2.1.3. Command Packet - the ATAPI equivalent for the SCSI term "Command Descriptor Block."

B.2.2. Supported Block Sizes

ATAPI does not use the block size in the mode select block descriptor. Instead, the block size shall be determined by the command. The READ command shall return 2048 bytes per block. The WRITE command shall send the number of bytes per block as determined by the WRITE PARAMETERS mode page. The READ CD and READ CD MSF commands shall return the number of bytes per block as specified by the command.

B.2.3. CD Audio error reporting

PLAY commands with the immediate bit set in the audio control mode return status as soon as the command has been validated (which may involve a seek to the starting address). The playback operation continues and may complete without notification to the initiator. Error termination of audio operations shall not be reported to the host by returning immediate CHECK CONDITION status to the next command. The status may be obtained with READ SUB-CHANNEL or any command that returns the audio status.

B.2.4. Multi-Initiator Environment

A multi-initiator environment cannot exist in ATAPI. Therefore, conditions that occur only in multi-initiator environments cannot occur. For example, there is no way in ATAPI to produce a reservation conflict, or for another initiator to change common mode parameters. The descriptions of these conditions in SCSI shall be ignored in ATAPI implementations.

B.2.5. Command Packet Padding

All ATAPI commands are twelve bytes long. SCSI commands are six, ten, or twelve bytes long. To build the appropriate ATAPI Command Packet, padding bytes shall be added to the six and ten byte SCSI Command Descriptor Blocks. Six byte commands shall have six padding bytes added. Ten byte commands shall have two padding bytes added. These pad bytes shall have a value of zero.

The Control byte shall be reserved and set to zero.

B.3. ATAPI CD Commands

Commands for ATAPI CD devices are listed in Table B.1. Commands that have no differences other than those mentioned in sub-clauses B.2.1. through B.2.5. are documented only in the main body of the document.

Table B.1. - ATAPI CD Commands

Command Name	Operation Code	Type	Sub-clause
Blank	A1h	E	MMC
Close Track/Session	5Bh	R	MMC
Format Unit	04h	E	MMC
Inquiry	12h	M	SPC
Load/Unload CD	A6h	C	MMC
Mechanism Status	BDh	M	MMC
Mode Select (10)	55h	M	SPC
Mode Sense (10)	5Ah	M	SPC
Pause/Resume	4Bh	A	MMC
Play Audio (10)	45h	A	MMC
Play Audio (12)	A5h	A	MMC
Play Audio MSF	47h	A	MMC
Play CD	BCh	O	MMC
Prevent/Allow Medium Removal	1Eh	M	SPC
Read (10)	28h	M	SBC
Read (12)	A8h	M	SBC
Read Buffer Capacity	5Ch	O	MMC
Read CD	BEh	M	MMC
Read CD MSF	B9h	M	6.1.14.
Read CD Recorded Capacity	25h	M	6.1.15.
Read Disc Information	51h	R	6.1.16.
Read Header	44h	M	6.1.18.
Read Master Cue	59h	O	6.1.19.
Read Sub-channel	42h	M	6.1.20.
Read TOC/PMA/ATIP	43h	M	6.1.21.
Read Track Information	52h	R	**Error! Reference source not found.**

Key: M = command implementation is mandatory
O = command implementation is optional
A = mandatory command when implementing Audio
R = mandatory command for CD-R/RW devices
E = mandatory command for CD-RW devices
C = mandatory for embedded changer

Table B.1. (cont.) - ATAPI CD Commands

Command Name	Operation Code	Type	Sub-clause
Repair Track	58h	O	
Request Sense	03h	M	SPC
Reserve Track	53h	R	6.1.25.
Scan	BAh	A	6.1.26.
Seek	2Bh	M	SBC
Send Cue Sheet	5Dh	O	6.1.27.
Send OPC Information	54h	O	6.1.29.
Set CD Speed	BBh	R	6.1.31.
Start/Stop Unit	1Bh	M	SBC
Stop Play/Scan	4Eh	M	
Synchronize Cache	35h	R	
Test Unit Ready	00h	M	SPC
Write (10)	2Ah	R	SBC
Write (12)	AAh	R	SBC

Key: M = command implementation is mandatory
O = command implementation is optional
A = mandatory command when implementing Audio
R = mandatory command for CD-R/RW devices
E = mandatory command for CD-RW devices
C = mandatory for embedded changer

Annex C Command Play/Scan Operation (normative)

The CD-ROM device should accept and perform the commands specified in Table C.1 without terminating an Audio Play command already in progress.

Table C.1 - Commands That Will Stop a Play or Scan Operation

Opcode	Command Description	Action Taken
ANY	When it generates an Illegal Field in Command Packet Check Condition	Will terminate normally
00h	TEST UNIT READY	Will execute normally
03h	REQUEST SENSE	Will execute normally
12h	INQUIRY	The data will be returned
1Bh	START/STOP UNIT	Will terminate immediately
1Eh	PREVENT/ALLOW MEDIA REMOVAL	Will terminate normally
25h	READ CD RECORDED CAPACITY	Will terminate normally
28h	READ (10)	Will terminate immediately
2Bh	SEEK	Will terminate immediately
42h	READ SUB-CHANNEL	Only the current position information (Format Code 01h) will be supported while the play is in progress. If any other type of information is requested the READ SUB-CHANNEL will not be executed and a CHECK CONDITION will be generated.
43h	READ TOC/PMA/ATIP	Only drives that cache the TOC will be able to respond to this command while the play is in progress. If the drive does not support caching the TOC, the command will not be executed and a CHECK CONDITION will be generated.
44h	READ HEADER	Will terminate immediately
45h	PLAY AUDIO (10)	Will terminate immediately
47h	PLAY AUDIO MSF	Will terminate immediately
4Bh	PAUSE/RESUME	Will terminate immediately
55h	MODE SELECT	The Mode Select will be accepted and executed as long as no Media or Mode information is changed. If parameters that affect the play are changed, the Mode Select will terminate with a CHECK CONDITION without being executed
5Ah	MODE SENSE	Will terminate normally
A6h	LOAD/UNLOAD CD	Will terminate immediately
B4h	PLAY CD	Will terminate immediately
BDh	MECHANISM STATUS	Will execute normally
BEh	READ CD	Will terminate immediately
B9h	READ CD MSF	Will terminate immediately
BAh	SCAN	SCAN command will be executed and the PLAY command will resume at completion of the scan
BBh	SET CD SPEED	Will terminate immediately

Annex E Requirements for SBP-2 Compliance (Normative)

To be added

Annex M Implementation of Features (Informative)

M.1 What's a Feature?

The Mt. Fuji specification introduces Features. Features were designed to be atomic units of functionality. On the first level, Features are only a description in a document. Traditional drivers work without modification with logical units that implement features. Features were a part of the documentation in SFF 8020, SFF 8090, and MMC; however they were not comprehensive, typically documenting only optional behavior. Mt. Fuji 2 (SFF 8090 r2) associates all normal functionality with Features. Detection of a whole group of functions (a "Feature") was typically accomplished by the host by issuing a command unique to that Feature and examining the completion status of that command.

The Mt. Fuji and T10 (MMC) groups have been consciously trying to avoid using errors as a method for status detection. Error handling code is typically one of the more complex parts of implementing drivers; reducing the number of cases that need to be handled helps implementations by reserving error status for only true errors. Status information is reported via explicit status reporting commands such as GET EVENT/STATUS NOTIFICATION and GET CONFIGURATION.

The descriptions of Features in Mt. Fuji 2 appear complex, and they are. However, these descriptions describe almost nothing new; they are simply the descriptions of existing legacy behavior. The only new parts are the descriptors themselves, which are either static identification blocks or groups of information that the drive must already have to operate, even in a legacy behavior. For example, a drive must internally identify whether or not a PLAY AUDIO command may succeed; Features are simply a way to let the host in on the secret.

Previously, new devices had to make a choice: to look completely like an old device with added functionality, or as a new device not compatible with old drivers. Feature and Profiles, a host can first determine if the "right" driver is available by examining the profiles. If "the" right driver isn't available, the host can identify operable subsets when multiple profiles are reported. Finally, the host can identify basic functions to use the device via the Feature reporting

M.2 History

The separation of status and error reporting is very important in multitasking environments. Typically, the operating system needs to constantly be aware of the status of the drive. Various applications, operating through a variety of OS interfaces, may also need to be aware of drive status. Reporting of status via errors breaks down in this environment; only one process is made aware of state changes via the error, while other processes cannot obtain the same state information because the error (status change) has already been reported to the host (according to the drive).

Features do not replace legacy behavior. Features, in most cases, define a subset of legacy behavior. Several Features, taken together, are generally equivalent to legacy devices of the same type. Error and status reporting in legacy host environments is the same as legacy devices, without any special mode setting.

The Features described in Mt. Fuji 2 add something new: reporting. Legacy devices, while implementing the content of the Features, did not have any mechanism to report specifically the drive's capabilities. The closest mechanism that has existed is a command that reported implemented commands. Implemented mode pages are also reportable via standard mechanisms. However, a command is more than an operation code (OpCode). A whole set of commands, mode pages, and behavior needs to be grouped together to be useful. For example, write once MO, hard disk drives, and CD-R all use the WRITE command, but it is impossible to use the same strategies for writing these three media. Typically, different drivers or fragments or drivers are used for each kind of media. The previous mechanism would only identify that the WRITE command was implemented, but could not identify how to use it.

The capabilities of a particular drive may change at arbitrary times. The most common example of this is seen in a removable medium device. Even a basic removable magnetic medium device changes: from a random read/write device to a virtually less functional device when the medium is removed. Multi-function devices can change their behavior even more radically when they accept a variety of physical and logical formats.

Before features, hosts had to use a trial and error method for determining what would or would not function. Medium codes became outdated even before publication of the relevant standard, and still were not adequate to describe all media. The Profiles, also introduced in Mt. Fuji 2, provide an equivalent to the medium type. However, the profile does not indicate exact capabilities for the drive/medium system, only a generic identification of core capabilities.

Feature reporting is not completely new. Operating systems first identify a driver via the device type. The device type implied a core set of functions, e.g. a CD-ROM drive would support READ, READ TOC, etc. However, even these commands would not work if no medium were loaded. A driver would determine media status by trying a few commands and examining the error codes. After determining that media was present, a driver would have to probe to find out about additional features such as audio or medium changers. Features were “reportable,” but each feature had a different mechanism, and many of the mechanisms relied on the success or failure of special “key” commands.

M.3 Implementation of Features

There are only two requirements to fully implement features. The first is the GET CONFIGURATION command. This command is a very basic reporting command that reports some very static information; only a few features have any dynamic fields; most features have only one bit that changes. The command is a form of Inquiry: a technique for the host to identify the device on the bus. The GET CONFIGURATION command simply provides more detail, and the information reported is expected to be dynamic.

Implementation of Feature reporting via the GET CONFIGURATION command is simple: the image of the result data can be copied from device ROM to its buffer, a few fields set with information already known to the drive (such as the block size), and a few bits set according to already existing flags in the firmware (i.e. DVD vs. CD, audio tracks present, etc.). Devices with non-removable media may have a completely static image that is reported. If a starting point other than the beginning is requested, the drive walks the table to find the first requested feature, subtracts the offset from the data length, and transfers data starting at the same offset.

The second part of Features is reporting when the Features change. As it is important for the host to know what operations will function with the drive at any given moment, preemptive reporting of Feature changes greatly eases host implementations by reducing the number of error conditions that must be handled. The GET EVENT/STATUS NOTIFICATION command is used for status change reporting (an “Event.”) In many drives, implementation simply requires recording an event whenever a UNIT ATTENTION is generated, and having the GET EVENT/STATUS NOTIFICATION command clear the UNIT ATTENTION when the command completes.

As mentioned earlier, Features are not new; their reporting is. This reporting has become very important in modern environments. Multiple drivers are talking to the same device, doing different tasks. For example, a DVD-ROM drive may use the basic CD-ROM driver when a CD is installed, and another driver when a DVD is installed, and both a basic DVD driver and a separate copy protection process when copy protected media is mounted. All of these processes must interact well to provide seamless and solid support. Feature reporting provides a method for clean interaction.

M.4 Compatibility

Drives implementing Feature reporting are fully compatible with legacy systems.

The GET CONFIGURATION changes no behavior of the drive; it simply reports existing state information. Repeated GET CONFIGURATION commands will report the same information (unless the user inserts or removes the medium, etc.). GET CONFIGURATION never changes any state information in the drive, including UNIT ATTENTION conditions.

The GET EVENT/STATUS NOTIFICATION command changes legacy behavior only slightly, and not at all in a legacy environment. In a legacy environment, UNIT ATTENTION conditions are reported as done in the past. In a new environment, completion of the GET EVENT/STATUS NOTIFICATION command clears the UNIT ATTENTION. In a legacy environment, it would be cleared anyway; there are two differences: 1) the error is reported as an event, rather than as an error, and 2) in a queued environment, the GESN command will complete before anything else, because it was idle in the drive, awaiting completion. In this environment, UNIT ATTENTION reporting will be very rare or non-existent.

M.5 Summary

Features do not radically modify any legacy behavior or functionality. The only new parts involve reporting of behavior, and typically reflect state information already required of any firmware implementation, via two new commands. One command reports status, and the other notifies the host that the status may have changed.

The benefits include easier coding of highly robust drivers, fewer error conditions, and forward and backward compatibility with operating system drivers.

Annex N Command Listings (Informative)

Table N.1 - Multimedia Commands - Alphabetically

Command Name	Operation Code	MMC Type	Sub-clause
BLANK Command	A1h	O	6.1.1.
CLOSE TRACK/SESSION	5Bh	M	6.1.2.
FORMAT UNIT	04h	O	6.1.3.
LOAD/UNLOAD CD	A6h	O	6.1.5.
MECHANISM STATUS	BDh	M	6.1.6.
PAUSE/RESUME	4Bh	O	6.1.7.
PLAY AUDIO (10)	45h	A	6.1.8.
PLAY AUDIO (12)	A5h	A	6.1.9.
PLAY AUDIO MSF	47h	A	6.1.10.
READ BUFFER CAPACITY	5Ch	O	6.1.12.
READ CD	BEh	O	6.1.13.
READ CD MSF	B9h	M	6.1.14.
READ CD RECORDED CAPACITY	25h	M	6.1.15.
READ DISC INFORMATION	51h	M	6.1.16.
READ HEADER	44h	M	6.1.18.
READ MASTER CUE	59h	O	6.1.19.
READ SUB-CHANNEL	42h	M	6.1.20.
READ TOC/PMA/ATIP	43h	M	6.1.21.
READ TRACK/RZONE INFORMATION	52h	O	6.1.22.
REPAIR TRACK/RZONE	58h	O	6.1.23.
RESERVE TRACK	53h	M	6.1.25.
SCAN	BAh	O	6.1.26.
SEND CUE SHEET	5Dh	O	6.1.27.
SEND KEY	A3h		6.1.28.
SEND OPC INFORMATION	54h	O	6.1.29.
SET C/DVD SPEED	BBh	M	6.1.31.
SET READ AHEAD			6.1.31.
STOP PLAY/SCAN	4Eh	O	6.1.32.
SYNCHRONIZE CACHE	35h	M	6.1.33.
WRITE (10)	2Ah	O	6.1.34.
WRITE (12)			

Key: M = command implementation is mandatory
O = command implementation is optional
A = Must be implemented for Audio

Table N.2 - Multimedia Commands - by OpCode

Command Name	Operation Code	MMC Type	Sub-clause
FORMAT UNIT	04h	O	6.1.3.
READ CD RECORDED CAPACITY	25h	M	6.1.15.
WRITE (10)	2Ah	O	6.1.34.
SEEK	2Bh	O	
SYNCHRONIZE CACHE(FLUSH)	35h	M	
READ SUB-CHANNEL	42h	M	6.1.20.
READ TOC/PMA/ATIP	43h	M	6.1.21.
READ HEADER	44h	M	6.1.18.
PLAY AUDIO (10)	45h	A	6.1.8.
PLAY AUDIO MSF	47h	A	6.1.8.
PAUSE/RESUME	4Bh	O	6.1.7.
STOP PLAY/SCAN	4Eh	O	
READ DISC INFORMATION	51h	M	6.1.16.
READ TRACK INFORMATION	52h	O	**Error! Reference source not found.**
RESERVE TRACK	53h	M	6.2.10
SEND OPC INFORMATION	54h	O	6.1.29.
REPAIR TRACK	58h	O	
READ MASTER CUE	59h	O	6.1.19.
CLOSE TRACK/SESSION	5Bh	M	6.1.2.
READ BUFFER CAPACITY	5Ch	O	6.1.12.
BLANK	A1h	O	6.2.2
PLAY AUDIO (12)	A5h	A	6.1.9.
LOAD/UNLOAD CD	A6h	O	6.1.5.
READ CD MSF	B9h	M	6.1.14.
SCAN	BAh	O	6.1.26.
SET CD SPEED	BBh	M	6.1.31.
MECHANISM STATUS	BDh	M	6.1.6.
READ CD	BEh	O	6.1.13.

Key: M = command implementation is mandatory
O = command implementation is optional
A = Must be implemented for Audio

Table N.3 - Commands Common to all SCSI Devices

Command Name	Operation Code	SCSI-3	
		Type	Ref Std
CHANGE DEFINITION	40h	O	
COMPARE	39h	O	
COPY	18h	O	
COPY AND VERIFY	3Ah	O	
INQUIRY	12h	M	
LOCK/UNLOCK CACHE	36h	O	
LOG SELECT	4Ch	O	
LOG SENSE	4Dh	O	
MODE SELECT (10)	55h	O	
MODE SELECT (6)	15h	M	
MODE SENSE (10)	5Ah	M	
MODE SENSE (6)	1Ah	M	
PREFETCH	34h	O	
PREVENT/ALLOW MEDIUM REMOVAL	1Eh	M	
READ (10)	28h	M	
READ (12)	A8h	O	
READ (6)	08h	O	
READ BUFFER	3Ch	O	
READ LONG	3Eh	O	
RECEIVE DIAGNOSTIC RESULTS	1Ch	O	
RELEASE (10)	57h	M	
RELEASE(6)	17h	O	
REQUEST SENSE	03h	M	
RESERVE(10)	56h	M	
RESERVE(6)	16h	O	
SEEK (10)	2Bh	M	
SEEK (6)	0Bh	M	
SEND DIAGNOSTIC	1Dh	M	
SET LIMITS (10)	33h	O	
SET LIMITS (12)	B3h	O	
START/STOP UNIT	1Bh	M	

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

Table N.4 (cont.) - Commands Common to all SCSI Devices

Command Name	Operation Code	SCSI-3	
		Type	Ref Std
TEST UNIT READY	00h	M	
VERIFY (10)	2Fh	O	
VERIFY (12)	AFh	O	
WRITE BUFFER	3Bh	O	

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

The following command codes are vendor-specific: 02h, 05h, 06h, 09h, 0Ch, 0Dh, 0Eh, 0Fh, 10h, 11h, 13h, 14h, 19h, 20h, 21h, 22h, 23h, 24h, 26h, 27h, 29h, and C0h through FFh.

Annex O Event/Status Notification Functions (Informative)

Annex P Power Management Functions (Informative)

P 1 Power Management States

Four power states are defined. These are named Active, Idle, Standby, and Sleep with Active being the “Full-On” state, Sleep the “Off” state and “Idle, Standby and Sleep” progressively more aggressive power managed states. This model differs significantly from previous ATA and SCSI power management definitions. This new model defines power states in terms of the perceived impact on the end user, instead of absolute power levels. The Idle state is optimized for minimal end user performance impact. The Standby state is optimized for power savings.

To provide consistent behavior across Logical Units, standard definitions are used for the power states of Logical Units. These states are defined in terms of the following criteria.

- Power Consumption: How much power the Logical Unit uses.

- Logical Unit Context: How much of the internal state of the Logical Unit is retained by hardware and what must be restored by the responsible software.

- Restore time: How long it takes to raise the power level to the active power state and to put the Logical Unit into operational condition (including mechanical operation such as spin up) required before entering into the Active power state. Restoring is vendor specific and any mechanism can be employed here to raise the power consumption and to put the Logical Unit in operation condition required in a higher power state. For example, “turning on or raising internal Vcc for power hungry circuits such as motors, laser sensors”, “raising internal Vcc or the clock frequency for the digital circuits”, etc. A critical factor is how quickly restoring the Logical Unit to operation condition required in a higher power state (e.g. spin up).

- De-power time: How long it takes to reduce the power to the desired level in lower power state after entering the lower power state from higher power state. De-powering is vendor specific and any mechanism can be employed here to reduce the power consumption. For example, “turning off or lowering internal Vcc for power hungry circuits such as motors, laser sensors”, “lowering internal Vcc or reducing the clock frequency for the digital circuits”, “dynamic clock gating”, “cutting off the DC paths for unused circuits”, “turning off PLLs”, etc.

Table P1 - Power Management Model States

Logical Unit State	Power Consumption	Logical Unit Context Retained	Restore Time
Active (D0)	As needed for operation	All	None
Idle (D1)	Less than Active	All	The Logical Unit shall be restored to active state within 1 second on any request to enter active state, independent of the de-powering process.
Standby (D2)	Less than idle	All buffers are empty before entering Standby state.	Vendor specific: Greater than or equal to Idle to Active
Sleep (D3)	Less than Standby	None, Buffer & All of Command queues are empty before entering Sleep state.	Greater than or equal to Standby to Active. Vendor Specific. May Need full initialization. The Host may remove Vcc.

Transitions between these power states may occur at the request of the host or the logical unit. Transitions to a higher power state from a lower power state shall occur after restoring the logical unit to the operating conditions (including mechanical operation if applicable, such as spin up) required in the higher power state. When the logical unit transitions from a higher power state to a lower power state, the logical unit shall be considered to be in the lower power state when the logical unit is assured of reaching the lower power condition. Actual de-powering occurs after the logical unit enters

the lower power state. The logical unit shall generate a power event when the logical unit is considered to have entered a power state.

In order to create a robust power management environment, logical units shall support the following:

- Four power states: Active(D0), Idle(D1), Standby(D2) and Sleep(D3).

- Idle Timer. Provides a method for the logical unit to enter Idle state from Active state, following a programmed period of inactivity.

- Standby Timer. Provides a method for the logical unit to enter Standby state from either Active or Idle state, following a programmed period of inactivity.

- START/STOP UNIT Command and the Power Condition Field. Provides a method for the host to request the logical unit to enter a power state.

- GET EVENT STATUS NOTIFICATION Command. Notifies the host of power state changes and current power status.

- Power Condition Mode page. Enables or disables timers and specifies the reload value of the Idle and Standby timers.

P 2 Power State Transitions

Active State (D0):

The logical unit is completely active and responsive. The logical unit is consuming its highest level of power. During the execution of a media access command (commands that reload both timers) the logical unit shall be in active state.

The logical unit should minimize power consumption at all times, even when in the active state. Any mechanism can be employed, as long as it is transparent to software and does not prevent the logical unit from performing expected functions.

For example, the logical unit may dynamically gate on/off internal clocks by monitoring bus activities and internal activities.

Idle State (D1):

In Idle state, the logical unit is capable of responding to commands but may take up to one second longer to complete commands than the Active state. The logical unit is consuming less power than the Active state. Any mechanism can be employed as long as the restoring time is less than one second. The logical unit may, for example:

- Reduce internal clock frequency

- Lower the internal Vcc for digital circuits

- Dynamically gate internal clocks by monitoring bus/internal activities

Standby State (D2):

In Standby state the logical unit shall only be required to accept commands from the host. All other mechanisms are in the power save condition. In Standby state, the logical unit is capable of responding to commands but the logical unit takes longer to complete commands than when in Idle state. Buffers shall be emptied before entering into Standby state. The logical unit context shall be preserved. The logical unit is consuming less power than when in Idle state.

Sleep State (D3):

Maximum power saving state. Buffers and all command queues, including GET EVENT STATUS NOTIFICATION commands, shall be emptied before entering into the Sleep state. When the logical unit enters the sleep state, any GESN commands present in the command queue, shall be removed from the command queue, without command completion. In this Sleep state, all functions are stopped and no commands, except for reset can be received. The unit is consuming less power than when in the Standby state. The logical unit context is invalid in the Sleep state.

The host software shall fully initialize the logical unit after exiting Sleep state, as all context may be lost in the Sleep state. Therefore, disc(s)/cassette may be manually ejected or inserted while in sleep state, independent of any lock/unlock mechanism employed. For the host to consistently rely on the logical unit Media Status Notifications, when the logical unit is unable to determine if media has been changed while the Logical Unit was in the sleep state, the logical unit shall report NEW MEDIA on the next GET EVENT STATUS NOTIFICATION (Media Status) command.

In the Sleep state, the host may completely remove power from the device by turning off Vcc.

P 3 Power Management State Diagram

The state diagram "Figure 51 - State Transition, Events and Status" on page 128 and "Table 42 - State Transition, Events and Status" on page 129 define state transitions for the power management model.

A power-on or hard reset always returns the Power State to the Standby state. A Device Reset does not alter the current power state, unless the current power state is Sleep. A Device Reset received while in sleep state returns the power state to Standby.

The Sleep state is entered when the logical unit has been commanded to go to Sleep but Vcc is still applied to the device. Removing Vcc always takes the device to the Power Off state. Removing Vcc is recommended only when all Logical Units on a given bus are in sleep state.

"Table 42 - State Transition, Events and Status" on page 129 shows transition conditions for this model, and shows the Initial state, the Resultant state, Notification class, and Event class (Media or Power). Notification class and Event class fields specify the events that shall be generated during the transitions as outlined in the GET EVENT STATUS NOTIFICATION command.

In Idle or Standby states, the logical unit should attempt to maintain the minimal power level for that state at all times. However, the logical unit may create transitory, higher power level conditions as needed. The transitory power conditions shall not affect the reported power state, or generate power state events. Example transitory conditions are: flushing the buffers, emptying command queues, media insertion spin up, or auto off-line, etc. On insertion of new media, the logical unit may enter a transitory, higher power condition and stay in this condition for vendor specific time period. If the logical unit has not received a media access command (commands which reload both timers) during this period, the logical unit shall return to the normal power level for the current power state. This prevents excessive power consumption while the host is off-line.

It is permissible to enter intermediate states while in transition between states, however, the logical unit shall not report power change events for the intermediate states. If the logical unit fails to enter the target power state, the logical unit shall return to the original power state. Simultaneous expiration of multiple timers, shall cause the logical unit to enter the lower power state, and shall only report the result of the transition to that state.

When the logical unit is reporting NOT READY, the logical unit shall enter the Standby State.

If a power change event has not been reported to the host, when a new event is generated, the logical unit may choose only to report the most recent power event.

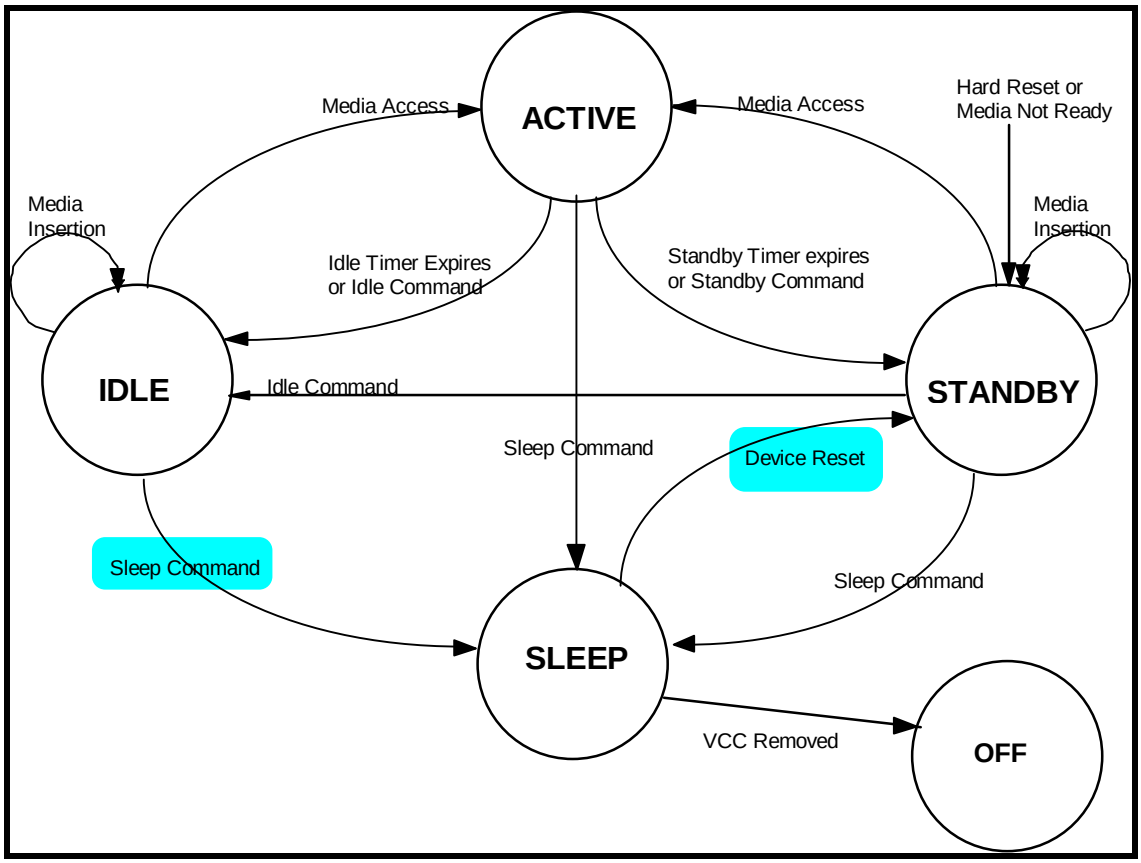

Figure 24 - STATE Diagram

P 4 Power Management Timers

The Idle and Standby timers provide a method for the logical unit to enter lower power states after a host programmable period of inactivity, without direct host command.

A timer is deactivated (no longer used by the Logical Unit, regardless of Enable / Disable setting provided from the host) when the logical unit is in the associated power state or a lower power state.

A timer is both reactivated (the logical unit shall use the timer if enabled) and reloaded when a logical unit transitions to power state higher than the associated timer.

Timers shall be reloaded, as specified in "Table 43 - Effects of Host Actions on Timers" on page 130, using the current timer value from the POWER CONDITION mode page.

Timers shall be disabled/enabled as specified in the POWER CONDITION mode page.

Timers shall be set to default conditions upon receiving a power-on, or hard reset. The default condition for the Timers shall be enabled with the values of the timers vendor specific.

P 5 Standby Timer

If the Standby Timer expires the logical unit shall attempt to flush all buffers.

If this operation fails, the logical unit shall remain in the current power state, and the Standby timer is reloaded. If the flush succeeds, the logical unit shall enter the Standby State.

Table P2 - State Transition, Events and Status

Initial State	Resultant State	Cause of Transition	Notification Class	Event
Active	Active	Unsuccessful Idle, Standby, or Sleep command	Power	PwrChg-Fail
	Idle	Successful completion of Idle command	Power	PwrChg-Succ
	Idle	The expiration of Idle timer	Power	PwrChg-Succ
	Standby	Successful completion of Standby command	Power	PwrChg-Succ
	Standby	The expiration of Standby timer, all Buffers are empty	Power	PwrChg-Succ
	Sleep	Successful completion of Sleep Command	Power	PwrChg-Succ
Idle	Idle	Successful completion of Idle command	Power	PwrChg-Succ
	Idle	Unsuccessful Idle, Standby, or Sleep command	Power	PwrChg-Fail
	Idle	Insertion of media and ready to use	Media	New Media
	Standby	The expiration of Standby timer, all buffers are empty	Power	PwrChg-Succ
	Standby	Successful completion of Standby command	Power	PwrChg-Succ
	Sleep	Successful completion of Sleep command	Power	PwrChg-Succ
	Active	Receptions of a command which reloads both timers	Power	PwrChg-Succ
Standby	Standby	Successful completion of Standby command	Power	PwrChg-Succ
	Standby	Unsuccessful Idle, Standby, or Sleep command	Power	PwrChg-Fail
	Standby	Insertion of media and ready to use	Media	NewMedia
	Idle	Successful completion of Idle command	Power	PwrChg-Succ
	Sleep	Successful completion of Sleep command	Power	PwrChg-Succ
	Active	Receptions of a command which reloads both timers	Power	PwrChg-Succ
Any	Standby	A power-on, or hard reset occurred, or the logical unit becomes NOT READY	Power	PwrChg-Succ
Sleep	Standby	Device Reset	Power	PwrChg-Succ

Table P3 - Effects of Initiator Commands on Timers

Initiator Command Issued	Timer Effects	Comments
BLANK	Reload Both	Recordable only
CHANGE DEFINITION	None	
CLOSE TRACK/RZONE	Reload Both	Recordable only
COMPARE	Reload Both	SCSI only
EXCUTE DRIVE DIAGNOSTIC	Reload Both	ATA command
FLUSH CACHE	Reload Both	
FORMAT UNIT	Reload Both	Recordable only
GET CONFIGURATION	None	
GET EVENT STATUS NOTIFICATION	None	
INQUIRY	None	
LOAD/UNLOAD C/DVD	Reload Both	
LOCK/UNLOCK CHACHE	None	SCSI only A Lock Cache command shall prevent the logical unit from entering Standby or Sleep states.
LOG SELECT/SENSE	None	SCSI only
MECHANISM STATUS	None	
MODE SELECT	May Reload Timers	A MODE SELECT command that changes the Standby or Idle timers shall reload the timer.
MODE SENSE	None	
PLAY AUDIO/MSF	Reload Both	
PLAY CD	Reload Both	
PREFETCH	Reload Both	SCSI only
PREVENT/ALLOW MEDIUM REMOVAL	Reload Standby	
READ (12)	Reload Both	
READ BUFFER	Reload Standby	
READ C/DVD CAPACITY	Reload Both	
READ CD	Reload Both	
READ CD MSF	Reload Both	
READ DISC INFORMATION	Reload Both	
READ DVD STRUCTURE	Reload Both	
READ FORMATABLE CAPACITIES	Reload Standby	
READ HEADER	Reload Both	
READ LONG	Reload Both	SCSI only
READ TRACK/RZONE INFORMATION	Reload Both	
READ SUB-CHANNEL	Reload Both	
READ TOC/PMA/ATIP	Reload Both	
REALEASE	None	SCSI only
REPAIR TRACK/RZONE	Reload Both	Sequential CD/DVD Recordable
REPORT KEY	Reload Both	
REPORT PERFORMANCE	Reload Both	May need to access media
REQUEST SENSE	None	
RESERVE	None	SCSI only
RESERVE TRACK/RZONE	Reload Both	Recordable only

Table P3 - Effects of Initiator Commands on Timers(continued)

Initiator Command Issued	Timer Effects	Comments
REZERO	Reload Both	SCSI only
SCAN	Reload Both	
SEEK	Reload Both	
SEND EVENT	Reload Both	May effect media access
SEND KEY	Reload Both	
SEND DVD STRUCTURE	Reload Both	Sequential DVD Recordable
SEND OPC INFORMATION	Reload Both	Recordable only
SET C/DVD SPEED	Reload Both	Obsolete
SET READ AHEAD	Reload Both	
SET STREAMING	Reload Both	
START/STOP UNIT	See Start Stop Unit Command	
TEST UNIT READY	Reload Both	
VERIFY	Reload Both	
WRITE	Reload Both	Recordable only
WRITE AND VERIFY	Reload Both	Recordable only
WRITE DVD STRUCTURE	Reload Both	Recordable only
Device Reset	Reload Both	Reset operation, the logical unit shall not return to default timer conditions.
Other Commands	Vendor Specific	

P 6 Power Management Status Reporting

The POWER STATUS field of the GESN (Power Management Class) event data shall always report the current Logical Unit power state. This provides a mechanism for the host to query the current power state, irrespective of state transitions.

Annex Q CD TEXT Format in the Lead-In Area (informative)

This annex explains the CD TEXT information that is stored in the Lead-In Area as raw R-W Sub-channel data. The information here is stored in a memory and can be retrieved to the host immediately.

Q.1. General

The CD TEXT information in the Lead-In area is retrieved from raw R-W Sub-Channel data. The data format of RAW Sub-channel is explained in the Table 96 "P-W RAW data format" of Read CD Command section. 6 bits of each bytes are R-W Raw data and it is converted from 6 bits to 8 bits from the 1st bytes, the it makes 4 chunk of 18 bytes data. Each 18 bytes data is called CD TEXT Pack Data as shown on the Table 150. CD TEXT information is recorded repeatedly in the Lead-In area and this one repeated data is called Text Group. Text Group consists of up to 8 types of language Blocks. Each Block represents one language and consists of maximum 255 Pack Data. Table Q.1. is the contents of one Pack Data.

Table Q.1. - CD TEXT Pack Data format for the Lead-In area

BYTE	CD TEXT Pack Data Format
0	Header Field ID1: Pack Type Indicator
1	Header Field ID2: Pack Type Indicator
2	Header Field ID3: Pack Type Indicator
3	Header Field ID4: Block Number and Character Position Indicator
4	Text Data Field byte 0
5	Text Data Field byte 1
6	Text Data Field byte 2
7	Text Data Field byte 3
8	Text Data Field byte 4
9	Text Data Field byte 5
10	Text Data Field byte 6
11	Text Data Field byte 7
12	Text Data Field byte 8
13	Text Data Field byte 9
14	Text Data Field byte 10
15	Text Data Field byte 11
16	CRC Field byte 0 or Reserved
17	CRC Field byte 1 or Reserved

Pack is used to indicate the chunk of data in 18 bytes as shown above. Each Pack consists of a Header Field, Text Data Field and CRC Field.

Pack Type Indicator has the value and descriptions defined in Table Q.2 . Packs shall be encoded in the order of the items listed in the Table.

Table Q.2 - Pack Type Indicator Definitions

Value	Descriptions
80h	Title of Album name(ID2=00h) or Track Titles (ID2=01h...63h)
81h	Name(s) of the performer(s) (in ASCII)
82h	Name(s) of the songwriter(s) (in ASCII)
83h	Name(s) of the composer(s) (in ASCII)
84h	Name(s) of the arranger(s) (in ASCII)
85h	Message(s) from content provider and/or artist (in ASCII)
86h	Disc Identification information
87h	Genre Identification and Genre information
88h	Table of Content information
89h	Second Table of Content information
8Ah	Reserved
8Bh	Reserved
8Ch	Reserved
8Dh	Reserved for content provider only
8Eh	UPC/EAN code of the album and ISRC code of each track
8Fh	Size information of the Block

Track Number Indicator consists with 2 information. MSB of this byte in the Extension Flag and is normally set to 0b. If it is set to 1b, the Pack is used for an extended application(TBD). Rest of the byte is used for Track Number or Pack Element Number. Track Number is used when the Text Data fields belongs to the track. If the Pack is independent to the Track, this field indicates Pack Element Number which depends on the type of the Pack.

Sequence Number Indicator is the number incrementally increased from the first Pack to the end in each Block. It starts from 00h to FFh.

Block Number and Character Position Indicator contains 3 information as follows.

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
DBCC	Block Number			Character Position			

Figure 25 - Block Number Character Position

Bit 7(MSB) is the Double Byte Character Code indication, which indicates if Text Data Field contains the Double Byte Character Code or not. If it is set to 0b, the Single Byte Character Code is used.

Bit 4 to 6, 3 bits, indicate the Block Number of the Block to which the Pack belongs. A Block is used to indicate a set of text information representing one particular language. It can be used up to 8 at the same time.

Bit 0 to Bit 3, indicate the Character Position. It is the number of character in the strings that belongs to the Text Data Field in the previous Pack. The Character Position starts from 0 to 15 and 15 indicates that the first character belongs to the one before the previous Pack. When the character code is double byte code, a set of 2 bytes in the Text Data Field is counted at one.

A null code is also counted as a character, which indicates termination of each strings.

Character Position is not used in Packs with ID1=88h, 89h and 8Fh. 00h shall be used in all these Packs.

A Text Data Field consists of 12 bytes. It contains either character strings or binary information depending on the type of Pack. All data in this field shall be transferred as recorded on the disc.

Packs except ID1=88h, 89h and 8Fh shall contains character strings in the Text Data Field. If Packs with ID1=80h to 85h, and 8Eh are used, a character strings for each track shall be provided.

A character string consists of series of characters and a terminator(One null code for single byte, two null code for double byte)

The size of a character string is recommended to be less than 160 bytes. If a character string does not fit in a Text Data Field of a Pack, it is continued onto the succeeding Packs. The succeeding character string will be encoded starting at the next byte in the Text Data Field after the terminator of the current string. Unused bytes in the Text Data Field shall be filled with null codes.

In case the same character stings is used for consecutive tracks, the Tab Indicator may be used to indicate the same as previous track. It is a single tab code (09h) for single byte codes, and two tab codes for double bytes character codes. It shall not used for the first track.

Packs with ID1=86h, 87h, 88h, 89h and 8Fh contains binary information in the Text Data Field.

CRC Field consists of 2 bytes. Host system may use these bytes to check errors in the Pack. The polynomial is $X^{16} + X^{12} + X^5 + 1$. All bits shall be inverted. This field is not mandatory for supporting CD TEXT data.