WORKING DRAFT

INCITS XXX
T10/1545-D

Revision – 1e

October 29, 2002

INFORMATION TECHNOLOGY - Multimedia Commands – 4 (MMC-4)

MMC-4 Technical Editor:

Bill McFerrin, CD Edge, Inc.

P. O. Box 429
Windsor, CO 80550
Tel. (720) 320-0790

E-mail: bmcferrin@aol.com

Reference number
ISO/IEC ***** :XXXX
ANSI INCITS .***** :XXXX
Printed: ******, XXXX

POINTS OF CONTACT

INCITS T10 Chair	INCITS T10 Vice-Chair
John B. Lohmeyer LSI Logic Corp. 4420 ArrowsWest Dr. Colo. Springs, CO 80907-3444 Tel: (719) 533-7560 Fax: (719) 533-7183 Email: lohmeyer@t10.org	George O. Penokie Tivoli Systems Inc. MS: 2C6 3605 Highway 52 N. Rochester, MN 55901 USA Telephone: (507) 253-5208 Facsimile: (507) 253-2880 Email: gpenokie@tivoli.com

INCITS Secretariat

INCITS Secretariat 1250 Eye Street, NW Suite 200 Washington, DC 20005	Telephone: 202-737-8888 Facsimile: 202-638-4922 e-mail: INCITS@itic.org

T10 Reflector

Internet address for subscription to the T10 reflector:	majordomo@t10.org
Internet address for distribution via T10 reflector:	t10@t10.org

MMC-3 Reflector

Internet address for subscription to the MMC Reflector	majordomo@dt.wdc.com
Internet address for distribution via MMC Reflector	mmc@dt.wdc.com

Document Distribution

Global Engineering	Telephone: 303-792-2181 or
15 Inverness Way East	800-854-7179
Englewood, CO 80112-5704	Facsimile: 303-792-2192

REVISION HISTORY

Draft Revision 1, January 17, 2002

Initial draft of the document:

ANSI title page content description has been rewritten to reflect ATAPI attitude of document.

Clause 1 (Scope) has been rewritten to reflect new document plan.

Clause 2 (References) has been updated to reflect latest standards publication names and numbers.

Clause 3 (Definitions) is largely rewritten. Definitions should now be complete sentences. New definitions were added. Unused definitions were removed.

Clause 4 (Models) is incomplete. CD, DDCD, Medium Changer, and Real-time Streaming sub-clauses are not changed. DVD model sub-clause is still under construction.

Clause 5 (Commands) is incomplete. All commands to be revisited for description completeness and accuracy.

Clause 6 (Parameters) is unmodified from MMC-3 at this time.

Annexes are unmodified at this time.

MMC-4 rev 01 is incomplete at this time and has that appearance.

Draft Revision 1a, February 28, 2002

Clause 4 has been reorganized. The CD and DDCD models have changed very little. The DVD model section has large sections rewritten with the purpose of presenting the different DVD media types separately. The intent is to make this sub-clause easier to use as reference material.

Clause 5 is largely unchanged.

Clause 6 contains stubbed sub-clauses for command descriptions. Each command will have a new table: associated features. This provides an important clarification to exactly what is mandatory and what is optional

Annexes have been stubbed for later resolution.

Draft Revision 1b, April 30, 2002

Applied corrections from Mar 2002 MMC WG review.

Additional changes were made:

The plan to switch clause 5 (commands) and clause 6 (parameters) was abandoned.

BLANK and CLOSE TRACK SESSION commands reviewed and edited.

Parameters clause (Clause 6) reviewed and edited.

Draft Revision 1c, July 11, 2002

Legacy Specifications annex added for the purpose of avoiding "obsolete". Contents:

FORMAT UNIT Command - Format Code = 111b, SEND EVENT Command,

CD Device Parameters Mode Page (Page 0Dh),

CD/DVD Capabilities and Mechanical Status Page (Page Code 2Ah)

Command descriptions added:

FORMAT UNIT, GET CONFIGURATION, GET EVENT STATUS NOTIFICATION, GET PERFORMANCE, INQUIRY, LOAD/UNLOAD MEDIA, MODE SELECT, MODE SENSE, PAUSE/RESUME, PLAY AUDIO (10), PLAY AUDIO (12), PLAY AUDIO MSF, TEST UNIT READY, WRITE BUFFER.

Plan for Draft Revision 1d, September 2002

DVD+MRW and DVD+R added to models, commands, and parameters clauses.

Command descriptions added:

READ (10), READ (12), READ BUFFER, READ BUFFER CAPACITY, READ CAPACITY, READ CD, READ CD MSF, READ DISC INFORMATION

Plan for Draft Revision 1e, October 29, 2002

Command descriptions added:

READ SUB-CHANNEL, RESERVE TRACK, REQUEST SENSE

Initial version of annexes present in document:

Annex A: ATAPI

Annex B: SCSI Parallel

Annex C: SCSI Serial

Annex F: Error Reporting

Annex G: Features and Profiles

Annex H: GESN

Annex I: Power Management

Annex J: MRW

Plan for Draft Revision 2, January 2003

First draft representing a complete document.

THIS PAGE
IS
INTENTIONALLY BLANK

BSR®

INCITS XXX

for Information Technology –

SCSI Multimedia Commands – 4 (MMC-4)

Secretariat

Information Technology Industry Council

Abstract

This standard defines a SCSI based command set required to access multimedia features. The applicable clauses of this standard when used in conjunction with other standards and publications define a full standard set of commands.

American National Standard

Approval of an American National Standard requires verification by ANSI that the requirements for due process, consensus and other criteria for approval have been met by the standards developer.

Consensus is established when, in the judgment of the ANSI Board of Standards Review, directly and materially affected interests have reached substantial agreement. Substantial agreement means much more than a simple majority, but not necessarily unanimity. Consensus requires that all views and objections be considered and that effort be made towards their resolution.

The use of American National Standards is completely voluntary; their existence does not in any respect preclude anyone, whether he has approved the standards or not, from manufacturing, marketing, purchasing, or using products, processes, or procedures not conforming to the standards.

The American National Standards Institute does not develop standards and in no circumstances give interpretation on any American National Standard. Moreover, no person shall have the right or authority to issue an interpretation of an American National Standard in the name of the American National Standards Institute. Requests for interpretations should be addressed to the secretariat or sponsor whose name appears on the title page of this standard.

CAUTION NOTICE: This American National Standard may be revised or withdrawn at any time. The procedures of the American National Standards Institute require that action be taken periodically to reaffirm, revise, or withdraw this standard. Purchasers of American National Standards may receive current information on all standards by calling or writing the American National Standards Institute.

CAUTION NOTICE: The developers of this standard have requested that holders of patents that may be required for the implementation of this standard, disclose such patents to the publisher. However, neither the developers nor the publisher has undertaken a patent search in order to identify which, if any, patents may apply to this standard. As of the date of publication of this standard and following calls for the identification of patents that may be required for the implementation of the standard, no such claims have been made. The developer or publisher in respect to any standard it processes conducts no further patent search. No representation is made or implied that licenses are not required to avoid infringement in the use of this standard.

Published by

American National Standards Institute
1430 Broadway, New York, NY 10018

Printed in the United States of America

Contents

Tables

Figures

Forward

(This foreward is not part of American National Standard INCITS ***-****.)

This standard defines the command set to access multimedia Features for all classes of SCSI devices. The applicable clauses of this standard when used in conjunction with SCSI Primary Commands, SCSI 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 environment.

Requests for interpretation, suggestions for improvement and addenda, or defect reports are welcome. They should be sent to the INCITS Secretariat, Information Technology Industry Council, 1250 I Street NW, Suite 200, Washington, DC 20005-3922.

This standard was processed and approved for submittal to ANSI by National Committee for Information Technology Standards (INCITS). Committee approval of this standard does not necessarily imply that all committee members voted for approval. At the time it approved this standard, INCITS had the following members:

To be supplied prior to forwarding to INCITS, Chair

To be supplied prior to forwarding to INCITS, Vice-Chair

To be supplied prior to forwarding to INCITS, Secretary

Organization Represented.. Name of Representative

Entire list to be supplied prior to forwarding to INCITS

Technical Committee T10 on Lower Level Interfaces, which developed and reviewed this standard, had the following members:

John B. Lohmeyer, Chair

George O. Penokie, Vice-Chair

Ralph O. Weber, Secretary

Entire list to be supplied prior to forwarding to INCITS

Multimedia Command Set - 4 (MMC-4)

1 Scope

This standard defines a set of SCSI command descriptor blocks that are useful in accessing and controlling Device Type 5 devices.

This command set is transport independent and may be implemented across a wide variety of environments for which a SCSI transport protocol has been defined. To date, these include Parallel SCSI, ATA/ATAPI, Universal Serial Bus 1 or 2 (USB), and High Performance Serial Bus (IEEE 1394).

The command set described has been selected for correct operation when the physical interface is ATA with the ATAPI command protocol. Although some commands are also described in the SPC-2 or the SBC, the descriptions are also in this standard for the purpose of completeness and specification of mandatory and optional command features when applied to multi-media devices.

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

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

2 References

2.1 Normative References

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

Copies of the following documents can be obtained from ANSI:

- approved and draft ANSI standards;

- approved and draft international and regional standards (ISO, IEC, CEN/CENELEC, ITUT);

- approved and draft foreign standards (including BSI, JIS, and DIN).

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, for further information.

Additional availability contact information is provided below as needed.

2.1.1 Approved References

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

ANSI NCITS.336:2000	SCSI Parallel Interface 3 (SPI-3)
ANSI NCITS.351:2001	SCSI-3 Primary Commands (SPC-2)
ANSI INCITS 360:2002	SCSI-3 MultiMedia Command Set 3 (MMC-3)
ANSI NCITS.306:1998	SCSI-3 Block Command Set (SBC)
ANSI NCITS.325:1998	Serial Bus Protocol - 2 (SBP-2)
ANSI NCITS.361:2002	AT Attachment with Packet Interface 6 (ATA/ATAPI-6)
ISO/IEC 3901	International Standard Recording Code (ISRC)
ANSI/ISO/IEC 10149	Information Technology-Data Interchange on Read-only 120 mm Optical Data Discs (CD-ROM).
ANSI/ISO/IEC 16448	120mm DVD Read-Only-Media (DVD-ROM)
ANSI/ISO/IEC 16449	80mm DVD Read-Only-Media (DVD-ROM)
ISO/IEC 16824	120 mm DVD ReWritable Disc (DVD-RAM)
ECMA 330	120 mm 4.7GB and 80 mm 1.46 GB DVD ReWritable Disc (DVD-RAM)
IEC 908:1987	Compact Disc Digital Audio System.
ANSI/IEEE Std 1394A-2000	High Performance Serial Bus

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

2.1.2 References Under Development

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

INCITS T10/xxxxD	SCSI Primary Command Set - 3 (SPC-3)
NCITS.T10/1417D	SCSI-3 Block Command Set - 2 (SBC-2)
INCITS T13/1532D	AT Attachment with Packet Interface 7 (ATA/ATAPI-7)

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

2.2 Other References

The following standards and specifications were also consulted:

System Description Compact Disc Digital Audio ("Red Book"), NV Philips and Sony Corporation. See also IEC 908:1987, Compact Disc Digital Audio System

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

CD-I Full Functional Specification ("Green Book"), NV Philips and Sony Corporation.

System Description Compact Disc Read Only Memory eXtended Architecture (CD-ROM XA), NV Philips and Sony Corporation.

Multi-session Compact Disc Specification, NV Philips and Sony Corporation.

System Description Recordable Compact Disc Systems, part II: CD-R (Orange Book part II), NV Philips and Sony Corporation

System Description Recordable Compact Disc Systems, part III: Compact Disc ReWritable (CD-RW), NV Philips and Sony Corporation

System Description Recordable Compact Disc Systems, part III Volume 2: CD-RW (Orange Book part III, Vol. 2), NV Philips and Sony Corporation

Mt. Fuji5 Commands for Multi-Media devices T10/00-361R2

Content Protection for Recordable Media Specification: Intel, IBM, Matsushita, Toshiba 2000, (CPRM-licensing@4Centity.com)

DVD+RW 4.7 Gbytes Basic Formats Specifications, Revision 1.1, September 2001, DVD+RW Promoters Group, published by Philips Electronics NV

DVD+R 4.7 Gbytes Basic Formats Specifications, Revision 1.0, January 2002, DVD+RW Promoters Group, published by Philips Electronics NV

CD-MRW Defect Management & Physical Formatting Revision 1.0, January 2001, Mount Rainier Promoters Group, published by Philips Electronics NV

DVD+MRW Defect Management & Physical For+RW Formats, Revision 1.1, January 2002, DVD+RW Promoters Group, published by Philips Electronics NV

Multimedia Command Set for the DVD+RW Basic Formats, Revision 1.2, September 2002, DVD+RW Promoters Group, published by Philips Electronics NV

DVD+R Multimedia Command Set Description, Revision 1.0, September 2002, DVD+RW Promoters Group, published by Philips Electronics NV

Multi-Media Command (MMC) Set for the MRW Formats, Revision 1.0, September 2002, DVD+RW Promoters Group, published by Philips Electronics NV

3 Terms and Definitions

3.1 Definitions

3.1.1 ADIP (ADdress In Pre-groove)

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

3.1.2 AGID (Authentication Grant ID)

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

3.1.3 Appendable disc

A disc with a pointer, in the last session, that points to the next possible session.

3.1.4 ASC (Additional Sense Code)

Specifically, this refers to the value stored in byte 12 of the sense information as defined in SPC-2.

3.1.5 ASCQ (Additional Sense Code Qualifier)

Specifically, this refers to the value stored in byte 13 of the sense information as defined in SPC-2.

3.1.6 ATA (AT Attachment)

ATA defines the physical, electrical, transport, and command protocols for the internal attachment of block storage devices. ANSI NCITS.340:2001, AT Attachment with Packet Interface 5 (ATA/ATAPI-5) describes ATA.

3.1.7 ATAPI (AT Attachment Packet Interface)

A device that implements the Packet command Feature set as defined in ANSI NCITS.340:2001, AT Attachment with Packet Interface 5 (ATA/ATAPI-5) is referred to as an ATAPI device or a device with the ATAPI.

3.1.8 ATIP (Absolute Time In Pre-groove)

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

3.1.9 BCA (Burst Cutting Area)

The Burst Cutting Area provides a unique physical identification mark for individual DVD medium. This area is not directly addressable by the user.

3.1.10 BCD (Binary Coded Decimal)

In this numerical representation, a byte contains two four-bit values each with a value from 0 to 9. The high order decimal digit occupies bits 7 through 4 of the byte, while the low order decimal digit occupies the bits 3 through 0 of the byte. Only non-negative values may be represented. The maximum value is 99bcd (99 decimal). Time addressing, track numbering and other information is BCD encoded at the physical format level on CD and DDCD media.

3.1.11 Bootable CD

If a CD has boot records recorded for some specific operating system, then for that operating system, the CD is bootable.

3.1.12 Bordered Area

A Bordered Area is a recorded area on DVD-R/-RW media that has the equivalent purpose as a session (see 3.1.112) on CD-R/-RW media.

3.1.13 C1, C2, C3

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

3.1.14 CDB (Command Descriptor Block)

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

3.1.15 CD (Compact Disc)

CD is a family of related optical storage media.

3.1.16 CD-DA (Compact Disc-Digital Audio)

The disc format for storing digital audio information on CD is referred to as CD-DA. See IEC 908:1987.

3.1.17 CD-R (CD Recordable)

A CD that can be written only once is named CD-R.

3.1.18 CD-ROM (Compact Disc - Read Only Memory)

CD-ROM is used to describe media with digital data rather than discs that encode audio only.

3.1.19 CD-R/RW

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

3.1.20 CD-RW (CD ReWritable)

A CD that can be re-written is named CD-RW.

3.1.21 CD-Text

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

3.1.22 Challenge key

The challenge key is data used during an authentication key exchange process.

3.1.23 Command Packet

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

3.1.24 complete session

A session that contains a completely written Lead-in, Data area, and Lead-out is named complete. In DVD-R a complete session contains a completed Border-In, and a Border-out.

3.1.25 control field

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

3.1.26 CPPM (Content Protection for Prerecorded Media)

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

3.1.27 CPRM (Content Protection for Recordable Media)

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

3.1.28 CIRC (Cross Interleaved Reed-Solomon Code)

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

3.1.29 CSS (Content Scrambling System)

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

3.1.30 DA (MRW Data Area)

On a MRW disc a DA is one of many primary zones of the disc where user data is stored. With the exception of the last DA, each DA contains the same number of sectors. The last DA contains only the remaining undedicated sectors prior to the space reserved for the STA.

3.1.31 data mode

One byte of the header of a CD data sector contains the data mode. This indicates if data is present and if layered error correction information is present. It is also applicable to DDCD data sectors.

3.1.32 DDCD (Double Density Compact Disc)

DDCD refers to a family of related optical storage media with twice the density of CD media.

3.1.33 DDCD-R (DDCD Recordable)

DDCD-R is DDCD media that can be written only once.

3.1.34 DDCD-ROM (Double Density Compact Disc - Read Only Memory)

DDCD-ROM is a standard for storing digital data on read-only media.

3.1.35 DDCD R/RW

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

3.1.36 DDCD-RW (DDCD ReWritable)

DDCD-RW is DDCD media that can be re-written.

3.1.37 Defect Management

Block addressable storage medium can have defects that render some sectors either temporarily of permanently unusable. A storage logical unit may implement a mechanism that provides an apparently defect free address space to the initiator. This mechanism is named Defect Management.

3.1.38 De-Icing

When an ECC block on a DVD-RW or DVD+RW medium is blank, no headers are present in any sector of the ECC block. This means that no sector within that ECC block can be located. This has been described as similar to sliding on ice until crashing into a written area. The process of insuring that each ECC block is written at least once to insure the presence of headers is called De-Icing.

Most read-only CD devices locate the groove only by the presence of data. When no data is present, a seek cannot find a stopping point. Again, this is like having the device actuator slide on ice. Writing the entire surface (formatting) of a CD-RW disc is also referred to de-icing.

3.1.39 Direct-overwrite

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

3.1.40 Disc Key

The Disc Key is a value used during the scrambling process of the title key data on DVD media.

3.1.41 DMA (Defect Managed Area)

A MRW disc contains a logical address space that is completely covered by the defect management system of the MRW format. This logical address space is the Defect Managed Area (DMA). The primary storage space of the DMA is the collection of DAs while the replacements for defective sectors from the DA collection comes from the collection of SAs.

3.1.42 Double Sided

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

3.1.43 Dual Layer

When two separate DVD tracks can be accessed from the one side of the media, the recording is named dual layer. Dual layer Discs are recorded either OTP or PTP.

3.1.44 DVD

DVD is a family of related optical storage media and Logical Units.

3.1.45 DVD Control Data Zone

The DVD Control data zone 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.

3.1.46 DVD Disc Manufacturing Information

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

3.1.47 DVD ECC-Block

The DVD ECC block packs 16 data sectors and then applies a 2 layer error correction.

3.1.48 DVD+R (DVD plus Recordable)

DVD+R is a wobble groove based DVD medium that can be written once.

3.1.49 DVD-R (DVD Recordable)

DVD-R is a smooth groove DVD medium that can be written once.

3.1.50 DVD-RAM (DVD-Random Access Memory)

DVD-RAM is a stamped header based DVD medium that can be re-written.

3.1.51 DVD-ROM (DVD-Read Only Memory)

DVD-ROM is a standard for recording digital data, including digital video movie data.

3.1.52 DVD+RW (DVD ReWritable)

DVD+RW is a wobble groove based DVD media that can be re-written.

3.1.53 DVD-RW (DVD Re-recordable)

DVD-RW is a smooth groove DVD media that can be re-written.

3.1.54 EAN (European Article Number)

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

3.1.55 ECC (Error Correction Code)

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

3.1.56 EDC (Error Detection Code)

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

3.1.57 EFM (Eight bit to Fourteen bit Modulation code)

EFM is the modulation code used in all CD recording. EFM-plus, a modified version of EFM, is the modulation coding used in all DVD recording.

3.1.58 Feature

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

3.1.59 Field

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

3.1.60 Fixed Packet Track

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

3.1.61 Format

As a noun, "format" refers to a well-defined arrangement or layout of information on a medium. Within the confines of the MMC, the verb "format" refers to process started by the FORMAT UNIT command and applies only to Rewritable media.

3.1.62 Frame

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

3.1.63 GAA (General Application Area)

When a disc is formatted as a MRW disc, the GAA is a separately addressed LBA space. The GAA contains of the first 2 MB of user data storage in the program area. This area is not covered by any MRW defect management mechanism. The GAA is defined as a legacy link for CD devices that always view LBA = 0 as being assigned to 00:02:00.

3.1.64 Hex

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

3.1.65 HMSF address (Hour/Minute/Second/Frame)

HMSF is the physical addressing for CD (H is always zero) and DDCD. 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 60. Valid contents of H fields are binary values from 0 through 2.

3.1.66 Hold Track State

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

3.1.67 ID (Identification Data)

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

3.1.68 IED (ID Error Detection)

The IED is an EDC for the ID field in a DVD sector.

3.1.69 Incomplete session

A session in which the Lead-in and Lead-out are unwritten is incomplete.

3.1.70 Index

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

3.1.71 Layer

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

3.1.72 Lead-in

On CD media the Lead-in 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.

3.1.73 Lead-out

On CD media the Lead-out 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 AAh.

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 the 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.

3.1.74 L-EC (Layered Error Correction)

CD data carry a layer of error correction beyond that which is in place for all CD data. This additional layer is named C3, but is often referred to as the L-EC.

3.1.75 Logical Block

The Initiator addressable units of data are named Logical Blocks..

3.1.76 LBA (Logical Block Address)

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

3.1.77 Logical Unit

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

3.1.78 LUN (Logical Unit Number)

The LUN is the address of a Logical Unit via a target.

3.1.79 Magazine

This is a term for multiple disc unit/container.

3.1.80 MCN (Media Catalog Number)

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

3.1.81 MDT (Main Defect Table)

A MRW disc stores its defect mappings and other format management information in this structure. The MDT is written into the MTA - an area in the disc lead-in.

3.1.82 Medium

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

3.1.83 Method 1 Addressing

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

3.1.84 Method 2 Addressing

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

3.1.85 Method 3 Addressing

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

3.1.86 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.

3.1.87 MIP (Main Information Packet)

The Main Information Packet contains information describing the MRW format, status, and defect management system. The MDT is written in the disc lead-in.

3.1.88 MRW (Mount Rainier reWritable)

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

3.1.89 MRW Accessible

At some point during the background formatting process, the Logical Unit provides read/write access for the initiator. Once the Logical Unit is capable of providing access, the media is MRW Accessible.

3.1.90 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. This addressing term has been replaced by the TIME address representation.

3.1.91 MTA (Main Table Area)

The MTA is the MRW disc area in which the MIP and MDT are written.

3.1.92 OPC (Optimum Power Calibration)

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

3.1.93 OTP (Opposite Track Path)

An opposite track path DVD is 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.

3.1.94 output port

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

3.1.95 PTP (Parallel Track Path)

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

3.1.96 Packet

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

3.1.97 packet size

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

3.1.98 packet track

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

3.1.99 Physical Sector Number (PSN)

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

3.1.100 post-gap

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

3.1.101 pre-gap

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

3.1.102 Profile

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

3.1.103 Program Area

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

3.1.104 PMA (Program Memory Area)

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

3.1.105 Regional Code

The regional code is used to identify one or more regions of the world. Currently there are six regions defined.

3.1.106 Region Playback Control (RPC)

RPC limits the playback of DVD-ROM content to specific regions of the world.

3.1.107 relative MSF field

See MSF address definition.

3.1.108 Rzone

A RZone is a logical subdivision of a DVD-R. The RZone may also be referred by the name, track.

3.1.109 SA (Spare Area)

The MRW format provides for some non-zero number of primary data areas (DA) and for some non-zero number of spare areas (SA).

3.1.110 SDT (Secondary Defect Table)

The MRW format requires a back-up copy of the MDT in the program area of the disc. This back-up copy is the SDT.

3.1.111 Sector

In case of CD media, "Sector" refers to the data contained in one CD 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 2 048 bytes.

3.1.112 Session

A session is a contiguous area of a CD or DVD Disc that contains a Lead-in, Program Area, and Lead-out.

3.1.113 Single Sided

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

3.1.114 Small Frame

A small frame is 1/98 of a CD frame.

3.1.115 SIP (Secondary Information Packet)

The Secondary Information Packet contains information describing the MRW defect management system. This is a back-up copy of the MIP.

3.1.116 SK (Sense Key)

Specifically, this refers to the value stored in the low order 4 bits of byte 2 of the sense information as defined in SPC-2.

3.1.117 STA (Secondary Table Area)

This is the MRW disc area in which the SIP and SDT are written.

3.1.118 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 Logical Unit, such as the control field and MSF address. The data rate of each Sub-channel (P, Q, etc.) is 1/192nd of that of the main channel.

3.1.119 TIME addressing

MSF (Minute, Second, Frame) addressing is used for physical sector addressing on CD media. HMSF (Hour, Minute, Second, Frame) addressing is used for physical sector addressing on DDCD media. The general term for physical addressing on either media is TIME addressing.

3.1.120 Title Key

The Title Key is a value used during the scrambling process of movie data on DVD media.

3.1.121 Table of Contents (TOC)

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

3.1.122 Track Descriptor Block (TDB)

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

3.1.123 Track

A track is logical sub-division of CD or DVD media.

3.1.124 Track at Once

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

3.1.125 transition area

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

3.1.126 UPC (Uniform Product Code)

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

3.1.127 Yellow book

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

3.2 List of Acronyms

ADIP	Address In Pre-groove
AGID	Authentication Grant ID
ASC	Additional Sense Code
ASCQ	Additional Sense Code Qualifier
ATA	AT Attachment
ATAPI	AT Attachment Packet Interface
ATIP	Absolute Time In Pre-groove
BCA	Burst Cutting Area
BCD	Binary Coded Decimal
CDB	Command Descriptor Block
CD	Compact Disc
CDZ	Control Data Zone (on DVD media0
CD-DA	CD - Digital Audio
CD-R	CD - Recordable
CD-ROM	CD - Read Only Memory
CD R/RW	a CD-R, a CD-RW, or both
CD-RW	CD ReWritable
CPPM	Content Protection for Prerecorded Media
CPRM	Content Protection for Recordable Media
CIRC	Cross Interleaved Reed-Solomon Code
DA	Data Area
DDCD	Double Density Compact Disc
DDCD-R	DDCD Recordable
DDCD-ROM	DDCD - Read Only Memory
DDCD-R/RW	a DDCD-R, a DDCD-RW, or both
DDCD-RW	DDCD ReWritable
DVD	Digital Versatile Disc
DVD-R	DVD Recordable
DVD-RAM	DVD-Random Access Memory
DVD-ROM	DVD-Read Only Memory
DVD+RW	DVD ReWritable
DVD-RW	DVD Re-recordable
DZ	Data Zone (on DVD media)
EAN	European Article Number
ECC	Error Correction Code
EDC	Error Detection Code
EFM	Eight bit to Fourteen bit Modulation code
GAA	General Application Area
HMSF	Hour/Minute/Second/Frame
ID	Identification Data
IED	ID Error Detection
L-EC	Layered Error Correction
LBA	Logical Block Address
LSB	Least Significant Bit
LUN	Logical Unit Number
MCN	Media Catalog Number
MDT	Main Defect Table
MIP	Main Information Packet
MM	Multi-Media
MRW	Mount Rainier reWritable
MSB	Most Significant Bit
MSF	Minute/Second/Frame
MTA	Main Table Area
OPC	Optimum Power Calibration
OTP	Opposite Track Path
PTP	Parallel Track Path
PMA	Program Memory Area
RPC	Region Playback Control
SA	Spare Area
SDT	Secondary Defect Table
SIP	Secondary Information Packet
SK	Sense Key
STA	Secondary Table Area
TOC	Table of Contents
TDB	Track Descriptor Block
TAO	Track at Once
UPC	Uniform Product Code

3.3 Keywords

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

3.3.1 expected

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

3.3.2 may

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

3.3.3 may not

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

3.3.4 shall

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

3.3.5 should

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

3.3.6 obsolete

A keyword used to describe bits, bytes, fields, and code values that may have been defined in previous standards are not defined in this standard and shall not be reclaimed for other uses in future standards.

However, some degree of functionality may be required for items designated as “obsolete” to provide for backward compatibility. The Initiator should not use obsolete commands or mode pages.

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

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

3.3.7 mandatory

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

3.3.8 optional

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

3.3.9 reserved

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

3.4 Conventions

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

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

Errors shown in mixed case indicate all errors, in that class, are valid.
Errors shown in uppercase refer to the identified specific error condition.

The string SK/ASC/ASCQ refers to the low order 4 bits of byte 2 and bytes 12, and 13 in the referenced Logical Unit's sense data. SK/ASC/ASCQ is used interchangeably with the names associated with the coded values in those sense bytes.

Numbers that are not immediately followed by lowercase “b,” “h,” or “bcd” are decimal values.

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

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

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

Values indicated by a lower case “k” have a base value of 1000 units, i.e. 2kBytes = 2 000 Bytes.
Values indicated by an uppercase “K” have a base value of 1024 units, i.e. 2 Kbytes = 2 048 Bytes.

4 Multi-Media Device Models

4.1 General

A multi-media device is defined primarily by the media it supports: CD, DDCD, DVD and each sub-case: read-only, recordable, or rewritable. Additionally, the devices are also defined by specific capabilities associated with each media type. Multi-media devices may also carry additional capabilities such as integrated media changers.

With each capability, there is modeling that describes it. This clause describes each multi-media device model.

4.1.1 Logical Blocks

Blocks of data are stored on the medium along with additional information that the Logical Unit uses to manage the storage and retrieval. The format of the additional information is unique and is hidden from the Initiator during normal read or write operations. This additional information is often used to identify the physical location of the blocks of data the address 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 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 shall be terminated with CHECK CONDITION status and the SK/ASC/ASCQ values shall be set to ILLEGAL REQUEST/LOGICAL BLOCK ADDRESS OUT OF RANGE.

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. For all multi-media Logical Units, the Block Descriptor Length field in the Mode Data Header shall be cleared to zero. Non-zero values for the Block Descriptor Length field of the Mode Data Header has been made obsolete in this standard for all Logical Units. When accessing the media with READ (10), READ (12), VERIFY (10), or VERIFY (12), the block length shall be 2 048 bytes.

In a typical Logical Unit the logical blocks are located in an ascending order. However, the location of a logical block on the medium is not required to have a specific relationship to the location of any other logical block. 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 any other block on the medium.

4.1.2 Data cache

Most Logical Units implement cache memory. A cache memory is usually an area of temporary storage in the Logical Unit with a fast access time that is used to enhance performance. It exists separately from the blocks of data stored and is normally not directly addressable by the Initiator. Use of cache memory for write or read operations typically reduces the access time to a logical block and can increase the overall data throughput.

During read operations, the Logical Unit uses the cache memory to store blocks of data that the Initiator may request at some future time. The algorithm used to manage the cache memory is not part of this specification. However, parameters are provided to advise the Logical Unit about future requests, or to restrict the use of cache memory for a particular request.

Sometimes the Initiator may request that the blocks of data read from the medium instead of from the cache memory. The force unit access (FUA) bit in the CDBs of some commands is used to indicate that the Logical Unit shall access the physical medium. For a write operation, setting FUA to one causes the Logical Unit to complete the data write to the physical medium before completing the command. For a read operation, setting FUA to one causes the logical blocks to be retrieved from the physical medium.

Commands may be implemented by the Logical Unit that allow the Initiator to control other behavior of the cache memory:

- The MODE SENSE (10) Command defines a page for the control of cache behavior and handles certain basic elements of cache replacement algorithms.
- The SYNCHRONIZE CACHE Command is used by the Initiator to guarantee that data in the cache has been moved to the media.

4.1.3 Resets

Within this standard there are three resets identified. These resets are named:

- Power-On Reset
- Hard Reset
- Device Reset

These resets are used differently in each physical interface referenced. For more information on the use in specific physical interfaces, see the appropriate Annex on implementation notes.

4.1.3.1 Power-On Reset

When power is applied, the Logical Unit 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 Logical Unit 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 Logical Units 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 Device Reset is used to bring a non-responding Logical Unit into an 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 condition and Power Management Event Notification shall be generated. Logical Unit should:

- Reset Initiator interface circuitry.
- Perform hardware initialization and device-internal diagnostics only if necessary.
- Do not revert to the default conditions, Logical Unit Number or TOC information.
- Stay in the current Power State.
- Not change Persistent Prevent state.
- Reset Key management to the default state.

4.1.4 Error reporting

If an initiator issues a command other than GET CONFIGURATION, GET EVENT/STATUS NOTIFICATION, INQUIRY or REQUEST SENSE while a unit attention condition exists for that initiator, the logical unit shall not perform the command and shall report CHECK CONDITION status unless a higher priority status as defined by the logical unit is also pending.

Typically, if any of the conditions in Table 1 occur during the execution of a command, the target shall return CHECK CONDITION status ant the logical unit shall set the appropriate SK/ASC/ASCQ values.

Table 1 – Sample Sense key Responses for Error Reporting

Condition	Sense Key
Recovered read error	RECOVERED ERROR[1]
Attempt to access media when no media is present	NOT READY
Un-recovered read error	MEDIUM ERROR/HARDWARE ERROR
Invalid Logical Block Address	ILLEGAL REQUEST
Self diagnostic failed	HARDWARE ERROR
Reset or medium change since last command	UNIT ATTENTION
Overrun or other error that might be resolved by repeating the command	ABORTED COMMAND
Note 1: Mode parameters may be selected in order to specify this behavior. Mode parameters may also be selected in order that the same condition should return GOOD status and set the sense key to NO SENSE.	

In the event that the error is associated with a specific logical block address, the sense data information field shall be set to that logical block address.

4.1.5 Deferred 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. These commands are associated with the use of the immediate bit or some forms of write caching. Multi-media Logical Units that implement these features shall implement deferred error reporting.

Returning CHECK CONDITION status to the Initiator as described below may indicate a deferred error. Sense data associated with the CHECK CONDITION shall contain 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 multi-media Logical Unit detects a deferred error condition in 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 Initiator.

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 Initiator. 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 Logical Unit is capable of performing read operations to the medium. A mounted disc may not be accessible by an Initiator, if another Initiator has reserved it. A disc is de-mounted at any other time (e.g. during loading, unloading, or storage).

An Initiator may check whether a disc is mounted by issuing a TEST UNIT READY command. In addition, there now exists a REMOVABLE MEDIUM Feature. This allows the Initiator 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 an Initiator to restrict the de-mounting of the disc. This is useful in maintaining system integrity. If the Logical Unit implements cache memory, it shall ensure that all logical blocks of the medium contain the most recent data prior to permitting de-mounting of the disc. If the Initiator 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 Logical Unit.

When the Persistent Prevent state is entered, the media shall remain locked in the Logical Unit, until the Initiator 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 Initiator. This allows the user to remove incorrectly inserted media without having to wait for Initiator 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. If a Logical Unit allows an eject between generating and reporting the NEW MEDIA event, the Logical Unit shall remove the NEW MEDIA event(s) from the Event queue. When the Initiator receives the Eject Request and determines that it is safe to eject the medium, an eject command (START STOP UNIT command with LoEj bit set to one) will be issued. At that time the Logical Unit shall eject the medium. The Persistent Prevent State shall be retained.

The Logical Unit shall only generate GET EVENT/STATUS NOTIFICATION (EJECT REQUEST) events after reporting a GET EVENT/STATUS NOTIFICATION (NEW MEDIA) event, and prior to reporting a GET EVENT/STATUS NOTIFICATION (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 Initiator enables the support using the PREVENT ALLOW MEDIUM REMOVAL command, the Logical Unit shall respond as described in this specification. When the Initiator disables this Feature, the Logical Unit shall 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 shall be processed exactly the same as they would be if Persistent Prevent was not enabled. For compatibility reasons, a unit attention condition shall be generated. Execution of the GET EVENT/STATUS NOTIFICATION command does not include terminating with CHECK CONDITION status when a unit attention condition is pending. For example, if the user inserts a new medium and the Logical Unit is accessed with a command, a unit attention condition shall be generated, but the Logical Unit shall also report the NEW MEDIA Event with the next available GET EVENT/STATUS NOTIFICATION (Media Status) command.

4.1.7 The MRW Format for ReWritable Media

The Mount Rainier Format for ReWritable media (MRW) provides an approach to defect management on MM rewritable media that maintains read-only backward compatibility for devices that do not understand MRW and yet providing a measure of overwrite protection from those same devices.

4.1.7.1 Overview

A MRW format cannot be defined for all media, however the specific requirements are minimal:

- The media must consist of a continuously recordable zone that is divided into a lead-in area, followed by a user data area, followed by a lead-out area. See .
- The medium must be randomly rewritable.
- From the Initiator's perspective, the recordable block size and readable block size must be equal and fixed at 2 048 bytes. If the low-level writable block size is greater than 2 048 bytes, then that block size shall be an integral multiple of 2 048 and an integral divisor of 65 536.
- The basic medium format must allow blocks to be written in the lead-in without interfering with the basic medium format.
- The media must have a firm, traditional definition for the physical location of LBA 0.

General Structure of MRW Candidate Media

Lead-in	User Data Area	Lead-out

Each area is redefined by the MRW format as shown in :

- A Main Table Area (MTA) is reserved from the lead-in. The MTA contains structures that identify the media format and structures for management of the defect replacement system. Parts LI1 and LI2 are not used by the MRW format and either or both may be zero in length.
- The General Application Area (GAA) provides minimally 2 Megabytes (2 097 152 bytes) of user space and must align its logical address space exactly with the logical address space associated with the traditional media format.
- The Defect Managed Area (DMA) contains both primary user data zones and spare sector zones. The layout is media specific. The DMA is independently addressable, so it contains its own well-defined LBA 0. The actual spared block size must be an integral multiple of 2 048, but not larger than the low-level writable block size.
- Following the DMA is the Secondary Table Area (STA). The STA is a backup copy of the MTA. The STA provides a way for a Initiator to access the MRW structures when connected to a device that is not MRW capable.
- The MRW format may affect the traditional start location of the disc lead-out (LO), but MRW stores no structural information in the disc LO.

Main Areas Defined by MRW

Lead-in			User Data Area			Lead-out
LI1	MTA	LI2	GAA	DMA	STA	LO

4.1.7.2 Consequences of a Multi-Volume Format

The Mount Rainier format is multi-volume. This simply means that a single, physical medium represents more than a single logical volume. In the case of Mount Rainier, the number of volumes is 2: the GAA and the DMA.

4.1.7.2.1 LBA Spaces

Two distinct LBA spaces - one for each logical volume - must be provided and under normal Initiator accesses, action on one volume cannot modify data on the other volume. The MRW Logical Unit provides a simple method to select between address spaces: the MRW Mode Page.

When a command references the media by LBA, the result is dependent upon the currently selected LBA Space.

4.1.7.2.2 Features and Events

The feature sets associated with GAA and DMA are different. In particular, the DMA has the Defect Management Feature, while the GAA does not.

When a MRW formatted (or formatting) disc is mounted, the Logical Unit shall always default to the LBA Space of the DMA. If the Initiator chooses to select the GAA, then the Logical Unit shall generate a Morph Event and change the set of features that are marked current.

4.1.7.3 Initiator Requests/Logical Unit Responses

When the DMA is the current LBA Space of a MRW disc, the Removable Medium, Random Read, Random Write, Formattable, and Defect Management Features are current. Since the Core, Morphing, Time-out, and Power Management Features are common to all defined Profiles, the DMA volume has the Removable Disk Profile as current. Consequently, the Initiator may view the DMA volume of the MRW disc as a removable magnetic medium with a 2 048-byte sector size.

4.1.7.3.1 Streamed Writing

MRW requires streamed writing. This simply disables the defect management system during the streamed writing, thereby providing a writing method that yields fixed rate data flows principally for video applications. Streamed writing uses only the primary user space. The spare area is not used. The MRW format has no mechanism for tracking areas that are stream written versus areas that are not stream written. The Initiator must provide its own mechanism.

The WRITE (12) command is used to control and utilize the streamed write capability. A "streamed" bit in the command descriptor block declares that the data should be written without utilizing the defect management system.

The READ (12) command is used to read streamed written data. A "streamed" bit in the command descriptor block tells the Logical Unit to disable use of the defect management system and to ignore data errors.

4.1.7.3.2 Formatting

In order to assure that a disc be recognized as a MRW disc, physically blank media or media with a non-MRW format must be written. In many cases the entire surface must be written or rewritten. This can require quite a lot of time. For this reason, MRW requires that most of the formatting occur in background. This must be done in such a way that the media is accessible for reading and writing as soon as possible.

Background formatting has specific definitions for specific media, but the following general rules apply:

- Some minimal amount of formatting must be done in foreground: initialization of the disc lead-in and GAA. Once this has been performed, the operation can go to background time.
- The Logical Unit must support a mechanism for format suspension and restart.
- The Logical Unit must always make current format status available to the Initiator.

Details of how background formatting operates relative to the Initiator are to be found in the description of the FORMAT UNIT Command.

4.2 CD Device Model

The CD device model is driven by the CD media organization and data formats.

4.2.1 Recorded CD Media Structure

A CD medium is an 80mm or 120mm disc with a continuously recorded physical track beginning near a diameter of 50mm and spiraling outward to a diameter near 78mm or 118mm.

4.2.1.1 The CD Frame Structure

Data is recorded in a continuous stream of Small Frames. Each byte of a Small Frame is encoded with an 8 bit to 14bit modulation (EFM) code. Three merging bits are appended. The merging bits are chosen to provide minimum low-frequency signal content and optimize phase lock loop performance. Each Small Frame consists of 588 EFM bits (see Table 2). Small Frame is defined in clause 3.1.

Table 2 – Small Frame layout and definition

1 synchronization pattern (24 + 3 bits)	1 byte of Sub-channel data (14 + 3 bits)	12 bytes of main channel data (12 x (14 + 3) bits)	4 bytes of CIRC code (4 x (14 + 3) bits)	12 bytes of main channel data (12 x (14 + 3) bits)	4 bytes of CIRC code (4 x (14 + 3) bits)
588 bits					

A CD frame consists of 98 contiguous Small Frames. This yields 24*98 = 2 352 bytes of main channel data per frame and 98 bytes of Sub-channel data per CD frame. A recorded CD is a succession of CD frames. For audio, the bounds of a Frame are defined by the Sub-channel bytes. For data, the bounds are determined by the sync bytes in the main channel data.

The 98 Sub-channel bytes are separated into 2 bytes of synchronization and 96 bytes of data. Each CD frame begins with the first Sub-channel sync byte and ends with the 96th Sub-channel data byte. A CD frame is constructed from Small Frames as shown in Table 3. This is a logical representation since Small Frames are physically interleaved. This means that precise CD frame boundaries do not exist.

Table 3 – CD Frame Structure from Small Frames

F	.	.	.
R	.	.	.
A	Small Frame 94	Sub-channel Data Byte 92	24 bytes main channel data
M	Small Frame 95	Sub-channel Data Byte 93	24 bytes main channel data
E	Small Frame 96	Sub-channel Data Byte 94	24 bytes main channel data
	Small Frame 97	Sub-channel Data Byte 95	24 bytes main channel data
N	Small Frame 98	Sub-channel Data Byte 96	24 bytes main channel data
F	Small Frame 1	Sub-channel Sync Byte 1	24 bytes main channel data
R	Small Frame 2	Sub-channel Sync Byte 2	24 bytes main channel data
A	Small Frame 3	Sub-channel data byte 1	24 bytes main channel data
M	.	.	.
E	.	.	.
	Small Frame 97	Sub-channel data byte 95	24 bytes main channel data
N+1	Small Frame 98	Sub-channel data byte 96	24 bytes main channel data
F	Small Frame 1	Sub-channel sync byte 1	24 bytes main channel data
R	Small Frame 2	Sub-channel sync byte 2	24 bytes main channel data
A	Small Frame 3	Sub-channel data byte 1	24 bytes main channel data
M	Small Frame 4	Sub-channel data byte 2	24 bytes main channel data
E	Small Frame 5	Sub-channel data byte 3	24 bytes main channel data
	.	.	.
N+2	.	.	.

4.2.1.2 Sub-channel

Each non-sync byte of Sub-channel is labeled according to bit position, See Table 4.

Table 4 – Sub-Channel byte layout

Small Frame Sub-channel Byte							
P	Q	R	S	T	U	V	W
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

Over the 98 Small Frames, the Sub-channel is separated into bytes associated with the Sub-channel letter. The Sub-channel sync bytes are not a part of Sub-channel data, so there are 96 bytes of Sub-channel. For example, the P Sub-channel is separated into bytes as shown in Table 5.

Table 5 – P-Sub-Channel Layout

Small Frame	P Bit	P Byte
1	SYNC 0	-
2	SYNC 1	-
3	7	0
4	6	
5	5	
6	4	
7	3	
8	2	
9	1	
10	0	
11	7	1
12	6	
13	5	
14	4	
15	3	
16	2	
17	1	
18	0	
•	•	•
•	•	•
•	•	•
•	•	•
•	•	•
•	•	•
83	7	10
84	6	
85	5	
86	4	
87	3	
88	2	
89	1	
90	0	
91	7	11
92	6	
93	5	
94	4	
95	3	
96	2	
97	1	
98	0	

The byte construction for other (Q - W) Sub-channels is identical.

P and Q Sub-channels provide information about the recording.

R-W Sub-channel is defined only for audio tracks. When used, it carries line graphics, MIDI Control, or text. In that case, specific formatting of the resulting data defines the meaning. Consult the appropriate format documents. For data tracks, R-W sub-channels shall be set to zeros.

4.2.2 Physical Track Topology: Single Session Disc

CD players and readers follow the physical track by following the path of recorded EFM data. When there is no EFM data, the player/reader is unable to follow the physical track.

The physical track is divided into 3 logical entities from the inner radius:

Lead-in	Program Area	Lead-out

Inner Radius ——————▶ Outer Radius

Figure 1 – Single Session disc

LEAD-IN - The Lead-in is a zone of protection from unrecorded areas near the disc center. The Lead-in also contains the table of contents (TOC) for the disc's Program Area.

PROGRAM AREA - This is also known as the user area of the disc. For example, on an audio CD, this is where the music is recorded.

LEAD-OUT - The Lead-out is a zone of protection from unrecorded areas toward the disc's outer edge.

4.2.3 Physical track topology - Multi-Session Disc

A Session is the recorded sequence: Lead-in, program area, Lead-out. The multi-session allows a single disc to have several concatenated sessions.

CD-ROM devices are not typically capable of reading through unrecorded areas on the medium. The CD-ROM device needs EFM data in order to find and stay in the physical track. This means that to ensure that a CD-ROM Logical Unit is capable of accessing all areas of a Program Area, the Program Area needs the protection zones of Lead-in and Lead-out. On a recorded disc, sessions may appear as shown in Figure 2.

Session 1 Lead-in (disc lead-in)	Session 1 Program Area	Session 1 Lead-out	Session 2 Lead-in	Session 2 Program Area	....

....	Last Session Lead-in	Last Session Program Area	Last Session Lead-out

Figure 2 – Multi-Session Recorded Disc

In order to assure readability by CD-ROM Logical Units, the recording system should always close the session with the most recently added program area before attempting interchange.

Additional information is needed in order to locate all of the program areas. This is accomplished by using Mode 5 Q in the Lead-in areas.

4.2.3.1 Tracks

The Program Area of the disc is divided into logically separated areas called tracks. There shall be at least one track in the Program Area. There may be gaps between tracks, primarily to provide a zone of digital silence between audio program selections. P Sub-channel is reserved for identifying these transition areas between tracks. The normal value for P is 0. During a transition area, the value for P is 1.

4.2.3.2 Frame Addressing

CD was originally developed for playing digital audio that has two channels of 16-bit samples at 44.1KHz. The number of frames per second of play is 75:

4 bytes/Sample*44 100 Samples/second = 176 400 bytes/second

176 400 bytes/second / 2 352 bytes/frame = 75 frames/second

Given this, CD frames are addressed in terms of audio play time, i.e. Minute, Second, and Frame (MSF). The traditional value of 60 seconds per minute is followed.

In all cases, when an address appears as part of the CD format, it is in MSF format using 2 bcd digits per time unit. This limits the time addressing on the disc to 99bcd minutes. The representation for a time based address is MM:SS:FF, where MM = minutes, SS = seconds, and FF = frames.

Addressing in the program area begins with 00:00:00. This advances up through the Lead-out.

The last frame in the Lead-in is 99:59:74 and decreases as the physical track is followed toward the center of the disc. The Lead-in is typically 3 to 4 minutes in length.

4.2.3.3 Q Sub-channel

Since an audio CD frame has no address field built into the main channel, the address is carried in the Q Sub-channel. Q Sub-channel may also carry information about the logical structure of the disc, disc identification, and music track identification. The general format of a Q Sub-channel record is shown in Table 6.

Table 6 – Q Sub-channel record format

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

Because the sync bits and the two bytes of CRC are overhead, the valid Q information length is actually 10 bytes.

4.2.3.4 Q Sub-channel in the Program Area

During the program area 3 types of Q Sub-channel may be encountered, Mode-1 Q, Mode-2 Q, or Mode-3 Q.

4.2.3.4.1 ADR=1 (0001b) – Mode-1 Q

Mode 1 Q occupies at least 9 out of 10 successive CD frames. Mode-1 Q in the program area is also referred to as current position Q. The Mode-1 Q format during data and audio tracks is shown in Figure 3.

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

Figure 3 – Q Sub-channel Mode-1 Format recorded in Program Area

TNO	=	01 to 99bcd is the track number
INDEX	=	00 to 99bcd is the Index to TNO. An audio track may be divided into up to 99 sections, identified by a non-zero index. The first indexed area in a track shall be 01. Most audio discs have only one indexed area per track. The pre-gap is the part of a track-to-track gap that belongs to the following track. In a track's pre-gap, the track number is that of the following track and the INDEX is 00.
MIN, SEC, FRAME	=	Is the relative time within the track encoded as 6 BCD digits. This is 00:00:00 at track start and advances through the track. During the pre-gap the time decreases.
ZERO	=	8 bits of zero (00000000b)
AMIN, ASEC, AFRAME	=	Is the program area absolute time address expressed in 6 BCD digits.

4.2.3.4.2 ADR=2 (0010b) – Mode-2 Q

Mode-2 Q is optional. If Mode-2 Q is present, it shall occupy 1 out of each 100 successive frames. The Mode-2 Q data format is shown in Figure 4.

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

Figure 4 – Q Sub-channel Mode-2 Format

The DATA-Q field is 52 bits long, organized as 13 nibbles (N1 – N13), each carrying a single BCD digit. The resulting BCD string is the Media Catalog Number (MCN). 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 as 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.

4.2.3.4.3 ADR=3 (0011b) – Mode-3 Q

Mode-3 Q is optional. 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 an audio track. This is done by means of the International Standard Recording Code (ISRC). The ISRC, as recorded on the media, is defined in Figure 5. If no ISRC is used, Mode-3 shall be deleted. During the Lead-in and Lead-out, Mode-3 is not present on the disc. The ISRC may only change immediately after the Track Number (TNO) has been changed. The Mode-3 data format is shown in Figure 5.

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

Figure 5 – Q Sub-channel, Mode-3 Format

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 6-bit cells, coded as shown in Table 7. The characters I6 - I12 are coded in 4 bit BCD numbers.

I1 - I12 define the ISRC.

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

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

Table 7 – ISRC 6 bit character codes (in hexadecimal)

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

4.2.3.5 Q Sub-channel in the Lead-out Area

Q Sub-channel in the Lead-out area is similar to Q Sub-channel in the program area. The differences are:

Mode-1 Q Sub-channel: TNO = AAh, INDEX = 01bcd

Mode-2 Q Sub-channel: No differences.

No other Q Sub-channel modes are allowed in the Lead-out area.

4.2.3.6 Q Sub-channel in the Lead-in Area

Q Sub-channel in the Lead-in area is referred to as the Table of Contents (TOC).

Three modes of Q are allowed in the Lead-in area: Mode-1 Q, Mode-2 Q, and Mode-5 Q.

4.2.3.6.1 Mode-1 Q

The Mode-1 Q format during the Lead-in is shown in Figure 6. TNO is always 00 during the Lead-in and ZERO is always 00 during the Lead-in. Variations of Mode-1 Q are defined by the value of POINT.

ADR	**DATA-Q**								
0001	TNO=00	POINT	MIN	SEC	FRAME	ZERO=00	PMIN	PSEC	PFRAME

Figure 6 – Q Sub-channel Mode-1 Format recorded in Lead-in

POINT = 01bcd – 99bcd is the track number of the track being defined.

MIN, SEC, FRAME	=	Running time in the Lead-in, encoded as BCD
PMIN, PSEC, PFRAME	=	Track start time, encoded as BCD

POINT = A0h

MIN, SEC, FRAME	=	Running time in the Lead-in, encoded as BCD
PMIN	=	Track number of the first track in the program area, encoded as BCD
PSEC	=	Program area format: 00h - CD-DA or CD-ROM
		10h - CD-I
		20h - CD-ROM-XA
PFRAME	=	0

POINT = A1h

MIN, SEC, FRAME	=	Running time in the Lead-in, encoded as BCD
PMIN	=	Track number of the last track in the program area, encoded as BCD
PSEC, PFRAME	=	0, 0

POINT = A2h

MIN, SEC, FRAME	=	Running time in the Lead-in, encoded as BCD
PMIN, PSEC, PFRAME	=	Start time of Lead-out, encoded as BCD

4.2.3.6.2 Mode-2 Q

Mode-2 Q Sub-channel is defined the same in the Lead-in, program area and Lead-out.

4.2.3.6.3 Mode-5 Q

Mode-5 Q Sub-channel provides additional information about CD-R and CD-RW recordings. The format of a Mode-5 Q Sub-channel is shown in Figure 7. TNO is always 00 during the Lead-in. Variations of Mode-5 Q are defined by POINT.

ADR	**DATA-Q**								
0101	TNO	POINT	MIN	SEC	FRAME	ZERO	PMIN	PSEC	PFRAME

Figure 7 – Q Sub-channel Mode-5 Format recorded in Lead-in

POINT = 01…40 (Audio only: This identifies a specific playback skip interval)

MIN, SEC, FRAME	=	Skip interval stop time in 6 BCD digits
ZERO	=	00
PMIN, PSEC, PFRAME	=	Skip interval start time in 6 BCD digits

POINT = B0h (multi-session disc)

MIN, SEC, FRAME	=	the start time for the next possible session's program area. A final session is indicated MIN, SEC, FRAME = FFh:FFh:FFh or when the Mode-5 point B0 is absent.
ZERO	=	the number of different Mode-5 pointers present.
PMIN, PSEC, PFRAME	=	the maximum possible start time of the outermost Lead-out

POINT = B1h (Audio only: This identifies the presence of skip intervals)

MIN, SEC, FRAME	=	00, 00, 00
ZERO	=	00
PMIN	=	the number of skip interval pointers
PSEC	=	the number of skip track assignments in POINT=B2, B3, and B4
PFRAME	=	00

POINT = B2h, B3h, B4h (Audio only: This identifies tracks that should be skipped during playback)

MIN	=	01-99bcd, track number to skip upon playback
SEC	=	00-99bcd, track number to skip upon playback, 00 if no skip track is specified
FRAME	=	00-99bcd, track number to skip upon playback, 00 if no skip track is specified
ZERO	=	00
PMIN	=	00-99bcd, track number to skip upon playback, 00 if no skip track is specified
PSEC	=	00-99bcd, track number to skip upon playback, 00 if no skip track is specified
PFRAME	=	00-99bcd, track number to skip upon playback, 00 if no skip track is specified

Note: Skip intervals are seldom written by recorders and typically ignored by readers.

POINT = C0h (Together with POINT=B0h, this is used to identify a multi-session disc)

MIN, SEC, FRAME	=	ATIP values from Special Information 1, ID=101 (See)
ZERO	=	00
PMIN, PSEC, PFRAME	=	Start time of the first Lead-in area of the disc

4.2.3.7 CD Main Channel Block Formats

Although some are rarely used, there are 6 main channel frame formats defined. Audio blocks are recorded unmodified. Data blocks are given a synchronization field at the beginning of the block. The pattern is shown in Figure 8.

00h	FFh	FFh	FFh	FFh	FFh	FFh	FFh	FFh	FFh	FFh	00h

Figure 8 – Synchronization Field pattern

The synchronization field is followed by a 4 byte header defined in Table 8. After the sync pattern the remaining bytes of the data block are scrambled with a feedback mechanism. This is done with a 15-bit shift register fed back according to the polynomial $X^{15}+X+1$.

Table 8 – Sync Pattern Block Header

Header Offset	Header Byte	Content
0	Minute	Program area time of block, minute component (00-79 bcd)
1	Second	Program area time of block, second component (00-59 bcd)
2	Frame	Program area time of block, frame component (00-74 bcd)
3	Mode	Bits 1, 0 = Data Mode, Bits 7 -.5 = block indicator field, Bits 4 - 2 = Reserved. When Bits 7 – 5 = 000 indicates user data.

Mode byte Format is shown below:

Bits 7, 6, 5	= 000	-	User Data block
	= 001	-	Fourth Run-in block
	= 010	-	Third Run-in block
	= 011	-	Second Run-in block
	= 100	-	First Run-in block
	= 101	-	Link block. Physical linking of EFM data
	= 110	-	Second Run-out block
	= 111	-	First Run-out block
Bits 4, 3, 2	= 000	-	Reserved
Bits 1, 0	= 00		Mode 0 Data
	= 01	-	Mode 1 Data
	= 10	-	Mode 2 Data
	= 11	-	Reserved

4.2.3.7.1 Block Format for Audio

Audio is streamed, so only user data resides within the frame. See the READ CD command description for byte ordering.

4.2.3.7.2 Block Format for Mode 0 Data

Mode 0 is a rarely used format as it is zero filled in the entire user data area. Mode zero data (Table 9) has the following format.

Table 9 – Mode Zero Data Format

Byte Offset	Field Length	Content
0	12	Data Block Sync pattern
12	3	Block MSF address (BCD)
15	1	Data mode = 0
16	2 336	User data (each byte is zero)

4.2.3.7.3 Block Format for Mode 1 Data

Mode 1 data (Table 10) is most prevalent in CD-ROM applications. The sync pattern, header and user data are protected by a 32-bit CRC. Two additional layers of error correction, P and Q, collectively called Level 3 correction cover the header and user data. This is also referred to as Layered error correction (L-EC or C3).

Table 10 – Mode 1 Data Format

Byte Offset	Field Length	Content
0	12	Data Block Sync pattern
12	3	Block MSF address (BCD)
15	1	Data mode = 01
16	2 048	User data
2064	4	CRC (P = $(X^{16}+X^{15}+X^2+X^1)*(X^{16}+X^2+X+1)$) Bytes 0 -2 063
2068	8	Zero fill
2076	172	P parity symbols
2248	104	Q parity symbols

The coverage of the CRC is the sync pattern, Header, and the User Data.

The coverage of Level 3 P is Header, User Data, CRC, and the zero fill.

The coverage of Level 3 Q is Header, User Data, CRC, the zero fill, and the P parity.

4.2.3.7.4 Block Format for Mode 2 Data

Mode 2 data blocks have two types: formless and formed. Mode 2 formed blocks have two forms: form 1 and form 2.

4.2.3.7.4.1 Block Format for Mode 2 formless Data

The Mode 2 formless block format (Table 11) is rarely used. There is no defined CRC or additional correction.

Table 11 – Mode 2 formless block format

Byte Offset	Field Length	Content
0	12	Data Block Sync pattern
12	3	Block MSF address (BCD)
15	1	Data mode = 2
16	2 336	User data

4.2.3.7.4.2 Block Format for Mode 2 form 1 Data

The Mode 2 form 1 block format (Table 12) is regularly used in recorder applications and Video CD movies. The Mode 2 form 1 format is very similar to Mode 1 format. The differences are:

- The 8 zero fill bytes have been moved to between the header and user data as two copies of a 4 byte sub-header.
- The CRC, P-parity, and Q-parity do not cover the block header. This assures the ability of relocating data, including all parity symbols.

Table 12 – Mode 2 form 1 data format

Byte Offset	Field Length	Content
0	12	Data Block Sync pattern
12	3	Block MSF address (BCD)
15	1	Data mode = 2
16	4	Sub-header, first copy
20	4	Sub-header, second copy
24	2 048	User data
2072	4	CRC ($P = (X^{16}+X^{15}+X^{2}+X^{1})*(X^{16}+X^{2}+X+1)$) Bytes 16 - 2 071
2076	172	P parity symbols
2248	104	Q parity symbols

The format of the sub-header is shown in Table 13.

Table 13 – Mode 2 Formed Sector Sub-header Format

Sub-Header Byte	Byte Name	Definition
0	File number	Identifies the file to which the block belongs
1	Channel number	Playback channel selection
2	Sub-mode	Bit 7: End-of-File
		Bit 6: Real-time block
		Bit 5: Form (0 = Form 1, 1 = Form 2)
		Bit 4: Trigger Block
		Bit 3: Data Block
		Bit 2: Audio Block (not traditional CD-DA audio)
		Bit 1: Video Block
		Bit 0: End-of-Record
3	Coding information	

4.2.3.7.4.3 Block Format for Mode 2 form 2 Data

Mode 2 form 2 data (Table 14) is regularly used in Video CD movies. The data is optionally covered by CRC within the last 4 bytes of the block.

Table 14 – Mode 2 form 2 data format

Byte Offset	Field Length	Content
0	12	Data Block Sync pattern
12	3	Block MSF address (BCD)
15	1	Data mode = 2
16	4	Sub-header, first copy
20	4	Sub-header, second copy
24	2 324	User data
2348	4	Optional CRC Bytes 16 - 2 347

4.2.3.8 CD Recordable and CD ReWritable Media Structure

An unrecorded CD-R or CD-RW disc does not have any EFM present to find the physical track in the traditional way of CD-ROM Logical Units. A blank CD-R or CD-RW is not smooth, it is pre-grooved and the groove has a built-in wobble for the purpose of defining and finding the physical track.

The wobble is a 22.05kHz signal (at 1X) modulated with digital information. The time position within the pre-groove is contained in each pre-groove frame of 42 bits. This is known as Absolute Time In Pre-groove (ATIP, see Table 15).

Table 15 – ATIP format

ATIP Frame Item	Content
Sync (4 bits)	Synchronization nibble
Minute (8 bits)	Absolute disc time: Minute (BCD)
Second (8 bits)	Absolute disc time: Seconds (BCD)
Frame (8 bits)	Absolute disc time: Frame (BCD)
CRC (14 bits)	CRC protection

In the area that is expected to be the disc's Lead-in, additional information is interleaved between positional ATIP frames. The additional information provided is:

- First possible start time for disc Lead-in (TOC)
- Last possible start time for disc Lead-out
- Special information about recording permissions
- Power and speed requirements for recording the medium
- CD-R vs. CD-RW medium

4.2.3.8.1 CD-R/RW Disc Management

CD-R/RW discs have two additional areas prior to the first Lead-in, the Power Calibration Area (PCA), and the Program Memory Area (PMA). See Figure 9.

PCA - The Power Calibration Area (PCA) is present only for CD-R and CD-RW media for the purpose of write power calibration. The PCA is divided into two areas: the test area and the count area. The test area is divided into 100 calibration partitions. The count area is an accounting area for recording usage of the test area.

PMA - The Program Memory Area is present only for CD-R and CD-RW media for the purpose of accounting for the usage of user data areas on the medium. This information is contained only within the Sub-channel of the PMA frames. The main channel content is not defined within the PMA.

Update the PMA means to update the PMA on the disc or to update the PMA Cache, that shall be written to the PMA on the disc prior to the removing the disc from the Logical Unit. PMA Caching is vendor specific.

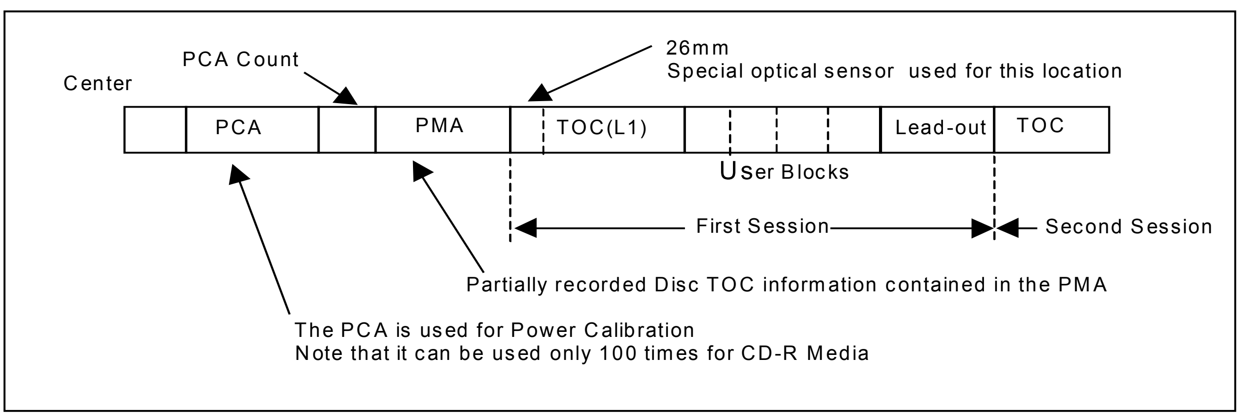


Figure 9 – CD-R and CD-RW medium

4.2.3.8.2 PMA Q Sub-channel

The PMA is a temporary TOC to be used as a disc is being recorded in increments. The format of the Q Sub-channel for PMA entries is similar to those in the Lead-in.

The PMA is recorded in groups of 10 frames called a PMA unity. If any of the frames in a unity is recorded, then all frames in the unity shall be recorded. A given PMA entry shall appear either 5 or 10 times within a unity.

Q Sub-channel in the PMA has the general form shown in Figure 10.

ADR	DATA-Q								
0001-0110	TNO	POINT	MIN	SEC	FRAME	ZERO	PMIN	PSEC	PFRAME

Figure 10 – PMA, Q Sub-channel

Mode-1 Q Sub-channel in the PMA is a TOC item:

TNO	=	00
POINT	=	Track number encoded as two BCD digits.
ZERO	=	00-09bcd is a label of the frame number in the PMA unity
MIN, SEC, FRAME	=	Track stop time in 6 BCD digits.
PMIN, PSEC, PFRAME	=	Track start time in 6 BCD digits.

Mode-2 Q Sub-channel in the PMA is a Disc Identification item (optional):

TNO	=	00
POINT	=	00
ZERO	=	00-09bcd is a label of the frame number in the PMA unity
MIN, SEC, FRAME	=	Disc identification as a 6 BCD digit number.
PMIN	=	00
PSEC	=	Sessions format: 00 - CD-DA or CD-ROM, 10 - CD-I, 20 - CD-ROM-XA
PFRAME	=	00

Mode-3 Q Sub-channel in the PMA is a Skip track item (optional, audio only):

TNO	=	00
POINT	=	01-21bcd is the mode-3 index of this item
ZERO	=	00-09bcd is a label of the frame number in the PMA unity
MIN	=	01-99bcd track number to skip upon playback
Each of the following:	=	00 if no skip track is specified
SEC, FRAME	=	01-99bcd (each byte) track number to skip upon playback
PMIN, PSEC, PFRAME		

Mode-4 Q Sub-channel in the PMA is an unskip track item (optional, audio only):

TNO	=	00
POINT	=	01-21bcd is the mode-4 index of this item
ZERO	=	00-09bcd is a label of the frame number in the PMA unity
MIN	=	01-99bcd track number to unskip upon playback
Each of the following:	=	00 if no unskip track is specified
SEC, FRAME	=	01-99bcd (each byte) track number to unskip upon playback
PMIN, PSEC, PFRAME		

Mode-5 Q Sub-channel in the PMA is a skip interval item:

TNO	=	00
POINT	=	01-40bcd is the mode-5 index of this item
ZERO	=	00-09bcd is a label of the frame number in the PMA unity
MIN, SEC, FRAME	=	Skip interval stop time in 6 BCD digits.
PMIN, PSEC, PFRAME	=	Skip interval start time in 6 BCD digits.

Mode-6 Q Sub-channel in the PMA is an “unskip interval” item:

TNO	=	00
POINT	=	01-40bcd is the mode-6 index of this item
ZERO	=	00-09bcd is a label of the frame number in the PMA unity
MIN, SEC, FRAME	=	Unskip interval stop time in 6 BCD digits.
PMIN, PSEC, PFRAME	=	Unskip interval start time in 6 BCD digits.

4.2.3.9 Recording

Blank CD-R is not randomly writable. CD-RW is limited in its random write capability. Due to the interleaved nature of CD frames, blank media shall be recorded in groups of frames with linkage for appending new recording.

There are two methods for linking separate writes on CD-R or CD-RW:

Audio - Linkage occurs within a single frame time. This assures that locating the linkage frame by its Q at a later time is nearly impossible.

Data - Since it is necessary to locate exact boundaries of user blocks, additional padding is inserted around the linkage frame. The collection of the link block, the pad blocks, and the user blocks is called a Packet. The format of the packet is shown in Figure 11.

Link Block	Run-in Block 1	Run-in Block 2	Run-in Block 3	Run-in Block 4	User Data Blocks	Run-out Block 1	Run-out Block 2

Figure 11 – Packet Format

Bits 5, 6, and 7 of the block's mode byte (see Table 16) uniquely identify blocks.

Table 16 – Block Identifier bits

Mode Byte Bits 7, 6, 5	Block
000	User Data
001	Run-in block 4
010	Run-in block 3
011	Run-in block 2
100	Run-in block 1
101	Link block
110	Run-out block 2
111	Run-out block 1

See 4.2.3.7 for a detailed definition of the Mode Byte. Main channel user data should be all zeros.

Only entire packets may be rewritten on CD-RW media.

There are 2 types of recording on CD-R: Uninterrupted and Incremental. Incremental recording requires linking, whereas uninterrupted does not.

Disc At Once is the only type of uninterrupted recording and is a special case of Session At Once. The recording begins at the start of the Lead-in and stops only when the last block of the Lead-out is written. The PMA is not written. No linking is required.

There are 5 types of incremental recording:

Session At Once - The recording begins at the start of the Lead-in of the next session and stops only when the last block of that session's Lead-out is written. The PMA is constructed and written as a separate write action. Linking between sessions is required.

Reserve Track - User data is not necessarily written. The PMA is written for the purpose of defining a new track.

Track At Once - A single packet that includes the pre-gap of the track and all of the track's user data.

Variable Packet - A variable number of user blocks is written between data linkage blocks. A variable packet shall be a part of the user data area of a track.

Fixed Packet - A fixed number of user blocks is written between the user blocks. A fixed packet shall be a part of the user data area of a track.

4.2.3.10 The Track Descriptor Block

The Track Descriptor Block (TDB) is required for Track at Once or Packet recording. When the TDB is present, each block of the pre-gap of a track is a TDB. When a track is only reserved for Track At Once recording, recording of the TDB is deferred until the track data is written. When a track is reserved for either sort of packet recording, the TDB shall be written as a single packet upon reservation.

The TDB contains main channel information about the track recording and optionally contains a history of tracks that preceded the TDB.

The TDB begins with an 8 byte header (Table 17). The TDB header is followed by one or more Track Descriptor Units (TDU) (Table 18).

Table 17 – Track Descriptor Block (TDB) header

Bit / Byte	7	6	5	4	3	2	1	0
0	54h (ASCII "T")							
1	44h (ASCII "D")							
2	49h (ASCII "I")							
3	Pre-gap Length encoded BCD							
4								
5	Reserved							Current
6	Lowest Track Number Listed (BCD)							
7	Highest Track Number Listed (BCD)							
8 : n	One or more Track Descriptor Unit(s) (TDU)							

Pre-gap length is given in number of blocks.

The Current bit, when set to 1, indicates that only the TDU for the current track is present. When cleared to 0, indicates that a TDU for tracks with numbers smaller than or equal to the current track, are present.

Table 18 – Track Descriptor Unit (TDU) Format

Bit / Byte	7	6	5	4	3	2	1	0
0	Track Number (BCD)							
1	Recording method							
2	(MSB)							
3	Fixed Packet Size in blocks (BCD)							
4	(LSB)							
5	Reserved							
…	Reserved							
15	Reserved							

Recording method is coded as follows:

00h Audio track written TAO

80h Data track written TAO

90h incrementally written data track, variable packets

91h incrementally written data track, fixed packets

Fixed Packet size is filled with FFFFFFh whenever the recording method is not fixed packet.

4.2.4 High Speed CD-RW media recording

High speed CD-RW is defined in System Description ReWritable Compact Disc Systems, part III Volume 2: CD-RW (Orange Book part III, Vol. 2). High Speed CD-RW recording speed ranges are from 4x to 10x recording and also allows CAV recording. Upon CAV recording, write speed needs to be set for each track. If the Logical Unit is not capable of recording continuous track in CAV, then the Logical Unit shall use CLV mode with initial speed of CAV recording. For example, if the 4x-10x CAV recording is attempted for TAO mode, but the Logical Unit does not support CAV for TAO mode, then the Logical Unit shall choose 4x CLV recording for that track. This condition is not considered as an error.

High speed CD-RW media cannot be recorded using Logical Units that comply with only Orange Book Part 3 volume 1. Upon write attempt to the High speed CD-RW media using Orange Book Part 3 volume 1 complying Logical Unit, some Logical Units return CHECK CONDITION Status and set SK/ASC/ASCQ values to either ILLEGAL REQUEST/WRITE PROTECTED or MEDIUM ERROR/NO SEEK COMPLETE. The recommended SK/ASC/ASCQ values for this case are ILLEGAL REQUEST/CANNOT WRITE MEDIUM - INCOMPATIBLE FORMAT.

In order to minimize the impact to the large number of MMC-1 based CD-R/RW Logical Units and software, extensions of SET CD SPEED Command and MM Capabilities & Mechanical Status Mode Page (2Ah) are defined as an optional Feature. Also SET STREAMING Command and GET PERFORMANCE Command for CD-R/RW implementation are defined.

Command Sequence example:

Upon media insertion, Initiator issues READ TRACK/RZONE INFORMATION Command to find the next writable address. Then either MM Capabilities & Mechanical Status Mode Page (2Ah) or GET PERFORMANCE Command are used to identify the Logical Unit's capability for the mounted media.

Initiator then issues either SET CD SPEED Command or SET STREAMING Command for the track to be recorded. Also the Initiator sets an appropriate Write Parameters, and ready to write data.

4.2.5 CD Audio error reporting

Audio play commands (PLAY AUDIO (10), PLAY AUDIO (12), PLAY AUDIO MSF) with the immediate bit set in the audio control mode page return status as soon as the command has been validated (that 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 CHECK CONDITION STATUS to the next command (except for REQUEST SENSE, INQUIRY, GET CONFIGURATION, and GET EVENT/STATUS NOTIFICATION). The deferred error sense data 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, the ASC is set to NO ADDITIONAL SENSE DATA and the audio status (see) is reported in the additional sense code qualifier field.

4.2.6 CD ready condition/not ready condition

The ready condition occurs after a disc is inserted and the Logical Unit has performed its initialization tasks. These tasks may include reading the Table of Contents from the media. Table 19 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 Logical Unit is unable to load or unload the medium.
c) The Logical Unit is unable to recover the Table of Contents.
d) The controller cannot select the Logical Unit.
e) As otherwise described in the command operation.

Table 19 – Not Ready Error Reporting (by command)

Command Name	Operation Code	Return Not Ready Status	Time-out
BLANK	A1h	Yes	Group 2 Note 1
CLOSE TRACK/SESSION	5Bh	Yes	Group 2 Note 1
SYNCHRONIZE CACHE	35h	Yes	Group 2
FORMAT UNIT	04h	Yes	Group 2 Note 1
GET CONFIGURATION	46h	No	Not Allowed
GET EVENT/STATUS NOTIFICATION	4Ah	No	Not Allowed
GET PERFORMANCE	ACh	No	Group 1
INQUIRY	12h	No	Not Allowed
LOAD/UNLOAD MEDIUM	A6h	Yes	Group 1 Note 1
LOCK/UNLOCK CACHE	36h	No	Group 2
LOG SELECT/SENSE	4Ch,4Dh	No	Group 1
MECHANISM STATUS	BDh	No	Group 1
MODE SELECT	55h, 15h	No	Group 1
MODE SENSE	5Ah, 1Ah	No	Group 1
PAUSE/RESUME	4Bh	Yes	Group 1
PLAY AUDIO	45h, A5h	Yes	Group 1
PLAY AUDIO MSF	47h	Yes	Group 1
PREFETCH	34h	Yes	Group 1
PREVENT ALLOW MEDIUM REMOVAL	1Eh	No	Group 1
READ	28h, A8	Yes	Group 1
READ BUFFER	3Ch	No	Group 1
READ BUFFER CAPACITY	5Ch	No	Group 1
READ CAPACITY	25h	Yes	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	ADh	Yes	Group 1
READ FORMAT CAPACITIES	23h	No	Group 1
READ SUB-CHANNEL	42h	Yes	Group 1

Table 18 (continued) – Not Ready Error Reporting (by command)

Command Name	Operation Code	Return Not Ready Status	Time-out
READ TOC/PMA/ATIP	43h	Yes	Group 1
READ TRACK INFORMATION	52h	Yes	Group 1
RECEIVE DIAGNOSTIC RESULTS	1Ch	No	Not Allowed
RELEASE	17h, 57h	No	Not Allowed
REPAIR TRACK	58h	Yes	Group 1
REPORT KEY	A4h	Yes	Group 1
REPORT LUNS	A0h	No	Group 1
REQUEST SENSE	03h	No	Not Allowed
RESERVE	16h, 56h	No	Not Allowed
RESERVE TRACK	53h	Yes	Group 2
REZERO UNIT	01h	Yes	Group 1
SCAN	BAh	Yes	Group 1
SEEK	2Bh	Yes	Group 1
SEND CUE SHEET	5Dh	No	Group 1
SEND DIAGNOSTICS	1Dh	No	Not Allowed
SEND DVD STRUCTURE	BFh	No	Group 1
SEND EVENT	A2h	Yes	Group 1
SEND KEY	A3h	Yes	Group 1
SEND OPC INFORMATION	54h	No	Group 1
SET CD SPEED	BBh	No	Group 1
SET READ AHEAD	A7h	Yes	Group 1
SET STREAMING	B6h	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	2Fh, AFh	Yes	Group 2
WRITE	2Ah, AAh	Yes	Group 1
WRITE AND VERIFY	2Eh	Yes	Group 1
Note 1: With the IMMED bit set, Time Out is not allowed and shall be completed within the Group 1 time.			

4.2.7 Sensing support for CD-audio commands.

The preferred method of sensing support for CD audio is the implementation of the GET CONFIGURATION command (sub-clause 5.6). For legacy implementations, if any commands related to audio operations are implemented, then the PLAY AUDIO (10) command (sub-clause 5.15) shall be implemented to allow a method for the Initiator to determine if audio operations are supported. A target 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.

4.2.8 The CD-MRW Format

A general description of the MRW format is found in sub-clause 4.1.7.

From the perspective of the original version of Orange Book, part III (CD-RW), the entire capacity of a MRW disc consists of a single session containing a single track of 32 sector fixed packets.

Figure 12 - Track/Session Structure of a MRW Disc

Disc Lead-in	Track 1: 32 Sector Fixed packets	Disc Lead-out

CD-MRW contains additional structure.

4.2.8.1 CD-MRW Structure

The CD-MRW disc does have this format, but the *CD-MRW Defect Management & Physical Formatting* requires additional features, built upon the basic format (Figure 13).

Figure 13 - The Additional Structure

A	B	A	B	C1	C2	……	Cn	D	A
Lead-in		Program Area							Lead-out

Lead-in, Part A	TOC, no change
Lead-in, Part B	TOC (in sub-channel Q) along with MTA (information is stored in main channel). The major change: Prior to CD-MRW, the lead-in has always been recorded track-at-once. With this new format, it is recorded as fixed packets. The MTA use begins with the packet that precedes the pre-gap. When needed, the MTA grows backward toward the disc center with a maximum size of 32 packets.
Program Area, Part A	Track 1 pre-gap has a fixed size of 150 sectors. The TDB identifies the track as fixed packet of length 32.
Program Area, Part B	The General Application Area (GAA) is a segment of the track that is NOT covered by the defect management system. This is fixed at 32 packets which is also 1024 sectors which is also 2 MB.
Program Area, Parts Cx	The Defect Managed Area (DMA) consists of DMA segments, Cx. Each Cx consists of a spare area (SA) followed by a data area (DA). Each SA must contain 8 packets. Each DA within C1, C2, …, Cn-1, must contain 136 packets for primary data. Cn may contain less than 136 packets, based upon disc capacity. The DMA is the logical concatenation of all DAs.
Program Area, Part D	STA: 33 packets reserved for secondary copies of the MTA structures.
Lead-out, Part A	Lead-out, no change

The number of Cx is determined as follows: P = number of 32 sector fixed packets available in the formatted track 1. The number of packets in all Cx is Pt = P – GAA size – STA size = P – 65. When Pt is divided by 144 (= 8 + 136), there is a quotient Q and remainder R.

If R ≤ 8, then Q = n. The DA size for each Cx is 136, and the lead-out begins R packets sooner.

If R > 8, then Q = n – 1. The DA for C1, C2,...Cn-1 is 136, the DA for Cn is R – 8 packets in length, and the lead-out is not offset into the program area.

The Host's primary address space is the DMA. By default, an LBA is presumed to refer to this address space. Note that LBAs for the DMA do NOT match LBAs for a similarly formatted non-MRW disc. The spare block size is 2 048 bytes - one CD user sector from a size 32 fixed packet.

The GAA is available for compatibility with older systems. The GAA LBA space is 0, 1, 2, 3, …, 1 023d. Note that LBAs for the GAA exactly match LBAs for a similarly formatted pre-MRW disc.

4.2.8.2 CD-MRW Addressing

Since MRW has two LBA spaces, CD-MRW has two logical addressing schemes. The GAA contains 1024 sectors, uses method 2 addressing , and exactly matches sector addressing as defined for traditional CD. See Table 20.

Table 20 - GAA Addressing on CD-MRW

Non-MRW LBA	MRW LBA in GAA
0	0
1	1
2	2
.	.
.	.
1 023	1023
1 024	Out of Range
1 025	Out of Range
....	....

When method 2 addressing is used, the primary LBA of the first sector of the DMA is at the non-MRW LBA of (32 + 8)*32 = 1280d. Table 21 shows the most inequities with non-MRW LBA.

Table 21 - DMA Addressing on CD-MRW

Non-MRW LBA	MRW LBA (primary)
1 280	DMA 0
1 281	DMA 1
1 282	DMA 2
....	....
5 631	DMA 4 351
....	....
5 888	DMA 4 352
5 889	DMA 4 353
....	....
10 239	DMA 8 703
....	....

This method of addressing is named "method 3 addressing" in the *CD-MRW Defect Management & Physical Formatting.*

4.3 DDCD Model

The Double Density CD (DDCD) Media Format is an extension of CD family whose capacity is more than double. This capacity is achieved by using a conventional 780 nm laser and using a NA of 0.50 or 0.55, and

- reduction of the track pitch (x 1.45)

- reduced minimum pit size (x 1.33)

Table 22 – Realization of higher density

Parameter	Red Book CD	DDCD	Factor
Track pitch (um)	1.60	1.10	1.45
Length of optical marks (3*n*11)	n*0.278	n*0.208	1.33
Program area radius (mm)	(120 mm disc) 25-37.5 (80 mm disc)	(120 mm disc) 24-37.5 (80 mm disc)	1.06
Total user bit rate/ Channel bit rate:	(CD-ROM *Mode 1*)	0.284 (CD-ROM *Mode 2*)	1.00

A DDCD medium is an 80 mm or a 120 mm disc with a continuously recorded physical track beginning from a radius of 24 mm and spiraling outward to a radius 37.5 mm or 58 mm.

Like a conventional CD Drive/Media there are three types of DDCD Drive/Media, Read Only (DDCD-ROM), Write Once (DDCD-R), and ReWritable (DDCD-RW). The capacities of these media are the same. The DDCD Media Format is not backward compatible with current CD devices

4.3.1 DDCD Specifications

Comparing the new DDCD specifications with those of the conventional CD, some major specifications are the same, such as the size of the disc. Other specifications indicate that some adaptations have to be made to the media production process of the DDCD.

Error correction and physical addressing require some changes to the decoding/encoding equipment.

Table 23 shows some DDCD parameters.

Table 23 – Main Parameters of DDCD

Parameter	DDCD-ROM	DDCD-R	DDCD-RW
Capacity (120 mm disc) [Mbytes]	1 300	1 300	1 300
Capacity (80 mm disc) [Mbytes]	400	400	400
Wavelength of laser diode [nm]	780	780	780
Reference NA [for read] [for write]	> 0.50	> 0.50 0.55	> 0.50 0.55
Data Bit length [um]	0.442	0.442	0.442
Channel Bit length [um]	0.208	0.208	0.208
Minimum Pit/Mark length [um]	0.62	0.62	0.62
Maximum Pit/Mark length [um]	2.29	2.29	2.29
Track pitch [um]	1.10	1.10	1.10
Sense of disc rotation seen from reading side	Counter clockwise	Counter clockwise	Counter clockwise
Thickness of the disc [mm]	1.2	1.2	1.2
User data per sector [bytes]	2 048	2 048	2 048
Error Correction Code	CIRC*	CIRC*	CIRC*
Layered ECC Constraint Length	1sector	1sector	1sector
Correctable burst error length [mm]	3.16	3.16	3.16
Scanning velocity at 1X speed [m/s]	0.90	0.90	0.90
Channel bit rate [Mbps]	4.3218	4.3218	4.3218
User data bit rate at 1X speed [k Bytes/s]	150	150	150
Note: CIRC* is different from the conventional CD. In the DDCD system, the delay parameter “D” of CIRC is extended from 4 to 7 to improve burst error correction ability in case of higher recording density. The maximum burst error correction ability of CIRC* is extended to 837 symbols.			

4.3.1.1 Disc Structure

There are three address expressions used in the DDCD system; the Block address contained in the sector header (Physical Sector Number), Subcode-Q channel (Subcode frame time number), and the address referred to the blocks of the Initiator system (LBA: Logical Block Address).

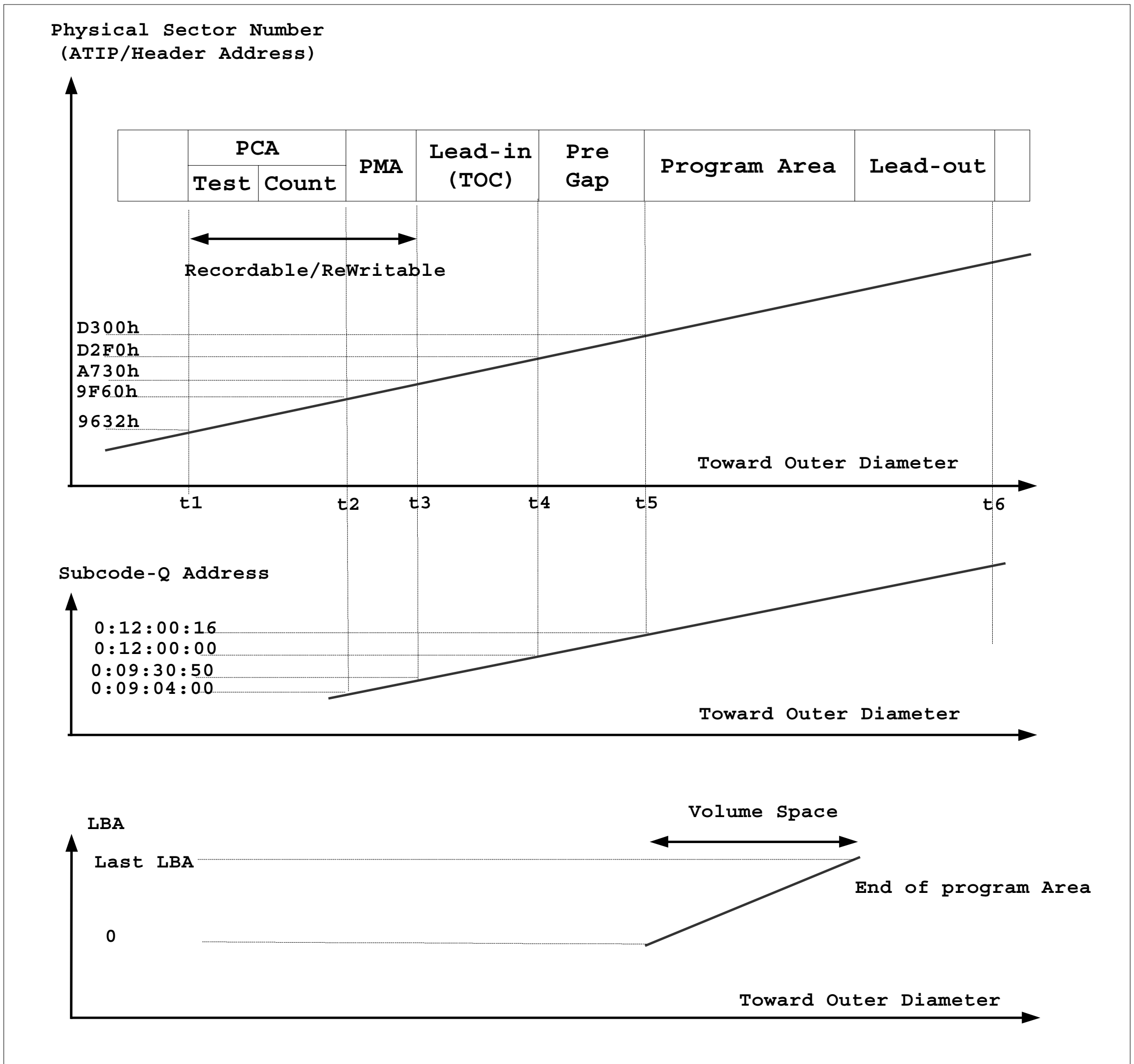
The address used by the Initiator system starts from 0 to the end of the recorded information on the disc. LBA 0 shall correspond with the sector header address of D300h and the Subcode-Q address of 0:12:00:16 (0 hour, 12 minutes, 00 second, 16 frame). Only the Data Area is generally addressable by using LBA.

Sub-code Q areas are addressed in time based address. The representation for a time based address is H:MM:SS:FF, where H = hours, MM = minutes, SS = seconds, and FF = frames. Hour field is 1 digit. MM:SS:FF are 2 digits respectively. When the time based address includes the hours field selection between LBA and H:MM:SS:FF is indicated by the appropriate TIME bit.

One Hour is subdivided into 60 Minutes. One Minute is 60 Seconds. One Second is 75 frames. See Figure 14.

4.3.1.2 Single Session Disc

A Session is a recorded sequence that includes a Lead-in Area, Program Area, and Lead-out Area. The Lead-in / Lead-out Area is a guard area at inner / outer part of the disc. The Lead-in Area also contains the table of contents (TOC) for Program Area. The Program Area is also known as the user area of the disc.



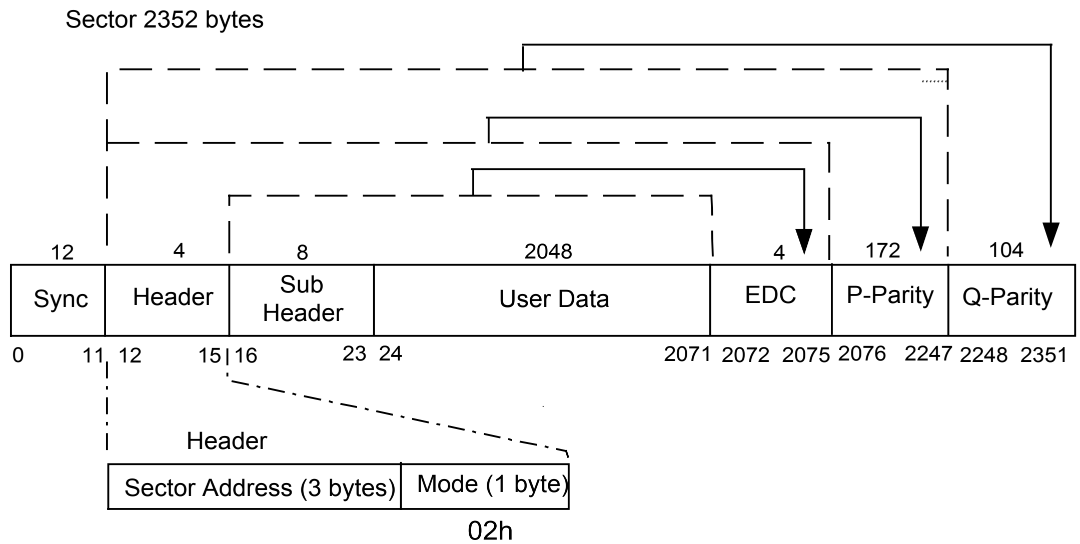
		Subcode-Q	ATIP/Header
t1	Start of PCA		9632h
t1	Start of PMA	0:09:04:00	9F60h
t1	Start time of Lead-in Area	0:09:30:50	A730h
t1	End time of Lead-in Area Start time of Program Area	0:12:00:00	D2F0h
t1	Start time of the User data	0:12:00:16	D300h
t1	Last Possible start time of Lead-out Area	Encoded in ATIP	Encoded in ATIP

Figure 14 – Physical and Logical Layout of DDCD-ROM/R/RW

4.3.1.3 Multi-Session Disc

The multi-session allows a single disc to have several concatenated sessions. On a recorded disc, session may appear as shown in Figure 15.

DDCD read only drives are not typically capable of reading through unrecorded areas on the medium. The DDCD read only drive needs EFM data in order to find and stay in the physical track. This is to ensure that a DDCD read only drive is capable of accessing all areas of a Program Area.



Session1 Lead-in	Session1 Program Area	Session1 Lead-out	Session2 Lead-in	Session2 Program Area	Session2 Lead-out	……	Last Session Lead-in	Last Session Program Area	Last Session Lead-out

Figure 15 – Multi-Session Recorded Disc

In order to assure readability with DDCD read only drives, the recording system shall always close the session before attempting interchange.

Additional information is needed in order to locate all of the program areas.

This is accomplished by using SubCode-Q Mode 5 in the Lead-in areas.

4.3.1.4 Physical Sector

The physical format defined by the DDCD media standard provides 2 352 bytes per sector. For computer data applications, 2 048 bytes is used for user data, 12 bytes for a synchronization field, 4 bytes for a sector address, 8 bytes for an additional information and 276 bytes – the auxiliary field – for Layered ECC.

4.3.1.5 Sector Structure

A Sector, called Mode2 Sector, shall consist of 2 352 bytes arranged with 12 Sync bytes, 4 Header bytes, 8 Sub-header bytes, 2 048 User Data bytes, 4 Error Detection Code (EDC) bytes, 172 P-Parity bytes, and 104 Q-Parity bytes. The User Data bytes are identified from 24th to 2071st. The Header shall consist of 3 bytes of Sector Address and 1 Mode byte. The Mode byte shall be 02h to indicate Mode 2 Disc Type.

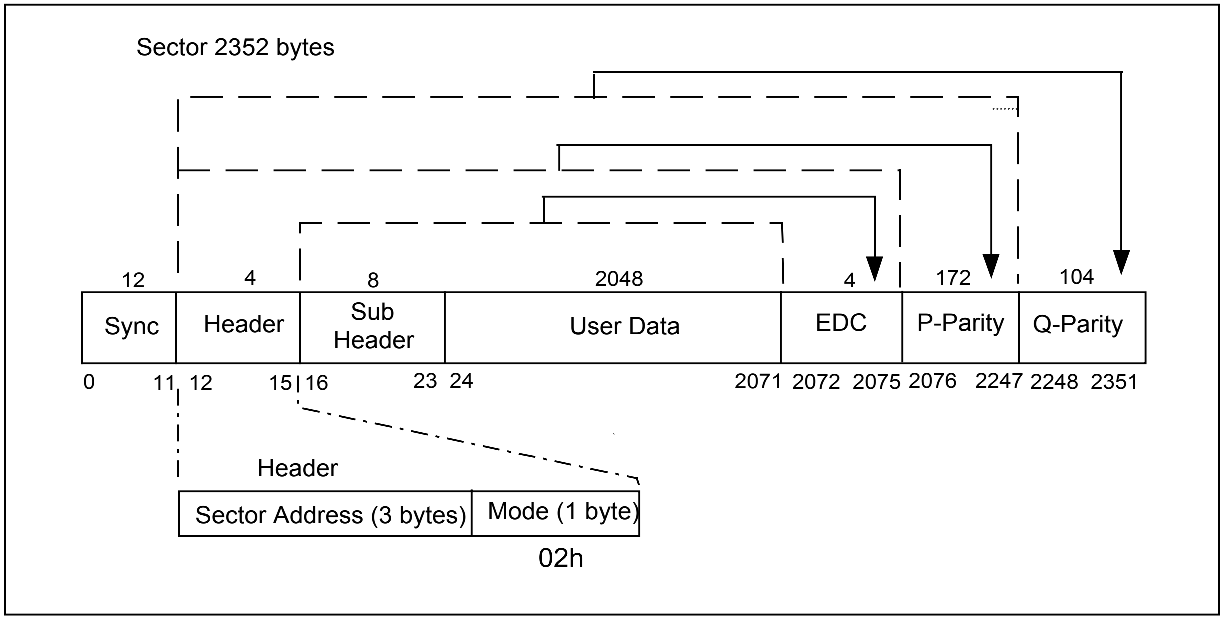


Figure 16 – Sector format Mode 2

The physical format of DDCD media uses smaller unit of synchronization than the other magnetic or optical recording systems.

The basic unit of the data stream synchronization is a small frame. This is different from large frame (sector) as referred to in the HMSF unit. Each small frame consists of 588 bits. A sector on DDCD media consists of 98 small frames.

A DDCD small frame consists of:

1. 1 synchronization pattern (24+3 bits)
2. 1 byte of sub-channel data (14+3 bits)
3. 24 bytes of data (24 x (14+3) bits)
4. 8 bytes of CIRC code (8 x (14+3) bits) Total:588 bits.

Data, sub-channel and CIRC bytes are encoded to 14-bit codes according to the EFM table; then three merging bits are added. The merging bits are chosen to minimize DSV (Digital Sum Value) and provide DC free characteristics.

The data bytes of 98 small frames comprise the physical unit of data referred to as a sector. 98 small frames times 24 bytes per small frame equals 2 352 bytes of data per sector.

4.3.1.6 Sub-Channel Information Formats

The sub-channel 1 byte of each frame is assigned one bit for each of the 8 sub-channels, designated P, Q, R, S, T, U, V, W. Sub-channel P and R to W are all reserved and set to zero. All the sub-channel Q bits of a sector define the sub-channel Q information block. The sub-channel Q block consists of 98 bits, one bit from each small frame in a sector.

The format provides the information of the location and is defined as follows (See Figure 17):

1. 2-bits sub-channel synchronization field
2. 4-bits ADR field (defines the format)
3. 4-bits control field (defines the type of information in this sector)
4. 8-bits Track number
5. 8-bits index number

6. 28-bits reserved
7. 28-bits Absolute HMSF address (4-bits Hour, 8-bits Minutes, 8-bits Seconds, 8-bits Frames)
8. 16-bits CRC error detection code

ADR	TNO	INDEX	Reserved	AHOUR	AMIN	ASEC	AFRAME	CRC

Figure 17 – Sub-code-Q Mode1 format recorded in Program Area

TNO = 01 to 99 is the track number in BCD

INDEX = 00.

AHOUR, AMIN, ASEC, AFRAME = the absolute time address expressed in 7 BCD digits.

4.3.1.7 DDCD Ready Condition/Not Ready Condition

The Ready Condition occurs after the disc is inserted and the Logical Unit has performed its initialization tasks. These tasks may include reading the lead-in information from the media. This “Ready” is different from and should not be confused with the ATA Ready Status. A CHECK CONDITION status shall be returned for the Not Ready Condition only for Commands that require or imply disc access.

A Not Ready Condition may occur for the following reasons:

1. There is no disc.
2. The Logical Unit is unable to load or unload the disc.
3. The Logical Unit is performing an extended operation as the result of an Immediate mode Command such as FORMAT UNIT, BLANK, or CLOSE TRACK/SESSION commands

The Logical Unit shall spin up and make the disc ready for media accesses when a disc is detected.

After the Logical Unit becomes ready, the Logical Unit may enter the power state in which the Logical Unit was when the previous medium was removed.

Any media access that occurs when the Logical Unit is not spinning shall spin the media up and not generate an error. Any media access that is requested while a deferred operation is in progress (i.e. writing from a write cache) shall not generate an error.

Note: Accesses to the media can be satisfied from the Logical Unit’s cache and may not require the media to be spinning.

Some commands are allowed to generate a CHECK CONDITION status with a NOT READY sense key and others are not.

4.3.1.8 DDCD Address Reporting Format (TIME bit)

Several (conventional) CD specific Commands can return addresses either in logical block address or in HMSF format. The READ SUBCHANNEL, and READ TOC/PMA/ATIP commands have this Feature.

Table 24 – TIME Address Format

Bit / Byte	7	6	5	4	3	2	1	0
0	H Field							
1	M Field							
2	S Field							
3	F Field							

A TIME bit in the CDB specifies the format. The TIME bit of zero requests that the logical block address format be used for the absolute address field.

A TIME bit of one requests that the HMSF format be used for these fields. The H, M, S, and F Fields are expressed as binary numbers. The value of the H field shall be zero for CD media and shall not exceed 2 for DDCD media. The value of the M field shall not exceed 99 for CD media and shall not exceed 59 for DDCD media. The value of the S field shall not exceed 59. The value of the F field shall not exceed 74.

4.3.1.9 Error Reporting

If any of the following conditions occur during the execution of a command, the DDCD Logical Unit shall return CHECK CONDITION status. The appropriate SK/ASC/ASCQ shall 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 25 – Error Conditions and Sense Key

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
Device 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 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 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 the error block shall be transferred.

4.3.1.10 Recording for DDCD media

There are several kinds of writing method of recording data in DDCD media. Session At Once, Track At Once, and Packet Writing are all used as methods of recording DDCD media. There is a special case of Session At Once recording known as Disc At Once. Packet Writing can be further classified into Variable Packet Writing and Fixed Packet Writing.

4.3.1.11 DDCD Recordable and DDCD ReWritable Structure

An unrecorded DDCD-R or DDCD-RW disc does not have an EFM to find the physical track in the traditional way of DDCD read only drives. A blank DDCD-R or DDCD-RW has pre-groove and it has the built in wobble for the purpose of defining and finding the physical track.

The wobble is a 22.05KHz signal modulated with digital information. The position within the pre-groove is contained in each pre-groove frame of 42 bits. This is known as an Absolute Time In Pre-groove (ATIP).

The ATIP frame shall consist of 42 bits.

The format of the ATIP frame is defined in Table 26.

Table 26 – ATIP format

Number of bits	4	3	21	14
Bit position	1234	567	0011 11111111 222222222 8901 23456789012345678	23333333333444 90123456789012
Data	Sync	Discriminator	Physical frame address	CRC remainder

In the area that is expected to be the disc's Lead-in Area, the additional information is interleaved between positional ATIP frames.

The additional information provided is:

- First possible start address for disc Lead-in (TOC)
- Last possible start address for disc Lead-out
- Special information about recording permissions
- Power and speed requirements for recording the medium
- DDCD-R vs. DDCD-RW medium

DDCD-R/RW discs have two additional areas prior to the first Lead-in; the Power Calibration Area (PCA), and the Program Memory Area (PMA).

The Power Calibration Area (PCA) is present only in DDCD-R and DDCD-RW media for the purpose of write power calibration. The PCA is divided into two areas: the test area and the count area. The test area is divided into 1000 calibration partitions. The count area is a counting area for use of the test recording.

The Program Memory Area (PMA) is present only for DDCD-R and DDCD-RW media for the purpose of counting for the use of user data area on the medium. This information is contained only within the Subcode-Q channel of the PMA frames.

4.3.1.12 Packet Layout for DDCD

The layout of a Packet on DDCD media is shown in Figure 18. Each packet starts with Link block followed by three Run-in blocks. The User data blocks are placed directly after the Run-in blocks. Finally, three Run-out blocks are located following the User data blocks. In the case of Fixed packet writing, the size of each Packet in a Track is constant in length.

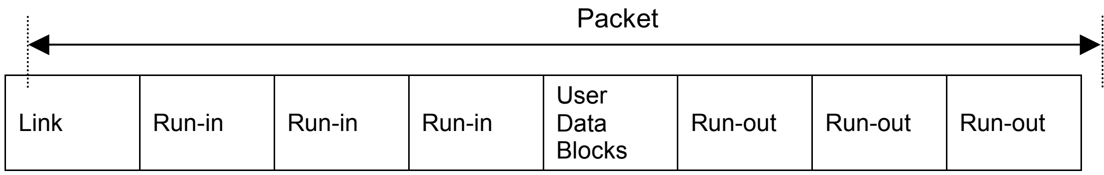


Figure 18 – Packet Layout

Blocks are uniquely identified by bit 5, 6, and 7 of the block's mode byte.

Table 27 – Block Identifier bits

Mode Byte, Bits 7, 6, 5	Block
000	User Data block
001	Third Run-in block
010	Second Run-in block
011	First Run-in block
100	Link block
101	Third Run-out block
110	Second Run-out block
111	First Run-out block

Figure 19 shows an example of the layout of a packet written Track.

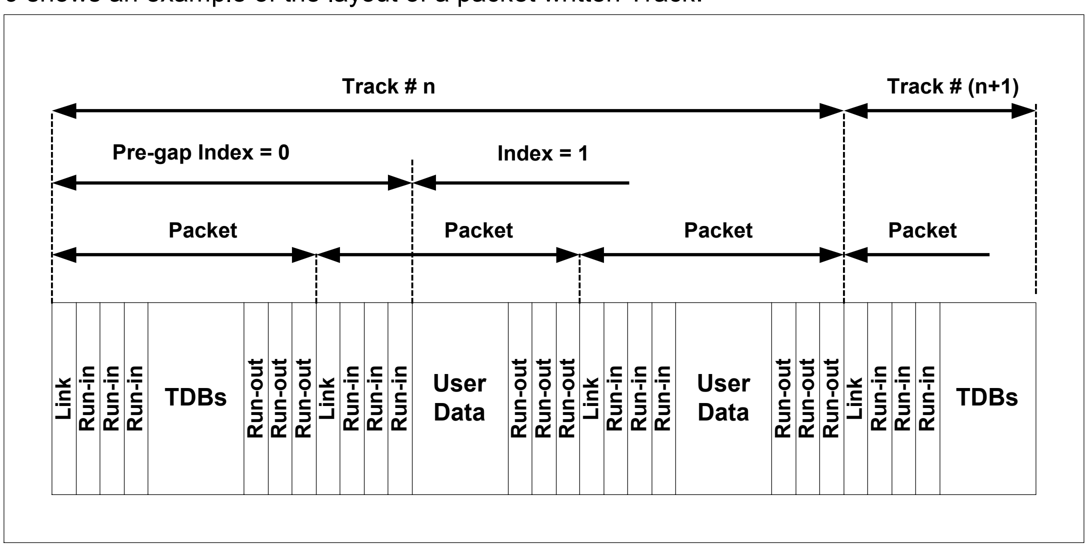


Figure 19 – Example of Packet written Track layout

4.4 DVD Model

The DVD Model is the description for the media types defined by the DVD Forum: DVD-ROM, DVD-RAM, DVD-R/-RW, and media types defined by the DVD+RW Alliance DVD+R and DVD+RW.

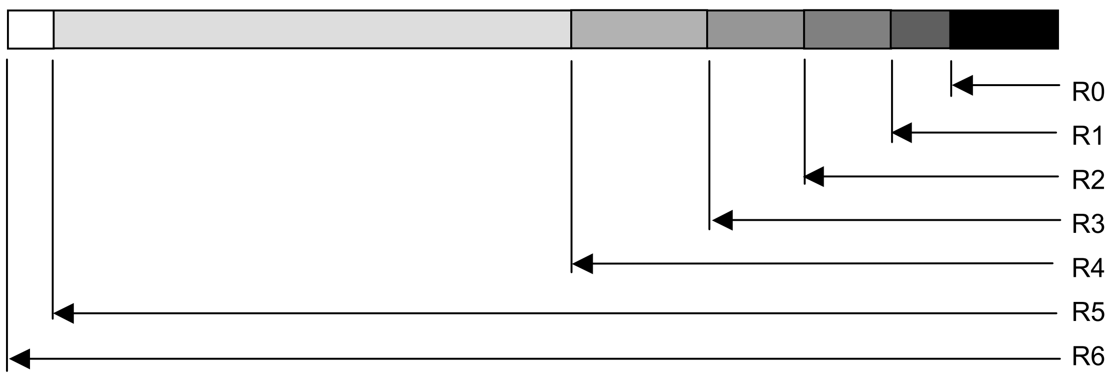
Like CD Logical Units/Media there are multiple types of DVD Logical Units/Media:

- Read Only (DVD-ROM)
- Recordable (i.e. write-once) (DVD-R and DVD+R)
- Re-Writable (DVD-RAM, DVD-RW, and DVD+RW).

The capacities of these different media vary. Some of these media also have the possibility of one or two sides, and independently, one or two layers per side. A DVD Logical Unit may be capable of reading CD-ROM.

4.4.1 Physical Media Characteristics

DVD media is either 8 or 12 centimeters in diameter and separated into zones as shown in .



R0	Center Hole	R4	3rd Transition Area
R1	1st Transition Area	R5	Information Zone
R2	2nd Transition Area	R6	Rim Area
R3	Clamping Zone		

Figure 20 – The Zones of a DVD Medium

The Center Hole, 1st Transition Area, 2nd Transition Area, Clamping Zone, and 3rd Transition Area are all part of the alignment and clamping mechanisms. These areas have no direct involvement with the readable/writable areas of the medium.

The Information Zone is the area in which actual recording may occur. It contains the lead-in, the data area, and the lead-out. This area typically begins at a radius of 22 millimeters. For 120-millimeter media, the information zone ends at a typical radius of 58.5 millimeters. For 80-millimeter media, the information zone ends at a typical radius of 38.5 millimeters.

The Rim Area is simply the area beyond the data groove. For 120-millimeter media, it typically ends at a radius of 60 millimeters. For 120-millimeter media, it typically ends at a radius of 40 millimeters.

4.4.1.1 Track (Groove) Structure

There are common properties among all of the DVD media types. In the simplest case (one-sided, single layer), the physical track structure is similar to CD: a continuous spiral. With respect to DVD, the word "track" is used in the same way that "groove" is used with CD media - a single word reference to a continuous spiral.

DVD provides the ability to use two focus depths in order that two tracks may be accessed from one side of the media. Additionally, media may be produced that contains recording on both sides of the media.

There are up to 4 possibilities for physical track structure:

1. Single sided, single layer
2. Single sided, dual layer
3. Two sided, single layer,
4. Two sided, dual layer.

In all cases, a track is one layer on one side of the media.

There are two types of track path for dual layer discs, either parallel or opposite. When the path is parallel, each track has its own Lead-in and Lead-out. When the path is opposite, the tracks share a single lead-in and a single lead-out and each layer has a transition zone called the middle area.

Figure 21 shows the single track case. Data zone sector numbering advances through the data zone with maximum data zone address at Lead-out start - 1.

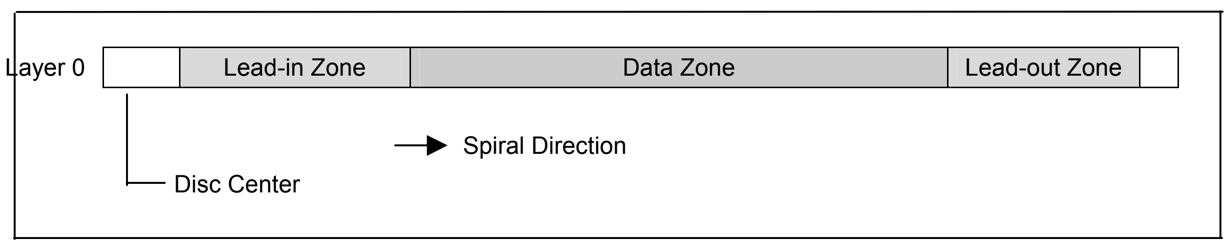


Figure 21 – Single Layer, Single Sided Disc

Figure 22 shows the parallel track path case. In each layer, data zone sector numbering advances through the data zone with maximum data zone address at Lead-out start - 1. In this case, there are two distinct address spaces.

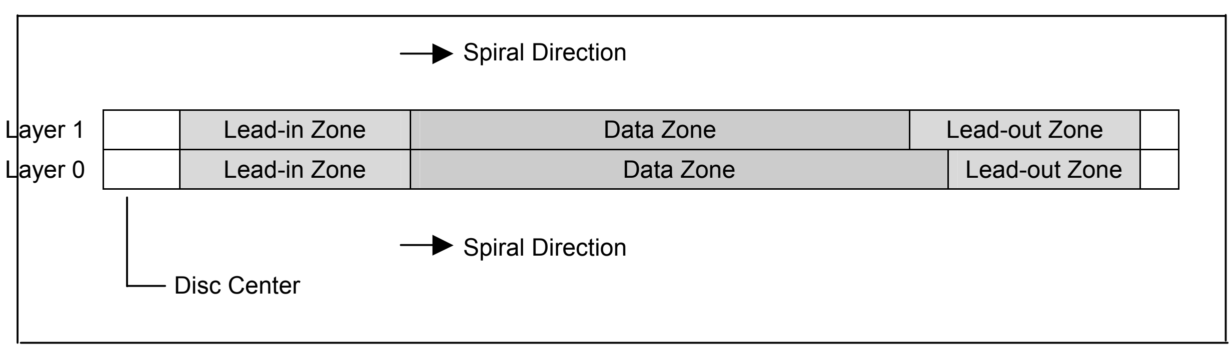


Figure 22 – Parallel Track Path Disc

Figure 23 shows the opposite track path case. Data zone sector numbering advances through the data zone stopping at the start of the middle zone for layer 0. The middle zones are constructed as an area where a layer reference change may occur and tracking direction may change. Sector numbering continues after the middle zone of layer 1 and continues to maximum data zone address at Lead-out start - 1.

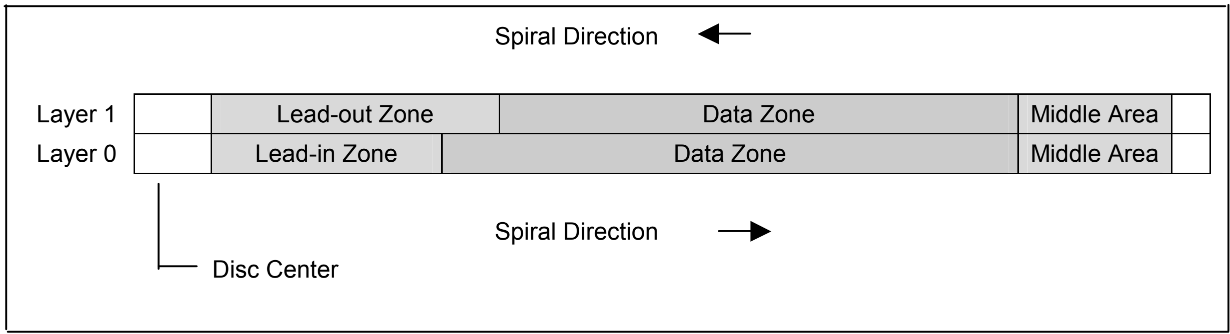


Figure 23 – Opposite Track Path Disc

4.4.1.2 ECC Blocks

When fully recorded, each track consists of an uninterrupted sequence of ECC blocks. Each ECC block contains 16 sectors of 2 048 data bytes each. Sectors are numbered with a 24-bit address. Numbering is linear and integral, beginning with zero. Sector zero exists only for the purposes of definition. No device has the need to access any sector with PSN smaller than 22F00h.

The general DVD ECC block is based upon the DVD-ROM standard.

Unlike CD media, adjacent sectors of DVD media are not necessarily interleaved. An ECC block consists of 16 sectors with headers, EDC symbols, and ECC symbols. Individual sector data are interleaved in order to minimize the effects of large media flaws. These ECC blocks are recorded serially on the medium.

In order to read and extract a single sector of data, the logical unit must read the ECC block containing the sector, apply error correction and de-interleaving prior to extracting the data from the selected sector.

4.4.1.2.1 The Structure of the Data Sector

A DVD data sector contains 2 064 bytes, 2 048 bytes of main data and 16 bytes of additional information.

The logical layout of a DVD data sector is shown in Figure 24.

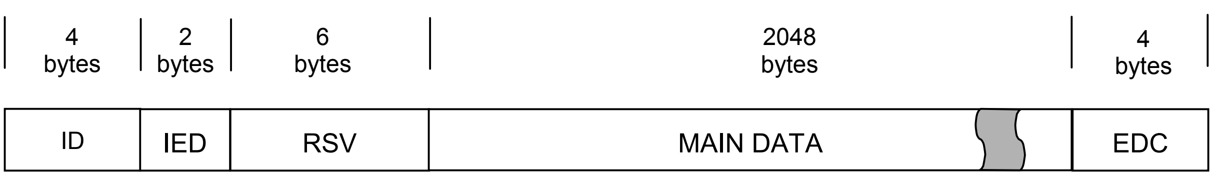


Figure 24 – Logical Layout of a DVD Data Sector

ID is a field that identifies the sector

IED contains 2 bytes of redundancy as an error detection code (EDC) for the ID field.

RSV is reserved and must be recorded with zeros.

MAIN DATA contains 2 048 information bytes.

EDC contains 4 bytes of redundancy as an error detection code (EDC) for the entire sector.

The ID field is viewed as a 32-bit field as shown in Figure 25.

Sector Information Bits 31 thru 24	Physical Sector Number Bits 23 through 0

Figure 25 – ID Field

Sector Information varies for different DVD media types.

Physical Sector Number (PSN) The least significant 24 bits (bits 23 through 0) contains the PSN in binary notation. The PSN of the first Physical Sector of an ECC Block shall be an integral multiple of 16. In the data zone, the translation of LBA to PSN varies according to media.

4.4.1.2.2 The Structure of the ECC Block

A 2 064 byte sector is divided into 12 rows of 172 bytes each. Main data is scrambled similar to CD-ROM data scrambling. When 16 sequential sectors are packed in this way and there are 192 rows, each with 172 bytes. Error correction redundancy symbols are appended in order to produce 208 rows of 182 bytes each.

The organization of sector data and redundancy symbols within an ECC block is illustrated in Figure 26. Columnar symbols (Cx,y) are calculated and appended to rows, then Row symbols (Rx,y) are calculated and appended to columns. Columnar redundancy symbols are collectively known as Inner Parity (PI). Row redundancy symbols are collectively known as Outer Parity (PO).

	User Data					ECC Parity on Rows				
User Data	B1,0	B1,1	B1,2	…	B1,171	C1,0	C1,1	C1,2	…	C1,9
	B2,0	B2,1	B2,2	…	B2,171	C2,0	C2,1	C2,2	…	C2,9
	B3,0	B3,1	B3,2	…	B3,171	C3,0	C3,1	C3,2	…	C3,9
	…	…	…		…	…	…	…	…	…
	B190,0	B190,1	B190,2	…	B190,171	C190,0	C190,1	C190,2	…	C190,9
	B191,0	B191,1	B191,2	…	B191,171	C191,0	C191,1	C191,2	…	C191,9
ECC Parity	R0,0	R0,1	R0,2	…	R0,171	C192,0	C192,1	C192,2	…	C192,9
	R1,0	R1,1	R1,2	…	R1,171	C193,0	C193,1	C193,2	…	C193,9
	R2,0	R2,1	R2,2	…	R2,171	C194,0	C194,1	C194,2	…	C194,9
	…	…	…	…	…	…	…	…	…	…
	R15,0	R15,1	R15,2	…	R15,171	C207,0	C207,1	C207,2	…	C207,9

Figure 26 – ECC Block Structure

Each of the 16 sectors of an ECC block has a unique PSN. The PSNs are sequential such that if the smallest is N, then N+1, N+2, N+3, …, N+15 are also present in the ECC block. That is, the sectors are sequenced in an intuitively correct way.

4.4.1.3 The Lead-in Area

The Lead-in Area has the general arrangement shown in Figure 27. Actual sizes and locations of each zone vary according to media type.

Lead-in Area	Initial Zone	Start of the spiral - zone of protection
	Area Specific to Media Type	Use varies according to media type
	Reference Code Zone	Read Calibration Area
	Buffer Zone 1	Separation Area
	Control Data Zone	Disc information - part of this is media specific
	Area Specific to Media Type	Use varies according to media type
Data Area	Data Zone	Viewed as user data area. Start PSN varies. Recordable media may implement a defect management.

Figure 27 - General Layout of Lead-in Area

For all DVD media types, the Control Data Zone consists of 192 ECC blocks. The information within each ECC block is identical. The structure of an ECC block within this zone is shown in Table 28.

Table 28 – Structure of Control Data ECC Block

Sector Number	Description
0	Physical Format Information
1	Disc Manufacturing Information
2	Reserved
… ... …	
14	
15	

Table 29 – Common Part of Physical Format Information

Bit / Byte	7	6	5	4	3	2	1	0
0	Book Type				Part Version			
1	Disc Size				Maximum Rate			
2	Reserved	Number of Layers		Track Path	Layer Type			
3	Linear Density				Track Density			
4	Data Area Allocation							
5								
…								
…								
…								
15								
16	BCA Flag	Reserved						
17-2047	Medium Unique Data							

Book Type defines the source of the media specification:

0	DVD-ROM	8	DVD+R
1	DVD-RAM	9	DVD+RW
2	DVD-R	10	Reserved
3	DVD-RW	11	Reserved
4	Reserved	12	Reserved
5	Reserved	13	Reserved
6	Reserved	14	Reserved
7	Reserved	15	Reserved

Part Version specifies the media version.

Disc Size shall be set to 0000b to indicate a 12 cm disc.

Maximum Rate defines the maximum read data rate. Meaning of specific values is media dependent.

Number of Layers, Track Path, Layer Type, Linear Density, and Track Density specify media recording structure. See the appropriate media specification.

Data Area Allocation specifies bounds of the recorded/recordable area. This is specific to media type.

The BCA Flag identifies the presence/absence of a Burst Cutting Area.

Medium Unique Data contains data specific to the media type.

The Disc Manufacturing Information has no standardized format.

4.4.2 DVD-ROM/DVD Video

4.4.2.1 Track Structure

DVD-ROM may have any of the 4 structures:

- single sided, single layer
- single sided, dual layer
- two sided, single layer,
- two sided, dual layer.

Two addresses are used: the Block address contained in the sector headers (Physical Sector Number), and the address used to reference the blocks from the Initiator system (LBA). The address used from the Initiator starts at 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 DVD-ROM media. Only the Data Area is generally addressable using an LBA.

4.4.2.2 Sector Structure

DVD-ROM ECC block structure is consistent with the definition in sub-clause 4.4.1.1. For DVD-ROM, the definition of the sector information part of the ID field is shown in Figure 28.

Sector Information ID bits 31 through 24							
31	30	29	28	27	26	25	24
Sector Format Type	Tracking Method	Reflectivity	Reserved	Zone Type		Data Type	Layer Number

Sector Format Type	0b	Indicates CLV format
Tracking Method	0b	Indicates pit tracking
Reflectivity	0b	Indicates reflectivity exceeds 40%
	1b	Indicates reflectivity is less than or equal to 40%
Reserved	0b	
Zone Type	00b	When sector is in Lead-in Zone
	01b	When sector is in Data Zone
	10b	When sector is in Lead-out Zone
	11b	When sector is in Middle Zone
Data Type	0b	Indicates read-only data
Layer Number	0b	When sector is in layer 0
	1b	When sector is in layer 1

Figure 28 – ID Field for DVD-ROM

4.4.2.3 The Lead-in

The DVD-ROM lead-in structure is consistent with the structure shown in Figure 27. Table 30 shows the lead-in structure specific to DVD-ROM.

Table 30 – DVD-ROM Lead-in Structure

Starting PSN	Disc Area
22FA0h	Initial Zone All 00h
2F000h	Reference Code Zone
2F020h	Buffer Zone 1 All 00h
2F200h	Control Data Zone (192 ECC Blocks)
2FE00h	Buffer Zone 2 All 00h
30000h . .	DATA AREA

DVD-ROM is consistent with the general structure of the Control Data ECC Block as shown in Table 28 and the Common Part of the Physical Format Information as shown in Table 29.

Table 31 shows the Data Allocation Area specific to DVD-ROM.

Table 31 - Data Area Allocation Definition

Byte	Single Layer/ Parallel Track Path	Opposite Track Path
4	00h	00h
5 6 7	Starting PSN of Data Area (030000h)	Starting PSN of Data Area (030000h)
8	00h	00h
9 10 11	End PSN of Data Area	End PSN of Data Area
12	00h	00h
13 14 15	000000h	End PSN in Layer 0

The Media Unique Data in the Physical Format area of the Control Data Zone is reserved and zero filled.

4.4.3 DVD-RAM

4.4.3.1 Track Structure

DVD-RAM is a single layer media that may be single sided or two sided. DVD-RAM is available in both 80 mm and 120 mm discs.

4.4.3.2 Sector Structure

The basic DVD ECC block structure as defined in 4.4.1.1 applies to DVD-RAM. For DVD-RAM, the definition of the sector information part of the ID field differs from other DVD media types.

The sector ID field is viewed as a 32-bit field as shown in Figure 29.

Sector Information ID Bits 31 thru 24						
31	30	29	28	27	25	24
Sector Format Type	Tracking Method	Reflectivity	Recording Type	Zone Type	Data Type	Layer Number

Sector Format Type	0b	Indicates CLV format
Tracking Method	1b	Indicates groove tracking
Reflectivity	0b	Indicates reflectivity exceeds 40%
	1b	Indicates reflectivity is less than or equal to 40%
Recording Type	0b	Lead-in, Lead-out, General Data in Data Area
	1b	Real-time Data in Data Area
Zone Type	00b	When sector is in Lead-in Zone
	01b	When sector is in Data Zone
	10b	When sector is in Lead-out Zone
	11b	When sector is in Middle Zone
Data Type	0b	Indicates embossed data
	1b	Indicates rewritable data
Layer Number	0b	DVD-RAM uses only layer 0

Figure 29 – ID Field for DVD-RAM

4.4.3.3 The Lead-in

The DVD-RAM lead-in structure is consistent with the structure shown in Figure 27. Table 32 shows the lead-in structure specific to DVD-RAM.

Table 32 – DVD-RAM Lead-in Structure

Starting PSN	Disc Area
22FA0h	Initial Zone All 00h
2F000h	Reference Code Zone
2F010h	Buffer Zone 1 All 00h
2F200h	Control Data Zone (192 ECC Blocks)
2FE00h	Buffer Zone 2 All 00h
30000h	Defect Controls
31000h . .	DATA AREA

DVD-RAM is consistent with the general structure of the Control Data ECC Block as shown in Table 28 and the Common Part of the Physical Format Information as shown in Table 29.

Table 33 shows the Data Allocation Area for DVD-RAM.

Table 33 – DVD-RAM Data Area Allocation Definition

Byte	DVD-RAM
4	00h
5 6 7	Starting PSN of Data Area (031000h)
8	00h
9 10 11	End PSN of Data Area
12	00h
13 14 15	000000h

The Media Unique Data in the Physical Format area of the Control Data Zone is shown in Table 34 and

Table 35.

Table 34 – DVD-RAM (Ver.1.0) Unique Part of Physical Format Information

Bit / Byte	7	6	5	4	3	2	1	0
32	Disc Type Identification							
33-47	Reserved							
48	Velocity 1							
49-65	Write conditions at Velocity 1							
66-479	Reserved for write conditions at velocity of Velocity 2 to Velocity 24							
480-2047	Reserved							

Table 35 – DVD-RAM (Ver. 2.1) Unique Part of Physical Format Information

Bit / Byte	7	6	5	4	3	2	1	0
32	Disc Type Identification							
33-499	Reserved							
500	Velocity							
501-548	Write conditions at Velocity							
549-596	Disc Manufacturer's name							
597-612	Disc Manufacturer's supplementary information							
613-2047	Reserved							

4.4.3.4 DVD-RAM Recording

DVD-RAM is randomly writable in ECC block increments. Random writability in 2 048 byte sectors is accomplished by read-modify-write actions with ECC blocks. DVD-RAM implements defect management that provides for a seamless LBA space for the initiator.

4.4.4 DVD-R/-RW

4.4.4.1 Track Structure

DVD-R and DVD-RW are single track, single layer media with possible capacities of 3.95 and 4.7 GB.

4.4.4.2 Sector Structure

The basic DVD ECC block structure as defined in 4.4.1.1 applies to DVD-R/-RW. For DVD-R/-RW, the definition of the sector information part of the ID field differs from other DVD media types.

The sector ID field is viewed as a 32-bit field as shown in Figure 30.

Sector Information ID Bits 31 thru 24						
31	30	29	28	27	25	24
Sector Format Type	Tracking Method	Reflectivity	Recording Type	Zone Type	Data Type	Layer Number

Sector Format Type	0b	Indicates CLV format
Tracking Method	1b	Indicates groove tracking
Reflectivity	0b	Indicates reflectivity exceeds 40%
	1b	Indicates reflectivity is less than or equal to 40%
Recording Type	0b	Lead-in, Lead-out, General Data in Data Area
	1b	Real-time Data in Data Area
Zone Type	00b	When sector is in Lead-in Zone
	01b	When sector is in Data Zone
	10b	When sector is in Lead-out Zone
	11b	When sector is in Middle Zone
Data Type	0b	Indicates read-only data or rewritable data
	1b	Indicates sector is linking data
Layer Number	0b	When sector is in layer 0
	1b	When sector is in layer 1

Figure 30 – ID Field for DVD-R/-RW

4.4.4.3 The Lead-in

The DVD-R/-RW lead-in structure is consistent with the structure shown in Figure 27. Table 36 and Table 37 show the lead-in structures specific to DVD-R and DVD-RW.

Table 36 – Lead-in Structure: DVD-RW and DVD-R for General Purpose, ver 2.0

Starting PSN	Disc Area
22FA0h	Initial Zone All 00h
2D600h	System Reserved Zone
2E200h	Buffer Zone 0 (all 00h)
2E400h	Physical Format Information Zone
2F000h	Reference Code Zone
2F020h	Buffer Zone 1 All 00h
2F200h	Control Data Zone (192 ECC Blocks)
2FE00h	Extra Border Zone
30000h . .	DATA AREA

Table 37 – Lead-in Structure: DVD-R ver 1.0, DVD-R for Authoring ver 2.0

Starting PSN	Disc Area
22FA0h	Initial Zone All 00h
2F000h	Reference Code Zone
2F020h	Buffer Zone 1 All 00h
2F200h	Control Data Zone (192 ECC Blocks)
2FE00h	Buffer Zone 2 All 00h
30000h	Defect Controls
31000h . .	DATA AREA

4.4.4.3.1 Control Data Zone

DVD-R/-RW is consistent with the general structure of the Control Data ECC Block as shown in Table 28 and the Common Part of the Physical Format Information as shown in Table 29.

Table 30 shows the Data Allocation Area for DVD-R/-RW.

Table 38 – DVD-R/-RW Data Area Allocation Definition

Byte	DVD-R Ver.1.0 DVD-R for Authoring Ver.2.0 (DAO)	DVD-R Ver.1.0 Incremental	DVD-RW/ DVD-R for General Ver.2.0
4	00h	00h	00h
5 6 7	Starting PSN of Data Area (030000h)	Starting PSN of Data Area (030000h)	Starting PSN of Data Area (030000h)
8	00h	00h	00h
9 10 11	End PSN of Data Area	Last Recorded Sector Number of the last Track in the Session	Last address of Data Recordable area
12	00h	00h	00h
13 14 15	000000h	000000h	000000h

Table 39 – DVD-R Ver 1.0/-R for Authoring Ver.2.0 Unique Part of Physical Format Information

Bit / Byte	7	6	5	4	3	2	1	0
32~35	Start PSN of the current Border-out							
36~39	Start PSN of the next Border-in							
40-2047	Reserved							

Table 40 – DVD-RW/-R for General Ver.2.0 Unique Part of Physical Format Information

Bit / Byte	7	6	5	4	3	2	1	0
32~35	Start PSN of the Extra Border Zone (= 02FE10h)							
36~39	Start PSN of Physical format information blocks in Extra Border Zone (= 02FFA0h)							
40-2047	Reserved							

4.4.4.3.2 DVD-R/-RW Physical format information Zone

The R/RW-Physical format information Zone is defined only for DVD-RW and DVD-R for General Ver.2.0 media. The R/RW-Physical format information Zone contains 192 ECC blocks. Each DVD-R/-RW Physical format information consists of 16 sectors and is repeated 192 times.

The structure of R/RW-Physical format information is shown in Table 41.

Table 41 – DVD-R/-RW Physical Format Information Zone

Sector Number	Description
0	Reserved
1	Manufacturing Information
2	Physical Format Information
3	Reserved
:	
15	

The contents of the Physical Format Information in DVD-R/-RW Physical format information Zone is same as the contents of Physical Format Information in Control Data Zone except Data Area Allocation field and unique part of Physical Format Information (byte 32 - byte 2047).

The definition of the Data Area Allocation field in DVD-R/-RW Physical format information is shown in Table 42.

Table 42 – Data Area Allocation Field in DVD-R/-RW Physical Format Information

Byte	Disc at Once	Incremental Write/Restricted Overwrite
4	00h	00h
5	Starting PSN of Data Area (030000h)	Starting PSN of Data Area (030000h)
6		
7		
8	00h	00h
9	End PSN of Data area	Last Recorded Sector Number of the last Track in the Session (1)
10		
11		
12	00h	00h
13	000000h	000000h
14		
15		
Note:	When the Lead-in or Border-in is recorded in the Restricted Overwrite mode, and when the last session is in an Intermediate state, this field shall be set to 30000h	

The definition of the Unique Part of Physical Format Information fields in DVD-R/-RW Physical format information Zone is shown in Table 43. When the Lead-in is recorded in the Disc at once recording mode, this field contains all 00h data.

Table 43 – Unique Part of Physical Format Information in DVD-R/-RW Physical format information

Bit / Byte	7	6	5	4	3	2	1	0
32 - 35	Start PSN of the current Border-out							
36 - 39	Start PSN of the next Border-in							
40 -2047	Reserved							

4.4.4.3.3 Extra Border Zone

The Extra Border Zone is defined for DVD-RW and DVD-R for General Ver.2.0 media.

The structure of Extra Border Zone is shown in

Figure 31.

The structure of Extra Border Zone is similar to Border Zone. However, the length of Extra Border Zone is only 32 ECC blocks and there are no Next Border Markers and Stop Blocks.

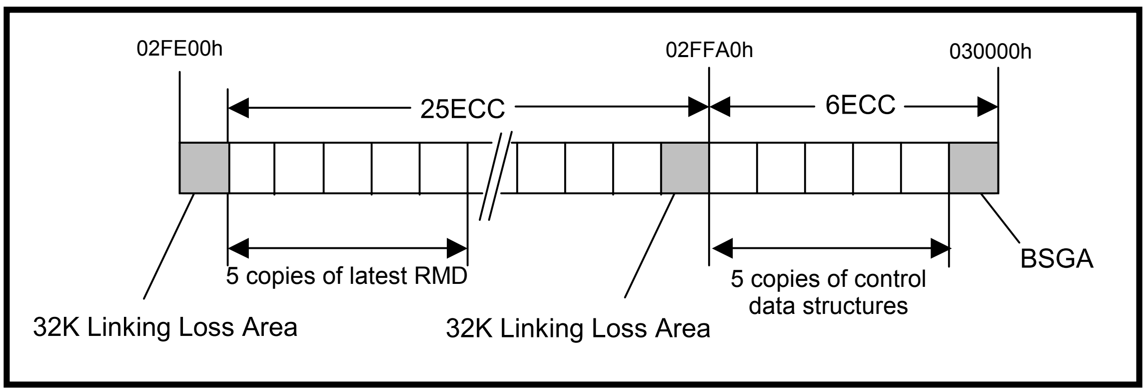


Figure 31 – Structure of Extra Border Zone

4.4.4.4 DVD-R/-RW Recording

4.4.4.4.1 RZone Description

The DVD-R specification describes a logical entity called RZone. This standard describes Tracks as they are implemented on CD. An RZone shall be treated as a Track, with the following differences from a CD Track:

1. An RZone may only contain data (no CD Audio Tracks).
2. An RZone has a pre-gap of 0 or 16 sectors instead of 150.
3. An RZone post-gap size is determined by rounding to the ECC block size, and is 0 - 15 sectors in length.

Note: Pre-gap, post-gap are not defined in the DVD-R specification. In this standard, pre-gap is Linking Loss Area at the beginning of an RZone, post-gap is Linking Loss Area at the end of an RZone. Linking Loss Areas are possible in the middle of an RZone.

4. CD track parameters such as Copy, Control, Data Mode, Packet, FP, and Packet Size either do not apply or have constant values. For purposes of reporting, Copy = 0, Control = 5, Data Mode = 1, FP = 0, Packet Size = 16.
5. The link size is variable due to both user selection of 2k or 32k linking and Logical Unit padding of the last write to an ECC boundary. As in CD, the Next Writable Address can always be obtained via the READ TRACK INFORMATION command.
6. The maximum number of RZones is 2 302.
7. RZones do not contain sub-channel information.

Whenever this standard references a Track, and the medium is DVD-R, the translation above should be applied.

4.4.4.4.2 Border-in/Border-out

The DVD-R specification describes entities called Lead-in, Lead-out, Border-in and Border-out. DVD-R always has zero or one Lead-in and zero or one Lead-out. The Lead-in, if recorded, is always at the beginning of the disc and the Lead-out, if recorded, is always at the end of the disc. No data can be recorded beyond the Lead-out. The information recording area is a collection of Lead-in/Border-in, Bordered Areas, and Border-out. This area, when written, is called a complete session.

If intermediate interchangeability is desired before recording the Lead-out, a Border-out is written in its place. When additional recording is to be done, a Border-in is recorded between the last Border-out and the new data.

If only a Border-in and Border-out are to be written (after incrementally recording data), the Initiator shall set the Multi-session field of the Write Parameters Page to 11b. If set to 11b, and insufficient space exists on the medium for another Border, the Logical Unit shall permanently close the medium by recording a Lead-out. If it is desired to permanently close a disc, the Multi-session field shall be set to 00b or 01b. The Multi-session field is ignored on DVD-R when the Write Type is set to Session at Once, and no next Border is possible. Within this standard Multi-session is used instead of Multi-Border, incomplete session is used instead of incomplete Border, complete session is used instead of complete Border for DVD-R Logical Units.

4.4.4.4.3 RMA Caching

RMA area is the Recording Management Area for DVD-R media. To Update the RMA means to update the RMA on the disc or to update the RMA Cache, that shall be written to the RMA on the disc prior to the removing the disc from the Logical Unit. RMA Caching is vendor specific.

4.4.5 DVD+R

The DVD+R medium was originally defined according to a simple, basic requirement of compatibility: when a fully recorded DVD+R medium is mounted on the spindle of a standard DVD player, the medium should be accepted as if it were a stamped DVD-ROM disc.

Meeting the original requirement means that the medium must have the physical characteristics to allow the DVD player to find the recording groove, track on the data, seek across the groove, and read and decode written data. Clearly, physical compatibility is important. Logical compatibility is also required.

4.4.5.1 Track Structure

DVD+R media is either 8 or 12 centimeters in diameter and separated into zones as shown in Figure 20**Error! Reference source not found.**. The Information zone is organized as a sequence of independently recorded units called ECC blocks. Each ECC block contains 16 user sectors. Each sector is identified by its PSN and contains 2048 bytes of data.

Physical addresses advance incrementally beginning at the virtual address 00000000h. It is virtual, because the physical nature of a DVD+R device guarantees that no drive will ever be able to reach the sector with PSN = 0. Similarly, the media is made with a zone of protection in the groove. Consequently, the first sector which is required to exist, has PSN = 023480h. As with DVD-ROM, the first user accessible sector has PSN = 30000h. The DVD+R 120-mm one-sided disc has 4.70GB available to the user, while the two-sided disc has 9.40GB. The DVD+R 80-mm one-sided disc has 1.46GB available to the user, while the two-sided disc has 2.92GB.

4.4.5.1.1 The ADIP (Address in Pre-groove)

Like CD-RW media:

- DVD+RW media has a wobble structure which defines the groove
- Information is modulated onto the wobble
- Within the Information Zone, this information contains the address of the associated sector
- Within the lead-in, there is additional information about the disc

This is generally called Address-In-Pre-groove or ADIP.

4.4.5.1.2 The ECC Block

The basic DVD ECC block structure as defined in 4.4.1.1 applies to DVD+R. The sector ID field is viewed as a 32-bit field as shown in Figure 25. For DVD+R, the definition of the sector information part of the ID field (Figure 32) differs from other DVD media types.

Sector Information ID Bits 31 thru 24						
31	30	29	28	27	25	24
Sector Format Type	Tracking Method	Reflectivity	Recording Type	Zone Type	Data Type	Layer Number

Figure 32 - DVD+R ID Field Details

Sector Format Type (Bit 31)	is cleared to ZERO, indicating a CLV format
Tracking Method (Bit 30)	is set to ONE, indicating groove tracking
Reflectivity (Bit 29)	is cleared to ZERO indicating that the reflectivity exceeds 40 %
Reserved (Bit 28)	and shall be cleared to ZERO
Zone Type (Bits 27 and 26)	is valued as: 00 when the sector is in the Data Zone (this includes session lead-in and session lead-out areas) 01 when the sector is in the Disc Lead-in 10 when the sector is in the Disc Lead-out
Data Type (Bit 25)	is cleared to ZERO, indicating write-once media
Layer Number (Bit 24)	is cleared to ZERO, indicating that through an entrance surface only one recording layer can be accessed

4.4.5.1.3 DVD+R Groove Layout

The groove, when recorded, is a continuous sequence of ECC blocks. If ECC block E and E+1 are consecutive, then whenever N is the largest PSN in E, then N+1 is the smallest address in E+1. That is, the ECC blocks are sequenced in an intuitively correct way.

The rest of logical groove architecture is given by specific use of individual sectors.

The DVD+R format provides only a continuous address space with no possibility of defect management. If defect management is desired, it is recommended that the host's system software provide the function.

Table 46 shows the zoned layout of the DVD+R groove. The Data Zone boundaries are based upon a single session recording.

Table 44 - DVD+R Format Lay-out

Disc Area	Zone	120 mm Disc		80 mm Disc	
		Start PSN (h)	Length (d)	Start PSN (h)	Length (d)
INNER DRIVE AREA	Initial Zone	-	Blank	-	Blank
	Inner Disc Test Zone	023480h	16 384	023480h	16 384
	Inner Disc Count Zone	027480h	4 096	027480h	4 096
	Inner Disc Administration Zone	028480h	4 096	028480h	4 096
	Table of Contents Zone	029480h	4096	029480h	4096
LEAD-IN	Guard Zone 1	02A480h	14 848	02A480h	14 848
	Reserved Zone 1	02DE80h	4 096	02DE80h	4 096
	Reserved Zone 2	02EE80h	64	02EE80h	64
	Inner Disc Identification Zone	02EEC0h	256	02EEC0h	256
	Reserved Zone 3	02EFC0h	64	02EFC0h	64
	Reference Code Zone	02F000h	32	02F000h	32
	Buffer Zone 1	02F020h	480	02F020h	480
	Control Data Zone	02F200h	3 072	02F200h	3 072
	Buffer Zone 2	02FE00h	512	02FE00h	512
DATA	Data Zone	030000h	max=2 295 104	030000h	max=714 544
LEAD-OUT	Buffer Zone 3	max = 260540h	768	max=0DE730h	768
	Outer Disc Identification Zone	max = 260840h	256	max=0DEA30h	256
	Guard Zone 2	max = 260940h	4 096	max=0DEB30h	4 096
OUTER DRIVE AREA	Outer Disc Administration Zone	261940h	4 096	0DFB30h	4 096
	Outer Disc Count Zone	262940h	4 096	0E0B30h	4 096
	Outer Disc Test Zone	263940h	16 384	0E1B30h	16 384
	Guard Zone 3	2652C0h	Blank	0E5B30h	Blank

4.4.5.2 Recording on DVD+R

4.4.5.2.1 Recording Structures

4.4.5.2.1.1 ECC Blocks

The minimal writable entity on DVD+R is the 32KB ECC block. Physically, DVD+R is randomly writable in 32KB ECC blocks, but not necessarily randomly readable. An ECC block is not fully decodable when it follows a blank area of media. In order to ensure readability, ECC blocks must be written in sequential regions.

4.4.5.2.1.2 Fragments

A fragment is a set of contiguous ECC blocks in the Data Area that contains at least one ECC block. Fragments are distinct. That is, given two different fragments, there are no ECC blocks in common. A fragment is the only unit of allocation on DVD+R.

Fragments are uniquely numbered beginning with one. The start address of fragment one is LBA 0. Fragments are numbered sequentially with no gaps. That is, if fragment N and fragment M are different fragments and there are no fragments between fragment N and fragment M, then M = N+1.

Fragment Oriented Definitions:

Reserved Fragment – Fragment allocation may be explicit, where both the start address and end address are specified. This is a reserved fragment.

The Incomplete Fragment – Fragment allocation may also be implicit, where the start address of the fragment is specified, but the end address is limited only by disc capacity. This is the incomplete fragment. The incomplete fragment may be transformed into two fragments: a reserved fragment and a new incomplete fragment.

Blank Fragment – If every ECC block within the fragment is blank, then the fragment is blank.

Closed Fragment – If every ECC block within a reserved fragment is written, the fragment is closed.

Next Writable Address – Fragments must be written sequentially, beginning with the start address of the fragment. This maintains the fragment in two parts: the written part that begins at the fragment start address and the blank part that begins with the first ECC block in the fragment that has not been written. The LBA of the first sector of the blank part is the Next Writable Address (NWA) of the fragment. The NWA of a blank fragment is the start address of the fragment.

The host may write using a 2 048-byte block size. The drive shall buffer sequentially written data and write only when:

1. An ECC block amount of data has been received from the host,
2. The host issues a SYNCHRONIZE CACHE command,
3. The host issues a CLOSE TRACK command, or
4. A new WRITE command is received for the NWA of a different fragment.

In cases 2 through 4, remaining user data in the ECC block shall be zero filled by the drive prior to writing the ECC block. If no data is buffered for a partial ECC block, then cases 2 through 4 shall cause no write to occur.

4.4.5.2.1.3 Sessions

The data area of a DVD+R disc may be recorded in sessions similar to session recording in CD-R. Each session contains a lead-in equivalent area called the session "Intro", a data area equivalent called session "user data", and a lead-out equivalent called the session "closure". The Intro of the first session is contained within the disc lead-in and the Closure of the final session is contained within the disc lead-out. Each Intro that is not in the disc lead-in is encoded as data. Each Closure that is not contained within the disc lead-out is encoded as data.

Sessions are uniquely numbered beginning with one. The start address of the user data of session one is LBA 0. Sessions are numbered with sequentially with no gaps. That is, if session N and session M are different sessions and there are no sessions between session N and session M, then M = N+1.

Figure 33 shows an example of a multi-session layout on a DVD+R disc. Session 2 is called an interior session. If the disc has no interior sessions, it is a single session disc.

	Disc Lead-in
Session 1	**User Data**
	Closure
	Intro
Session 2	**User Data**
	Closure
	...
	Intro
Final Session	**User Data**
	Disc Lead-out

Figure 33 – General Layout of a Multi-Session DVD+R

The user data zone of a session is made up of a collection fragments. The user data zone contains at least one fragment and may contain up to 16 fragments.

Session Oriented Definitions:

Empty (Blank) Session – If no ECC block in a session is written, the session is blank.

Closed Session – If every ECC block within the session is written, the session is closed.

Open Session – If a session is not closed, then the session is open. An empty session is open.

Open (Incomplete, or Appendable) Disc – If a disc has an open session, then the disc is open.

Closed Disc – During the process of closing a session, the host may specify that no new sessions are allowed. That session is called the Final session and once that session is closed, the disc is closed. No new writing is allowed on a closed disc.

Run-in Block – A single ECC block, zero filled and written, shall separate two adjacent fragments within a session. This "run-in block" ensures that the first ECC block of the second fragment will be readable.

The status of a session and of the fragments within its user data zone is found within the session's Intro.

Table 45 shows the zones of a session.

Table 45 – Zones of a Session

<table>
<tr><th rowspan="2">Session Zone</th><th rowspan="2">Description</th><th colspan="2">Size</th></tr>
<tr><th>Physical Sectors</th><th>ECC Blocks</th></tr>
<tr><td rowspan="9">Disc Lead-in containing
Session 1 Intro</td><td>Guard Zone 1</td><td>14 848</td><td>928</td></tr>
<tr><td>Reserved Zone 1</td><td>4 096</td><td>256</td></tr>
<tr><td>Reserved Zone 2</td><td>64</td><td>4</td></tr>
<tr><td>Inner Disc Identification Zone</td><td>256</td><td>16</td></tr>
<tr><td>Reserved Zone 3</td><td>64</td><td>4</td></tr>
<tr><td>Reference Code Zone</td><td>32</td><td>2</td></tr>
<tr><td>Buffer Zone 1</td><td>480</td><td>30</td></tr>
<tr><td>Control Data Zone</td><td>3 072</td><td>192</td></tr>
<tr><td>Buffer Zone 2</td><td>512</td><td>32</td></tr>
<tr><td rowspan="4">Session (≠1) Intro</td><td>Buffer Zone A</td><td>64</td><td>4</td></tr>
<tr><td>Inner Session Identification Zone</td><td>256</td><td>16</td></tr>
<tr><td>Session Control Data Zone</td><td>640</td><td>40</td></tr>
<tr><td>Buffer Zone B</td><td>64</td><td>4</td></tr>
<tr><td>User Data Zone</td><td>User Data</td><td>16 min</td><td>1 min</td></tr>
<tr><td rowspan="2">Session (not final) Closure</td><td>Buffer Zone C</td><td>768</td><td>48</td></tr>
<tr><td>Outer Session Identification Zone</td><td>256</td><td>16</td></tr>
<tr><td rowspan="3">Disc Lead-out containing final session Closure</td><td>Buffer Zone 3</td><td>768</td><td>48</td></tr>
<tr><td>Outer Disc Identification Zone</td><td>256</td><td>16</td></tr>
<tr><td>Guard Zone 2 (minimum size)</td><td>4 096</td><td>256</td></tr>
</table>

The time to write each of these areas is as follows:

- Guard Zone 1 through Reserved Zone 2 are completely written when session 1 first becomes non-empty open. Buffer Zone A and Buffer Zone B are completely written when the session (≠1) becomes non-empty open.
- The User Data area is written as the host provides data.
- The Inner Disc/Session Identification Zone is written incrementally as fragments within the session are defined. When a fragment is defined, a record (the Fragment Item) is included in the Inner Disc/Session Identification Zone that identifies the boundaries of the fragment. When the session is closed, all unused ECC blocks within he Inner Disc/Session Identification Zone are written with all zeros.

- The remaining areas are written when the session is closed. The Outer Disc/Session Identification Zone may optionally contain a copy of the Inner Disc/Session Identification Zone.

NOTE: When the final session is closed, the ECC blocks of the lead-out shall be encoded as lead-out.

Session Oriented Rules:

There may be at most one open session on a disc - the session that contains the current incomplete fragment.

When a session is closed a new ECC block is appended to the Table of Contents Zone (see Table 46) containing a TOC item that identifies the bounds of the new session.

A session may be closed only when every fragment within the session is closed.

4.4.5.2.2 The Host's Perspective

The MMC command set was developed specifically for CD. Rather than force a new model upon host software developers, the command set described here maintains the CD-R model when working with DVD+R. Certain command set restrictions associated with CD remain with DVD+R.

The host approaches the device and the media from the perspective of CD-R: sectors, packets, tracks, and sessions. For the host, a track is the unit of allocation. The host views a DVD+R fragment as a fixed packet track where the packet size is 16. When a DVD+R session is open, fragments and tracks have equivalent meaning. Numbering for CD-R tracks and DVD+R tracks is different. The user data zone of a closed session is viewed as a track and its number is the session number. Fragments in the open session are viewed as tracks with:

Track Number =

Session Number + Fragment Number - Fragment Number of first fragment in session.

The host will typically use the following commands for the purpose of inspecting and recording DVD+R media:

READ DISC INFORMATION – Provides detailed information about disc status.

READ TRACK INFORMATION – Provides detailed information about any track. Track number translation is according to the above description. A reference to track number FFh results in information for the incomplete fragment.

READ TOC/PMA/ATIP (form 0) – Provides general information about tracks on the media. Tracks reported in response to this command represent only closed sessions. Since CD identifies the lead-out as track AAh, the maximum track number is A9h (169d). This provides for a maximum of 153 closed sessions and 16 fragments in the open session.

READ TOC/PMA/ATIP (form 1) – Provides general information about the last closed session.

WRITE (10 or 12) – Allows writing any sector with location restrictions. The first sector in the write must begin with the NWA for some track (fragment) in the open session.

SYNCHRONIZE CACHE – When writes to a track (fragment) may not have reached an ECC block boundary, the host may issue this command in order to ensure that all buffered data is actually written to the disc.

RESERVE TRACK – Provides the host with the ability to reserve blank disc space for a single track (fragment). The track is not referenced by a number. The fragment will be created from the beginning of the incomplete fragment. The new, reserved fragment will receive the fragment number of the old incomplete fragment, and a new incomplete fragment will be given the next fragment number.

CLOSE TRACK/SESSION (Track) – The host may choose to close a reserved track (fragment) or to define a track (fragment) from the written part of the incomplete fragment.

CLOSE TRACK/SESSION (Session) – For the purpose of making the disc read compatible with a DVD-ROM device, the equivalent of a lead-out (closure) or a real lead-out must follow user data. The host may request either case with this command.

4.4.5.2.3 Building from a Blank Disc

When a DVD+R disc is blank, the user definable space begins as session 1, fragment 1 at LBA 0. In this state fragment 1 is incomplete. When beginning recording on a blank disc, the host has two options: WRITE beginning at LBA 0 or RESERVE TRACK beginning at LBA 0.

- If the host chooses to WRITE, then the host's data is written beginning with LBA 0. The end address of fragment 1 is still unknown, so fragment 1 remains the only fragment on the disc. When this write is executed by the drive, it shall record a session identification item in the first ECC block of the Inner Disc/Session Identification Zone, leaving 15 blank ECC blocks in that zone. This allows for at most 15 incrementally defined fragments in the session. In this case the session may contain at most 15 fragments. Writing may proceed until the host determines that the fragment is completed. At that point the host may define the fragment as complete by issuing a CLOSE TRACK command. The drive shall respond by appending an ECC block into the Inner Disc/Session Identification Zone with a new fragment identification item.
- If the host chooses to issue the RESERVE TRACK command, then a size must be selected. The size will be rounded up to an ECC block boundary. At this point, the end address of fragment 1 is known, thereby defining fragment 2 as an incomplete fragment beginning at an ECC block after fragment 1. In executing the RESERVE TRACK command the drive shall record a session identification item and a fragment identification item (for fragment 1) in the Inner Disc/Session Identification Zone, leaving 15 blank ECC blocks in that zone. This allows for at most 16 incrementally defined fragments in the session. In this case the session may contain at most 16 fragments. The reserved fragment may be written sequentially as the host deems it necessary. If all necessary writing

Subsequent fragment usage operates similarly.

When the user wishes to eject the disc, the host should elect to close the currently open session prior to disc eject. This will ensure that the disc will be read compatibility with DVD read-only devices. If the user wishes to disallow further writing after the session is closed, it is possible to select a close function that will close the disc.

4.4.6 DVD+RW

The DVD+RW medium was originally defined according to a simple, basic requirement of compatibility: when a fully recorded DVD+RW medium is mounted on the spindle of a standard DVD player, the medium should be accepted as if it were a stamped DVD-ROM disc.

Meeting the original requirement means that the medium must have the physical characteristics to allow the DVD player to find the recording groove, track on the data, seek across the groove, and read and decode written data. Clearly, physical compatibility is important. Logical compatibility is also required.

4.4.6.1 Track Structure

DVD+RW is specified as single layer, either one-sided or two-sided, and available in either 8 centimeter or 12 centimeter.

4.4.6.1.1 The ADIP (Address in Pre-groove)

Like CD-RW media:

- DVD+RW media has a wobble structure which defines the groove
- Information is modulated onto the wobble
- Within the Information Zone, this information contains the address of the associated sector
- Within the lead-in, there is additional information about the disc

This is generally called Address-In-Pre-groove or ADIP.

4.4.6.1.2 Logical Structure

The Information zone is organized as a sequence of independently recorded units called ECC blocks.

Each ECC block contains 16 user sectors. Each sector is identified by its PSN and contains 2048 bytes of data.

Physical addresses advance incrementally beginning at the virtual address 00000000h. It is virtual, because the physical nature of a DVD+RW device guarantees that no drive will ever be able to reach the sector with PSN = 0. Similarly, the media is made with a zone of protection in the groove. Consequently, the first sector which is required to exist, has PSN = 1D830h. As with DVD-ROM, the first user accessible sector has PSN = 30000h. The DVD+RW 120-mm one-sided disc has 4.70GB available to the user, while the two-sided disc has 9.40GB. The DVD+RW 80-mm one-sided disc has 1.46GB available to the user, while the two-sided disc has 2.92GB.

4.4.6.2 The ECC Block

The basic DVD ECC block structure as defined in 4.4.1.1 applies to DVD+RW. The sector ID field is viewed as a 32-bit field as shown in Figure 25. For DVD+RW, the definition of the sector information part of the ID field (Figure 34) differs from other DVD media types.

Sector Information ID Bits 31 thru 24						
31	30	29	28	27	25	24
Sector Format Type	Tracking Method	Reflectivity	Recording Type	Zone Type	Data Type	Layer Number

Sector Format Type	0b	Indicates CLV format
Tracking Method	1b	Indicates groove tracking
Reflectivity	1b	Indicates reflectivity is less than or equal to 40%
Recording Type	0b	Reserved for DVD+RW
Zone Type	00b	When sector is in Lead-in Zone
	01b	When sector is in Data Zone
	10b	When sector is in Lead-out Zone
Data Type	1b	Indicates rewritable data
Layer Number	0b	DVD+RW uses only layer 0

Figure 34 – ID Field for DVD+RW

4.4.6.2.1 The Groove Layout

The groove, when recorded, is a continuous sequence of ECC blocks. If ECC block E and E+1 are consecutive, then whenever N is the largest PSN in E, then N+1 is the smallest PSN in E+1. That is, the ECC blocks are sequenced in an intuitively correct way.

The rest of logical groove architecture is given by specific use of individual sectors.

The DVD+RW format provides only a continuous address space with no possibility of defect management. If defect management is desired, it is recommended that the Initiator's system software provide the function.

Table 46 shows the zoned layout of the DVD+RW groove.

Table 46 – DVD+RW Media Lay-out

Disc Area	Zone	120 mm Disc		80 mm Disc	
		Start PSN (h)	Length (d)	Start PSN (h)	Length (d)
LEAD-IN	Initial Zone	01D830h	nominal=52 304	01D830h	nominal=52 304
	Inner Disc Test Zone	02A480h	2 048	02A480h	2 048
	Inner Drive Test Zone	02AC80h	12 288	02AC80h	12 288
	Guard Zone 1	02DC80h	512	02DC80h	512
	Reserved Zone 1	02DE80h	4 096	02DE80h	4 096
	Reserved Zone 2	02EE80h	64	02EE80h	64
	Inner Disc Identification Zone	02EEC0h	256	02EEC0h	256
	Reserved Zone 3	02EFC0h	64	02EFC0h	64
	Reference Code Zone	02F000h	32	02F000h	32
	Buffer Zone 1	02F020h	480	02F020h	480
	Control Data Zone	02F200h	3 072	02F200h	3 072
	Buffer Zone 2	02FE00h	512	02FE00h	512
DATA	Data Zone	030000h	max=2 295 104	030000h	max=714 544
LEAD-OUT	Buffer Zone 3	max=260540h	768	max=0DE730h	768
	Outer Disc Identification Zone	max=260840h	256	max=0DEA30h	256
	Guard Zone 2	max=260940h	4 096	max=0DEB30h	4 096
	Reserved Zone 4	261940h	4 096	0DFB30h	4 096
	Outer Drive Test Zone	262940h	12 288	0E0B30h	12 228
	Outer Disc Test Zone	265940h	2 048	0E3B30h	2 048
	Guard Zone 3	266140h	nominal=24 400	0E4330h	nominal=7 936

4.4.6.3 DVD+RW Basic Format

Relative to the Initiator, the Data Zone is the user space and should be addressed according to LBA. The physical to logical address mapping for DVD+RW is the same as that for DVD-ROM: When physical sector number (PSN) represents a sector in the data zone, its LBA = PSN - 030000h.

4.4.6.3.1 Reading

When recorded, DVD+RW medium is ECC block readable. An intelligent controller can separate individual sector data from a decoded ECC block. Thus for the Initiator, DVD+RW media is 2048 byte sector readable.

NOTE: The function of locating and separating the data of one specific sector from the appropriate ECC block is typically an automated feature within a silicon sub-system. So, select any 2 sectors within the ECC block. There is virtually no difference in the times required to separate each sector's data from the ECC block. That is, there is no real performance difference.

4.4.6.3.2 Writing

Since the Initiator's perception is that the media is sector readable, then in order to maintain compatibility with other block devices, a DVD+RW drive must be able to also write single sectors for its Initiator.

The drive is required to write DVD+RW media only in complete ECC blocks. So, the drive must often perform a read/modify/write function in order to place the Initiator's data in the correct position within the ECC block. That works when the ECC block to be written has already been written. When the ECC block has never been written and the drive must write less than a full ECC block, then the drive must create data. The correct method is to zero fill sectors for which no data is available.

4.4.6.3.3 Formatting

When every ECC block in the Information Zone (lead-in, Data Zone, lead-out) of a DVD+RW has been recorded, the disc is "formatted". Clause 21 of *DVD+RW 4.7 Gbytes Basic Format Specifications*, additionally, defines specific data content for all sectors. This makes it DVD+RW formatted.

Write commands shall not be accepted prior to format of blank media.

Physically blank DVD+RW media has no data recorded in its groove, so those devices can find no references on the surface of a blank DVD+RW disc. This has been compared to trying to run on ice. There is no control. So, in order to assure read compatibility with DVD-RO devices, it is very important to have formatted media.

The high capacity together with the low (relative to HDD) write speeds means that completely formatting a disc requires more time than desired - today, about 30 minutes. This problem is not new with DVD+RW. The solution offered here is recycled from one of many for CD-RW: most of the format time is pushed into background time so that the user never experiences any significant delays. This is done by understanding use models and arranging for both the drive and the Initiator to control those use models in order to make an incompletely formatted media appear to be completely formatted.

Background formatting has some controlling requirements:

- After some minimal amount of formatting has been performed, the operation goes from foreground time to background time. The formatting operation in the drive must strive to maintain the Data Zone in two areas: the inner area written and the outer area unwritten. For data applications devices, the formatting bit map in the FDCB shall be implemented in order to minimize excessive reformatting associated with random writing.
- The Initiator must modify its allocation algorithms to minimize blank area fragmentation.
- If the user wishes to remove the medium prior to format completion, the Initiator may request that the drive create a temporary and minimally acceptable lead-out that allows a continuation of the formatting process at a later time. The Initiator may also request that the medium be ejected in its current state.
- In support of the previous requirement, the drive must provide a format re-start mechanism.
- The drive must always make current format status available to the Initiator.

Details of how background formatting operates relative to the Initiator are to be found in the description of the FORMAT UNIT command (sub-clause).

4.4.6.3.4 Disc Control Blocks

DVD+RW media format includes a generalized structure called the Disc Control Block (DCB). The DVD+RW Basic Format has only one defined DCB: the Formatting DCB (FDCB).

All DCBs include handling control for DVD+RW devices that have no understanding of the specific DCB: the Unknown Content Descriptor (UCD). This bit significant value in the DCB defines actions that the Initiator may take (e.g. write the DCB, do not write the DCB, read the DCB, etc). In the event that the Initiator violates the instructions of the UCD, the associated command shall be terminated with CHECK CONDITION status and SK/ASC/ASCQ values shall be set to ILLEGAL REQUEST, ILLEGAL FUNCTION (05h/22h/00h).

4.4.6.4 DVD+MRW

A general description of the MRW format is found in sub-clause 4.1.7.

A description of DVD+RW media can be found in *DVD+RW 4.7 Gbytes Basic Format Specifications.* For the purpose of presenting the mapping of MRW onto DVD+RW media it is only necessary to:

- Identify the location of the MTA within the lead-in.
- Identify the location of the GAA.
- Identify the location of the DMA.
- Identify the location of the STA within the data zone.
- Present use models.

4.4.6.4.1 DVD+MRW Structure

The DVD+RW 120-mm one-sided disc has a 4.70GB information zone, while the two-sided disc has 9.40GB. The (one-sided) MRW capacity is either 4.56GB or 4.16GB, based on formatting.

The DVD+RW 80-mm one-sided disc has 1.46GB information zone, while the two-sided disc has 2.92GB. The (one-sided) MRW capacity is 1.33GB.

The Information Zone is divided into the three primary areas: Lead-in, Data Area, and Lead-out.

MRW is mapped onto DVD+RW media as follows (see Figure 35):

- The MTA is 128 sectors in length in two 64-sector parts.
- The GAA is 1024 sectors in length, beginning with PSN = 30000h
- The DMA is constructed as follows:
  - Spare Area 1 (SA1) has a length of 4 096 sectors.
  - The User Data Area (UDA) has a length of 2 227 488 or 2 032 928.sectors on 12 cm media and a length of 647 984 on 8 cm media.
  - Spare Area 2 (SA2) has a length of 61 440 sectors. On 12 cm media, SA2 may optionally have be 256 000 sectors.
- The STA is 1056 (66 ECC blocks) sectors in length, beginning with PSN = 260120h.
- The Lead-out begins at PSN = 2601A0h and has a nominal length of 47952 sectors.

<table>
<tr><td colspan="11">Information Zone</td></tr>
<tr><td colspan="5">Lead-in</td><td colspan="5">Data Area</td><td rowspan="3">Lead-out</td></tr>
<tr><td rowspan="2"></td><td rowspan="2">MTA part 1</td><td rowspan="2"></td><td rowspan="2">MTA part 2</td><td rowspan="2"></td><td rowspan="2">GAA</td><td>SA1</td><td>UDA</td><td>SA2</td><td rowspan="2">STA</td></tr>
<tr><td colspan="3">DMA</td></tr>
</table>

Figure 35 – MRW Mapping onto DVD+RW, General

The spare block size is 32 768 bytes - one ECC block.

Table 47 shows the layout of the DVD+MRW formatted groove.

Table 47 – DVD+MRW Format Lay-out

Disc Area	Zone		12 cm Disc		8 cm Disc	
			Start PSN	Length in Sectors	Start PSN	Length in Sectors
LEAD-IN	Initial Zone		01D830h	52 304 nominal	01D830h	52 304 nominal
	Inner Disc Test Zone		02A480h	2 048	02A480h	2 048
	Inner Drive Test Zone		02AC80h	12 288	02AC80h	12 288
	Guard Zone 1		02DC80h	512	02DC80h	512
	MTA, part 1		02DE80h	4 096	02DE80h	4 096
	MTA, part 2		02EE80h	64	02EE80h	64
	Inner Disc Identification Zone		02EEC0h	256	02EEC0h	256
	MTA, part 3		02EFC0h	64	02EFC0h	64
	Reference Code Zone		02F000h	32	02F000h	32
	Buffer Zone 1		02F020h	480	02F020h	480
	Control Data Zone		02F200h	3 072	02F200h	3 072
	Buffer Zone 2		02FE00h	512	02FE00h	512
DATA	GAA		030000h	1 024	030000h	1 024
	DMA	SA1	030400h	4 096	030400h	4 096
		UDA	031400h	2 227 488/ 2 032 928	031400h	646 928
		SA2	251120h	61 440/ 256 000	0CF310h	61 440
	STA		260120h	1056	0DE310h	1056
LEAD-OUT	Buffer Zone 3		260540h	768	0DE730h	768
	Outer Disc Identification Zone		260840h	256	0DEA30h	256
	Guard Zone 2		260940h	4 096	0DEB30h	4 096
	Reserved Zone 4		261940h	4 096	0DFB30h	4 096
	Outer Drive Test Zone		262940h	12 288	0E0B30h	12 288
	Outer Disc Test Zone		265940h	2 048	0E3B30h	2 048
	Guard Zone 3		266140h	24 400 nominal	0E4330h	7 936 nominal

4.4.6.4.2 Addressing

Table 47 shows that the GAA begins at PSA = 030000h and the DMA primary space begins at PSA = 031400h.

Logical addressing for the GAA exactly overlaps the logical addressing for first 1 024 sectors of DVD-ROM.

Logical addressing for the primary DMA sectors is exactly DVD-ROM logical addressing plus the offset of 1 400h. Note that the DMA has two possible sizes for SA2 (spare area 2) and consequently, two possible capacities. The specific capacity must be selected at format time.

4.5 Changer Model

The changer is a Feature of a MM device. It shall support two (2) additional commands, MECHANISM STATUS (sub-clause 5.11) and LOAD/UNLOAD MEDIUM (sub-clause 5.10).

A changer device provides a storage area for more than one MM 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 magazine to hold the discs. In the former, individual discs can be changed, while in the latter all the stored discs shall be changed at one time.

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

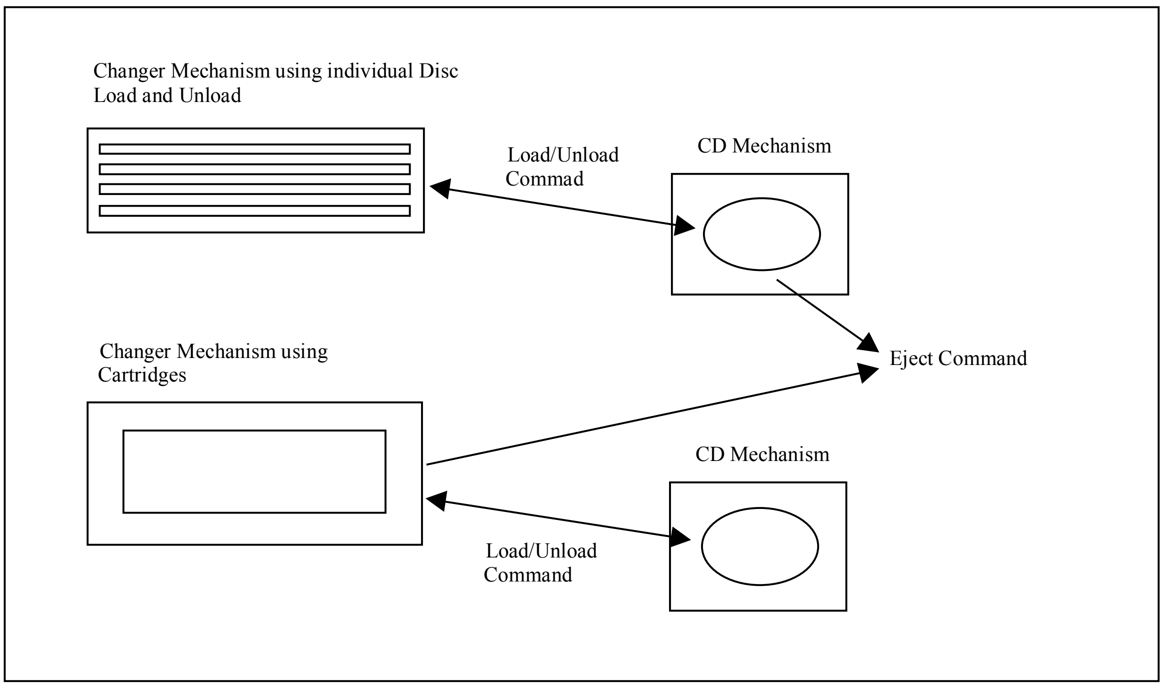


Figure 36 – Media Changer Mechanism Model

4.5.1 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 allows devices that are capable of automatically changing sides. For MM 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 has 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 flip the media over.

For a Logical Unit that supports changing sides (see Table 406), the number of Slots reported shall be even, and every other slot shall be an alternating side.

4.5.1.1 Side Changing Only Logical Unit

A Logical Unit that is capable of changing the side of the Disc, but does not have separate Slots from the playing position, reports that it has a Mechanism type that is not a changer, but also reports Side Change Capable. This style of Logical Unit still uses the LOAD/UNLOAD MEDIUM command to change the currently selected side. The Logical Unit shall report two slots available.

When the Logical Unit can only change sides, and not discs, it does not perform any action. This appears to the Initiator as a Logical Unit with a Delayed Load type of operation.

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

4.5.1.2 Attention Conditions for Sided Discs

Devices that support changing sides shall set SK/ASC/ASCQ to UNIT ATTENTION/NOT READY TO READY CHANGE - MEDIUM MAY HAVE CHANGED (06h/28h/00h) for changes that involve disc loading.

4.5.1.2.1 Error Conditions for Sided Discs

Devices that support changing disc sides shall set SK/ASC/ASCQ to NOT READY, NO REFERENCE POSITION FOUND (02h/06h/00h) to report when the currently selected side does not contain valid data.

4.5.1.3 Initialization

The Changer shall perform its initialization routine at power on or hard reset.

“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 responds immediately and provides no slot table information (only the Header).

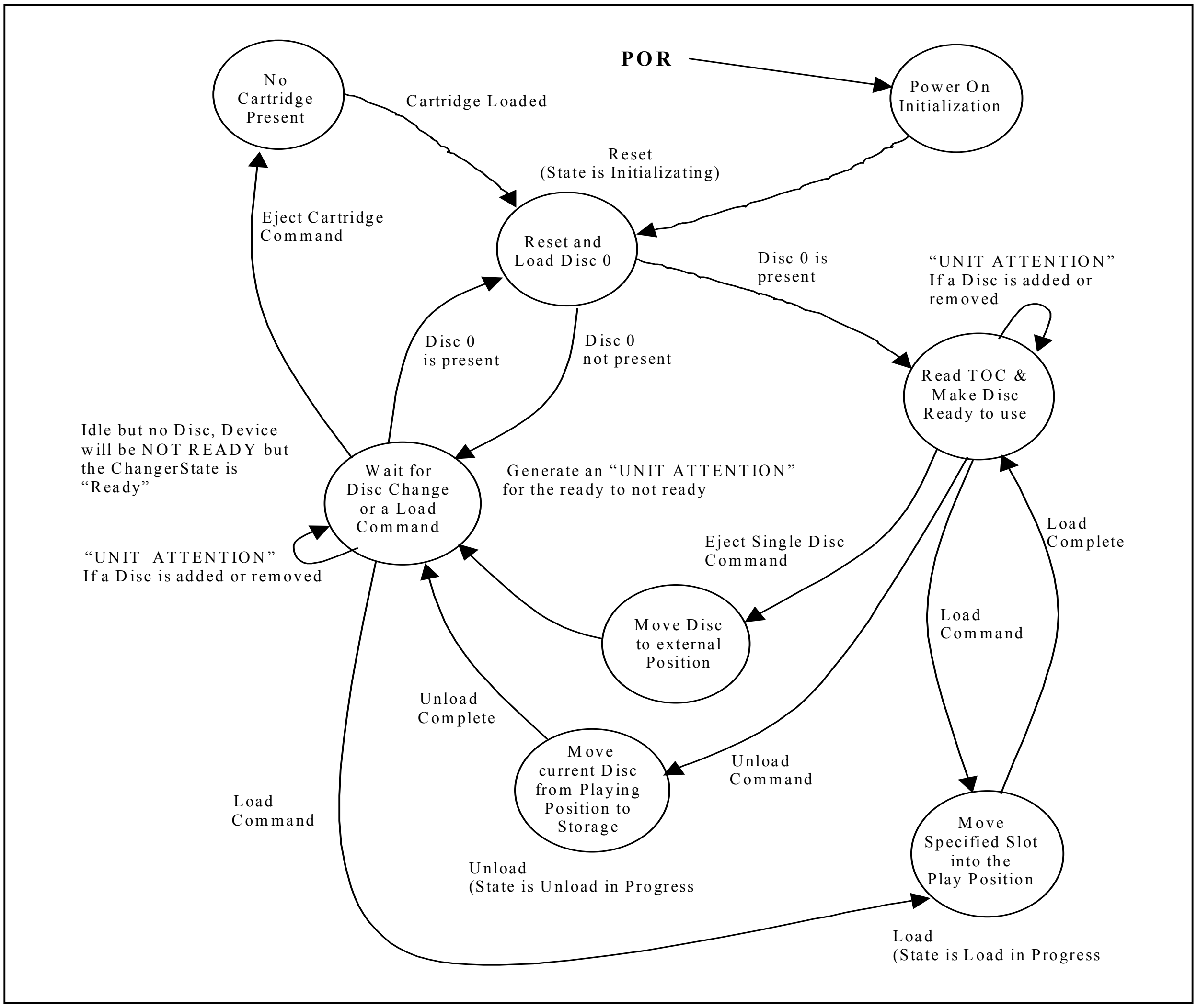


Figure 37 – Changer State Diagram

4.5.2 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 Logical Unit is a changer type device, the Embedded Changer Feature shall be reported in response to an appropriate GET CONFIGURATION command.

There is a legacy method to determine if a Logical Unit is a changer type device. The Loading Mechanism Type field in the MM Capabilities & Mechanical Status Mode Page contains one of the two changer type codes (See Table 148) for individual disc or magazine implementations.

4.5.3 Automatic Load and Unload Operations

After initialization is complete the changer shall have Disc 0 loaded into the play position. This enables drivers that are not changer aware to work with a changer device as if it were a normal single MM device. This also ensures compatibility with a Bootable MM. 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/UNLOAD command is received and a Disc is present in the Playing position, it shall be unloaded automatically before the specified Load operation is performed.

4.5.4 Delayed Disc load operation

MM 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 48 shall move the selected disc into the play position when data that has not been cached has been requested by the Initiator.

Table 48 – Commands that may not cause delayed loads to occur

Commands
Play Audio (10)
Play Audio MSF
Read (10)
Read (12)
Read CD
Read CD MSF
Read CD-ROM Capacity
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 49).

Table 49 – Commands that may 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 50)

Table 50 – 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

4.5.5 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 Magazine and not individually controlled slots should not report the Software Slot Selection capability.

4.5.6 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 SK/ASC/ASCQ values shall be set. Table 51 lists 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 51 – 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
Device 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 magazine and there is a Disc in the playing position shall be rejected with a CHECK CONDITION status and SK/ASC/ASCQ values shall be set to ILLEGAL REQUEST/MECHANICAL POSITIONING OR CHANGER ERROR.

4.6 Real-Time Stream Recording/Playback Model

The Real-Time Stream recording/playback is one of the most important applications for recordable optical discs. It is also expected as a bridge between PC peripherals and consumer devices such as DVD Player. However, optical disc drives, especially consumer players, have low access performance comparing with hard drives from the viewpoint of data rate or seek delay. In addition, dispersion of recorded Streaming data on recordable optical discs may further degrade the performance leading to the poor quality of data playback. In order to address the issue, streaming data should be arranged continuously on a disc in order to guarantee the minimum bit rate for Real-Time Stream recording/playback.

One of factors to make dispersion of Streaming data may be attributed to defects. When a recordable optical disc is handled without a cartridge on consumer players, more defects due to contamination may be encountered during stream recording than used with a cartridge only. On the other hand, because of the real-time requirement, a Logical Unit may not be allowed as much time and efforts to overcome defects encountered during Stream recording as it has during conventional data recording. The real-time Stream recording/playback model specifies new methods to handle defective sectors on a recordable optical disc.

4.6.1 Stream recording operation

A defect management scheme like Linear Replacement Algorithm is applied when the Logical Unit encounters such a defective sector during the conventional WRITE operation. This is one of the solution to make the disc defect free, and it is applied to many optical discs.

But for Stream recording/playback application, such a defect management makes the access speed be spoiled for real-time operation, because the alternative good block locates physically away from the defective one. If this scheme is applied to Stream recording system, the system is required to have enough buffer memory to maintain the recording transfer rate. The playback picture may be jerky if a long distance seek operation is required to read the alternative block in the Spare Area during playing back a Streaming data from the media.

To solve this problem, the Logical Unit commanded to write data using Stream recording shall not replace a defective block with the other block even if the Logical Unit encounters a defective block during Stream recording operation.

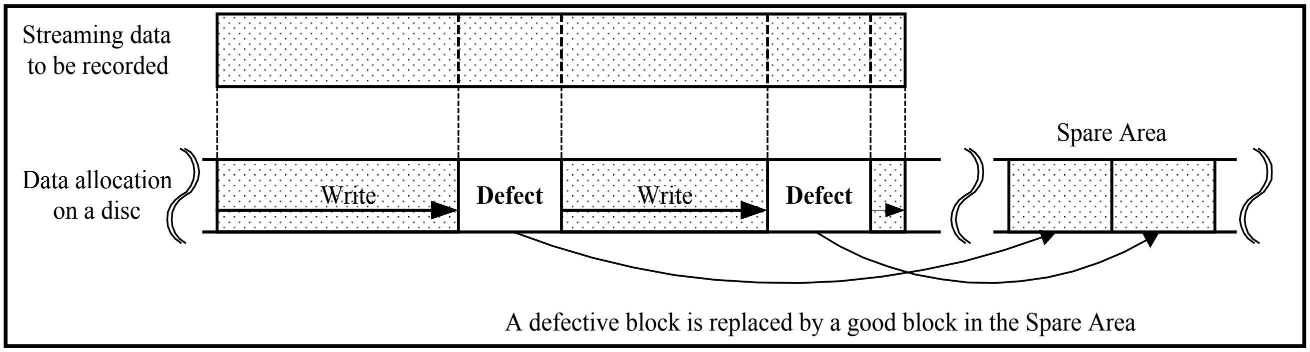


Figure 38 – Example of Data Allocation in case of Linear Replacement

The Logical Unit that returns Real-Time Streaming Feature with Version field of 1 and SW bit of 1 shall supports the following functions.

An example of data allocation on a disc is shown in Figure 39. When the Stream recording operation is executed the Logical Unit shall continue recording without reporting error even if a defective block is found on the Stream recording operation. The Streaming data recorded to the defective block may not be read correctly.

The Initiator shall use WRITE (12) command with Streaming bit set to one to execute the Stream recording operation. The Logical Unit shall not execute Linear Replacement operation for defective block. The Logical Unit's performance shall be at least 1x speed even if this prevents the Logical Unit from retry or verify operation.

The Logical Unit shall not report CHECK CONDITION status except fatal error, even if a defective block is found on Stream recording operation. The Logical Unit returns a fatal error when the Stream recording operation can not be continued because of critical error such as hardware error.

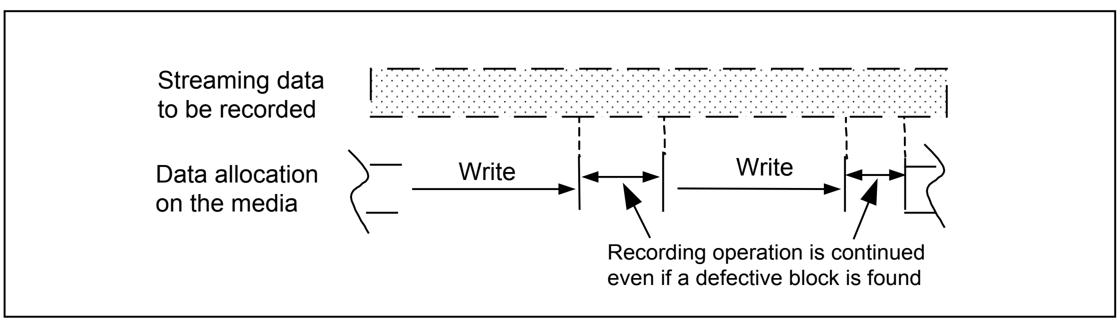


Figure 39 – An example of data allocation on the Stream recording operation

4.6.2 Stream playback operation

Using Real Time Stream playback operation may result in erroneous data. If the data is not correctable, the Logical Unit on conventional READ operation performs error recovery operations. In case of Stream playback operation, the highest priority should be given to continuity of data.

In order to distinguish the data attribute to be read, Streaming data or other normal data, Streaming bit is defined to the READ (12) command. If the Logical Unit receives the READ (12) command with Streaming bit set to one, the data should be read out continuously without reporting uncorrectable read error, even if erroneous blocks are detected. The Logical Unit shall transfer the required size of data on the erroneous block without reporting error, though the transferred data may contain error. Read Ahead operation should be applied on Stream playback operation in order to secure continuity.

Note: The cached data that contains an erroneous portion shall not be returned by the READ (12) command when the Streaming bit cleared. In such cases, cached data in a buffer memory is discarded and attempts to read with the conventional READ operation.

4.6.3 Error Handling on Stream recording/playback operation

An erroneous block encountered on Stream recording/playback operation should be handled according Table 52. The defective block may be registered in defect list but the linear replacement algorithm shall not be applied on Stream recording/playback operation.

Table 52 – Error Handling on Stream recording/playback operation

Sector Status	**Command**	**Description**
Good block	Read	No Error
	Write	No Error
	Read with Stream=1	No Error
	Write with Stream=1	No Error
Defective block registered in defect list and replaced	Read	No Error
	Write	No Error
	Read with Stream=1	No Error (Defect list is ignored, Null (00h) data shall be returned for Blocks listed in a defect list) [1]
	Write with Stream=1	Ignore defect list and keep recording (The data written on the defective block is not guaranteed)
Defective block registered in defect list, but not replaced or defective block with Recording Type bit set to 1	Read	No Error[2] (NULL (00h)or partially corrected data may be returned)[3]
	Write	No Error (The defective block should be replaced and the data should be written to an alternative block)
	Read with Stream=1	No Error (Erroneous data may be returned)
	Write with Stream=1	No Error (The data should be written to the defective block without error reporting, and the defective block should still be registered in defect list)[4]
Defective block which is not registered in defect list	Read	Report Error (Erroneous data shall not be returned)
	Write	No Error (The defective block should be replaced and the data should be written to an alternative block)
	Read with Stream=1	No Error (Erroneous data may be returned)
	Write with Stream=1	No Error (The data should be written to the defective block without error reporting, and the defective block should be registered in defect list)[4]

Notes:
(1) Legacy Logical Unit that may not comply with this specification may return erroneous data and continue reading
(2) In response to the VERIFY command, the Logical Unit shall report an error.
(3) This is defined to be able to playback on a legacy system that uses the conventional READ command.
(4) The defective block should be registered in defect list, but linear replacement shall not be applied.

5 Commands for Multi-Media Devices

5.1 Overview

The commands described in this clause are defined uniquely for Multi-Media Logical Units or have a unique behavior when executed by a Multi-Media Logical Unit.

Certain commands or command options that were present in earlier versions of this standard have been defined as Legacy and are no longer recommended for use in Multi-Media devices and are not described in this clause. Those commands and command options are described in Annex E.

Some commands that may be implemented are not described in this standard, but can be found in other SCSI standards. For a complete description of these commands, SCSI Primary Commands, SCSI Block Commands, and others should be referenced.

The commands described in this clause are listed in Table 53 and

Table 54.

Table 53 – Commands for Multi-Media Logical Units (Alphabetic order)

Command Name	Op Code	Ref-erence
BLANK	A1h	5.2
CLOSE TRACK/SESSION	5Bh	5.3
ERASE (10)	2Ch	5.4
FORMAT UNIT	04h	5.5
GET CONFIGURATION	46h	5.6
GET EVENT/STATUS NOTIFICATION	4Ah	5.7
GET PERFORMANCE	ACh	5.8
INQUIRY	12h	5.9
LOAD/UNLOAD MEDIUM	A6h	5.10
MECHANISM STATUS	BDh	5.11
MODE SELECT (10)	55h	0
MODE SENSE (10)	5Ah	5.13
PAUSE/RESUME	4Bh	5.14
PLAY AUDIO (10)	45h	5.15
PLAY AUDIO (12)	A5h	5.16
PLAY AUDIO MSF	47h	5.17
PREVENT ALLOW MEDIUM REMOVAL	1Eh	5.18
READ (10)	28h	5.19
READ (12)	A8h	5.20
READ BUFFER	3Ch	5.21
READ BUFFER CAPACITY	5Ch	5.22
READ CAPACITY	25h	5.23
READ CD	BEh	5.24
READ CD MSF	B9h	5.25
READ DISC INFORMATION	51h	5.26
READ DVD STRUCTURE	ADh	5.27
READ FORMAT CAPACITIES	23h	5.28
READ SUB-CHANNEL	42h	5.29
READ TOC/PMA/ATIP	43h	5.30
READ TRACK INFORMATION	52h	5.31
REPAIR TRACK	58h	5.32
REPORT KEY	A4h	5.33
REQUEST SENSE	03h	5.34
RESERVE TRACK	53h	5.35
SCAN	BAh	5.36
SEEK (10)	2Bh	5.37
SEND CUE SHEET	5Dh	5.38
SEND DVD STRUCTURE	BFh	5.39
SEND KEY	A3h	5.40
SEND OPC INFORMATION	54h	5.41
SET CD SPEED	BBh	5.42
SET READ AHEAD	A7h	5.43
SET STREAMING	B6h	5.44
START STOP UNIT	1Bh	5.45
STOP PLAY/SCAN	4Eh	5.46
SYNCHRONIZE CACHE	35h	5.47
TEST UNIT READY	00h	5.48
VERIFY (10)	2Fh	5.49
WRITE (10)	2Ah	5.50
WRITE (12)	AAh	5.51
WRITE AND VERIFY (10)	2Eh	5.52
WRITE BUFFER	3Bh	5.53

Table 54 – Commands for Multi-Media Logical Units (Opcode order)

Command Name	Op Code	Ref-erence
TEST UNIT READY	00h	5.48
REQUEST SENSE	03h	5.34
FORMAT UNIT	04h	5.5
INQUIRY	12h	5.9
START STOP UNIT	1Bh	5.45
PREVENT ALLOW MEDIUM REMOVAL	1Eh	5.18
READ FORMAT CAPACITIES	23h	5.28
READ CAPACITY	25h	5.23
READ (10)	28h	5.19
SEEK (10)	2Bh	5.37
ERASE (10)	2Ch	5.4
WRITE (10)	2Ah	5.50
WRITE AND VERIFY (10)	2Eh	5.52
VERIFY (10)	2Fh	5.49
SYNCHRONIZE CACHE	35h	5.47
WRITE BUFFER	3Bh	5.53
READ BUFFER	3Ch	5.21
READ SUB-CHANNEL	42h	5.29
READ TOC/PMA/ATIP	43h	5.30
PLAY AUDIO (10)	45h	5.15
GET CONFIGURATION	46h	5.6
PLAY AUDIO MSF	47h	5.17
GET EVENT/STATUS NOTIFICATION	4Ah	5.7
PAUSE/RESUME	4Bh	5.14
STOP PLAY/SCAN	4Eh	5.46
READ DISC INFORMATION	51h	5.26

Command Name	Op Code	Ref-erence
READ TRACK INFORMATION	52h	5.31
RESERVE TRACK	53h	5.35
SEND OPC INFORMATION	54h	5.41
MODE SELECT (10)	55h	0
MODE SENSE (10)	5Ah	5.13
REPAIR TRACK	58h	5.32
CLOSE TRACK/SESSION	5Bh	5.3
READ BUFFER CAPACITY	5Ch	5.22
SEND CUE SHEET	5Dh	5.38
BLANK	A1h	5.2
SEND KEY	A3h	5.40
REPORT KEY	A4h	5.33
PLAY AUDIO (12)	A5h	5.16
LOAD/UNLOAD MEDIUM	A6h	5.10
SET READ AHEAD	A7h	5.43
READ (12)	A8h	5.20
WRITE (12)	AAh	5.51
GET PERFORMANCE	ACh	5.8
READ DVD STRUCTURE	ADh	5.27
SET STREAMING	B6h	5.44
READ CD MSF	B9h	5.25
SCAN	BAh	5.36
SET SPEED	BBh	5.42
MECHANISM STATUS	BDh	5.11
READ CD	BEh	5.24
SEND DVD STRUCTURE	BFh	5.39

5.2 BLANK Command

ReWritable media that reports either the Restricted Overwrite Feature or the Rigid Restricted Overwrite Feature carries the restriction that it must be recorded in a sequential way. When those features are present, it becomes necessary to provide a re-initialization of the media to the blank state. The blanking action performed in this command is a Logical Erase. For example, CD-RW data is overwritten with Mode 0 data.

The BLANK command provides this capability. Features that specify the use of the BLANK command are listed in Table 55.

Table 55 – Features Associated with the BLANK Command

Feature Number	Feature Name	Command Requirement
0021h	Incremental Streaming Writable	Mandatory for DD/CD-RW and DVD-RW
002Dh	CD Track At Once	Mandatory for DD/CD-RW
Note: The command requirement is valid only when the feature is current.		

5.2.1 The CDB and its Parameters

The BLANK command descriptor block is shown in Table 56.

Table 56 – BLANK Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code (A1h)							
1	Reserved			IMMED	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							

If IMMED is zero, then the requested operation is executed to completion prior to returning status. If IMMED is one, then status is returned once the operation has begun.

Blanking Type identifies the method and coverage of blanking. Blanking Type codes for CD-RW are defined in Table 57 and Blanking Type codes for DVD-RW are defined in Table 58.

Start Address/Track Number meanings are defined within the specific Blanking Type cases (Table 57 and Table 58).

Table 57 – Blanking Types CD-RW

Value	Name	Description
000b	Blank the disc	The entire disc is to be blanked. The Start Address parameter is ignored. This is used for clearing a complete disc. The PCA may be excluded. At completion of the operation, the entire PMA, the area from the start time of the lead-in through the last possible start time of lead-out, and 6 750 blocks into the lead-out shall be blank.
001b	Minimally blank the disc	Blanks only the PMA, disc lead-in 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 shall be exercised when using this command since the program area still contains user data.
010b	Blank a Track	Blanks the track specified in the Start Address/Track Number field. This command blanks the track only, it does not blank the TOC or the PMA. The track to be blanked shall be in the incomplete session. If the Start Address/Track Number does not reference a track on the media, then this command shall be terminated with CHECK CONDITION status and SK/ASC/ASCQ values shall be set to ILLEGAL REQUEST/INVALID FIELD IN CDB.
011b	Un-reserve a Track	All data for the last track in the incomplete session shall be blanked. If the track has a PMA entry, the PMA entry shall be blanked. If the disc is blank, the command shall be terminated with GOOD status. The Start Address/Track Number parameter is ignored.
100b	Blank a Track Tail	This blank type is valid only for Packet tracks within the incomplete session. If Start Address/Track Number specifies a valid LBA within a track and the LBA is the first sector of a packet, then the area between the LBA and the end of the track that shall be blanked. If the LBA does not exist in any track within the incomplete session, or if the LBA is not the first sector of a packet, then the command shall be terminated with CHECK CONDITION status and SK/ASC/ASCQ values shall be set to ILLEGAL REQUEST/LOGICAL BLOCK ADDRESS OUT OF RANGE. If the track is not a packet track, then this command shall be terminated with CHECK CONDITION status and SK/ASC/ASCQ values shall be set to ILLEGAL REQUEST/INVALID FIELD IN CDB.
101b	Unclose the last session	The last session shall be empty. The Lead-in and Lead-out of the last complete session shall be blanked. If the last session is not empty, then this command shall be terminated with CHECK CONDITION status and SK/ASC/ASCQ values shall be set to ILLEGAL REQUEST/INVALID FIELD IN CDB.
110b	Blank Session	If the last session is empty, then the Lead-in, program area, and Lead-out of the last compete session shall be blanked. If the last session is incomplete, its program area shall be blanked. If the disc is blank, the command shall be terminated with GOOD status.
111b	Reserved	

Table 58 – Blanking Types for DVD-RW media

Value	Name	Description
000b	Blank the disc	The entire disc is to be blanked. The area from the RMA through the end of Last address of Data Recordable Area plus 3 ECC blocks except RMA Lead-in and six RMD blocks at the beginning of RMA shall be blanked. The Start Address or Track Number parameter is ignored. If a disc is to be blanked that is already fully blanked, no error shall be reported.
001b	Minimally blank the disc	This operation is used for blanking a disc quickly. Lead-in and the entire RMA except RMA Lead-in and six RMD blocks at the beginning of RMA shall be blanked. The Start Address or Track Number parameter is ignored. Caution should be exercised when using this command since the data area still contains user data. If a disc is to be blanked that is already fully/minimally blanked, no error shall be reported.
010b	Reserved	
011b	Un-reserve a Track	This operation is valid only when the last session is incomplete state. If the last track is invisible, the track that immediately precedes the invisible track and its RMD entry are blanked. If the last track is incomplete, the incomplete track is blanked. The Start Address or Track Number parameter is ignored.
100b	Blank a Track Tail	This blanking type is valid for only a incrementally recorded track. The track to be blanked shall be in an incomplete session. Blank the area between the LBA specified Start Address or Track Number field and the end of the track that includes the LBA specified. When the track that is to be blanked is complete track and if the next track is recorded, the last ECC block of the complete track shall be remained as BSGA to guarantee next track readable. If attempting to blank a track that causes generation of fourth NWA, the command shall be terminated with CHECK CONDITION status and SK/ASC/ASCQ shall be set to ILLEGAL REQUEST/NO MORE TRACK RESERVATIONS ALLOWED. The LBA specified shall be the first user data block of an ECC block and shall be an existing linking point of a track. If the start address sector is not a linking point, the command shall be terminated with CHECK CONDITION status and SK/ASC/ASCQ shall be set to ILLEGAL REQUEST/INVALID ADDRESS FOR WRITE.
101b	Unclose the last session	This blanking type is valid for only a incrementally recorded disc. This operation is valid only when the last session is complete state. Blanks the Lead-in/ Border-in and Lead-out/Border-out of the last session. If the last session is empty state, the complete session immediately preceding the empty session shall be blanked.
110b	Blank Session	If the last session is complete state, its Lead-in/Border-in through the end of the Lead-out/Border-out shall be blanked. If the last session is incomplete state, all track(s) in the incomplete session shall be blanked. If the last session is empty state, the complete session immediately preceding the empty session shall be blanked. If the disc is blank, blanking shall not be considered an error.
111b	Reserved	

5.2.2 Command Execution

During a Blanking operation that began with the IMMED bit set to one, the Logical Unit shall respond to commands as follows:

a) In response to all commands except REQUEST SENSE, INQUIRY, GET CONFIGURATION, and GET EVENT/STATUS NOTIFICATION, the Logical Unit shall return CHECK CONDITION status and set SK/ASC/ASCQ to NOT READY/LOGICAL UNIT NOT READY/OPERATION IN PROGRESS.

b) In response to the INQUIRY, GET CONFIGURATION, GET EVENT/STATUS NOTIFICATION commands, the Logical Unit shall respond as commanded.

c) In response to the REQUEST SENSE command, unless an error has occurred, the Logical Unit shall return a SK/ASC/ASCQ values set to NOT READY/LOGICAL UNIT NOT READY/OPERATION IN PROGRESS, with the sense key specific bytes set for progress indication.

If the Logical Unit changes to a not ready state during execution, a Class 1 Event shall be generated. When execution is completed and the state returns to ready, a class 1 event shall be generated. If the blanking results in one or more features changing currency, an additional class 1 event shall be generated.

5.2.3 Error Reporting

Recommended error reporting is defined in Table 59.

Table 59 – Recommended errors for BLANK Command

Error	Reference
Deferred Errors	
General Errors	
Media Access Errors	
Write Errors	
ERASE FAILURE	

5.3 CLOSE TRACK/SESSION Command

The CLOSE TRACK/SESSION command allows closure of either a track or a session. The features associated with this command are shown in Table 60.

Table 60 – Features Associated with the CLOSE TRACK/SESSION command

Feature Number	Feature Name	Command Requirement
0021h	Incremental Streaming Writable	Mandatory
0028h	MRW	Mandatory (when Write bit is one)
002Ah	DVD+RW	Mandatory (when Write bit is one)
002Bh	DVD+R	Mandatory (when Write bit is one)
002Dh	CD Track At Once	Mandatory
Note: The command requirement is valid only when the feature is current.		

5.3.1 The CDB and its Parameters

The CLOSE TRACK/SESSION CDB is shown in Table 61.

Table 61 – CLOSE TRACK/SESSION Command Descriptor Block

Byte \ Bit	7	6	5	4	3	2	1	0
0	Operation Code (5Bh)							
1	Reserved							IMMED
2	Reserved					Close Function		
3	Reserved							
4	(MSB)			Track Number				
5								(LSB)
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 Close Functions are given in Table 62.

Track Number meanings are defined within the specific Close Function cases listed in Table 62.

Note: MRW format shall have precedence over physical media type.

Table 62 – Close Function Definitions

Close Function	Media/ Format	Description
000b	DD/CD-R/RW	Reserved
	DVD-R/-RW	Reserved
	DVD+RW	Optional behavior for DVD+RW media is defined. If a background format is in progress and de-icing is not completed, the format de-icing operation shall be stopped at some DVD+RW ECC block boundary. No further writing shall occur. If the medium mounted is DVD+RW and there is no background format in progress, then no operation shall occur and this shall not be considered an error. In this case, the drive shall support FDCB bit maps.
	DVD+R	Reserved
	MRW	Reserved
001b	DD/CD-R/RW	Close the track associated with the track number in the CDB. If this is the incomplete track, the Logical Unit shall pad with all zero main data to the minimum length of 4 seconds. No other padding shall be done. If this is a partially recorded or empty reserved track, the Logical Unit shall pad until the end of the track. In the case of an empty track, the Logical Unit shall write the track according to the Write Parameters Page. If the Write Parameters Page is inconsistent with the PMA, CHECK CONDITION status shall be returned and SK/ASC/ASCQ shall be set to ILLEGAL REQUEST/ILLEGAL MODE FOR THIS TRACK. For a partially recorded reserved track, the Logical Unit shall continue writing in the same mode as the data already recorded.
	DVD-R/-RW	If this is the Partially Recorded Reserved Track or the Empty Reserved Track, the Logical Unit shall pad the Track with 00h bytes. If the Track status is Invisible, no close operation is to be done. In the case of an Incomplete Track, no padding is to be done and cached RMD shall be written into the RMA.
	DVD+RW	Reserved
	DVD+R	Close the track associated with the track number in the CDB as follows: If the current track is reserved and blank or partially written, the Logical Unit shall pad the track to its defined length. User data areas in all pad sectors shall be zero filled. If the track being closed is the incomplete track and the incomplete track is not blank, then a new DCB shall be appended into the Session Identification Zone defining the existence of the track. If the track being closed is the incomplete track and the incomplete track is blank, then the command shall be terminated with GOOD status and sense data shall be set to NO SENSE/NO ADDITIONAL INFORMATION.
	MRW	Reserved

Table 62 (continued) – Close Function Definitions

Close Function	Media/ Format	Description
010b	DD/CD-R/RW	Close the last session. If some track in the last Session is not open, terminate the command with CHECK CONDITION status and set SK/ASC/ASCQ values to ILLEGAL REQUEST/SESSION FIXATION ERROR – INCOMPLETE TRACK IN SESSION. Behavior of the closing operation is dependent on the Multi-Session field in the Write Parameters Page (05h). If the last session is empty, the command will be terminated with GOOD status.
	DVD-R/-RW	When the last session is in the intermediate state, Lead-in and/or Border-out are recorded to make the session complete. (if the session is to be closed that is the first one, Lead-in and Border-out shall be recorded. If the session is to be closed that is second or later one, only the Border-out shall be recorded.)
	DVD+RW	If a background format is in progress, the format operation shall be stopped and the disc shall be structured for removal according to the *DVD+RW 4.7 Gbytes Basic Format Specifications* for the specific purpose of providing DVD-RO compatibility. In general, this means that a [partial] lead-in shall be written, a [temporary] lead-out shall be appended and all unrecorded gaps between lead-in and lead-out shall be format written. The radius difference between the start of the temporary lead-out and the end of the temporary lead-out shall approximate 1 mm. The data zone shall be expanded to ensure that the total recorded area reaches at least a radius of 30 mm.
	DVD+R	Close the last session. If not all Tracks in the last Session are closed, the DVD+R Drive shall terminate this command with CHECK CONDITION Status and sense data shall be set to ILLEGAL REQUEST/SESSION FIXATION ERROR/ INCOMPLETE TRACK IN SESSION. If upon completion of the closure, less than 65 ECC blocks would remain, the drive shall finalize the disc. If the session being closed is session number 154, when the close session is requested, the drive shall finalize the disc.
	MRW	If no background is in progress, the command shall be terminated with GOOD status. If a background format is in progress, the format operation shall be stopped and the disc shall be structured for removal. For CD-RW media, the *CD-MRW Defect Management & Physical Formatting Specification, revision 1.1*, defines the structuring. For DVD+RW media, the *DVD+MRW Defect Management & Physical Formatting Specification, revision 1.0* defines the structuring.
011b	DD/CD-R/RW	Reserved
	DVD-R/-RW	If the disc is in restricted overwrite mode and the last session is complete state and Lead-out is not written, Lead-out shall be appended after the last Border-out. If the last session is intermediate state, Border-out and Lead-out is recorded. If the disc is not formatted, the Logical Unit shall report CHECK CONDITION status and set SK/ASC/ASCQ values to ILLEGAL REQUEST/INVALID FIELD IN CDB. For all other media this condition is Reserved, not valid.
	DVD+RW	If a background format is in progress, the format operation shall be stopped and the disc shall be structured for removal according to the *DVD+RW 4.7 Gbytes Basic Format Specifications* for the specific purpose of providing DVD-RO compatibility. In general, this means that a [partial] lead-in shall be written, a [temporary] lead-out shall be appended and all unrecorded gaps between lead-in and lead-out shall be format written. The radius difference between the start of the temporary lead-out and the end of the temporary lead-out shall approximate 1 mm.
	DVD+R	Reserved
	MRW	Reserved

Table 62 (continued) – Close Function Definitions

Close Function	Media/ Format	Description
100b	DD/CD-R/RW	Reserved
	DVD-R/-RW	Reserved
	DVD+R	Reserved
	MRW	Reserved
101b	DD/CD-R/RW	Reserved
	DVD-R/-RW	Reserved
	DVD+R	Close the last session and finalize the disc. Once this close function has been executed, no more writing to the disc is allowed. If not all Tracks in the last Session are closed, the DVD+R Drive shall terminate this command with CHECK CONDITION Status and sense data shall be set to ILLEGAL REQUEST/SESSION FIXATION ERROR/ INCOMPLETE TRACK IN SESSION. In order to assure maximum interchange compatibility with read only devices, Guard Zone 2 shall be recorded to a device defined PSN that approximates a disc radius of 30 mm. Suggested value: 70DE0h (462 304).
	MRW	Reserved
110b	DD/CD-R/RW	Close the last session and finalize the disc. If some track in the last Session is not open, terminate the command with CHECK CONDITION status and set SK/ASC/ASCQ values to ILLEGAL REQUEST/SESSION FIXATION ERROR – INCOMPLETE TRACK IN SESSION. If the last session is empty, the command will be terminated with GOOD status.
	DVD-R/-RW	Reserved
	DVD+RW	Reserved
	DVD+R	Close the last session and finalize the disc. Once this close function has been executed, no more writing to the disc is allowed. If not all Tracks in the last Session are closed, the DVD+R Drive shall terminate this command with CHECK CONDITION Status and sense data shall be set to ILLEGAL REQUEST/SESSION FIXATION ERROR/ INCOMPLETE TRACK IN SESSION.
	MRW	Reserved
111b	DD/CD-R/RW	Reserved
	DVD-R/-RW	Reserved
	DVD+RW	Reserved
	DVD+R	Reserved
	MRW	Reserved

5.3.2 Command Execution

During a Close Track/Session operation that began with the IMMED bit set to one, the Logical Unit shall respond to commands as follows:

a) In response to all commands except REQUEST SENSE, INQUIRY, GET CONFIGURATION, and GET EVENT/STATUS NOTIFICATION the Logical Unit shall return CHECK CONDITION status and set SK/ASC/ASCQ to NOT READY/LOGICAL UNIT NOT READY/LONG WRITE IN PROGRESS or NOT READY/LOGICAL UNIT NOT READY/OPERATION IN PROGRESS unless a reservation conflict exists, in that case RESERVATION CONFLICT status shall be returned.

b) In response to the INQUIRY, GET CONFIGURATION, GET EVENT/STATUS NOTIFICATION commands, the Logical Unit shall respond as commanded.

c) In response to the REQUEST SENSE command, unless an error has occurred, the Logical Unit shall return with SK/ASC/ASCQ values set to NOT READY/LOGICAL UNIT NOT READY/LONG WRITE IN PROGRESS or NOT READY/LOGICAL UNIT NOT READY/OPERATION IN PROGRESS (02h/04h/07h), with the sense key specific bytes set for progress indication. See ANSI X3.301:1997, SPC standard for sense key specific field location.

Closing a Track or Session shall cause a Class 1 Event when the command is issued if the Logical Unit becomes NOT READY. A Class 1 Event shall occur if the medium returns to READY or if the medium becomes un-writable. Other Class 1 Events may occur due to closing a Track or Session.

5.3.3 Error Reporting

Recommended error reporting is defined in Table 63.

Table 63 – Recommended errors for CLOSE TRACK/SESSION Command

Error	Reference
Deferred Errors	
General Errors	
Media Access Errors	
Write Errors	
Fixation Errors	

5.4 ERASE (10) Command

The ERASE (10) command requests that the Logical Unit erase the specified number of blocks starting at the specified logical block address on the medium. The features associated with this command are shown in Table 64.

Table 64 – Features Associated with the ERASE (10) Command

Feature Number	Feature Name	Command Requirement
0022h	Sector Erasable	Mandatory
Note: The command requirement is valid only when the feature is current.		

5.4.1 The CDB and its Parameters

The ERASE (10) CDB is shown in Table 65.

Table 65 – ERASE (10) Command Descriptor Block

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (2Ch)							
1	Reserved					ERA	IMMED	RelAdr
2	(MSB)							
3	Starting Logical Block Address							
4								
5								(LSB)
6	Reserved							
7	(MSB)	Number of Blocks						
8								(LSB)
9	Control							

An ERA bit (Erase All) of one indicates that all remaining blocks on the medium shall be erased. If ERA is one and the number of blocks is not zero, the command shall be terminated with CHECK CONDITION status and SK/ASC/ASCQ shall be set to to ILLEGAL REQUEST/INVALID FIELD IN CDB.

If IMMED is zero, then the requested operation is executed to completion prior to returning status.

If IMMED is one, then status is returned once the operation has begun.

Multi-media devices do not support relative addressing. RelAdr shall be set to zero. If RelAdr is set to one, the command shall be terminated with CHECK CONDITION status and SK/ASC/ASCQ shall be set to to ILLEGAL REQUEST/INVALID FIELD IN CDB.

Number of Blocks specifies the number of contiguous logical blocks that shall be erased when ERA is zero. If ERA is zero, a Number of Blocks of zero indicates that no blocks shall be erased. This condition shall not be considered an error and no data shall be erased. Any other value indicates the number of logical blocks that shall be erased.

5.4.2 Command Execution

As used here, erased means either the medium shall be erased, or a pattern shall be written on the medium that appears to the Logical Unit as no data present. The blocks erased shall be considered blank for purposes of blank checking. Previous data recorded on the medium, if any, shall not be recoverable.

During an Erasing operation that began with the IMMED bit set to one, the Logical Unit shall respond to commands as follows:

d) In response to all commands except REQUEST SENSE, INQUIRY, GET CONFIGURATION, and GET EVENT/STATUS NOTIFICATION, the Logical Unit shall return CHECK CONDITION status and set SK/ASC/ASCQ to NOT READY/LOGICAL UNIT NOT READY/OPERATION IN PROGRESS. When the Logical Unit changes ready state, a Class 1 Event shall be generated.

e) In response to the INQUIRY, GET CONFIGURATION, GET EVENT/STATUS NOTIFICATION commands, the Logical Unit shall respond as commanded.

f) In response to the REQUEST SENSE command, unless an error has occurred, the Logical Unit shall return a SK/ASC/ASCQ values set to NOT READY/LOGICAL UNIT NOT READY/OPERATION IN PROGRESS, with the sense key specific bytes set for progress indication.

5.4.3 Error Reporting

Recommended error reporting is defined in Table 66.

Table 66 – Recommended errors for ERASE (10) Command

Error	Reference
Deferred Errors	
General Errors	
Media Access Errors	
Write Errors	
ERASE FAILURE	

5.5 FORMAT UNIT Command

The FORMAT UNIT command formats a medium into Initiator addressable logical blocks according to Initiator defined options. The medium may be certified and control structures created for the management of the medium and defects. The medium may or may not be altered.

In order to fully support random reading and/or random writing, many types of rewritable media must be fully written (formatted). This is the case for CD-RW, DDCD-RW, DVD-RW, and DVD+RW. Based upon media and device types, full format time can be unreasonably high. This can be mitigated by use of the IMMED bit in the Format Unit Parameter List or with Background Formatting.

The features associated with this command are shown in Table 67.

Table 67 – Features Associated with the FORMAT UNIT Command

Feature Number	Feature Name	Command Requirement
0023h	Formattable	Mandatory
0028h	MRW	Mandatory when the Write bit is one
002Ah	DVD+RW Basic Format	Mandatory when the Write bit is one
Note: The command requirement is valid only when the feature is current.		

5.5.1 The CDB and Its Parameters

The FORMAT UNIT command descriptor block is shown in Table 68.

Table 68 – FORMAT UNIT Command Descriptor Block

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

If the FmtData bit is zero, there is no parameter list. If FmtData is one, a parameter list is available from the Initiator. For all Multi-media Logical Units, FmtData shall be set to one. If FmtData is zero, the command shall be terminated with CHECK CONDITION status and SK/ASC/ASCQ shall be set to to ILLEGAL REQUEST/INVALID FIELD IN CDB.

The CmpList bit is used in conjunction with the DCRT () bit to determine usage of the existing G1-list, G2-list and SDL to construct new G1-list and G2-list (Table 69) on DVD-RAM media. 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. On CD-RW, DDCD-RW, DVD-RW, and DVD+RW media, CmpList bit shall be set to zero.

Table 69 – DVD-RAM Defect List Handling

CmpList	DCRT	Certification	PDL			SDL	Remarks
			P-list	G1-list	G2-list		
0	0	Yes	Preserved	New from Certification	Disposed	Disposed	Slow initialization
0	1	No	Preserved	Preserved	Old + New from SDL	Disposed	Change linear replacement to slipping, quickly
1	0	Yes (Partial) Obsolete	Preserved	Old plus New from Certification	Disposed	Disposed	Create new defect list by disposing all except P-list and G1-list
1	1	No	Preserved	Preserved	Disposed	Disposed	Return to original slipping at the latest certification, quickly

The Format Code identifies the parameter list format. The Format Code shall be set to one (001b). The Format Code seven (111b) has a legacy definition for CD-RW and DDCD-RW. See Annex E.

The Interleave Value field identifies the value to be used when formatting. Interleave Value shall be zero.

5.5.2 Format Parameter List

The FORMAT UNIT parameter list (Table 70) consists of three descriptors: the Format List Header, the Initialization Pattern Descriptor, and the Format Descriptor.

Table 70 – Format Unit Parameter List

Bit / Byte	7	6	5	4	3	2	1	0
0 – 3	Format List Header							
4 – n	Initialization Pattern Descriptor (present if IP = 1)							
n+1 to n+8	Format Descriptor							

5.5.2.1 Format List Header

The Format List Header (Table 71) provides several format control bits. Logical Units that implement these bits give Initiators additional control over the formatting operation. If the Initiator attempts to select any function not implemented by the Logical Unit, the Logical Unit shall terminate the command with CHECK CONDITION status and SK/ASC/ASCQ values shall be set to ILLEGAL REQUEST/INVALID FIELD IN PARAMETER LIST.

Table 71 – Format List Header

Bit / Byte	7	6	5	4	3	2	1	0
0	Reserved							
1	FOV	DPRY	DCRT	STPF	IP	Try-out	IMMED	VS
2	(MSB)	Format Descriptor Length						
3								(LSB)

If the Format Options Valid (FOV) bit is zero, the Logical Unit shall use its default settings for the values of DPRY, DCRT, STPF, IP, Try-out, IMMED, and VS. When the FOV bit is zero, the Initiator shall set these bits to zero. If any of these bits are not zero, the Logical Unit shall terminate the command with CHECK CONDITION status and set SK/ASC/ASCQ values to ILLEGAL REQUEST/INVALID FIELD IN PARAMETER LIST. The default value for VS is vendor specific. If FOV is one, the Logical Unit shall examine the setting of the DPRY, DCRT, STPF, IP, and Try-out bits. When the FOV bit is one, the DPRY, DCRT, STPF, IP, and Try-out bits are defined as follows:

- When Disable Primary (DPRY) is set to zero, the Logical Unit shall not use portions of the medium identified as defective in the primary defect list (PLIST) for Initiator addressed logical blocks. When DPRY is set to one, the Logical Unit shall not use the PLIST to identify defective areas of the medium. The PLIST shall not be deleted. DPRY may be set to one for DVD-RAM media. DPRY may not be set to one when the currently mounted medium is CD-RW, DDCD-RW, DVD-RW, or DVD+RW. If DPRY is set to one, and the currently mounted medium is CD-RW, DDCD-RW, DVD-RW, or DVD+RW, the Logical Unit shall terminate the command with CHECK CONDITION status and SK/ASC/ASCQ values shall be set to ILLEGAL REQUEST/INVALID FIELD IN PARAMETER LIST.
- If the Disable Certification (DCRT) bit is set to zero, the Logical Unit shall perform a vendor-specific medium certification operation. A DCRT bit of one indicates that the Logical Unit shall not perform the vendor-specific medium certification process or format verification operation while executing the FORMAT UNIT command.
- The STPF bit is reserved. If STPF is not zero, the Logical Unit shall terminate the command with CHECK CONDITION status and set SK/ASC/ASCQ values to ILLEGAL REQUEST/INVALID FIELD IN PARAMETER LIST.
- If the Initialization Pattern (IP) bit is set to zero, an initialization pattern descriptor is not included and that the Logical Unit shall use its default initialization pattern. If IP is set to one, an initialization pattern descriptor is sent to the Logical Unit as part of the FORMAT UNIT Parameter List. For CD-RW media and DVD+RW media, the IP bit is reserved.
- When the Try-out bit is set to zero, the Logical Unit shall perform whatever format writing is required. When the Try-out bit is set to one, the Logical Unit shall use available information to determine the possibility of formatting the media according to the parameter list provided. The Logical Unit shall not write to the media. If formatting is possible, then the command shall be terminated with GOOD status. If the Logical Unit determines that error free formatting is not possible, the command shall be terminated with CHECK CONDITION status and SK/ASC/ASCQ values shall be set to MEDIUM ERROR/CORRUPTED MEDIUM FORMAT. For CD-RW and DVD+RW media, the Try-out bit is reserved.
- If the immediate (IMMED) bit is zero, status shall be returned only after the format operation has completed. If the IMMED bit is set to one, the Logical Unit shall return status as soon as the command descriptor block and the Format Descriptor have been validated and the format process has begun.
- The Vendor Specific (VS) bit has a vendor-specific definition.

The Format Descriptor Length field in the Format list header specifies the total length in bytes of the Format descriptors that follow and does not include the initialization pattern descriptor or initialization pattern, if any.

The Format Descriptor Length shall be set to 8. If any other value in found in this field, the Logical Unit shall terminate the command with CHECK CONDITION status and SK/ASC/ASCQ values shall be set to ILLEGAL REQUEST/INVALID FIELD IN PARAMETER LIST.

5.5.2.2 Initialization Pattern

If the IP bit in the Format List Header is set to one, the initialization pattern descriptor (Table 72) is included as part of the FORMAT UNIT parameter list.

Table 72 – Initialization Pattern Descriptor

Bit / Byte	7	6	5	4	3	2	1	0
0	IP Modifier		SI	Reserved				
1	Pattern Type							
2	(MSB) Initialization Pattern Length							
3								(LSB)
4	Initialization Pattern							
:								
n								

The IP Modifier field specifies the type and location of a header that modifies the initialization pattern (see Table 73).

Table 73 – IP Modifier Field

IP Modifier	Descriptor
00b	No header. The Logical Unit shall not modify the initialization pattern.
01b	The Logical Unit shall overwrite the initialization pattern to write the logical block address in the first four bytes of the logical block. The LBA shall be written with the most significant byte first.
10b	The Logical Unit shall overwrite the initialization pattern to write the logical block address in the first four bytes of each physical block contained within the logical block. The lowest numbered logical block or part there of which occurs within the physical block is used. The LBA shall be written with the most significant byte first.
11b	Reserved

The Pattern Type field (Table 74) indicates the type of pattern the Logical Unit shall use to initialize each logical block within the Initiator accessible portion of the medium. All bytes within a logical block shall be written with the initialization pattern. The IP Modifier field modifies the Initialization Pattern.

Table 74 – Initialization Pattern Type

Initialization Pattern Type	Description
00h	Use default pattern. If the initialization pattern length is not zero the Logical Unit shall terminate the command with CHECK CONDITION status and SK/ASC/ASCQ shall be set to ILLEGAL REQUEST/INVALID FIELD IN PARAMETER LIST.
01h	Repeat the initialization pattern as required to fill the logical block. If the initialization pattern length is zero the Logical Unit shall terminate the command with CHECK CONDITION status and SK/ASC/ASCQ shall be set to ILLEGAL REQUEST/INVALID FIELD IN PARAMETER LIST.
02h – 7Fh	Reserved
80h - FFh	Vendor Specific

If the SI bit is zero, the Logical Unit shall initialize the Initiator accessible area of the media. The Logical Unit is not required to initialize other areas of the media, however the Logical Unit shall format the medium as defined in the FORMAT UNIT command.

If the Security Initialize (SI) bit is set to one the Logical Unit shall attempt to write the initialization pattern to all areas of the media including those that may have been reassigned. The initialization pattern shall be written using a security erasure write technique. Initiators may choose to use this command multiple times to fully erase the previous data. Such security erasure write technique procedures are outside the scope of this standard. The exact requirements placed on the security erasure write techniques are vendor-specific. The intent of the security erasure write is to render any previous user data unrecoverable by any analog or digital technique. The Logical Unit is not required to write (format) header and other information not previously accessible to the Initiator. If any area of the medium that previously was accessible to the Initiator cannot be written, the Logical Unit shall terminate the command with CHECK CONDITION status and the sense key shall be set to MEDIUM ERROR with the appropriate ASC for the condition.

The Initialization Pattern Length field indicates the number of bytes contained in the initialization pattern.

If the length exceeds the current logical block size the Logical Unit shall terminate the command with CHECK CONDITION status and SK/ASC/ASCQ values shall be set to ILLEGAL REQUEST/INVALID FIELD IN PARAMETER LIST.

5.5.2.3 Format Descriptor

When the the currently mounted media is CD-RW or DDCD-RW and the CDB Format Code is 111b, a legacy Format Descriptor for may be appended. See Annex E.

When the CDB Format Code is 001b, a Format Descriptor in included in the FORMAT UNIT Parameter List. The Format Descriptor (Table 75) is an eight-byte entry.

Table 75 – Format Code 001b Format Descriptor

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)							
1	Number of Blocks							
2								
3								(LSB)
4	Format Type						Reserved	
5	(MSB)							
6	Type Dependent Parameter							
7								(LSB)

The Format Type field specifies the type of formatting. Contents of the Number of Blocks field and the Type Dependent Parameter field depend on Format Type.

5.5.2.3.1 Format Type = 00h (Full Format)

Formatting for the entire media is specified. Except as noted, the Number of Blocks field specifies the number of addressable blocks for the entire disc and the Type Dependent Parameter field specifies the Block Length.

This format type is optional for CD-RW media. If supported, the entire media shall be formatted using Write Parameter Mode Page information.

For DVD-RAM media, the defect list handling is specified by the combination of the CmpList bit and the DCRT bit as shown in Table 69. In the case that the CmpList bit is set to zero and the DCRT bit is set to one, the Number of Blocks field shall be ignored and the number of addressable blocks shall be retained. Otherwise, the Number of Blocks field specifies the number of addressable blocks for the whole disc. The Type Dependent Parameter field specifies the Block Length.

On DVD-RW media, this format operation is always available. The area from the beginning of the RMA to the end of the Lead-out shall be recorded. There is only one session on the medium and the number of track is one after this operation. The Disc Status field of Format 3 RMD shall be set to 13h when the operation is completed.

5.5.2.3.2 Format Type = 01h (Spare Area Expansion)

This Format Type is defined only for DVD-RAM media.

In order to keep more Spare area, this formatting is used. Eventually the capacity of the formatted area is reduced. Therefore, this formatting type is just available with the case of reduction of formatted capacity.

The Logical Unit shall ignore the defect list handling specified by the combination of the CmpList bit and the DCRT bit. The defect list entries and the written user data within the range of the area that is specified by this command shall be preserved through the execution of this command. The number of Blocks field specifies the number of addressable blocks for the whole disc and the Type Dependent Parameter field specifies the Block Length. Neither field is changeable from the values reported by the READ FORMAT CAPACITIES command (5.28).

5.5.2.3.3 Format Type = 04h (Zone Reformat)

This Format Type is defined only for DVD-RAM media.

The Zoned formatting for a zone of the media is specified where the size of zone is not constant across zones. The defect list handling is specified by the combination of the CmpList bit and the DCRT bit as shown in Table 69. The Number of Blocks field specifies the number of addressable blocks for the zone and the Type Dependent Parameter field specifies the Zone number of the zone to be formatted. If a spare sector is used as a replacement for another zone so that the zoned formatting cannot be preformed, the command shall be terminated with a CHECK CONDITION status, SK/ASC/ASCQ values shall be set to MEDIUM ERROR/ZONED FORMATTING FAILED DUE TO SPARE LINKING, and the sense key specific bytes set to zone number of the first zone that has a spare linking into the designated zone.

The discarding of G1-list, G2-list, and SDL is only applicable to defects within the zone being reformatted.

5.5.2.3.4 Format Type = 05h (Zone Format)

This Format Type is defined only for DVD-RAM media.

The Zoned formatting for a zone of the media is specified where the size of zone is constant for each zone, e.g. floppy media where each track is labeled a zone. The Number of Blocks field specifies the number of addressable blocks for the zone and the Type Dependent Parameter field specifies the Zone number of the zone to be formatted. The zone number shall be in the range of 0 to the Type Dependent Parameter reported in READ FORMAT CAPACITIES command (5.28).

5.5.2.3.5 Format Type = 10h (CD/DVD-RW Full Format)

Formatting to create a session on CD/DVD-RW media is specified. The created session shall become the only session on the medium. The Number of Blocks field specifies the number of addressable blocks for the new session and the Type Dependent Parameter field specifies the Fixed Packet Size for CD or set to ECC block size (16) for DVD-RW. The number of blocks field may be adjusted to a value less than or equal to the values reported by the READ FORMAT CAPACITIES command (5.28). The Logical Unit shall round the Number of Blocks up to be an integral multiple of the packet size for CD or set to ECC block size (16) for DVD-RW. The Packet Size field shall not be adjusted. In the case of CD media, if a different Fixed Packet Size is desired, the Initiator shall modify the Write Parameters Page.

On DVD-RW media, this format operation is always available. The track number in the created session is one after this operation. The Disc Status field of Format 3 RMD shall be set to 12h when the operation is completed.

5.5.2.3.6 Format Type = 11h (CD/DVD-RW Grow Session)

In the case of CD-RW, formatting to expand the last session is specified. The Number of Blocks field specifies the number of addressable blocks to be enlarged and the Type Dependent Parameter field specifies the Packet Length. The Number of Blocks field may be adjusted to a value greater than the existing Session size and less than or equal to the values reported by the READ FORMAT CAPACITIES command. The Logical Unit shall round the Number of Blocks up to be an integral multiple of the packet size. The Packet Size field shall not be adjusted.

In the case of DVD-RW, formatting to expand the last session and enter the last session program area into intermediate state is specified. The Number of Blocks field specifies the number of addressable blocks to be added to current session capacity and the Type Dependent Parameter field is set to ECC block size (16). The Logical Unit shall round the Number of Blocks up to be an integral multiple of the ECC block size.

This format operation is available only when a disc is in restricted overwrite mode and the last session is in a complete state. Growing of session operation shall start from the next sector of End Sector Number of Track #n field that is corresponded to the last track. End PSN of Data Area and Start PSN of the current Lead-out/Border-out field of Lead-in/Border-in shall be changed to reflect the expanded session. The number of sessions and tracks does not change after this operation.

5.5.2.3.7 Format Type = 12h (CD/DVD-RW Add Session)

Formatting to add a new session to a CD/DVD-RW media is specified. The Number of Blocks field specifies the number of addressable blocks for the new session and the Type Dependent Parameter field specifies the Fixed Packet Size for CD or set to ECC block size (16) for DVD-RW. The Number of Blocks field may be adjusted to a value less than or equal to the values reported by the READ FORMAT CAPACITIES Command (5.28).

The Logical Unit shall round the Number of Blocks up to be an integral multiple of the packet size for CD or the ECC block size for DVD. The Packet Size field shall not be adjusted. On CD media, if a different Fixed Packet Size is desired, the Initiator shall modify the Write Parameters Page.

On DVD-RW media, this format operation is available only when a disc is in restricted overwrite mode and the last session is in a complete state. Start PSN of the next Border-in field in the previous Border-in/Lead-in shall be updated.

5.5.2.3.8 Format Type = 13h (DVD-RW Quick Grow the last Session)

Formatting to expand the last session and enter the last session into intermediate state of a DVD-RW medium is specified. The Number of Blocks field specifies the number of addressable blocks to be added to current session capacity and the Type Dependent Parameter field is set to ECC block size (16). The Logical Unit shall round the Number of Blocks up to be an integral multiple of the ECC block size.

This format operation is available only when the disc is in restricted overwrite mode and the last session is complete state. Growing of session operation shall start from the next sector of End Sector Number of Track #n field that is corresponded to the last track.

The number of sessions and tracks does not change after this operation. The Disc Status field of Format 3 RMD shall be set to 13h when the operation is completed. End PSN of Data Area field in Lead-in/Border-in of the last session shall be set to 30000h. And Start PSN of the current Border-out and Start PSN of the next Border-in field in Lead-in/Border-in of the last session shall be set to 00h.

5.5.2.3.9 Format Type = 14h (DVD-RW Quick Add Session)

Formatting to add a new intermediate state session to an existing session on DVD-RW media is specified. At least one or more sessions shall exist on a medium and the last session shall not be intermediate state before start this operation.

The area from the beginning of Border-in that follows the last Border-out, user data blocks and 32 ECC blocks with Lead-out attribute is recorded. Start PSN of the next Border-in field in the previous Border-in/Lead-in shall not be changed to reflect the intermediate state session that is added.

If FORMAT UNIT command with this Format Type is issued when the last session is already intermediate state, the command shall be terminated with CHECK CONDITION status and SK/ASC/ASCQ values shall be set to ILLEGAL REQUEST/INVALID FIELD IN PARAMETER LIST.

The Number of Blocks field specifies the number of addressable blocks for the new session and the Type Dependent Parameter field is set to ECC block size (16). The Number of Blocks field may be adjusted to a value less than or equal to the values reported by the READ FORMAT CAPACITIES command. The Logical Unit shall round the Number of Blocks up to be an integral multiple of the ECC block size.

5.5.2.3.10 Format Type = 15h (DVD-RW Quick)

Formatting to create an Intermediate State session on DVD-RW media is specified. The created session shall become the only session on the medium. The Number of Blocks field specifies the number of addressable blocks for the new session and the Type Dependent Parameter field is set to ECC block size (16). The Number of Blocks field may be adjusted to a value less than or equal to the values reported by the READ FORMAT CAPACITIES command. The Logical Unit shall round the Number of Blocks up to be an integral multiple of the ECC block size for DVD.

This format operation is always available. If a disc is to be formatted that is blanked, new intermediate state session is created at the beginning of the disc and the recording mode is changed to restricted overwrite mode. The number of track in the created session is one after this operation. The Disc Status field of Format 3 RMD shall be set to 13h when the operation is completed.

5.5.2.3.11 Format Types = 24h, (MRW Full Format)

If the currently mounted medium is neither CD-RW nor DVD+RW, the command shall be terminated with CHECK CONDITION status and set SK/ASC/ASCQ values to ILLEGAL REQUEST/INVALID FIELD IN PARAMETER BLOCK.

If the currently mounted media is CD-RW and a new format is requested, the Number of Blocks parameter shall have the value 0xFFFFFFFF. If the field contains any other value, the drive shall terminate the command with CHECK CONDITION status and set SK/ASC/ASCQ values to ILLEGAL REQUEST/INVALID FIELD IN PARAMETER BLOCK.

If the currently mounted media is 8 cm DVD+RW and a new format is requested, the Number of Blocks parameter shall have the value 0xFFFFFFFF. If the field contains any other value, the drive shall terminate the command with CHECK CONDITION status and set SK/ASC/ASCQ values to ILLEGAL REQUEST/INVALID FIELD IN PARAMETER BLOCK. Spare area 1 shall be 4 096 sectors in length while spare area 2 shall be 61 440 sectors in length. Sparing represents approximately 10% of the primary user data space.

If the currently mounted media is 12 cm DVD+RW and a new format is requested, the Number of Blocks parameter shall have either the value 0xFFFFFFFF or 0xFFFF0000. If the field contains any other value, the drive shall terminate the command with CHECK CONDITION status and set SK/ASC/ASCQ values to ILLEGAL REQUEST, INVALID FIELD IN PARAMETER BLOCK. Spare area 1 is always 4 096 sectors in length. When the Number of Blocks value is 0xFFFFFFFF, spare area 2 is 61 440 in length. In this case, sparing represents approximately 3% of the primary user data space. When the Number of Blocks value is 0xFFFF0000, spare area 2 is 256 000 in length. In this case, sparing represents approximately 12.8% of the primary user data space.

Formatting operates in background for Format Type 24h (see 0). The Initiator may suspend a format in progress and may restart the format.

The Type Dependent Parameter has the meaning of “New format” when it has the value 000000h. The Type Dependent Parameter has the meaning of “Restart format” when it has the value 000001h. If the field contains any other value, the drive shall terminate the command with CHECK CONDITION status and set SK/ASC/ASCQ values to ILLEGAL REQUEST/INVALID FIELD IN PARAMETER BLOCK.

Certification of the format is based upon current medium status as shown in Table 76.

Table 76 - Use of DCRT when MRW Formatting

Current Disc Status	DCRT = 0	DCRT = 1
Physically Blank	Write entire surface format, verify MRW structures and user areas	Write entire surface format, verify only MRW structures
Written, but not MRW Formatted (includes logically blank)	Write format, verify MRW structures and user areas. Note: In this case, the *CD-MRW Defect Management & Physical Formatting Specification* and the *DVD+MRW Defect Management & Physical Formatting Specification* require certification of the user area.	
MRW formatted	Reinitialize MRW structures, verify MRW structures and user areas. Note: In this case, the *CD-MRW Defect Management & Physical Formatting Specification* and the *DVD+MRW Defect Management & Physical Formatting Specification* require certification of the user area.	

In all cases when:

- DCRT is cleared to zero,
- the Initiator requests to WRITE the sector at LBA = N, and
- sector N has not yet been verified by the format operation,.

The WRITE command shall be treated as a WRITE and VERIFY command.

5.5.2.3.12 Format Type = 26h, (DVD+RW Basic Format)

If the currently mounted medium is not DVD+RW, the command shall be terminated with CHECK CONDITION status and set SK/ASC/ASCQ values to ILLEGAL REQUEST/INVALID FIELD IN PARAMETER BLOCK.

The Number of Blocks field shall be set to either the value returned by the READ FORMAT CAPACITIES command or 0xFFFFFFFF. The drive shall accept either value. If any other value is sent by the Initiator, then the drive shall terminate the command with CHECK CONDITION status and set SK/ASC/ASCQ values to ILLEGAL REQUEST/ILLEGAL VALUE IN PARAMETER BLOCK. Implementation of background format is mandatory.

Formatting operates in background for Format Type 26h (see 0). The Initiator may suspend a format in progress and may restart the format.

The Type Dependent Parameter has the meaning of “New format” when it has the value 000000h. The Type Dependent Parameter has the meaning of “Restart format” when it has the value 000001h. If the field contains any other value, the drive shall terminate the command with CHECK CONDITION status and set SK/ASC/ASCQ values to ILLEGAL REQUEST/INVALID FIELD IN PARAMETER BLOCK.

DCRT has no meaning when formatting type 26h. The device ignores DCRT.

5.5.3 Command Execution

5.5.3.1 Use of the IMMED Bit

If the IMMED bit is cleared to zero, the Logical Unit shall format the entire media according to the Format Unit Parameter List and shall not terminate the command until completed. This is undesirable when the Initiator/Device interface has limited or no disconnect/reselect capability.

If the IMMED bit is set to one, the Logical Unit shall verify that execution Format Unit command can begin without error and then terminate the command with GOOD status.

During a format operation that began with the IMMED bit set to one, the Logical Unit shall respond to commands as follows:

g) In response to all commands except REQUEST SENSE, INQUIRY, GET CONFIGURATION, and GET EVENT/STATUS NOTIFICATION, the Logical Unit shall return CHECK CONDITION status and set SK/ASC/ASCQ to NOT READY/LOGICAL UNIT NOT READY/FORMAT IN PROGRESS. When the Logical Unit changes ready state, a Class 1 Event shall be generated.

h) In response to the INQUIRY, GET CONFIGURATION, GET EVENT/STATUS NOTIFICATION commands, the Logical Unit shall respond as commanded.

In response to the REQUEST SENSE command, unless an error has occurred, the Logical Unit shall return a SK/ASC/ASCQ values set to NOT READY/LOGICAL UNIT NOT READY/FORMAT IN PROGRESS, with the sense key specific bytes set for progress indication (Table 77). SKSV shall be set to one and the Progress Indication field shall contain 16 bit unsigned value such that (Progress Indication)/65 536 X 100% approximates the percentage of completion of the operation. Once the operation is completed, SKSV shall be cleared to zero.

Table 77 – Sense Key Specific Bytes in Sense Data

Bit / Byte	7	6	5	4	3	2	1	0
15	SKSV	Reserved						
16	(MSB)			Progress				
17				Indication				(LSB)

5.5.3.2 Background Formatting

Background formatting is defined for MRW (Format Type 24h) and DVD+RW (Format Type 26h). Background Formatting is divided into 2 processes: the foreground format process, and the background format process. The foreground format process is performed first. Once the foreground process has completed, the background format process begins. Of total format time required, the foreground format process should represent a very small part, while the background format process represents a significantly larger part.

Once the background format process has begun, the Initiator may request a suspension of the format operation for the purpose of media removal. If a suspension is requested, the Logical Unit shall write to the media in such a way that the format state and level of completion can be identified for the purpose of continuing the background format process.

During the term of the background format, its state (Completed (3), Not Complete and running (2), Not complete and not running (1)) may is reported in the returned data of the READ DISC INFORMATION command. See Figure 40.

5.5.3.2.1 The Foreground Part of the Format Process

During the foreground format process, basic media structures must be minimally initialized such that the media Format State may be identified. Relative to the Initiator, the operation is no different from other formatting. The foreground format process is completed when:

1. The specific format type is identifiable based upon written media structures.
2. Format restart information indicates that a suspended background format can be continued with an indication that zero amount of the background format process has been performed.

If the IMMED bit is cleared to zero, then once the foreground format process has completed, the command shall be terminated with GOOD status.

If the IMMED bit is set to one, the Format Unit Command will terminate with GOOD status and proceed with all format-writing functions performed in the background.

5.5.3.2.2 The Background Format Process

Once the foreground part of the formatting has completed, the Format Unit Command is terminated with GOOD status. The Logical Unit shall continue the format in background.

If any media accessing command is issued before the medium becomes write accessible, the Logical Unit shall terminate the command with CHECK CONDITION status and set sense data to NOT READY, LOGICAL UNIT NOT READY, FORMAT IN PROGRESS (02/04/04).

Regardless of the setting of IMMED, once the disc has become write accessible, and there are no pending errors, sense data shall be set to NO SENSE, FORMAT IN PROGRESS (00/04/04) and the sense key specific bytes (Table 77) shall be set as a progress indicator.

> Warning to Implementers:
>
> Logical Unit panel indicators (e.g. LEDs) may normally indicate writing. Implemeters may choose to modify this behavior during background formatting in order to avoid confusing to the user.

5.5.3.2.3 Stopping and Restarting Background Format

If a format is executing in background:

- Only issuing the CLOSE TRACK/SESSION Command may stop the formatting process. See 5.3 for details.
- The inactivity timer (CD-ROM Mode Page) is disabled. This insures that lack of Initiator activity will not allow a spin down during background formatting.
- If the Initiator sends a SCSI command block which requires that the medium spin down, the Logical Unit shall terminate the command with CHECK CONDITION status and set sense data to NOT READY, LOGICAL UNIT NOT READY, FORMAT IN PROGRESS (02/04/04). Example: START/STOP UNIT Command is issued with Start = 0.
- If the Initiator/drive physical interface provides a command layer with commands that can cause the medium to spin down, then those commands will be terminated with the appropriate error status. For example if the interface is ATA and the command is IDLE or SLEEP, then the command shall be terminated with the status register ERROR bit set to true.
- If any other command is issued to the Logical Unit, it shall be executed normally.

The format process may be restarted with a FORMAT UNIT Command in which the format descriptor is sent with the type dependent parameter set to 000001h. If the format has been completed, restarting the background format function shall not be considered and error. The command will terminate with GOOD status and the BGformatCompleted event shall be posted.

The format process may also be restarted automatically by the drive. If a write is requested at an address within the final media capacity and beyond the current user formatted space, the background format shall be restarted using parameters saved on the media. The BGformatRestarted Media

Event shall be posted. The format state shall be changed to "Not Complete and Running", and the write shall proceed accordingly. See clause 5.5.3.2.4.

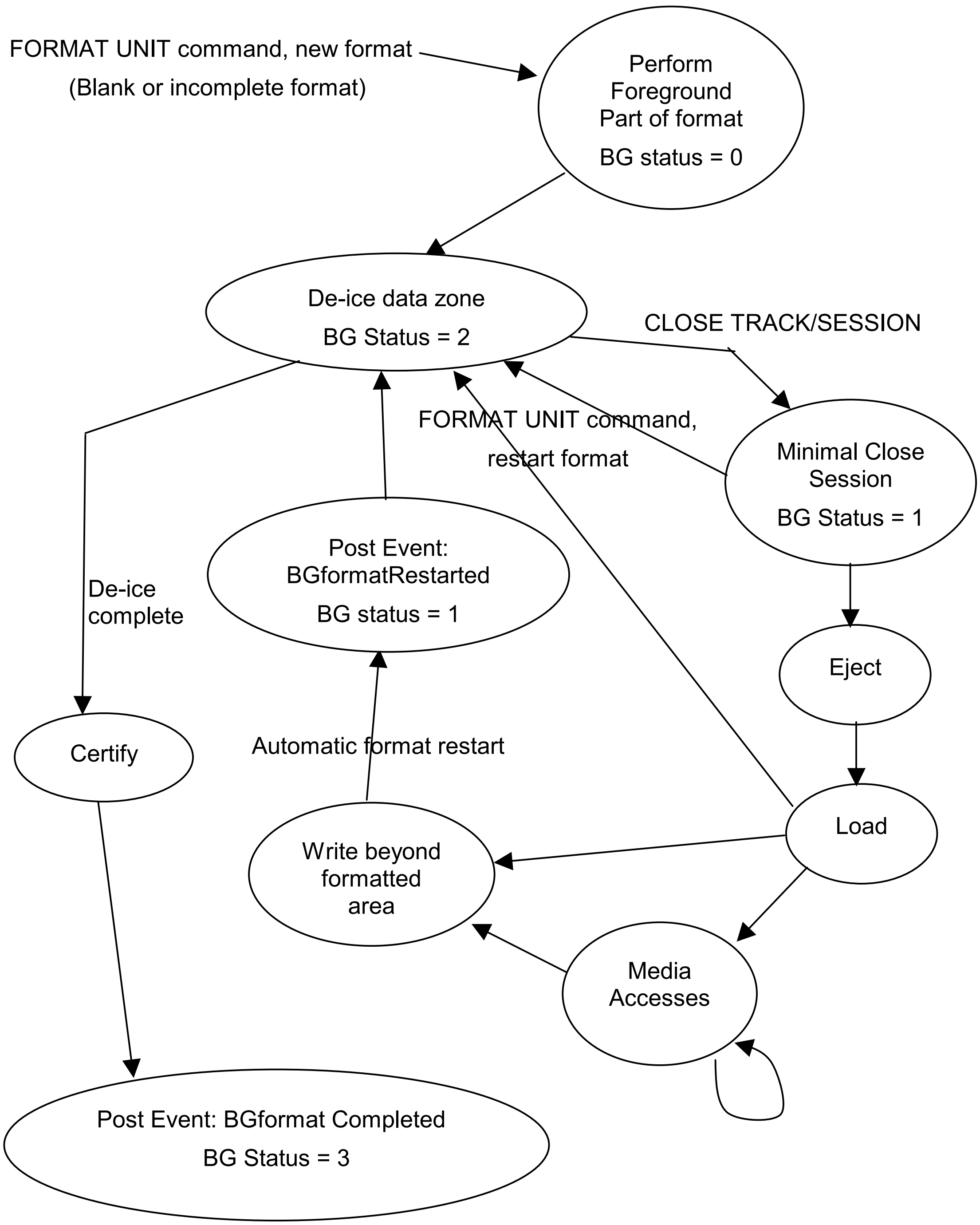


Figure 40 – Background Process Flow

5.5.3.2.4 Writing During the Background Format Process

Writing to the media during different format states sometimes requires different action by the drive. The cases are shown in Table 78.

Table 78: Writing During different Format States

State of Format	Write Range	Action By Drive
Completed	All valid user space addresses	The Initiator's data will be written as provided.
Not Complete and running	All valid user space addresses	The Initiator's data will be written as provided. Format state shall not be changed.
Not complete, not running	Valid user space addresses in formatted region	The Initiator's data will be written as provided. Format state shall not be changed.
	Valid user space addresses beyond formatted region	The background format shall be restarted using parameters saved on the media. The BGformatRestarted Media Event shall be posted. The format state is now "Not Complete and Running", so the write shall proceed accordingly.

5.5.3.2.5 Recovering an Incomplete Format

The background format can be stopped in a controlled way as described in 5.5.3.2.3, above. An interface level RESET or loss of power can also stop a background format operation, but not in a controlled way. This can produce a disc that is partially formatted, however, it may also contain recoverable data. The format may not be recoverable, however, user data should be recoverable.

A Initiator operated recovery application can be produced in order to recover data from the disc. Refer to the appropriate physical format documents.

5.5.4 Error Reporting

Recommended error reporting is defined in Table 79.

Table 79 – Recommended Errors for the FORMAT UNIT Command.

Error	Reference
Deferred Errors	
General Errors	
Media Access Errors	

5.6 GET CONFIGURATION Command

The GET CONFIGURATION command provides information about the Logical Unit capabilities - both current and potential.

Persistent Prevent may be used to control when morphing occurs. If a Persistent Prevent is enabled, the configuration should not change except under Initiator control.

This command shall not return a CHECK CONDITION Status due to a pending UNIT ATTENTION Condition. Any pending UNIT ATTENTION Condition shall not be cleared for the Logical Unit issuing the GET CONFIGURATION Command.

Features that specify implementation of the GET CONFIGURATION command are listed in Table 80.

Table 80 – Features Associated with the GET CONFIGURATION Command

Feature Number	Feature Name	Command Requirement
0001h	Core	Mandatory
0002h	Morphing	Mandatory

5.6.1 The CDB and its Parameters

The Get Configuration CDB is shown in Table 81.

Table 81 – GET CONFIGURATION Command Descriptor Block

<table>
<tr><th>Bit
Byte</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>0</td><td colspan="8">OPERATION CODE (46h)</td></tr>
<tr><td>1</td><td colspan="6">Reserved</td><td colspan="2">RT</td></tr>
<tr><td>2</td><td colspan="8">(MSB) Starting Feature Number</td></tr>
<tr><td>3</td><td colspan="8">(LSB)</td></tr>
<tr><td>4</td><td colspan="8">Reserved</td></tr>
<tr><td>5</td><td colspan="8">Reserved</td></tr>
<tr><td>6</td><td colspan="8">Reserved</td></tr>
<tr><td>7</td><td colspan="8">(MSB) Allocation Length</td></tr>
<tr><td>8</td><td colspan="8">(LSB)</td></tr>
<tr><td>9</td><td colspan="8">Control</td></tr>
</table>

The RT field identifies the type of data to be returned by the drive. The meaning of the Starting Feature Number is dependent upon the value of RT. The possibilities and meanings for the RT field are listed in Table 82.

Table 82 – RT Field Definitions

RT value	Definition
00b	The Logical Unit shall return the Feature Header and all Feature Descriptors supported by the Logical Unit without regard to currency.
01b	The Logical Unit shall return the Feature Header and only those Feature Descriptors in which the Current bit is set to one.
10b	The Feature Header and the Feature Descriptor identified by Starting Feature Number shall be returned. If the Logical Unit does not support the specified feature, only the Feature Header shall be returned.
11b	Reserved

The Starting Feature Number field indicates the first Feature number to be returned. All supported Feature numbers higher than the Starting Feature Number shall be returned.

The Allocation Length field specifies the maximum length in bytes of the Get Configuration response data. An Allocation Length field of zero indicates that no data shall be transferred. This condition shall not be considered an error.

5.6.2 Command Execution

5.6.2.1 GET CONFIGURATION Response Data

The GET CONFIGURATION response Data (Table 83) consists of a header field and zero or more variable length feature descriptors.

Table 83 – GET CONFIGURATION response data format

Bit / Byte	7	6	5	4	3	2	1	0
0 - 7	Feature Header							
8 - n	Feature Descriptor(s)							

The Feature Header field to be returned is shown in Table 84.

Table 84 – Feature Header

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)							
1	Data Length							
2								
3								(LSB)
4	Reserved							
5	Reserved							
6	(MSB)			Current Profile				
7								(LSB)

The Data Length field indicates the amount of data available given a sufficient allocation length following this field. This length shall not be truncated due to an insufficient Allocation Length. If the Data Length is greater than 65 530 bytes, multiple GET CONFIGURATION commands with different

Starting Feature Numbers are required for the initiator to read all configuration data. This field is adjusted as appropriate for the given Starting Feature Number.

The maximum number of definable Features is 65,536. The maximum number of bytes that a Logical Unit may return to describe its Features in one Command is 65,534. Feature lists longer than 65,534 bytes require multiple Commands.

> Note: In this standard, the entire set of defined feature descriptors amounts to less than 1KB. The limit shown above is only a problem in future versions.

The Current Profile field shall indicate the Logical Unit's current Profile. The Logical Unit shall select the current Profile from the list of Profiles (see Table 337) with their CurrentP bit set. If more than one Profile is current, the largest Profile number is used. If no Profile is currently active, this field shall contain zero.

5.6.2.2 Features

Features are the smallest set of commands, pages, and behavior that may be implemented. A list of defined features is shown in Table 334.

The Feature Descriptor(s) generic format returned is defined in 7.2. Each individual Feature description is defined in the appropriate sub-clause.

5.6.2.3 Profile List

This Feature identifies Profiles supported by the Logical Unit. Profiles are defined as collections of Features and provide a method to quickly determine the Logical Unit's type. This Feature is always current, even if none of the Profiles listed is current.

The Profile Descriptor format is shown in Table 336. All Profiles supported by the Logical Unit shall always be reported. The Profile Number identifies a Profile to which the Logical Unit conforms. See 7.4. Profile descriptors are returned in descending numerical order.

5.6.3 Error Reporting

Recommended error reporting is defined in Table 85.

Table 85 – Recommended Errors for the GET CONFIGURATION Command.

Error	Reference
Deferred Errors	
General Errors	
Media Access Errors	

5.7 GET EVENT/STATUS NOTIFICATION Command

The GET EVENT/STATUS NOTIFICATION command requests the Logical Unit to report events and statuses as specified in the Notification Class Request field as a method of asynchronous notification. Two modes of operation are defined: polling and asynchronous.

When polling, the Initiator shall issue GET EVENT/STATUS NOTIFICATION commands at periodic intervals. The target shall complete this command with the most recently available event status requested. The Logical Unit shall support polling mode.

Asynchronous operation requires a transport that provides command queueing and disconnect. The Initiator should issue a single GET EVENT/STATUS NOTIFICATION command. The Logical Unit shall execute the command and return requested event information only when some requested event has occurred.

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 where lowest Classes are higher priority.

This command shall not return CHECK CONDITION status to report a unit attention condition. Any pending unit attention condition for which a corresponding event is reported shall not be cleared for the target.

Features that specify implementation of the GET EVENT/STATUS NOTIFICATION command are listed in Table 86.

Table 86 – Features Associated with the GET EVENT/STATUS NOTIFICATION Command

Feature Number	Feature Name	Command Requirement
0001h	Core	Mandatory
0002h	Morphing	Mandatory

5.7.1 The CDB and its Parameters

The GET EVENT/STATUS NOTIFICATION command descriptor block is shown in Table 87.

Table 87 – GET EVENT/STATUS NOTIFICATION Command Descriptor Block

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

The Polled bit is used to select operational mode. When Polled is cleared to zero, the Initiator is requesting asynchronous operation. If the Logical Unit does not support asynchronous operation, the command shall be terminated with CHECK CONDITION status and the values for SK/ASC/ASCQ shall be set to ILLEGAL REQUEST/INVALID FIELD IN CDB. When Polled is set to one, the Initiator is requesting polled operation. The Logical Unit shall return event information for the highest priority requested event. If no event has occurred, the Logical Unit shall report the "No Change" event for the highest priority requested event class.

Notification Class Request field specifies that the Logical Unit report event(s) from the event classes requested in this field. Table 88 defines the codes listed in this field.

Table 88 – Notification Class Request field definition

Bit	Definition
0	Reserved
1	Operational Change
2	Power Management
3	External Request
4	Media
5	Multi-Initiator
6	Device Busy
7	Reserved

Lowest class number has highest priority.

Bit 7 is reserved for future standardization and shall be treated as unsupported event class. Bit 0 is perpetually reserved. If either of these bits is set to one, it shall not be considered an error.

A Notification Class Request field of zero shall not be considered an error.

The Allocation Length field indicates the maximum number of bytes that shall be transferred from the Logical Unit. If Allocation Length is 4 or less, then the Logical Unit shall transfer Event Header only and shall not clear any event. An event shall be considered reported for all Allocation Lengths greater than 4. An Allocation Length of zero shall not be considered an error.

> Implementers Note: The Initiator should set Allocation Length field to 8 or greater to retrieve Event Data correctly.

5.7.2 Command Execution

5.7.2.1 Event Status Notification Data

The Event Status Notification Response (Table 89) is a 4-byte header followed by an Event Descriptor associated with exactly one event class.

Table 89 – Event Status Notification Response

Byte \ Bit	7	6	5	4	3	2	1	0
0 - 3	Event Header							
4 - n	Event Descriptor							

The Event Header content defined in Table 90.

Table 90 – Event Header

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

The Event Descriptor Length field specifies the number of bytes of data that follows the Event Status Notification Header.

If NEA (No Event Available) is set to one, the Logical Unit supports none of the requested notification classes. If NEA is cleared to zero, at least one of the requested notification classes is supported.

The Notification Class field specifies the class of notification as defined in Table 91. If NEA is set to one, this field shall contain 000b.

Table 91 – Notification Class Field Values

Field	Description
000b	No requested Event Classes are supported
001b	Operational Change Request/Notification
010b	Power Management
011b	External Request
100b	Media
101b	Multiple Initiators
110b	Device Busy
111b	Reserved

Supported Event Classes field specifies the event classes that the Logical Unit supports. See Table 88.

The general format of the Event Descriptor is shown in Table 92.

Table 92 – General Event Descriptor Format

Byte \ Bit	7	6	5	4	3	2	1	0
0		Reserved				Event Code		
1 - N				Specific Event Information				

When Event Code is zero, no change has occurred. Non-zero values for Event Code are Event specific.

Upon reporting an event to the Initiator, this field is reported as 0h on subsequent GET EVENT/STATUS NOTIFICATION commands until a new event of the same class occurs.

5.7.2.2 Operational Change Events

When the Notification Class code in the Event Header is 001b, an Operational Change Event Descriptor (Table 93) follows the header.

An Operational Change event indicates that the operational capabilities or parameters may have changed for this Logical Unit.

Table 93 – Operational Change Event Descriptor

Byte \ Bit	7	6	5	4	3	2	1	0
0	Reserved				Event Code			
1	Persistent Prevented	Reserved			Operational Status			
2	(MSB)	Operational Change						
3								(LSB)

Persistent Prevented bit reports the current state of the persistent prevent for the Logical Unit. See sub-clause 7.3.4.

The Event Code (Table 94) identifies the operational change.

Table 94 – Event Codes For the Operational Change Class

Code	Status	Description
0h	NoChg	No changes in the Logical Unit Operational state
1h	Operational Change Request	An operational change has been requested and the change is in progress
2h	Logical Unit has changed Operational state	The Logical Unit has changed Operational state
3h - Fh	Reserved	Reserved

If a new Event occurs before an existing Event is reported to the Initiator, the new event shall replace the old Event if the new Event has a higher Code than the old Event. Otherwise, the new Event shall be deleted.

The Operational Status field (Table 95) reports the device's ability to respond to the Initiator.

Table 95 – Operational Status

Code	Status	Description
0h	Available	The Logical Unit is ready for operation
1h	Temporarily busy	The Logical Unit is performing a task that should self-terminate
2h	Reservation	The Logical Unit is reserved by another Initiator.
3h - Fh	Reserved	Reserved

The Operational Change field (Table 96) reports the change requested or the change that has been performed. The request usually originates from another Initiator.

Table 96 – Operational Change

Code	Event	Description
0h	NoChg	No changes in operational state requested or performed
1h	Feature Change	An unspecified event has changed Feature currency
2h	New Features	The Feature list may have added Current Features (No Features became non-Current)
3h	Reset	The Logical Unit has been reset
4h	Firmware Changed	The Logical Unit’s Microcode may have changed
5h	Inquiry change	The Logical Unit’s identification information may have changed
6h - FFFFh	Reserved	

5.7.2.3 Power Management Events

When the Notification Class code in the Event Header is 010b, a Power Management Event Descriptor (Table 97) follows the header.

A Power Management Event is reported whenever there is a change to power status. Power changes may occur due to a command from the Initiator or a time-out as specified in the Time-out and Protect Mode Page (see 6.8).

Table 97 – Power Management Event Descriptor

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

The Power Event field (Table 98) identifies the power change event.

Table 98 – Power Event Field

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 Status field.
3h - Fh	Reserved	

If the Logical Unit is commanded to go the same state that it is currently in, the next GET EVENT/STATUS NOTIFICATION (Power Management Class) command shall report a Power Change Successful event.

The Power Status field (Table 100) indicates the current power state of the Logical Unit. The Logical Unit shall be set to Standby (3h) by a Hard reset, a power-on reset or a Device reset (issued from a Sleep state).

Table 99 – Power Status Field

Code	Status	Description
0h	Reserved.	-
1h	Active	The Logical Unit is in Active state
2h	Idle	The Logical Unit is in Idle state
3h	Standby	The Logical Unit is in Standby state
4h	Sleep	The Logical Unit is about to enter Sleep state
5h - Fh	Reserved	-

5.7.2.4 External Request Events

When the Notification Class code in the Event Header is 011b, an External Request Event Descriptor (Table 100) follows the header. Note: This does not include the Load/Eject button.

The External Request Event field reports external requests to change state and notifications of changes in Logical Unit state.

Table 100 – External Request Descriptor

<table>
<tr><th>Bit
Byte</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>0</td><td colspan="4">Reserved</td><td colspan="4">Event Code</td></tr>
<tr><td>1</td><td>Persistent Prevented</td><td colspan="3">Reserved</td><td colspan="4">External Request Status</td></tr>
<tr><td>2</td><td colspan="8" rowspan="2">(MSB) External Request (LSB)</td></tr>
<tr><td>3</td></tr>
</table>

The External Request Events are listed in Table 101.

Table 101 – External Request Events

Code	Event	Description
0h	NoChg	No changes in the Logical Unit Operational state performed or requested
1h	Logical Unit Key Down	A front, back, or remote button has been depressed
2h	Logical Unit Key Up	A front, back, or remote button has been released
3h	External Request Notification	The Logical Unit has received a command from another Initiator that would require an action that may interfere with the Persistent Prevent owner's operation.
4h – Fh	Reserved	-

The Initiator may respond to Events 1-3 with no action, an appropriate action, or with a SEND EVENT command. If a Persistent Prevent is in place for the Initiator, the Logical Unit shall not perform the requested action. If a Persistent Prevent is not in place for the Initiator, the Logical Unit shall notify the Initiator of actions that change Logical Unit state.

The Initiator may respond to Event 4 with a GET CONFIGURATION command. Events 1 and 2 should occur in pairs.

The Persistent Prevented bit reports the current state of the persistent prevent for the Logical Unit. This bit shall be set to 1 if any Initiator has performed a persistent reservation.

The External Request Status field (Table 102) reports the Logical Unit's ability to respond to the Initiator.

Table 102 – External Request Status Codes

Code	Status	Description
0h	Ready	The Logical Unit is ready for operation
1h	Other Prevent	Indicates that another Initiator has an active Persistent Prevent. The Persistent Prevented bit shall be set to one.
2h - Fh	Reserved	Reserved

The External Request field (Table 103) 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 103 – External Request Codes

Code	Status	Description
0h	No Request	No requests are pending
1h	Overrun	The Request Queue has overflowed, External Request Events may be lost.
2h - 100h	Reserved	
101h	Play	The play button was pressed or another initiator requested a play operation.
102h	Rewind/back	The rewind/back button was pressed or another initiator requested a rewind/back operation.
103h	Fast Forward	The fast/forward button was pressed or another initiator requested a fast/forward operation.
104h	Pause	The pause button was pressed or another initiator requested a pause.
105h	Reserved	
106h	Stop	The stop button was pressed or another initiator requested a stop.
107h – 1FFh	Reserved	
200h – 2FFh	ASCII Button	A front panel button was pressed or equivalent action requested by another Initiator. The button has an associated ASCII value. The ASCII value shall be the least significant 8 bits of the Code.
300h - EFFFh	Reserved	
F000h - FFFFh	Vendor Unique	

5.7.2.5 Media Events

When the Notification Class code in the Event Header is 100b, a Media Event Descriptor follows the header.

Table 104 – Media Event Descriptor

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

The Media Event field is defined in Table 105.

Table 105 – Media Event Format

Code	Event	Description
0h	NoChg	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 it.
3h	MediaRemoval	The media has been removed from the specified slot, and the Logical Unit is unable to access the media without user intervention. This applies to media changers only.
4h	MediaChanged	The user has requested that the media in the specified slot be loaded. This applies to media changers only.
5h	BGformatCompleted	A MRW or DVD+RW background format has completed. Since MRW and DVD+RW Logical Units are capable of generating multiple media events concurrently, such Logical Units shall be capable of queuing media events.
6h	BGformatRestarted	A MRW or DVD+RW background format has been automatically restarted by the Logical Unit
7h - Fh	Reserved	
Note: All Logical Units capable of generating more than one media event, shall be capable of queuing media events. Events shall be reported in FIFO order.		

The Media Status byte is defined in Table 106.

Table 106 – Media Status Byte Definition

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

If the Media Present bit is cleared to zero, no media is present in the Logical Unit. If the Media Present bit is set to one, media is present in the Logical Unit.

If the Door or Tray Open bit is cleared to zero, the Tray or Door mechanism is in the closed state. If the Door or Tray Open bit is set to one, the Tray or Door mechanism is in the open state.

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 defined in the MECHANISM STATUS command, see sub-clause 5.11.

5.7.2.6 Multiple Initiator Events

When the Notification Class code in the Event Header is 101b, a Multiple Initiator Event Descriptor (Table 106) follows the header.

Multi-Initiator Class Events notify the Initiator of requests for control by other Initiators.

Table 107 – Multiple Initiator Descriptor

Byte \ Bit	7	6	5	4	3	2	1	0
0	Reserved				Event Code			
1	Persistent Prevented	Reserved			Multiple Initiator Status			
2	(MSB)	Multiple Initiator Priority						
3								(LSB)

The Multi-Initiator Event field reports requests for control of and reporting of changes in Logical Unit state. If a Persistent Prevent is in place for that Initiator, the Logical Unit shall not perform the action requested. If a Persistent Prevent is not in place for that Initiator, the Logical Unit shall notify the Initiator of actions that change the Logical Unit state.

The Multi-Initiator Events are listed in Table 110.

Table 108 – Multiple Initiator Event Format

Code	Event	Description
0h	NoChg	No changes in the Logical Unit Operational state performed or requested
1h	Control Request	Another Initiator has requested Logical Unit control.
2h	Control Grant	Another Initiator has received Logical Unit control.
3h	Control Release	Another Initiator has released Logical Unit control.
4h – Fh	Reserved	

The Initiator may respond to Events 1-3 with no action or an appropriate Persistent Prevent or Persistent Allow.

The Persistent Prevented bit reports the current state of the Persistent Prevent for the Logical Unit.

The Multiple Initiator Status (Table 109) filed reports the Logical Unit ability to respond to the Initiator.

Table 109 – Multiple Initiator Status Codes

Code	Status	Description
0h	Ready	The Logical Unit is ready for operation
1h	Other Prevent	Indicates that another Initiator has an active Persistent Prevent. The Persistent Prevented bit shall be set to one.
2h - Fh	Reserved	Reserved

The Multiple Initiator Priority (Table 110) reports the other initiator's relative priority.

Table 110 – Multiple Initiator Priority Codes

Code	Status	Description
0h	No Request	No requests are pending
1h	Low	There are no tasks pending on the Initiator for this Logical Unit.
2h	Medium	There are no critical tasks pending on the Initiator for this Logical Unit.
3h	High	There are critical tasks pending on the Initiator for this Logical Unit
4h - FFFFh	Reserved	

5.7.2.7 Device Busy Events

When the Notification Class code in the Event Header is 110b, a Device Busy Event Descriptor (Table 111) follows the header.

Device Busy Events are used to notify the Initiator of commands that are executing but that require an abnormally long time to complete.

Table 111 – Device Busy Event Descriptor

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

The Device Busy Event code is defined in Table 112.

Table 112 – Device Busy Event Codes

Code	Event	Description
0h	NoChg	No command has timed out.
1h	Busy Event	A time-out has occurred
2h - Fh	Reserved	

The Device Busy Status byte is defined in Table 113.

Table 113 – Device Busy Status

Code	Status	Description
0h	No Event	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 Time field is the predicted amount of time remaining for the Logical Unit to become not busy, in units of 100ms.

When used in a queued environment, the GET EVENT/STATUS NOTIFICATION command may be issued in a non-immediate mode prior to executing commands or in the immediate mode while commands are being executed. If a non-queued command is issued while the device is busy, the GET EVENT/STATUS NOTIFICATION command cannot be issued until the non-queued command completes. Therefore, if queuing is not used, the GET EVENT/STATUS NOTIFICATION command should precede any command that may time out. If a GET EVENT/STATUS NOTIFICATION command with the Device Busy class bit set, is queued, the Logical Unit shall complete the command after a time-out as defined in the in sub-clause 7.3.33 has occurred. However, instead of generating a unit attention condition, the only action is to complete this command. If this event is to be used via polling in the immediate mode, the Logical Unit should disable the Logical Unit time-outs.

In a non-queued environment, immediate commands, automatic spin-ups, and deferred writing may require an indeterminate amount of time to execute to completion. The GET EVENT/STATUS NOTIFICATION command may be used requesting the Device Busy Event class in order to monitor progress.

5.7.3 Error Reporting

Recommended error reporting for the GET EVENT/STATUS NOTIFICATION Command is defined in Table 114.

Table 114 – Recommended Errors for GET EVENT/STATUS NOTIFICATION Command.

Error	Reference
Deferred Errors	
General Errors	
Media Access Errors	

5.8 GET PERFORMANCE Command

The GET PERFORMANCE command provides a method for the Initiator to profile the performance of the Logical Unit. The command also provides a means for the Initiator to get current status and events that occurred during Stream recording/playback operation. Performance parameters are reported separately for read and write.

Table 115 shows the features associated with the GET PERFORMANCE command.

Table 115 – Features Associated with the GET PERFORMANCE Command

Feature Number	Feature Name	Command Requirement
0107h	Real-time Streaming	Mandatory
Note: The command requirement is valid only when the feature is current.		

5.8.1 The CDB and its Parameters

The GET PERFORMANCE CDB is shown in Table 116.

Table 116 – GET PERFORMANCE Command Descriptor Block

Byte \ Bit	7	6	5	4	3	2	1	0
0	Operation Code (ACh)							
1	Reserved			Data Type				
2	(MSB)							
3	Starting LBA							
4								
5								(LSB)
6	Reserved							
7	Reserved							
8	(MSB)	Maximum Number of Descriptors						
9								(LSB)
10	Type							
11	Control							

The Data Type field definition is dependent upon the Type field value.

Use of the Starting LBA field is determined by the contents of the Type field.

The Type field specifies the type of data requested. shows the valid values for Type.

Table 117 – Type Field Definitions

Type Field	Description
00h	Performance data
01h	Unusable Area data
02h	Defect Status data
03h	Write Speed Descriptor
04h - FFh	Reserved

The Logical Unit shall not return more performance descriptors than specified by the Maximum Number of Descriptors field. If Maximum Number of Descriptors is zero, then only the descriptor header shall be returned.

5.8.2 Command Execution

The performance response (Table 118) shall contain a Performance header and zero or more Performance descriptors.

Table 118 – Performance response format

Bit / Byte	7	6	5	4	3	2	1	0
0 – 7	Performance Header							
8 - n	Performance Descriptor(s)							

The Performance Header is defined in Table 119.

Table 119 – Performance Header

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)							
1	Performance Data Length							
2								
3								(LSB)
4	Reserved						Write	Except
5	Reserved							
6	Reserved							
7	Reserved							

The Performance Data Length field shall specify the amount of result data not including the Performance Data Length. This value is not modified when the allocation length indicated by the Maximum Number of Descriptors is insufficient to return all of the data available.

The values of Write and Except are dependent upon the Peformance Type.

5.8.2.1 Performance (Type field = 00h)

The command reports its characteristics of reading/writing performance.

The Data Type Field (Table 120) is a collection of bit fields that specify the form of the returned descriptor.

Table 120 – Data Type Field Definitions for Type = 00h

Data Type Bit Fields				
4	3	2	1	0
Tolerance		Write	Except	
00b = Reserved		0b = Read Performance	00b = nominal performance	
01b = 10%, nominal; 20%, exceptions		1b = Write Performance	01b = Entire performance list	
10b = Reserved			10b = performance exceptions only	
11b = Reserved			11b reserved	

The Starting LBA field in the CDB is valid only when Except = 01b. If Except = 01b, the Starting LBA field shall indicate the starting point for returning performance data. All performance data shall be for logical block addresses greater than or equal to this LBA.

The Write bit (in the Header), when set to zero, shall indicate that the result data is for read performance using the nominal command for the data type. When set to one, shall indicate that the result data is for write performance.

The Except bit (in the Header), when set to zero, shall indicate that the result data is for nominal performance (see Table 121). When set to one, shall indicate that the result data is for exception conditions (Table 122). Performance Descriptors shall be returned for the current medium. If no media is present, Performance Descriptors for the fastest medium shall be returned.

The Performance Descriptors (Table 121) for nominal performance are intended to give the Initiator an approximation of Logical Unit performance. All numbers are nominal. On CD media, all sectors shall be reported as 2 352 byte sectors. The descriptor includes a Start LBA value, a Start Performance value in increments of 1 000 Bytes/second, an End LBA value, and an End Performance value in increments of 1 000 Bytes/second.

Table 121 – Performance Descriptor – Nominal Performance

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)							
1				Start LBA				
2								
3								(LSB)
4	(MSB)							
5				Start Performance				
6								
7								(LSB)
8	(MSB)							
9				End LBA				
10								
11								(LSB)
12	(MSB)							
13				End Performance				
14								
15								(LSB)

The Start LBA field contains the first logical block address of the extent described by this descriptor.

The Start Performance field contains the nominal Logical Unit performance at the Start LBA.

The End LBA field contains the last logical block address of the extent described by this descriptor.

The End Performance field contains the nominal Logical Unit performance at the End LBA.

Table 122 – Performance Descriptor - Exceptions

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)							
1				LBA				
2								
3								(LSB)
4	(MSB)			Time				
5								(LSB)

The LBA field shall indicate that there is a seek delay between (LBA - 1) and LBA.

The Time field shall indicate the expected additional delay between (LBA - 1) and LBA from nominal, in units of tenths of milliseconds (100 microseconds). This seek delay may be due to linear replacement, zone boundaries, or other media dependent Features. The expected additional delay should represent the typical time expected for the type of exception described.

Note: A block replaced by linear replacement may cause two exceptions to appear in the Exception Descriptor list - one between the non-replaced area and the beginning of the replaced block, and one from the end of the replaced block back to the non-replaced area.

5.8.2.2 Unusable Area Data (Type=01h)

This command reports data to the Initiator that how the physically unusable areas are allocated on the mounted writable media. If the mounted media is not a writable media, the Logical Unit shall terminate the command with CHECK CONDITION status and set SK/ASC/ASCQ values to ILLEGAL REQUEST/INVALID FIELD IN CDB.

The corresponding parameter field allocation is specified in Table 123.

The Unusable Area Type field specifies the type of the unusable area to be transferred. See Table 123.

Table 123 – Unusable Area Type values

Unusable Area Type value	Description
000b	Zone boundary information
001b	PDL information
010b	SDL information
Others	Reserved

The Write and Except bits in the Performance Header for Unusable Area data are not used and shall be set to zeros.

All Unusable Area data shall be for LBAs that are greater than or equal to the Starting LBA specified in the CDB. Each Unusable Area Descriptor shall be transferred to the Initiator in ascending order.

Table 124 – Unusable Area Descriptor

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)							
1	LBA							
2								
3								(LSB)
4	(MSB)							
5	Number of Unusable Physical Blocks							
6								
7								(LSB)

The LBA field shall specify the first LBA of the unusable area if the Unusable Area Type field in CDB is set to 010b. The LBA field shall specify the LBA just before the unusable area when the Unusable Area Type field in CDB is set to 000b or 001b.

The Number of Unusable Physical Blocks field shall specify number of physical blocks included in the specified unusable area. When the Unusable Area Type field in CDB is set to 000b, this field is reserved.

5.8.2.3 Defect Status data (Type=02h)

This command reports Defect Status data to the Initiator that is created by certification on the Restricted Overwrite media. If the mounted media is not a Restricted Overwrite media or if the Logical Unit does not support certification, this command shall be terminated with CHECK CONDITION status and SK/ASC/ASCQ values shall be set to ILLEGAL REQUEST/INVALID FIELD IN CDB.

The Data Type field in CDB shall be set to 0.

All Defect Status data shall be for LBAs that are greater than or equal to the Starting LBA specified in the CDB.

The Write and Except bits in the Performance Header for Defect Status data are not used and shall be set to zeros.

Defect Status Descriptors shall be transferred to the Initiator in ascending order. If the certified areas are non-contiguous and scattered, separate descriptors, to exclude the void areas shall return the Defect Status Descriptor(s).

The Defect Status Data Length field shall specify the amount of data that follows the Defect Status Data Length field. If there is no Defect Status data on the media, Defect Status Data Length field shall be set to 4 and no Defect Status Descriptor shall be transferred.

Table 125 – Defect Status Descriptor

Byte \ Bit	7	6	5	4	3	2	1	0
0	(MSB)							
1	Start LBA							
2								
3								(LSB)
4	(MSB)							
5	End LBA							
6								
7								(LSB)
8	Blocking Factor							
9	Reserved					First Bit Offset		
10	DS #8	DS #7	DS #6	DS #5	DS #4	DS #3	DS #2	DS #1
…	…	…	…	…	…	…	…	…
2047	DS # 16 304	DS # 16 303	DS # 16 302	DS # 16 301	DS # 16 300	DS # 16 299	DS # 16 298	DS # 16 297

The Start LBA field contains the start Logical Block Address of the certified sector where the following Defect Status (DS #n bits) starts. The returned Logical Block Address shall be the first sector of a Block that contains logical blocks specified by the Blocking Factor field.

The End LBA field contains the end Logical Block Address of the certified sector where the following Defect Status (DS #n bits) ends. The returned Logical Block Address shall be the last sector of a Block that contains logical blocks specified by the Blocking Factor field.

The Blocking Factor field shall indicate the number of logical blocks per DS #m bit. In the case of DVD-RW, this filed shall be set to 16 as an ECC Block.

The First Bit offset field shall indicate the start valid bit number in the byte 10. The lower bits in the byte 10 are invalid. For example, if First Bit offset field contains 3, bit 3 of byte 10 has the defect status of the block that contains the Logical block specified Start LBA field. From bit 2 to bit 0 are invalid in this case.

DS #n bit contains the certification result of the block #m. When DS #n bit is set to 0, indicate that the block has no defect and is able to read and write the block safely. When DS #n bit is set to 1, indicates that the block has defect and might not be able to read and write the block safely.

5.8.2.4 Write Speed (Type=03h)

This command reports a list of possible Write Speed descriptors. If recordable media is mounted, Logical Unit shall report the list of speeds that are available for the Blocks of the current mounted medium. If no recordable media is mounted, the Logical Unit shall report the most appropriate list of speeds or only the maximum recording speed. Write Speed descriptors shall be reported in descending order of the Write Speed value. If the Logical Unit supports both CLV and CAV on the media, then the Logical Unit shall report all CLV descriptors first. The Initiator may determine a desired write speed descriptor from the result of this command, then set the Write Speed accordingly via the SET STREAMING command. To apply this descriptor to the SET STREAMING command, the Start LBA field is set to 0, the Read Time field and the Write Time filed are set to 1000 (1sec).

Table 126 – Write Speed Descriptor

Byte \ Bit	7	6	5	4	3	2	1	0
0	Reserved			WRC		RDD	Exact	MRW
1	Reserved							
2	Reserved							
3	Reserved							
4	(MSB)							
5	End LBA							
6								
7								(LSB)
8	(MSB)							
9	Read Speed							
10								
11								(LSB)
12	(MSB)							
13	Write Speed							
14								
15								(LSB)

The Write Rotation Control (WRC) field specifies the type of the medium Rotation Control. See Table 127.

Table 127 – Write Rotation Control values

WRC value	Description
00b	CLV, ZCLV, PCAV
01b	Pure CAV
Others	Reserved

Media default rotation control is the rotation control defined by the media specification. Media default rotation control is as follows:

- CD-R/RW CLV
- DVD-R/-RW CLV
- DVD-RAM ZCLV
- DVD+RW CLV

If default rotation control is CAV, this field shall be set to 0.

RDD bit shall be set to 0.

Exact bit of one indicates that the Logical Unit can perform the recording operation specified by Write Speed Descriptor on the whole media mounted. If the Logical Unit is uncertain, this bit shall set to 0.

The MRW bit indicates that this Write Speed Descriptor is suitable for mixture of read and write (e.g. overwrite mode).

The End LBA field shall indicate the medium capacity if a medium is mounted. The value shall be same as the value reported by READ CAPACITY command. If no medium is mounted, the Logical Unit shall report the maximum capacity of the most appropriate media.

The Read Speed field shall indicate the lowest read performance data of all Blocks in kilobytes per second.

The Write Speed field shall indicate the lowest write performance data of all Blocks in kilobytes per second.

5.8.3 Error Reporting

Recommended error reporting is defined in Table 128.

Table 128 – Recommended errors for GET PERFORMANCE Command

Error	Reference
Deferred Errors	
General Errors	
Media Access Errors	

5.9 INQUIRY Command

The INQUIRY Command requests that information regarding identification of the Logical Unit be sent to the Initiator. Options allow the Initiator to request additional information about the Logical Unit. Features that specify implementation of the INQUIRY command are listed in Table 129.

Table 129 – Features Associated with the INQUIRY Command

Feature Number	Feature Name	Command Requirement
0001h	Core Feature	Mandatory

5.9.1 The CDB and its Parameters

The INQUIRY CDB is shown in Table 130.

Table 130 – INQUIRY Command Descriptor Block

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (12h)							
1	Reserved						CmdDt	EVPD
2	Page or Operation Code							
3	Reserved							
4	Allocation Length							
5	Control							

If the command support data bit (CmdDt) is set to one, the Logical Unit shall return the optional command support data specified by the Page or Operation Code field. Multi-Media Logical Units do not support returning command data. If this bit is set to one, the Multi-Media Logical Unit shall terminate this command with CHECK CONDITION status and set SK/ASC/ASCQ values to ILLEGAL REQUEST/ INVALID FIELD IN CDB.

If the enable vital product data bit (EVPD) is set to one, the Logical Unit shall return the vital product data specified by the Page or Operation Code field. See the most recent version of SPC for standard vital product page definitions.

If the Page or Operation Code field is not zero when EVPD is zero, the Logical Unit shall terminate this command with CHECK CONDITION status and set SK/ASC/ASCQ values to ILLEGAL REQUEST/ INVALID FIELD IN CDB.

Allocation Length is the number of bytes of INQUIRY data that shall be returned. If available INQUIRY data is greater than Allocation Length, the data shall be truncated to Allocation Length bytes. An Allocation Length of zero shall not be considered an error.

Inquiry Data

Table 131 shows the standard INQUIRY data. Standard INQUIRY data shall contain at least 36 bytes.

Table 131 – Standard INQUIRY Data Format

Bit / Byte	7	6	5	4	3	2	1	0
0	Peripheral Qualifier			Peripheral Device Type				
1	RMB	Reserved						
2	Version							
3	AERC	Reserved	NormACA	HiSup	Response Data Format			
4	Additional Length (n-4)							
5	SCCS	ACC	ALUA		3PC	Reserved		
6	BQue	EncServ	VS	MultiP	MChngr	Reserved	Reserved	Addr16
7	RelAdr	Reserved	WBus16	Sync	Linked	Reserved	CmdQue	VS
8	(MSB)							
...	Vendor Identification							
15								(LSB)
16	(MSB)							
.,..	Product Identification							
31								(LSB)
32	(MSB)							
...	Product Revision Level							
35								(LSB)
36	(MSB)							
...	Vendor Specific							
55								(LSB)
56	Reserved							
...								
95								
96	Vendor Specific							
...								
n ≤ 254								

The PERIPHERAL QUALIFIER and PERIPHERAL DEVICE TYPE fields identify the device currently connected to the Logical Unit. For Multi-Media Logical Units, PERIPHERAL DEVICE TYPE shall contain 00101b (5h) and PERIPHERAL QUALIFIER shall contain 000b.

The removable medium bit (RMB) shall be set to one for Multi-Media Logical Units, indicating that the medium is removable.

The VERSION field indicates the implemented version of this standard. Multi-Media Logical Units attached via the ATA-PI shall report 00h. Multi-Media Logical Units attached via the SCSI shall report 04h.

The asynchronous event reporting capability (AERC) bit shall be set to zero. Multi-Media Logical Units report asynchronous events via the GET EVENT STATUS NOTIFICATION command.

The Normal ACA Supported bit (NormACA) is set to zero for all Mult-Media Logical Units.

The hierarchical support bit (HiSup) is set to zero for all Mult-Media Logical Units.

A RESPONSE DATA FORMAT field value of two indicates that the data shall be in the format specified in this standard.

The Additional Length field shall specify the length in bytes of the parameters. If theAllocation Length of the CDB is too small to transfer all of the parameters, the Additional Length shall not be adjusted to reflect the truncation.

The SCC Supported bit (SCCS) shall be set to zero. Multi-Media devices do not contain embedded storage array controllers.

The Access Controls Coordinator bit (ACC) shall be set to zero. Multi-Media Logical Units cannot address any access controls coordinator.

The asymmetric logical unit access field (ALUA) field shall be set to 00b. Multi-Media Logical Units do not support asymmetric logical unit access.

The Third-Party Copy bit (3PC) shall be set to zero. Multi-Media Logical Units do not support third-party copy commands.

The setting of the basic queueing (BQue) bit is dependent upon the setting of the CmdQue bit.

The Enclosure Services bit (EncServ) shall be set to zero. Multi-Media Logical Units do not support enclosure services.

If the Multi Port bit (MultiP) is zero, the device has a single port and does not implement multi-port requirements.

The medium changer bit (MChangr) is set to one to indicate that the device is associated with or is attached to a medium transport element that conforms to the SMC standard. If the MChngr bit is zero, the device is not embedded within or attached to a medium transport element.

The relative addressing bit (RelAdr) shall be set to zero. Multi-Media Logical Units do not support the relative addressing mode.

The linked command bit (Linked) shall be set to zero. Multi-Media Logical Units do not support command linking.

A command queuing (CmdQue) bit of one indicates that the Logical Unit supports tagged tasks (command queuing). A value of zero indicates the Logical Unit may support tagged tasks. Table 132 shows the meanings of BQue and CmdQue bit combination.

Table 132 – Relationship of BQue and CmdQue bits

BQue	CmdQue	Description
0	0	No command queueing supported
0	1	Command queueing with all types of task tags supported
1	0	Basic task management model supported
1	1	Reserved

Vendor Identification, Product Identification, and Product Revision Level are ASCII fields. An ASCII field shall contain only graphic codes (i.e., code values 20h through 7Eh). Left-aligned fields shall place any unused bytes at the end of the field (highest offset) and the unused bytes shall be filled with space characters (20h). Right-aligned fields shall place any unused bytes at the start of the field (lowest offset) and the unused bytes shall be filled with space characters (20h).

The Vendor Identification field contains eight bytes of right-aligned ASCII data identifying the vendor of the product.

NOTE: It is intended that this field provide a unique vendor identification of the manufacturer of the device. In the absence of a formal registration procedure, a list of vendor identification codes may be found in Annex C of the most recent version of the SPC.

The Product Identification field contains sixteen bytes of left-aligned ASCII data as defined by the vendor.

The Product Revision Level field contains four bytes of left-aligned ASCII data as defined by the vendor.

The Vendor Specific fields may be defined for vendor specified purposes.

5.9.2 Command Execution

The Logical Unit shall return CHECK CONDITION status in resonse to the INQUIRY command only when the Logical Unit is unable to return the requested INQUIRY data.

If the Logical Unit has a pending unit attention condition for an initiator and that initiator sends the INQUIRY command, the Logical Unit shall perform the INQUIRY command and shall not clear the unit attention condition.

The INQUIRY data should be returned even though the Logical Unit is not ready for other commands. The standard INQUIRY data should be available without incurring any media access delays. If the Logical Unit does store some of the INQUIRY data on the media, it may return zeros or ASCII spaces (20h) in those fields until the data is available from the media.

The INQUIRY data may change as the target executes its initialization sequence. For example, the target may contain a minimum command set in its nonvolatile memory and may load its final firmware from the media when it becomes ready. After the target has loaded the firmware, it may support more options and therefore return different supported options information in the INQUIRY data.

If the standard INQUIRY data changes for any reason, the Logical Unit shall generate a unit attention condition for all initiators. The Logical Unit shall set the SK/ASC/ASCQ values to UNIT ATTENTION/INQUIRY DATA HAVE CHANGED. Logical Units that support event class 1 (Operational Change), shall also generate a class 1 event.

5.9.3 Error Reporting

Table 133 describes errors that may occur during the operation of the Command or which may cause a CHECK CONDITION status to be reported.

Table 133 – INQUIRY Command Errors

Error	Reference
Deferred Errors	
General Errors	
Media Access Errors	

5.10 LOAD/UNLOAD MEDIUM Command

The LOAD/UNLOAD MEDIUM command requests the Logical Unit Changer to load or unload a Disc. This command is associated with the features listed in Table 138.

Table 134 – Features Associated with the LOAD/UNLOAD MEDIUM Command

Feature Number	Feature Name	Command Requirement
0102h	Embedded Media Changer	Mandatory
Note: The command requirement is valid only when the feature is current.		

5.10.1 The CDB and its Parameters

The LOAD/ONLOAD MEDIUM command descriptor block is shown in Table 135.

Table 135 – LOAD/UNLOAD MEDIUM Command Descriptor Block

<table>
<tr><th>Bit
Byte</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>0</td><td colspan="8">OPERATION CODE (A6h)</td></tr>
<tr><td>1</td><td colspan="3">Reserved</td><td colspan="4">Reserved</td><td>IMMED</td></tr>
<tr><td>2</td><td colspan="8">Reserved</td></tr>
<tr><td>3</td><td colspan="8">Reserved</td></tr>
<tr><td>4</td><td colspan="6">Reserved</td><td>LoUnlo</td><td>Start</td></tr>
<tr><td>5</td><td colspan="8">Reserved</td></tr>
<tr><td>6</td><td colspan="8">Reserved</td></tr>
<tr><td>7</td><td colspan="8">Reserved</td></tr>
<tr><td>8</td><td colspan="8">SLOT</td></tr>
<tr><td>9</td><td colspan="8">Reserved</td></tr>
<tr><td>10</td><td colspan="8">Reserved</td></tr>
<tr><td>11</td><td colspan="8">Control</td></tr>
</table>

If the IMMED is cleared to zero, the command shall not be terminated until the load/unload operation has completed. If the IMMED bit is set to one the Logical Unit shall return status as soon as the CDB has been validated.

Meanings of the Start and LoUnlo bits are defined in Table 136.

Table 136 – LoUnlo/Start Operation

LoUnlo	Start	Operation
0	0	Abort any prior changer command
0	1	Reserved
1	0	Unload media. The Slot parameter has no meaning
1	1	Either move the disc in the selected slot to the play position or select the specified slot for use with media access commands

The Slot field indicates the Slot to be loaded. The Logical Unit should always initialize (Load) Slot 0 at Power On or Hard Reset.

If a Load is requested when the requested slot does not contain a disc, the Logical Unit shall terminate the command with CHECK CONDITION Status and set SK/ASC/ASCQ values to NOT READY/MEDIUM NOT PRESENT.

If an Unload is requested when the Play Position does not contain a disc, the Logical Unit shall terminate the command with CHECK CONDITION Status and set SK/ASC/ASCQ values to ILLEGAL REQUEST/INVALID FIELD IN CDB for the Slot Byte.

5.10.2 Command Execution

No UNIT ATTENTION Condition shall be generated for the Initiator issuing the LOAD/UNLOAD MEDIUM Command when discs are loaded or unloaded from the playing position.

5.10.3 Error Reporting

Table 208 describes errors that may occur during the operation of the Command or which may cause a CHECK CONDITION status to be reported.

Table 137 – LOAD/UNLOAD MEDIUM Command Errors

Error	Reference
Deferred Errors	
General Errors	
Media Access Errors	

5.11 MECHANISM STATUS Command

The Mechanism Status command requests that the Logical Unit respond 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 Logical Unit takes operational direction from both the Initiator and the user. Movement of media in/out of the Logical Unit as well as Play operations 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 139 shows the features associated with this command.

Table 138 – Features Associated with the MECHANISM STATUS Command

Feature Number	Feature Name	Command Requirement
0003h	Removable Medium	Mandatory
0102h	Embedded Media Changer	Mandatory
Note: The command requirement is valid only when the feature is current.		

5.11.1 The CDB and its Parameters

The MECHANISM STATUS CDB is shown in Table 138.

Table 139 – 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 Mechanism Status Parameter list 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.

5.11.2 Command Execution

5.11.2.1 Mechanism Status Parameter List

The Mechanism Status Parameter list returned contains a header followed by zero or more fixed-length Slot Tables (Table 140). If the Logical Unit does not support the changer commands, then the number of slot tables returned to the Initiator shall be zero.

Table 140 – Mechanism Status Parameter List Format

Byte \ Bit	7	6	5	4	3	2	1	0
0 – 7	Mechanism Status Header							
8 - n	Slot Tables							

The Mechanism Status Header format is shown in Table 141.

Table 141 – Mechanism Status Header

Byte \ Bit	7	6	5	4	3	2	1	0
0	Fault	Changer State		Current Slot (Low order 5 bits)				
1	Mechanism State			Door open	Reserved	Current Slot (High order 3 bits)		
2	(MSB)							
3	Current LBA							
4								(LSB)
5	Number of Slots Available							
6	(MSB)	Length of Slot Tables						
7								(LSB)

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

The Changer State field (Table 142) indicates the current state of the changer.

Table 142 – Changer State Field

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

The Current Slot field (an 8-bit field) indicates the Current Slot selected. Changers compatible with a bootable device specification should always initialize (Load) Slot zero on power-on reset or hard reset. This value shall only be changed when a LOAD/UNLOAD command is processed. Operations initiated by a user shall not cause this value to change. If the Logical Unit is not a changer, then this field is reserved.

The Mechanism State field (Table 143) encodes the current operation of mechanism.

Table 143 – Mechanism State Field

Mechanism State	Definition
0h	Idle
1h	Playing (Audio or Data)
2h	Scanning
3h	Active with Initiator, Composite or Other Ports in use (i.e. READ)
4h-6h	Reserved
7h	No State Information Available

The Slot Table response data format is defined in Table 144. Each slot shall respond with the status defined.

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

The Current LBA value returns the location that was last used while reading or playing. Once a Read or Play operation has been completed the value of this field may be undefined. While a Read or Play is in progress this field shall contain the LBA of the current block being processed.

The Number of Slots Available field indicates the number of slots available. The maximum number of slots is 255.

The Length of Slot Tables field specifies the length in bytes of the all the slot information that follows (e.g. for a 2 slot Logical Unit this value would be 8). The Slot Table format is shown in Table 144.

Table 144 – Slot Table Format

Bit / Byte	7	6	5	4	3	2	1	0
0	Disc Present	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Change
1	Reserved						CWP_V	CWP
2	Reserved							
3	Reserved							

The Disc Present bit indicates that there is a Disc in this slot. The reporting of this information is optional after a reset or Disc change. If this capability is not supported, the 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 zero for any following response.

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

CWP_V, if set to one, indicates that the Media Cartridge Write Protection (CWP) of the Cartridge in that slot has been checked and CWP bit is valid. If set to zero, the CWP bit is invalid.

CWP, if set to 1, indicates that the CWP status is active on the Cartridge. If CWP_V is set to 0, CWP bit is invalid and shall be set to zero.

5.11.3 Error Reporting

Recommended error reporting for the MECHANISM STATUS command is defined in Table 145.

Table 145 – Recommended errors for Mechanism Status Command

Error	Reference
Deferred Errors	
General Errors	

5.12 MODE SELECT (10) Command

The MODE SELECT (10) command provides a means for the initiator to specify medium, Logical Unit, or peripheral device parameters. Initiators should issue MODE SENSE (10) prior to each MODE SELECT (10) to determine supported mode pages, mode page lengths, and current settings.

Table 146 shows the features associated with the NODE SELECT command.

Table 146 – Features Associated with the Mode Select Command

Feature Number	Feature Name	Command Requirement
0001h	Core Feature	Mandatory

5.12.1 The CDB and its Parameters

The MODE SELECT CDB format is shown in Table 147.

Table 147 – Mode Select Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation code (55h)							
1	Reserved			PF	Reserved			SP
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	(MSB)			Parameter List Length				
8								(LSB)
9	Control							

If the Page Format bit (PF) is set to one, the MODE SELECT parameters are structured as pages of related parameters and are specified in this standard. Multi-Media Logical Units shall support parameter pages and consequently require that this bit be set to one. If this bit is zero, the Logical Unit shall terminate the command with CHECK CONDITION status and set SK/ASC/ASCQ values to ILLEGAL REQUEST/INVALID FIELD IN CDB.

If the Save Pages (SP) bit is zero, the Logical Unit shall perform the specified MODE SELECT (10) operation, and shall not save any Pages.

If the SP bit of is set to one, the Logical Unit shall perform the specified MODE SELECT (10) operation, and shall save to a non-volatile vendor-specific location all the savable Pages. The SP bit is optional, even when the Logical Unit supports saving Mode Pages. Each mode page contains a Page Savable (PS) bit readable by the MODE SENSE (10) Command. PS identifies pages that are saved. If the PS bit is set in the MODE SENSE (10) data then the Page shall be savable by issuing a MODE SELECT (10) Command with the SP bit set. If the Logical Unit does not implement saved pages and the SP bit is set to one, the Command shall be terminated with CHECK CONDITION status and SK/ASC/ASCQ values shall be set to ILLEGAL REQUEST/INVALID FIELD IN CDB.

The Parameter List Length field specifies the maximum length in bytes of the mode parameter list. The parameter list shall be transferred from the Initiator to the Logical Unit after the CDB hs been transferred. A Parameter List Length of zero indicates that no data shall be transferred. This condition shall not be considered as an error. If the Parameter List Length results in the truncation of any mode parameter header or Mode Page, the Logical Unit shall terminate the Command with CHECK CONDITION status and set SK/ASC/ASCQ values to ILLEGAL REQUEST/PARAMETER LIST LENGTH ERROR.

5.12.2 Command Execution

See clause 6, Mode Parameters for Multi-Media Devices for detailed descriptions of mode pages, parameters and formats.

5.12.3 Error Reporting

Recommended error reporting for the MODE SELECT (10) command is defined in Table 148.

Table 148 – Recommended errors for Mode Select (10) Command

Error	Reference
Deferred Errors	
General Errors	

5.13 MODE SENSE (10) Command

The MODE SENSE (10) command provides a means for the initiator to specify medium, Logical Unit, or peripheral device parameters. Initiators should issue MODE SENSE (10) prior to each MODE SELECT (10) to determine supported mode pages, mode page lengths, and current settings.

Table 149 shows the features associated with the MODE SENSE command.

Table 149 – Features Associated with the Mode Sense Command

Feature Number	Feature Name	Command Requirement
0001h	Core Feature	Mandatory

5.13.1 The CDB and its Parameters

The MODE SENSE (10) CDB format is shown in Table 150.

Table 150 – Mode Sense Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation code (5Ah)							
1	Reserved			LLBAA	DBD	Reserved		
2	PC		Page Code					
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	(MSB) Allocation Length							
8								(LSB)
9	Control							

The Long LBA Accepted (LLBAA) bit shall be zero. Multi-Media Logical Units do not support LLBAA.

Multi-Media Logical Units shall ignore the disable block descriptors (DBD) bit. Multi-Media Logical Units do not return Block Descriptors.

The page control (PC) field defines the type of mode parameter values to be returned in the mode pages. The PC field affects only the mode parameters within the mode pages. The PC field is defined in Table 151.

Table 151 – Page Control Field Definition

PC Value	Returned Data Requested
00b	Current values a) The current values of the mode parameters established by the last successful MODE SELECT command; b) The saved values of the mode parameters if a MODE SELECT command has not successfully completed since the last power-on or hard reset condition; or c) The default values of the mode parameters, if saved values, are not available or not supported.
01b	Changeable values The Logical Unit shall return Masks denoting those mode parameters that are changeable. In the mask, the fields of the mode parameters that are changeable shall be set to all one bits and the fields of the mode parameters that are not changeable shall be set to all zero bits. Implementation of changeable mode page parameters is optional. If the target does not implement changeable parameters and the Logical Unit receives a MODE SENSE command with 01b in the PC field, the command shall be terminated with CHECK CONDITION status and the SK/ASC/ASCQ values shall be set to ILLEGAL REQUEST/INVALID FIELD IN CDB. An attempt to change a non-changeable mode parameter using the MODE SELECT command shall result in an error condition.
10b	Default Values The Logical Unit shall return the default values of the mode parameters. Unsupported parameters shall be set to zero. Default values should be accessible even if the device is not ready.
11b	Saved values Implementation of saved mode page parameters is optional. If saved values are not implemented, the command shall be terminated with CHECK CONDITION status and SK/ASC/ASCQ values shall be set to ILLEGAL REQUEST/SAVING PARAMETERS NOT SUPPORTED. If supported, the Logical Unit shall return the saved values of the mode parameters. Mode parameters not supported by the target shall be set to zero. The method of saving parameters is vendor specific. The parameters are preserved in such a manner that they are retained when the device is powered down. All saveable mode pages should be considered saved when a MODE SELECT command issued with the SP bit set to one has returned a GOOD status or after the successful completion of a FORMAT UNIT command.

The Page Code field specifies which mode pages to return (see Table 152).

Table 152 – Mode Page Codes for Multi-Media Logical Units

Page Code	Meaning	Reference
00h	Vendor Unique Page	6.1
01h	Read/Write Error Recovery Page	6.2
03h	MRW Page	6.3
05h	Write Parameters Page	6.4
0Eh	CD Audio Control Page	6.5
1Ah	Power Conditions Page	6.6
1Ch	Fault/Failure Reporting Control Page	6.7
1Dh	Time-out and Protect Page	6.8
3Fh	Return all mode pages	-

5.13.2 Command Execution

The Initiator should initially issue a MODE SENSE command with the PC field set to 01b (Changable Values) and the Page Code field set to 3Fh. This allows the Initiator to determine which mode pages are supported, which mode parameters within the mode pages are changeable and the supported length of each mode page prior to issuing any MODE SELECT commands.

After a power-up condition or hard reset condition, the Logical Unit shall respond in the following manner:

a) If default values are requested, report the default values.
b) If saved values are requested and saved parameters are supported, mode parameters should be restored prior to reporting. If the saved values of the mode parameters are not able to be accessed from the nonvolatile vendor specific location, the command shall be terminated with CHECK CONDITION status and SK/ASC/ASCQ sense values shall be set to NOT READY/LOGICAL UNIT NOT READY.
c) If current values are requested and the current values of the mode parameters have not been sent by the Initiator (via a MODE SELECT command), the Logical Unit may return either the default or saved values, as defined above. If current values have been sent, the current values shall be reported.

See clause 6, Mode Parameters for Multi-Media Devices for detailed descriptions of mode pages, parameters and formats.

5.13.3 Error Reporting

Recommended error reporting for the MODE SENSE (10) command is defined in Table 153.

Table 153 – Recommended errors for Mode Sense (10) Command

Error	Reference
Deferred Errors	
General Errors	

5.14 PAUSE/RESUME Command

The PAUSE/RESUME command requests that the Logical Unit stop or restart an audio playback operation. This command is used with PLAY AUDIO commands that are executing in immediate mode.

Table 154 shows the Features associated with the PAUSE/RESUME command.

Table 154 – Features Associated with the PAUSE/RESUME Command

Feature Number	Feature Name	Command Requirement
0103h	CD Audio External Play, version 0	Mandatory
Note: The command requirement is valid only when the feature is current.		

5.14.1 The CDB and Its Parameters

The PAUSE/RESUME command descriptor block is defined in Table 155.

Table 155 – Pause/Resume Command Descriptor Block

Byte \ Bit	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							

If the Resume bit is set to zero (Pause), the Logical Unit shall play (or scan) the current block, save the address of the next block, mute the audio outputs, and enter the hold track state.

If the Resume bit is set to one, the Logical Unit shall restore play at the saved address and restore audio outputs to conditions as specified by the CD Audio Control Page (see sub-clause 6.5).

5.14.2 Command Execution

5.14.2.1 Pause

If audio play (or scan) cannot be paused, (i.e. no audio play or scan operation has been requested, or the requested audio play or scan operation has been completed), the command is terminated with CHECK CONDITION status and SK/ASC/ASCQ values shall be set to ILLEGAL REQUEST/ COMMAND SEQUENCE ERROR. It shall not be considered an error to request a Pause when a pause is already in effect.

5.14.2.2 Resume

If an audio play (or scan) operation cannot be resumed, the command shall be terminated with CHECK CONDITION status and SK/ASC/ASCQ values shall be set to ILLEGAL REQUEST/ COMMAND SEQUENCE ERROR. It shall not be considered an error to request a Resume when a play (or scan) operation is in progress.

If audio play is in progress due to PLAY AUDIO (10), PLAY AUDIO (12), or PLAY AUDIO MSF, then audio play shall be continued from the pause location for the range originally requested. If a SCAN is in progress and a resume is requested, the play shall continue until the end of audio data.

5.14.3 Error Reporting

Recommended error reporting for the PAUSE/RESUME command is defined in Table 156.

Table 156 – Recommended errors for PAUSE/RESUME Command

Error	Reference
Deferred Errors	
General Errors	
COMMAND SEQUENCE ERROR	

5.15 PLAY AUDIO (10) Command

The PLAY AUDIO (10) command requests that the 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 CD Audio Control Page (see 6.5).

Table 157 shows the Features associated with the PLAY AUDIO (10) command.

Table 157 – Features Associated with the PLAY AUDIO (10) Command

Feature Number	Feature Name	Command Requirement
0103h	CD Audio External Play	Mandatory
Note: The command requirement is valid only when the feature is current.		

5.15.1 The CDB and Its Parameters

The PLAY AUDIO (10) command descriptor block is shown in Table 158.

Table 158 – PLAY AUDIO (10) Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code (45h)							
1	Reserved							RelADR
2	(MSB)							
3	Starting Logical Block Address							
4								
5								(LSB)
6	Reserved							
7	(MSB) Play Length							
8								(LSB)
9	Control							

The RelAdr bit shall be set to zero. Multi-media devices do not support relative addressing.

The Starting Logical Block Address field specifies the logical block that 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. If the starting address is not found, the command shall be terminated with CHECK CONDITION status and SK/ASC/ASCQ values shall be set to ILLEGAL REQUEST/LOGICAL BLOCK ADDRESS OUT OF RANGE.

The Play Length field specifies the number of contiguous logical blocks that shall be played. A Play Length field of zero indicates that no audio operation shall occur. This condition shall not be considered an error. If the logical block address requested is not within an audio track and the Play Length is non-zero, the command shall be terminated with CHECK CONDITION status and SK/ASC/ASCQ values shall be set to ILLEGAL REQUEST/ILLEGAL MODE FOR THIS TRACK.

5.15.2 Command Execution

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 CHECK CONDITION status and SK/ASC/ASCQ values shall be set to ILLEGAL REQUEST/END OF USER AREA ENCOUNTERED ON THIS TRACK.

The PLAY AUDIO and SCAN commands continue to play while the logical unit may process other commands. Some commands can be accepted without disrupting the audio operations, while others cause the Play operation to stop.

The 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 CD Audio Control Mode Page was set to one when the command started, execution of a new command 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 shall 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.

5.15.3 Error Reporting

Recommended error reporting for the PLAY AUDIO (10) command is defined in Table 159.

Table 159 – Recommended errors for PLAY AUDIO (10) Command

Error	Reference
Deferred Errors	
General Errors	
Media Access Errors	

5.16 PLAY AUDIO (12) Command

The PLAY AUDIO (12) command requests that the 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 CD Audio Control Page (see 6.5).

Table 160 shows the Features associated with the PLAY AUDIO (12) command.

Table 160 – Features Associated with the PLAY AUDIO (12) Command

Feature Number	Feature Name	Command Requirement
0103h	CD Audio External Play	Optional
Note: The command requirement is valid only when the feature is current.		

The PLAY AUDIO (12) command descriptor block is shown in Table 161.

Table 161 – 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	Play Length							
8								
9								(LSB)
10	Reserved							
11	Control							

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

Recommended error reporting for the PLAY AUDIO (12) command is defined in Table 162.

Table 162 – Recommended errors for PLAY AUDIO(12) Command

Error	Reference
Deferred Errors	
General Errors	
Media Access Errors	

5.17 PLAY AUDIO MSF Command

The PLAY AUDIO MSF command requests that the 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 CD Audio Control Page (see 6.5).

Table 163 shows the Features associated with the PLAY AUDIO MSF command.

Table 163 – Features Associated with the PLAY AUDIO MSF Command

Feature Number	Feature Name	Command Requirement
0103h	CD Audio External Play	Mandatory
Note: The command requirement is valid only when the feature is current.		

The PLAY AUDIO MSF command descriptor block is shown in Table 164.

Table 164 – 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 and SK/ASC/ASCQ values shall be set to ILLEGAL REQUEST/INVALID FIELD IN CDB.

If the starting address is not found the command shall be terminated with CHECK CONDITION status and SK/ASC/ASCQ values shall be set to ILLEGAL REQUEST/LOGICAL BLOCK ADDRESS OUT OF RANGE. If the address is not within an audio track the command shall be terminated with CHECK CONDITION status and SK/ASC/ASCQ values shall be set to ILLEGAL REQUEST/ILLEGAL MODE FOR THIS TRACK or ILLEGAL REQUEST/INCOMPATIBLE MEDIUM INSTALLED. If a not ready condition exists, the command shall be terminated with CHECK CONDITION status and SK/ASC/ASCQ shall be set to the appropriate values.

Recommended error reporting for the PLAY AUDIO MSF command is defined in Table 165.

Table 165 – Recommended errors for PLAY AUDIO MSF Command

Error	Reference
Deferred Errors	
General Errors	
Media Access Errors	

5.18 PREVENT ALLOW MEDIUM REMOVAL Command

The PREVENT/ALLOW MEDIUM REMOVAL Command requests that the Logical Unit enable or disable the removal of the medium in the Logical Unit. The Logical Unit shall not allow medium removal if any initiator currently has medium removal prevented. The method of prevention of medium removal is vendor specific.

Table 166 shows the Features associated with the PREVENT ALLOW MEDIUM REMOVAL command.

Table 166 – Features Associated with the PREVENT ALLOW MEDIUM REMOVAL Command

Feature Number	Feature Name	Command Requirement
0002h	Morphing	Mandatory
0003h	Removable Medium	Mandatory

5.18.1 The CDB and its Parameters

The PREVENT ALLOW MEDIUM REMOVAL command descriptor block is shown in Table 167.

Table 167 – PREVENT ALLOW MEDIUM REMOVAL Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code (1Eh)							
1	Reserved							
2	Reserved							
3	Reserved							
4	Reserved						Persistent	Prevent
5	Control							

The Persistent bit controls the Logical Unit responses to the setting of the Prevent bit. Table 168 defines the meaning of Prevent when Persistent is zero.

Table 168 – Prevent Definition when Persistent is Zero

Prevent	Device State	Response by Logical Unit
0		Medium removal is allowed by all defined methods.
1		Medium removal by any defined method is prevented.

5.18.2 Command Execution

Recommended error reporting for the PREVENT ALLOW MEDIUM REMOVAL command is defined in Table 169.

Table 169 – Recommended errors for PREVENT ALLOW MEDIUM REMOVAL Command

Error	Reference
Deferred Errors	
General Errors	
Media Access Errors	

5.19 READ (10) Command

The READ (10) command requests that the Logical Unit transfer data to the Initiator. The most recent data value written in the addressed logical block region shall be returned.

Table 170 shows the Features associated with the READ(10) command.

Table 170 – Features Associated with the READ (10) Command

Feature Number	Feature Name	Command Requirement
0010h	Random Readable	Mandatory
001Dh	MultiRead	Mandatory
001Fh	DVD Read	Mandatory
0028h	MRW	Mandatory
Note: The command requirement is valid only when the feature is current.		

5.19.1 The CDB and Its Parameters

The READ(10) command descriptor block is shown in Table 171.

Table 171 – READ (10) Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (28h)							
1	Reserved			DPO	FUA	Reserved		RELADR
2	(MSB)							
3	Logical Block Address							
4								
5								(LSB)
6	(MSB) Transfer Length							
7								(LSB)
8	Reserved							
9	Control							

The Disable Page Out (DPO) bit is not used by MM Logical Units and shall be set to zero.

A Force Unit Access (FUA) bit of one indicates that the Logical Unit shall access the media in performing the command. Read commands shall access the specified logical blocks from the media (i.e. the data is not directly retrieved from the cache). 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.

An FUA bit of zero indicates that the Logical Unit may satisfy the command by accessing the cache memory. For read operations, any logical blocks that are contained in the cache memory may be transferred to the Initiator directly from the cache memory.

The Relative Address (RELADR) bit is not used by MM Logical Units and shall be set to zero.

The Logical Block Address field contains the LBA of the first block from which data shall be returned. If the Logical Block Address is beyond the range of recorded data, the Logical Unit shall terminate the command with CHECK CONDITION status and SK/ASC/ASCQ values shall be set to ILLEGAL REQUEST/LOGICAL BLOCK ADDRESS OUT OF RANGE.

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.

5.19.2 Command Execution

The block size for the READ (10) command shall be 2 048 bytes. If the block size of a requested sector is not 2 048, the Logical Unit shall:

1. Terminate the command with CHECK CONDITION status,
2. Set sense bytes SK/ASC/ASCQ to ILLEGAL REQUEST/ILLEGAL MODE FOR THIS TRACK,
3. The ILI bit in sense data byte 2 shall be set to one, and
4. Set the sense Information bytes to the LBA of the sector.

Any read by the Initiator to a Logical Block with a Title Key present in the sector (DVD-ROM Media Only), when the Authentication Success Flag (ASF) is set to zero shall be blocked. The command shall be terminated with CHECK CONDITION status and SK/ASC/ASCQ values shall be set to ILLEGAL REQUEST/READ OF SCRAMBLED SECTOR WITHOUT AUTHENTICATION.

Recommended error reporting for the READ (10) command is defined in Table 172.

Table 172 – Recommended errors for READ (10) Command

Error	Reference
Deferred Errors	
General Errors	
Media Access Errors	

5.20 READ (12) Command

The READ (12) command requests that the Logical Unit transfer data to the Initiator. The most recent data value written in the addressed logical block shall be returned.

Table 173 shows the Features associated with the READ(12) command.

Table 173 – Features Associated with the READ (12) Command

Feature Number	Feature Name	Command Requirement
001Fh	DVD Read	Mandatory
0028h	MRW	Mandatory
0107h	Real-time Streaming	Mandatory
Note: The command requirement is valid only when the feature is current.		

5.20.1 The CDB and Its Parameters

The READ(12) command descriptor block is shown in Table 174.

Table 174 – READ (12) Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (A8h)							
1	Reserved			DPO (0)	FUA	Reserved		RELADR
2	(MSB)							
3	Logical Block Address							
4								
5								(LSB)
6	(MSB)							
7	Transfer Length							
8								
9								(LSB)
10	Streaming	Reserved						
11	Control							

The Disable Page Out (DPO) bit is not used by MM Logical Units and shall be set to zero.

A Force Unit Access (FUA) bit of one indicates that the Logical Unit shall access the media in performing the command. Read commands shall access the specified logical blocks from the media (i.e. the data is not directly retrieved from the cache). 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.

An FUA bit of zero indicates that the Logical Unit may satisfy the command by accessing the cache memory. For read operations, any logical blocks that are contained in the cache memory may be transferred to the Initiator directly from the cache memory.

The Relative Address (RELADR) bit is not used by MM Logical Units and shall be set to zero.

The Logical Block Address field contains the LBA of the first block from which data shall be returned. If the Logical Block Address is outside the range of recorded data, the Logical Unit shall terminate the command with CHECK CONDITION status and SK/ASC/ASCQ values shall be set to ILLEGAL REQUEST/LOGICAL BLOCK ADDRESS OUT OF RANGE.

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 Streaming bit of one specifies that the Stream playback operation shall be used for the command (see 4.6.2). The Streaming bit of zero specifies that the conventional READ operation shall be used for the command. If the Streaming bit is set to one, the cache control Mode parameter may be ignored.

When the Streaming bit is set to one, the FUA bit shall be set to zero. If both the Streaming bit and the FUA bit is set to one, the Logical Unit shall terminate the command with CHECK CONDITION status and SK/ASC/ASCQ values shall be set to ILLEGAL REQUEST/INVALID FIELD IN CDB.

5.20.2 Command Execution

The block size for the READ (12) command shall be 2 048 bytes. If the block size of a requested sector is not 2 048, the Logical Unit shall:

5. Terminate the command with CHECK CONDITION status,
6. Set sense bytes SK/ASC/ASCQ to ILLEGAL REQUEST/ILLEGAL MODE FOR THIS TRACK,
7. The ILI bit in sense data byte 2 shall be set to one, and
8. Set the sense Information bytes to the LBA of the sector.

Any read by the Initiator to a Logical Block with a Title Key present in the sector (DVD-ROM Media Only), when the Authentication Success Flag (ASF) is set to zero shall be blocked. The command shall be terminated with CHECK CONDITION status and SK/ASC/ASCQ values shall be set to ILLEGAL REQUEST/READ OF SCRAMBLED SECTOR WITHOUT AUTHENTICATION.

Recommended error reporting for the READ (12) command is defined in Table 175.

Table 175 – Recommended errors for READ (12) Command

Error	Reference
Deferred Errors	
General Errors	
Media Access Errors	

5.21 READ BUFFER Command

The READ BUFFER command is used in conjunction with the WRITE BUFFER command as a diagnostic function for testing memory in the device and the integrity of the service delivery subsystem. Execution of this command shall not alter the medium.

The READ BUFFER command is optional for all MM devices. The READ BUFFER command is not mandatory under any Feature defined in this standard.

5.21.1 The CDB and Its Parameters

The READ BUFFER command descriptor block is shown in Table 176.

Table 176 – READ BUFFER Command Descriptor Block

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

The Mode field is defined in Table 177.

Table 177 – READ BUFFER Mode Field

Mode Value	Description	Implementation Requirements
00h	Combined Header and Data	Not Recommended
01h	Vendor Specific	Not Recommended
02h	Data	Optional
03h	Descriptor	Optional
04h - 09h	Reserved	—
0Ah	Echo Buffer	Optional
0Bh	Echo Buffer Descriptor	Optional
0Ch - 1Fh	Reserved	—

Definitions of Buffer ID, Buffer Offset, and Allocation Length fields are specific to the value of Mode.

5.21.2 Command Execution

The function of the READ BUFFER command and the meaning of fields within the CDB depend on the contents of the Mode field.

5.21.2.1 Combined Header and Data Mode (00h)

In this mode, Buffer ID and Buffer Offset are reserved. A four-byte header followed by data bytes is returned to the Initiator.

The four-byte READ BUFFER header (see Table 178) is followed by data bytes from the buffer.

Table 178 – READ BUFFER Header

Byte \ Bit	7	6	5	4	3	2	1	0
0	Reserved							
1	(MSB)							
2	Buffer Capacity							
3								(LSB)

The Buffer Capacity field specifies the total number of data bytes available in the buffer. This number is not reduced to reflect the allocation length; nor is it reduced to reflect the actual number of bytes written using the WRITE BUFFER command. Following the READ BUFFER header, the device server shall transfer data from the buffer. The Logical Unit shall terminate data transfer when Allocation Length bytes have been transferred or when all the header plus data from the buffer has been transferred to the Initiator, whichever amount is less.

5.21.2.2 Vendor Specific Mode (01h)

In the Vendor Specific mode, the meanings of the Buffer ID, Buffer Offset, and Allocation Length fields are not specified by this standard.

5.21.2.3 Data Mode (02h)

The Logical Unit shall transfer only buffer data when the Mode field is Data Mode.

The Buffer ID field identifies a specific buffer within the Logical Unit from which data shall be transferred. The MM device vendor assigns Buffer ID codes to buffers within the Logical Unit. Buffer ID zero shall be supported. Buffer ID code assignments for the READ BUFFER command shall be the same as for the WRITE BUFFER command. If an unsupported Buffer ID code is selected, the Logical Unit shall terminate the command with CHECK CONDITION status, shall set the sense bytes SK/ASC/ASCQ to ILLEGAL REQUEST/INVALID FIELD IN CDB.

The Buffer Offset field contains the byte offset within the specified buffer from which data shall be transferred. The Initiator should conform to the offset boundary requirements returned in the READ BUFFER descriptor. If the Logical Unit is unable to accept the specified buffer offset, it shall return CHECK CONDITION status and set sense bytes SK/ASC/ASCQ to ILLEGAL REQUEST/INVALID FIELD IN CDB.

The Logical Unit shall terminate data transfer when Allocation Length bytes have been transferred or when all the available data from the buffer has been transferred to the Initiator, whichever amount is less.

5.21.2.4 Descriptor Mode (03h)

In this mode, a maximum of four bytes of READ BUFFER descriptor information is returned. The READ BUFFER descriptor is shown in Table 179.

The Buffer ID field identifies the specific buffer within the Logical Unit from which data shall be transferred. The MM device vendor assigns Buffer ID codes to buffers within the Logical Unit. Buffer ID zero shall be supported. Buffer ID code assignments for the READ BUFFER command shall be the same as for the WRITE BUFFER command. If an unsupported Buffer ID code is selected, the Logical Unit shall terminate the command with CHECK CONDITION status, shall set the sense bytes SK/ASC/ASCQ to ILLEGAL REQUEST/INVALID FIELD IN CDB.

Buffer Offset is reserved.

The Logical Unit shall terminate data transfer when Allocation Length bytes have been transferred or when all the available data from the buffer has been transferred to the Initiator, whichever amount is less.

Table 179 – READ BUFFER Descriptor

Bit / Byte	7	6	5	4	3	2	1	0
0	Offset Boundary							
1	(MSB)							
2	Buffer Capacity							
3								(LSB)

The Logical Unit shall return the descriptor information for the buffer specified by the Buffer ID field. If there is no buffer associated with the specified Buffer ID, the Logical Unit shall return all zeros in the READ BUFFER descriptor. The Buffer Offset field is reserved in this mode. The allocation length should be set to four or greater. The device server shall transfer the lesser of the allocation length or four bytes of READ BUFFER descriptor.

The Offset Boundary field returns the boundary alignment within the selected buffer for subsequent WRITE BUFFER and READ BUFFER commands. The value contained in the Offset Boundary field shall be interpreted as a power of two.

The value contained in the Buffer Offset field of subsequent WRITE BUFFER and READ BUFFER commands should be a multiple of $2^{\text{Offset Boundary}}$ as shown in .

Table 180 – Buffer Offset Boundary

Offset Boundary Field	Interpretation of Offset Boundary	Buffer Offsets
0h	1	Byte Boundaries
1h	2	Even-Byte Boundaries
2h	4	4-byte Boundaries
3h	8	8-Byte Boundaries
4h	16	16-Byte Boundaries
...	...	...
FFh	N/A	0 is the only supported buffer offset

The Buffer Capacity field shall return the size of the selected buffer in bytes.

NOTE: In a system employing multiple Initiators, a buffer may be altered between the WRITE BUFFER and READ BUFFER commands by another Initiator. Buffer testing applications should insure that only a single Initiator is active. Use of reservations to all Logical Units on the device or linked commands may be helpful in avoiding buffer alteration between these two commands.

5.21.2.5 Read Data From Echo Buffer (0Ah)

In this mode the Logical Unit transfers data to the Initiator from the echo buffer. The echo buffer shall transfer the same data as when the WRITE BUFFER command with the mode field set to echo buffer was issued. The Buffer ID and Buffer Offset fields are ignored in this mode.

The READ BUFFER command shall return up to the number of bytes of data as received in the prior echo buffer mode WRITE BUFFER command from the same initiator. If the allocation length is insufficient to accommodate the number of bytes of data as received in the prior echo buffer mode

WRITE BUFFER command, the data returned shall be truncated. This shall not be considered an error. If a prior echo buffer mode WRITE BUFFER command was not successfully completed the echo buffer mode READ BUFFER command shall terminate with a CHECK CONDITION status, and the sense bytes SK/ASC/ASCQ shall be set to ILLEGAL REQUEST/COMMAND SEQUENCE ERROR. If the data in the echo buffer has been overwritten by another initiator the target shall terminate the echo buffer mode READ BUFFER command with a CHECK CONDITION status, the sense key shall be set to ABORTED COMMAND and the additional sense code to ECHO BUFFER OVERWRITTEN.

The initiator may send a READ BUFFER command requesting the echo buffer descriptor prior to a WRITE BUFFER command.

If an echo buffer mode WRITE BUFFER command is successful then the initiator may send multiple echo buffer mode READ BUFFER commands to read the echo buffer data multiple times.

5.21.2.6 Echo Buffer Descriptor Mode (0Bh)

In this mode, a maximum of four bytes of READ BUFFER descriptor information is returned. The device server shall return the descriptor information for the echo buffer. If there is no echo buffer implemented, the device server shall return all zeros in the READ BUFFER descriptor. The Buffer Offset field is reserved in this mode. The allocation length should be set to four or greater. The device server shall transfer the lesser of the allocation length or four bytes of READ BUFFER descriptor. The READ BUFFER descriptor is defined as shown in .

Table 181 – Echo Buffer Descriptor

Bit / Byte	7	6	5	4	3	2	1	0
0	Reserved							EBOS
1	Reserved							
2	(MSB)			Buffer Capacity				
3								(LSB)

The Buffer Capacity field shall return the size of the echo buffer in bytes aligned to a four-byte boundary. The maximum echo buffer size is 65 532 bytes.

If the echo buffer is implemented then the echo buffer descriptor shall be implemented.

If Echo Buffer Overwritten Supported (EBOS) bit is set to one, then either:

a) The target returns the ECHO BUFFER OVERWRITTEN additional sense code if the data being read from the echo buffer is not the data previously written by the same initiator, or

b) The target ensures echo buffer data from each initiator is the same as that previously written by the same initiator.

An EBOS bit of zero specifies that other initiators or intervening commands may overwrite the echo buffer.

Recommended error reporting for the READ BUFFER command is defined in Table 182.

Table 182 – Recommended errors for READ BUFFER Command

Error	Reference
Deferred Errors	
General Errors	
Media Access Errors	

5.22 READ BUFFER CAPACITY Command

During certain streamed write operations, the READ BUFFER CAPACITY command (Table 183) returns the Logical Unit's total length of buffer and its length of available buffer. The Logical Unit reports the length of the buffer during Track at Once Recording, Session at Once Recording, or Disc at once recording.

Table 183 shows the Features associated with the READ BUFFER CAPACITY command.

Table 183 – Features Associated with the READ BUFFER CAPACITY Command

Feature Number	Feature Name	Command Requirement
0107h	Real-time Streaming	Mandatory. Conditional for Block bit = 1.
Note: The command requirement is valid only when the feature is current.		

5.22.1 The CDB and Its Parameters

The READ BUFFER CAPACITY command descriptor block is shown in Table 184.

Table 184 – READ BUFFER CAPACITY Command Descriptor Block

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

When the BLOCK bit is zero, the Initiator is requesting that buffer legnth information be reported as bytes. The BLOCK bit, if set to one, indicates that the Initiator is requesting buffer length information reoprted as blocks. If the Logical Unit does not support the case for Block = 1, the command shall be terminated with CHECK CONDITION status and sense bytes SK/ASC/ASCQ shall be set to ILLEGAL REQUEST/INVALID FIELD IN CDB.

If Allocation Length is 12 or greater, the entire Buffer Capacity structure shall be returned. If Allocation Length is less than 12, the returned data shall be truncated to that length. An Allocation Length of zero is not an error.

5.22.2 Command Execution

5.22.2.1 Reporting Available Buffer in Bytes

If the Real-time Streaming Feature is present and current, the Logical Unit shall return the Buffer Capacity structure associated with Block = 0 (Table 185).

Table 185 – Buffer Capacity Structure, when Block = 0

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

The Data Length field defines the number of data bytes to be transferred by the Logical Unit. The Data Length value does not include the Data Length field itself.

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

The Available Length of Buffer indicates the length of unused area of the buffer in bytes. If the Real-time Streaming Feature is present, but not current, the contents of this field are not defined.

5.22.2.2 Reporting Available Buffer in Blocks

If the Real-time Streaming Feature is present and current, and the RBCB bit in the Feature Descriptor is set to one, the Logical Unit shall return the Buffer Capacity structure associated with Block = 1 (Table 186).

Table 186 – Buffer Capacity Structure, when Block = 1

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

The Data Length field defines the number of data bytes to be transferred by the Logical Unit. The

Data Length value does not include the Data Length field itself.

The Available Length of Buffer indicates the length of unused area of the buffer in blocks. If the Real-time Streaming Feature is present, but not current, the contents of this field are not defined.

The Available Length of Buffer field indicates the number of blocks of buffer currently available to be written to by the Initiator. The Logical Unit shall be able to immediately accept at least this much data for writing. If the Available Length of Buffer becomes zero, the Logical Unit shall begin writing. The Logical Unit may begin writing before the Available Length of Buffer reaches zero.

Note: (Current Write Block Size)*(Available Length of Buffer in Blocks) should be identical to Available Length of Buffer in Bytes.

5.22.3 Error Reporting

Recommended error reporting for the READ BUFFER CAPACITY command is defined in Table 187.

Table 187 – Recommended errors for READ BUFFER CAPACITY Command

Error	Reference
Deferred Errors	
General Errors	
Media Access Errors	

5.23 READ CAPACITY Command

The READ CAPACITY command provides a means for the Initiator to request information regarding the capacity of media currently loaded into the Logical Unit.

Table 188 shows the Features associated with the READ CAPACITY command.

Table 188 – Features Associated with the READ CAPACITY Command

Feature Number	Feature Name	Command Requirement
0010h	Random Readable	Mandatory
0029h	Random Writable	Mandatory
0025h	Write-Once	Mandatory
0026h	Restricted Overwrite	Mandatory
0027h	CD-RW CAV Write	Mandatory
0028h	MRW	Mandatory
002Ch	Rigid Restricted Overwrite	Mandatory
Note: The command requirement is valid only when the feature is current.		

5.23.1 The CDB and Its Parameters

The READ CAPACITY command descriptor block is shown in Table 189.

Table 189 – READ CAPACITY Command Descriptor Block

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

The RelAdr field is not used by MM Logical Units and shall be set to zero.

The Logical Block Address field is not used by MM Logical Units and shall be set to zero.

The PMI field is not used by MM Logical Units and shall be set to zero.

5.23.2 Command Execution

The Logical Unit shall respond to this command by returning eight bytes of READ CAPACITY response data (Table 190).

Table 190 – READ CAPACITY Response Data

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)							
1	Logical Block Address							
2								
3								(LSB)
4	(MSB)							
5	Block Length in Bytes = 2 048d							
6								
7								(LSB)

The returned Logical Block Address is dependent upon media and format type. Table 191 shows the reporting for each MM case.

Table 191 – Logical Block Address Reporting

Media/Format	Logical Block Address
CD-MRW	Method 3 address of the last block in the Defect Managed Area.
DVD+MRW	The PSN of the last block of the Defect Managed Area - 31400h.
CD, non-MRW formats	If the Start address of last recorded lead-out minus 1 is a run-out block, this value is the Start address of last recorded lead-out minus 2. Otherwise, this value is the Start address of last recorded lead-out minus 1. The Logical Address calculation shall be according to the addressing method of the track that immediately precedes the lead-out. If no complete session exists on the medium, this field shall be set to zero.
DVD, non-MRW formats	The Start address of last recorded lead-out (or border-out) minus 1.

For all MM media and format types, the Block Length shall be reported, in bytes, as 2 048d.

5.23.3 Error Reporting

Recommended error reporting for the READ CAPACITY command is defined in Table 192.

Table 192 – Recommended errors for READ CAPACITY Command

Error	Reference
Deferred Errors	
General Errors	
Media Access Errors	

5.24 READ CD Command

The READ CD command provides a method for accessing most fields within any CD sector. This command has a large variety of execution outcomes due the numerous parameters.

Table 193 shows the Features associated with the READ CD command.

Table 193 – Features Associated with the READ CD Command

Feature Number	Feature Name	Command Requirement
001Dh	MultiRead	Mandatory
001Eh	CD Read	Mandatory
Note: The command requirement is valid only when the feature is current.		

5.24.1 The CDB and Its Parameters

The READ CD command descriptor block is shown in Table 194.

Table 194 – READ CD Command Descriptor Block

<table>
<tr><th>Bit
Byte</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>0</td><td colspan="8">Operation Code (BEh)</td></tr>
<tr><td>1</td><td colspan="3">Reserved</td><td colspan="3">Expected Sector Type</td><td>DAP</td><td>RelAdr</td></tr>
<tr><td>2</td><td colspan="8" rowspan="4">(MSB)
Starting Logical Block Address
(LSB)</td></tr>
<tr><td>3</td></tr>
<tr><td>4</td></tr>
<tr><td>5</td></tr>
<tr><td>6</td><td colspan="8" rowspan="3">(MSB)
Transfer Length
(LSB)</td></tr>
<tr><td>7</td></tr>
<tr><td>8</td></tr>
<tr><td rowspan="2">9</td><td colspan="5">Main Channel Selection Bits</td><td colspan="2" rowspan="2">C2 Error Information</td><td rowspan="2">Reserved</td></tr>
<tr><td>SYNC</td><td colspan="2">Header Codes</td><td>User Data</td><td>EDC & ECC</td></tr>
<tr><td>10</td><td colspan="5">Reserved</td><td colspan="3">Sub-channel Selection Bits</td></tr>
<tr><td>11</td><td colspan="8">Control</td></tr>
</table>

The Expected Sector Type field (Table 195) is used to restrict reading to a specific CD sector type. 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. The sector/sectors that do not match shall not be transferred to the Initiator.

Table 195 – Expected Sector type field bit definitions

Sector Type	Definition	Description	Requirement
000b	All types	No checking of the data type is performed. If there is a transition between CD data and CD-DA data, the command shall be terminated with a CHECK CONDITION status and sense bytes SK/ASC/ASCQ shall be set to ILLEGAL REQUEST/ILLEGAL MODE FOR THIS TRACK.	Mandatory
001b	CD-DA	Only IEC 908 (CD-DA) sectors shall be returned. If any other sector type is encountered, the command shall be terminated with a CHECK CONDITION status and sense bytes SK/ASC/ASCQ shall be set to ILLEGAL REQUEST/ILLEGAL MODE FOR THIS TRACK.	Mandatory
010b	Mode 1	Only sectors with a user data field of 2 048 bytes shall be returned. If any other sector type is encountered, the command shall be terminated with a CHECK CONDITION status and sense bytes SK/ASC/ASCQ shall be set to ILLEGAL REQUEST/ ILLEGAL MODE FOR THIS TRACK.	Mandatory
011b	Mode 2 formless	Only sectors with the expanded user data field (2 336 bytes) shall be returned. If any other sector type is encountered, the command shall be terminated with a CHECK CONDITION status and sense bytes SK/ASC/ASCQ shall be set to ILLEGAL REQUEST/ILLEGAL MODE FOR THIS TRACK.	Optional
100b	Mode 2 form 1	Only sectors that have a user data field of 2 048 bytes shall be returned. If any other sector type is encountered, the command shall be terminated with a CHECK CONDITION status and sense bytes SK/ASC/ASCQ shall be set to ILLEGAL REQUEST/ ILLEGAL MODE FOR THIS TRACK.	Mandatory
101b	Mode 2 form 2	Only sectors that have a user data field of 2 324 bytes shall be returned. If any other sector type is encountered, the command shall be terminated with a CHECK CONDITION status and sense bytes SK/ASC/ASCQ shall be set to ILLEGAL REQUEST/ ILLEGAL MODE FOR THIS THIS TRACK.	Mandatory
110b-111b	Reserved	—	—

Digital Audio Play (DAP) is used to control error concealment when the data being read is CD-DA. If the data being read is not CD-DA, DAP shall be ignored. If the data being read is CD-DA and DAP is cleared to zero, then the user data returned to the Initiator shall not be modified by flaw obscuring mechanisms such as audio data mute and interpolate. If the data being read is CD-DA and DAP is set to one, then the user data returned to the Initiator shall be modified by flaw obscuring mechanisms such as audio data mute and interpolate.

The RelAdr bit is not used by MM dLogical Units and shall be set to zero.

The Starting Logical Block Address field specifies the logical block that the read operation shall begin.

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

The Main Channel Field Selection Bits identify fields of the 2 352 bytes of main channel that the Initiator is requesting for each sector:

When Sync is zero, the sync field of data sectors shall not be included in the read data stream. If Sync is one, the 12-byte sync field (Figure 8) of data sectors shall be included in the read data stream.

The Header Codes refer to the sector header and the sub-header that is present in mode 2 formed sectors:

- 00b No header information shall be transferred.
- 01b The 4-byte sector header (Table 8) of data sectors shall be transferred,
- 10b The 8-byte sector sub-header (Table 13) of mode 2 formed sectors shall be transferred.
- 11b Both sector header and sub-header (12 bytes) shall be transferred. Header shall be transferred first.

When User Data is zero, the User Data field shall not be included in the read data stream. If User Data is one, the User Data field shall be included in the read data stream. The size of the user data field varies according to sector type.

When EDC & ECC is zero, no field that follows the user data field shall be included in the read data stream. If EDC & ECC is one, all fields that follow the user data field shall be included in the read data stream. The size of the EDC/ECC field varies according to sector type.

A few problems arise:

- The main channel fields selected may not actually be present in a given CD sector.
- It is not practical to provide data from 2 or more non-contiguous fields.

In these cases, the combination may be either considered invalid or mapped to a valid combination according to the following rules:

1. If no field is requested, then regardless of sector type, no data shall be transferred. This shall not be considered an error.
2. If the sector is CD-DA and any non-zero number of fields is requested, then the entire 2 352 bytes of main channel shall be transferred.
3. If the sector is a CD data type and the Initiator has selected fields that are non-contiguous for that sector type, the command shall be terminated with CHECK CONDITION status and sense bytes SK/ASC/ASCQ shall be set to ILLEGAL REQUEST/INVALID FIELD in CDB.

Table 196 shows a complete mapping of Main Channel Selection bits.

Table 196 – Main Channel Selection and Mapped Values

Main Channel Selection	Main Channel Selection Value[1]	Requirement[2]	CD-DA	Mode 1	Mode 2 Formless	Mode 2 Form 1	Mode 2 Form 2
If the Initiator selects these fields		—	The Logical Unit shall map the selection to this value.				
No fields	00h	M	00h	00h	00h	00h	00h
EDC/ECC Only	08h	O	10h	08h	10h	08h	08h
User Data	10h	M	10h	10h	10h	10h	10h
User Data + EDC/ECC	18h	O	10h	18h	10h	18h	18h
Header	20h	O	10h	20h	20h	20h	20h
Header Only + EDC/ECC	28h	O	10h	Invalid	Invalid	Invalid	Invalid
Header & User Data	30h	O	10h	30h	30h	Invalid	Invalid
Header & User Data + EDC/ECC	38h	O	10h	38h	30h	Invalid	Invalid
Sub-Header Only	40h	O	10h	00h	00h	40h	40h
Sub-Header Only + EDC/ECC	48h	O	10h	Invalid	Invalid	Invalid	Invalid
Sub-Header & user data	50h	O	10h	10h	10h	50h	50h
Sub-Header & user data + EDC/ECC	58h	O	10h	18h	10h	58h	58h
All Headers Only	60h	O	10h	20h	20h	60h	60h
All Headers Only + EDC/ECC	68h	O	10h	Invalid	Invalid	Invalid	Invalid
All Headers & user data	70h	O	10h	30h	30h	70h	70h
All Headers & user data + EDC/ECC	78h	O	10h	38h	38h	78h	78h
Sync Only	80h	O	10h	80h	80h	80h	80h
Sync + EDC/ECC	88h	O	10h	Invalid	Invalid	Invalid	Invalid
Sync & User Data	90h	O	10h	Invalid	Invalid	Invalid	Invalid
Sync & User Data + EDC/ECC	98h	O	10h	Invalid	Invalid	Invalid	Invalid
Sync & Header Only	A0h	O	10h	A0h	A0h	A0h	A0h
Sync & Header Only + EDC/ECC	A8h	O	10h	Invalid	Invalid	Invalid	Invalid
Sync & Header + User Data	B0h	O	10h	B0h	B0h	Invalid	Invalid
Sync & Header + User Data + EDC/ECC	B8h	O	10h	B8h	B0h	Invalid	Invalid
Sync & Sub Header Only	C0h	O	10h	Invalid	Invalid	Invalid	Invalid
Sync & Sub Header Only + EDC/ECC	C8h	O	10h	Invalid	Invalid	Invalid	Invalid
Sync & Sub Header & User Data	D0h	O	10h	Invalid	Invalid	Invalid	Invalid
Sync & Sub Header & User Data + EDC/ECC	D8h	O	10h	Invalid	Invalid	Invalid	Invalid
Sync & All Headers Only	E0h	O	10h	A0h	A0h	E0h	E0h
Sync & All Headers Only + EDC/ECC	E8h	O	10h	Invalid	Invalid	Invalid	Invalid
Sync & All Headers & user data	F0h	O	10h	B0h	B0h	F0h	F0h
Sync & All Headers & user data + EDC/ECC	F8h	M	10h	B8h	B0h	F8h	F8h

Notes:
1. CDB Byte 9 logically ANDed with F8h.
2. M = Mandatory, O = Optional

The C2 Errors code (

Table 197) provides for the inclusion of fabricated information based upon the results of C2 error correction (on main channel).

Table 197 – C2 Errors Codes

C2 Errors Code	Number of Bytes	Description
00b	0	No error information is returned.
01b	294	A bit is associated with each of the 2 352 bytes of main channel where: 0 = No C2 error and 1 = C2 error. This results in 294 bytes of C2 error bits. Return the 294 bytes of C2 error bits in the data stream.
10b	296	The Block Error Byte = Logical AND of all of the 294 bytes of C2 error bits. First return Block Error Byte, then a pad byte of zero and finally the 294 bytes of C2 error bits.
11b	—	Reserved

The Sub-channel Selection bits (Table 198) allow the Initiator to request that certain sub-channel information be included in the data stream.

Table 198 – Sub-Channel Selection Field Values

Sub-Channel Selection Bits	Meaning of Initiator Request	Field Size in Bytes
000b	No Sub-channel data shall be returned.	0
001b	RAW P-W Sub-channel data shall be returned.	96
010b	Formatted Q sub-channel data shall be transferred (See).	16
011b	Reserved	—
100b	Corrected and de-interleaved R-W sub-channel data shall be transferred.	96
101b	Reserved	—
110b	Reserved	—
111b	Reserved	—

The Initiator may select multiple fields in CDB bytes 9 and 10. The Logical Unit shall transfer the selected fields in the following order:

1. Sync
2. Header
3. Sub-header
4. User Data
5. EDC
6. Mode 1 pad
7. ECC parity
8. C2 block error bytes
9. C2 Error flags
10. Sub-channel

5.24.2 Main Channel Field Formats

5.24.2.1 Sync Field

Synchronization for CD-DA sectors is performed by scanning sub-channel, so there is no sync pattern in the main channel of CD-DA.

Synchronization for CD data sectors is performed by scanning for the sync pattern in the main channel. This 12-byte pattern is identical for all types of data sectors. See Figure 8.

5.24.2.2 Headers

The specific sector address identification is based upon its synchronization method. A CD-DA sector address is identified by the Q sub-channel that follows its sub-channel synchronization pattern. So, a CD-DA sector does not contain a header in main channel.

Data sectors are synchronized in main channel, so the address identification is also in main channel: the header. The 4-byte header has the same format for all data sector types. See Table 8.

Only Mode 2 formed data types have a sub-header. The sub-header is 4 bytes in length, but is repeated so that it appears as the 8 bytes that immediately follows the sector header. See Table 13.

5.24.2.3 User Data

The user data is defined according to sector type:

For CD-DA, User Data is all 2 352 bytes of main channel.

For data Mode 1, User Data is 2 048 bytes beginning at offset 16 of the 2 352 bytes of main channel (see Table 10).

> For data Mode 2 formless, User Data is 2 336 bytes beginning at offset 16 of the 2 352 bytes of main channel (see Table 11).
>
> For data Mode 2, form 1, User Data is 2 048 bytes beginning at offset 24 of the 2 352 bytes of main channel (see Table 12).
>
> For data Mode 2, form 2, User Data is 2 324 bytes beginning at offset 24 of the 2 352 bytes of main channel (see Table 14).

5.24.2.4 EDC and ECC

The presence and size of EDC redundancy or ECC parity within the 2 352 bytes of main channel is defined according to sector type:

CD-DA sectors have neither EDC redundancy nor ECC parity.

Data Mode 1 sectors have 288 bytes of EDC redundancy, Pad, and ECC parity beginning at offset 2 064 of the 2 352 bytes of main channel (see Table 10).

Data Mode 2 formless sectors have neither EDC redundancy nor ECC parity (see Table 11).

Data Mode 2 form 1 sectors have 280 bytes of EDC redundancy and ECC parity beginning at offset 2 072 of the 2 352 bytes of main channel (see Table 12).

Data Mode 2 form 2 sectors optionally have 4 bytes of EDC redundancy beginning at offset 2 348 of the 2 352 bytes of main channel (see Table 14).

5.24.2.5 C2 Errors

A bit is associated with each of the 2 352 bytes of main channel where: 0 = No C2 error and 1 = C2 error. The resulting bit field is ordered exactly as the main channel bytes. Each 8-bit boundary defines a byte of flag bits. The

5.24.3 Sub-Channel Field Formats

Sub-channel data may be collected into 96 bytes of P-W sub-channel as described as it is separated from masin channel during the read process. P and Q sub-channel is typically copied elsewhere for independent construction of 12 bytes each of P and Q sub-channel. See 4.2.1.2.

5.24.3.1 RAW P-W Sub-channel

Raw P-W sub-channel is the 96 bytes of sub-channel returned in the order received from the disc surface.

5.24.3.2 P and Q Sub-Channel

P sub-channel is recorded with the same bit value in each sub-channel byte. Due to potential media flaws and the lack of error correction, the most accurate method of determining P is by a redundancy vote.

Q sub-channel has a wide variety of formats (see 4.2.3.3 through 4.2.3.6), however all formats are based on one basic format of 10 bytes of data with 2 bytes of CRC. Both P and Q sub-channel as accessible via the READ CD command in a format shown in Table 199.

Table 199 – Formatted Q- Subchannel 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 (CRC is optional)
11	CRC or 00h (CRC is optional)
12	00h (pad)
13	00h (pad)
14	00h (pad)
15	Bits 6-0 shall be cleared to zero, Bit 7 may (optionally) contain the P Sub-channel value. If P sub-channel reporting is not supported, then bit 7 shall be cleared to zero.

5.24.3.3 Corrected and De-interleaved R-W Sub-channel

5.24.3.4 CD-Text

When the Starting Logical Block Address is set to F000 0000h and P-W raw data is selected, the Logical Unit 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 and set the values of SK/ASC/ASCQ to ILLEGAL REQUEST/ILLEGAL MODE FOR THIS TRACK or ILLEGAL REQUEST/INCOMPATIBLE MEDIUM INSTALLED.

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

5.24.4 Error Reporting

Recommended error reporting for the READ CD command is defined in Table 200.

Table 200 – Recommended errors for READ CD Command

Error	Reference
Deferred Errors	
General Errors	
Media Access Errors	

5.25 READ CD MSF Command

The READ CD MSF command provides a method for accessing most fields within any CD sector. This command is valuable for reading CD digital audio.

Table 201 shows the Features associated with the READ CD MSF command.

Table 201 – Features Associated with the READ CD MSF Command

Feature Number	Feature Name	Command Requirement
001Eh	CD Read	Mandatory
0028h	MRW	Recommended for CD-MRW
Note: The command requirement is valid only when the feature is current.		

5.25.1 The CDB and Its Parameters

The READ CD MSF command descriptor block is shown in Table 202.

Table 202 – READ CD MSF Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (B9h)							
1	Reserved			Expected Sector Type			DAP	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	C2 Errors		Reserved
10	Reserved					Sub-channel Selection Bits		
11	Control							

See 5.24.1 for the definition of the Expected Sector Type field.

See 5.24.1 for the definition of the DAP field.

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 Starting MSF shall not begin earlier than the start of the first lead-in on the disc.

The Ending M field, the Ending S field, and the Ending F field specify the absolute MSF address where the Read operation shall end. The Ending MSF shall not end later than 1.5 minutes beyond the start address of the last lead-out of the disc.

All contiguous sectors between the starting and ending MSF addresses shall be read.

Implementers Note: Reading across some CD structural boundaries may result in data errors.

If the Starting MSF Address is not found, the command shall be terminated with CHECK CONDITION status and set the values of SK/ASC/ASCQ to ILLEGAL REQUEST/ INVALID FIELD IN CDB.

If the Starting MSF Address is equal to the Ending MSF Address, no read operation will 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 and set the values of SK/ASC/ASCQ to ILLEGAL REQUEST/ INVALID FIELD IN CDB.

For definitions of Sync, Header Codes, User Data, EDC & ECC, C2 Errors, and Sub-channel Selections bits, see 4.2.

5.25.2 Command Execution

This command operates identically to the READ CD command with the exception of how the Initiator selects the address range.

Recommended error reporting for the READ CD MSF command is defined in Table 203.

Table 203 – Recommended errors for READ CD MSF Command

Error	Reference
Deferred Errors	
General Errors	
Media Access Errors	

5.26 READ DISC INFORMATION Command

The READ DISC INFORMATION command allows the Initiator to request information about the currently mounted MM disc. When this command is required by an implemented Feature, the command shall always function, even if that Feature's Current bit becomes zero.

Table 204 shows the Features associated with the READ DISC INFORMATION command.

Table 204 – Features Associated with the READ DISC INFORMATION Command

Feature Number	Feature Name	Command Requirement
001Dh	Multi-Read	Mandatory
0021h	Incremental Streaming Writable	Mandatory
0025h	Write Once	Mandatory
0027h	CD-RW CAV Write	Mandatory
0028h	MRW	Mandatory
002Bh	DVD+R	Mandatory (when Write bit is set to one)
002Eh	CD Mastering	Mandatory

5.26.1 The CDB and Its Parameters

The READ DISC INFORMATION command descriptor block is shown in Table 205.

Table 205 – 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 bytes returned is limited by the Allocation Length parameter of the CDB. 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 is transferred.

5.26.2 Command Execution

If the currently mounted medium is blank, and the Logical Unit is unable to write to the medium, the Logical Unit should terminate the command with CHECK CONDITION status and set sense bytes SK/ASC/ASCQ to MEDIUM ERROR/UNKNOWN FORMAT.

The Logical Unit shall gather information about the medium, format it as shown in Table 206, and transfer to the Initiator, limited by the Allocation Length.

Table 206 – Disc Information Block

Byte \ Bit	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 (Least Significant Byte)							
5	First Track Number in Last Session (Least Significant Byte)							
6	Last Track Number in Last Session (Least Significant Byte)							
7	DID_V	DBC_V	URU	Reserved		DBit	BG Format Status	
8	Disc Type							
9	Number of Sessions (Most Significant Byte)							
10	First Track Number in Last Session (Most Significant Byte)							
11	Last Track Number in Last Session (Most Significant Byte)							
12	(MSB)							
13				Disc				
14				Identification				
15								(LSB)
16	(MSB)							
17				Last Session Lead-in Start Address				
18								
19								(LSB)
20	(MSB)							
21				Last Possible Lead-out Start Address				
22								
23								(LSB)
24	(MSB)							
...				Disc Bar Code				
31								(LSB)
32	Reserved							
33	Number of OPC Tables							
34 - n	OPC Table Entries							

The Disc Information Length is the number of bytes Disc Information available. The Disc Information Length excludes itself. The maximum length is 34 + 8*(Number of OPC Tables).

The Erasable bit, when set to one, indicates that CD-RW, DVD-RAM, DVD-RW or DVD+RW medium is present and the Logical Unit is capable of writing the media. If the Erasable bit is set to zero, then either the medium is not erasable or the Logical Unit is unable to write the media.

The State of Last Session field is defined in Table 207. For media that is not recordable in sessions, this field shall be 11h.

Table 207 – State of Last Session

Session State	Definition
00b	Empty Session
01b	Incomplete Session (1)
10b	Reserved / Damaged Session (Only for DVD-R/-RW media)
11b	Complete Session (only possible when Disc Status is Complete)
1. When a disc is in DVD-RW restricted overwrite mode and the last session is in the Intermediate State, this status code is returned.	

The Disc Status field (Table 208) indicates the recorded status of the disc. A Logical Unit that does not have the ability to write the inserted medium shall return only COMPLETE (10b) status.

Table 208 – Disc Status

Status	Definition
00b	Empty disc
01b	Incomplete disc (Appendable) (1)
10b	Complete Disc (eg. Not Appendable. C/DD/DVD-ROM, complete CD-R, CD-RW, DDCD-R/RW, DVD-R/-RW, or write protected Random Writable media)
11b	Others (Other media (e.g. DVD-RAM) that is not write protected)
(1) When a disc is in DVD-RW restricted overwrite mode and the last session is Intermediate state, this status code is returned.	

The Number of First Track on Disc is the track number of the track that contains LBA 0. The value reported in based upon media type and recorded status:

- For CD-ROM and DDCD-ROM the value is the smallest track number recorded in the first TOC on the disc.
- For CD-R, CD-RW, DDCD-R, and DDCD-RW recorded as ROM (i.e. the PMA is blank, but the first TOC is written), the value is the smallest track number recorded in the first TOC on the disc.
- For CD-R, CD-RW, DDCD-R, and DDCD-RW, where the PMA is not blank, the value is the smallest track number recorded in the PMA.
- For CD-R, CD-RW, DDCD-R, and DDCD-RW, where the PMA is blank and the first TOC on the disc is also blank, the value is one (1).
- For all other media regardless of recording status, the value is one (1).

First Track Number in Last Session (bytes 5 & 10) is the track number of the first track in the last session. This includes the incomplete track.

Last Track Number in Last Session (bytes 6 & 11) is the track number of the last track in the last session. This includes the incomplete 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 may be zero for special use CD-R, CD-RW, DVD-R, or DVD-RW medium. For all other media types, URU shall be set to one. When URU is zero, the mounted disc is defined for restricted use. Recording to a restricted use disc, required the appropriate Initiator Application code set in the Write Parameters Page. When URU is set to one, the mounted medium has unrestricted write use.

The BG format status is the background format status of the mounted disc (See Table 209). Logical Units that report the Formattable Feature and either the MRW Feature or the DVD+RW Feature, or both are required to implement Background format. For all other Logical Units, this field shall be 00b.

Table 209 – Background Format Status Codes

BG format status	Meaning
00b	There are 3 cases: The disc is neither CD-RW nor DVD+RW. If disc is CD-RW: Background format is not in progress and the disc does NOT have the MRW format. If disc is DVD+RW: Disc is not formatted and background format is not in progress.
01b	A background format was started but is not currently running and is not complete.
10b	A background format is in progress. A format has been started or restarted and is not yet completed.
11b	Formatting has completed. A fully formatted MRW disc or a fully formatted DVD+RW disc is currently mounted.

If the disc is formatted (or formatting) as a MRW disc (state = 01b, 10b, or 11b), then bit 2 of byte 7 (Dbit) is a copy of the “dirty bit” from the defect table. If Dbit is cleared to zero, then the MRW structures are current. If Dbit is set to one, then the MRW structures may not be current. When BG format status = 00b, Dbit shall be cleared to zero.

The Disc Type field is associated only with CD and DDCD media types. For all other media types, this field shall contain FFh. The Disc Type field specifies the type of data recorded on the disc. For DDCD, the Disc Type shall be set to 20h. For CD media, the Disc Type shall be obtained from the PMA or from the TOC of the first session. The discovery sequence is as follows:

1. Initialize Disc Type to FFh.
2. If a Disc ID item is written in the PMA, replace with the Disc Type field from that item.
3. If the disc is COMPLETE, replace with Session Format from the first Session. Otherwise, scan all complete sessions for a session that contains at least one data track. If found replace with the Session Format field.

Valid Disc Types are shown in Table 210.

Table 210 – Disc Type Field

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

For CD and DDCD, 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. This value should be zero filled for all other media types.

The Last Session Lead-in Start Address field is dependent on medium and recorded status:

- For CD-R, CD-RW, DDCD-R and DDCD-RW media the Last Session Lead-in Start Address is the HMSF format address of where the next Lead-in shall be recorded. If the disc has complete status, then the value returned shall be FFh, FFh, FFh, FFh.
- For DVD+R media the Last Session Lead-in Start Address is the LBA of where the next Intro shall be recorded. If the disc has complete status, then the value returned shall be FFFFFFFFh.
- For all other media types, this field shall be filled with zeros.

The Last Possible Lead-out Start Address field is dependent on medium and recorded status:

- For CD-R, CD-RW, DDCD-R and DDCD-RW the Last Possible Lead-out Start Address is the HMSF format address found in the ATIP of the disc's lead-in. If the disc is Complete, the Last Possible Lead-out Start Address shall be FFh/FFh/FFh/FFh HMSF.
- For DVD+R media the Last Possible Lead-out Start Address is the LBA found in the ADIP of the disc's lead-in. If the disc is Complete, the Last Possible Lead-out Start Address shall be FFFFFFFFh.
- For all other media types, this field shall be filled with zeros.

The Disc Bar Code field contains the hexadecimal value of the bar code if the Logical Unit has the ability to read Disc Bar Code and a bar code is present. For all other media this field should be set to zeros.

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. For DVD-R/-RW, the use of OPC tables is vendor specific.

The format of an OPC Table is shown in Table 211. Speed is in kbytes per second. The OPC Value field is associated with the speed specified in the speed field, and its content is vendor specific.

Table 211 – OPC Table Entry

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

Recommended error reporting for the READ DISC INFORMATION command is defined in Table 212.

Table 212 – Recommended errors for READ DISC INFORMATION Command

Error	Reference
Deferred Errors	
General Errors	
Media Access Errors	

5.27 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 Initiator.

Table 213 shows the Features associated with the READ DVD STRUCTURE command.

Table 213 – Features Associated with the READ DVD STRUCTURE Command

Feature Number	Feature Name	Command Requirement
0004h	Write Protect	Format codes C0h, FFh Mandatory
001Fh	DVD Read	Mandatory
0024h	Defect Management (SSA = 1)	Format code 0Ah Mandatory
0106h	DVD CSS	Format code 02h Mandatory
010Ah	DCB	Format code 30h Mandatory
10Bh	DVD CPRM	Mandatory

5.27.1 The CDB and Its Parameters

The READ DVD STRUCTURE command descriptor block is shown in Table 214.

Table 214 – READ DVD STRUCTURE Command Descriptor Block

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

The Address field definition is dependent upon the value in the Format field.

The Layer Number field specifies the layer number for the response data returned by the READ DVD STRUCTURE command.

The Format field, Table 170, indicates the type of information that is requested by the Initiator.

The Allocation Length field specifies the maximum number of bytes that may be returned by the Logical Unit. An Allocation Length field of zero shall not be considered an error.

The AGID field is described in the REPORT KEY command. This field is used only when the Format field contains 2h, 6h or 7h with Address field of 00000000h, for all other values it is reserved.

Requests for Format FFh shall always be fulfilled, even if there is no medium or an incompatible medium installed.

When a READ DVD STRUCTURE command is issued for non-DVD media, with format codes 00h - BFh, the command shall be terminated with CHECK CONDITION status and SK/ASC/ASCQ shall be set to ILLEGAL REQUEST/CANNOT READ MEDIUM/INCOMPATIBLE FORMAT. When the Logical Unit/media combination does not support the specified Format code, the command shall be terminated with CHECK CONDITION status and SK/ASC/ASCQ shall be set to ILLEGAL REQUEST/INVALID FIELD IN CDB.

Table 215 – Format Code Definitions

Format Code	Layer Field Usage	Address Field Usage	Description
00h	Layer	Reserved	Physical Information in the DVD Lead-in area. Multi-session DVD-R/-RW returns information in the last Border-in.
01h	Layer	Reserved	Copyright Information from the DVD Lead-in area
02h	Reserved	Reserved	Disc Key obfuscated by a Bus Key
03h	Reserved	Reserved	Burst Cutting Area information on DVD media
04h	Layer	Reserved	Disc Manufacturing Information from the DVD Lead-in area
05h	Reserved	LBA	Copyright Management information from specified sector
06h	Reserved	Reserved	Media Identifier protected by a Bus Key
07h	Reserved	Pack Number	Media Key Block protected by a Bus Key
08h	Reserved	Reserved	DDS information on DVD-RAM Media
09h	Reserved	Reserved	DVD-RAM Medium Status
0Ah	Reserved	Reserved	DVD-RAM Spare Area Information
0Bh	Reserved		
0Ch	Reserved	Reserved	DVD-R/-RW RMD in last border-out
0Dh	Reserved	Start Field Number of RMA blocks	Specified RMD field from last recorded border out on DVD-R/-RW
0Eh	Reserved	Reserved	Pre-recorded information from DVD-R/-RW lead-in
0Fh	Reserved	Reserved	DVD-R/-RW Media Identifier
10h	Layer	Reserved	DVD-R/-RW Physical Format Information
11h - 2Fh	Reserved	Reserved	
30h	Reserved	Content Descriptor	Disc Control Block identified by content descriptor
31h	Reserved	PSN	Read MTA ECC Block from DVD+MRW disc
31h - BFh	Reserved		
C0h	Reserved	Reserved	Write Protection Status
C1h - FEh	Reserved		
FFh	Layer	Reserved	READ/SEND DVD STRUCTURE capability list

5.27.2 Command Execution

5.27.3 Error Reporting

Recommended error reporting for the READ DVD STRUCTURE command is defined in Table 216.

Table 216 – Recommended errors for READ DVD STRUCTURE Command

Error	Reference
Deferred Errors	
General Errors	
Media Access Errors	

5.28 READ FORMAT CAPACITIES Command

The READ FORMAT CAPACITIES command allows the Initiator to request a list of the possible format capacities for an installed writable media. This command also has the capability to report the capacity for a media when it is installed. If an implemented Feature requires the command it shall function independently of the state of that Feature's Current bit.

Table 217 shows the Features associated with the READ FORMAT CAPACITIES command.

Table 217 – Features Associated with the READ FORMAT CAPACITIES Command

Feature Number	Feature Name	Command Requirement
0023h	Formattable	Mandatory
0028h	MRW	Mandatory

5.28.1 The CDB and Its Parameters

The READ FORMAT CAPACITIES command descriptor block is shown in Table 218.

Table 218 – READ FORMAT CAPACITIES Command Descriptor Block

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (23h)							
1	Reserved							
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	(MSB) Allocation Length							
8								(LSB)
9	Control							

The Allocation Length field specifies the maximum number of bytes that an Initiator has allocated for returned data. An Allocation Length of zero indicates that no data shall be transferred. This condition shall not be considered as an error. The Logical Unit shall terminate the data transfer when Allocation Length bytes have been transferred or when all available data have been transferred to the Initiator, whatever is less.

5.28.2 Command Execution

Byte Range	Content
0 - 3	Capacity List Header
4 - 11	Current/Maximum Capacity Descriptor
12 - 19	Formattable Capacity Descriptor 0
20 - 27	Formattable Capacity Descriptor 1
...	...
12+ 8*(N-1) - 1	Formattable Capacity Descriptor N-1

Bit / Byte	7	6	5	4	3	2	1	0
0 - 3	Capacity List Header							
4 – 11	Current/Maximum Capacity Descriptor							
Formattable Capacity Descriptor(s)								
0	Formattable Capacity Descriptor 0							
..								
7								
….								
0	Formattable Capacity Descriptor n							
..								
7								

Table 219 – Capacity List Header

Bit / Byte	7	6	5	4	3	2	1	0
0	Reserved							
1	Reserved							
2	Reserved							
3	Capacity List Length							

The Capacity List Length specifies the length in bytes of the Capacity Descriptors that follow. Each Capacity Descriptor is eight bytes in length, making the Capacity List Length equal to eight times the number of descriptors. Values of n * 8 are valid, where 0 < n < 32.

Table 220 – Current/Maximum Capacity Descriptor

Bit / Byte	7	6	5	4	3	2	1	0
4	(MSB)							
5	Number of Blocks							
6								
7								(LSB)
8	Reserved						Descriptor Type	
9	(MSB)							
10	Block Length							
11								(LSB)

Table 221 indicates the values returned if the Logical Unit implements the command.

Table 221 – Returned Current/Maximum Descriptor for Combination of Logical Unit and Media

<table>
<tr><th>Logical Unit Type</th><th>No Media</th><th>ROM Media</th><th>Sequential Writable Media</th><th>Random Writable Media</th></tr>
<tr><td>ROM</td><td rowspan="3">Descriptor Type = 11b</td><td rowspan="3">Descriptor Type = 10b</td><td>Descriptor Type = 10b or 11b</td><td>Descriptor Type = 10b</td></tr>
<tr><td>Sequential Writable</td><td>Descriptor Type = 10b</td><td>Descriptor Type = 10b</td></tr>
<tr><td>Random Writable</td><td>Descriptor Type = 10b or 11b</td><td>Descriptor Type = 01b or 10b plus Formattable Capacity Descriptor(s)</td></tr>
</table>

This command is not mandatory for all Logical Unit types shown in Table 221; the table indicates the values returned if the command is implemented.

The Number of Blocks indicates the number of addressable blocks for the capacity defined by each Descriptor Type.

The Descriptor Type field (Table 222) indicates the type of information the descriptor contains.

Table 222 – Descriptor Types

Descriptor Type	Description
00b	Reserved
01b	Unformatted Media. The reported value is for the maximum formatted capacity for this media. For DDCD/CD-RW medium, the value reported is the maximum possible when using Format Type 10h.
10b	Formatted Media. The reported value is the current media's capacity. In the case of sequential writable media, the number of blocks field indicates the number of blocks between the first Lead-in and the Lead-out or Border-out. When the media done not have a complete session it shall be reported as "No Media Present" with Descriptor Type = 11b.
11b	No Media Present. The reported value is for the maximum capacity of a media that the Logical Unit is capable of reading.

The Block Length specifies the length in bytes of each logical block.

Table 223 – Formattable Capacity Descriptor(s)

<table>
<tr><th>Bit
Byte</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>0</td><td colspan="8" rowspan="4">(MSB)
Number of Blocks
(LSB)</td></tr>
<tr><td>1</td></tr>
<tr><td>2</td></tr>
<tr><td>3</td></tr>
<tr><td>4</td><td colspan="6">Format Type</td><td colspan="2">Reserved</td></tr>
<tr><td>5</td><td colspan="8" rowspan="3">(MSB)
Type Dependent Parameter
(LSB)</td></tr>
<tr><td>6</td></tr>
<tr><td>7</td></tr>
</table>

The Format Type field, Table 224, indicates the type of information required for formatting.

Table 224 – Format Types

Format Type	Description	Type Dependent Parameter
00h	The descriptor shall contain the number of addressable blocks and the block size used for formatting the whole media. If multiple formatting for the whole media is possible, each capacity/block size combination shall be reported as a separate descriptor.	Block length in bytes
01h	The descriptor shall contain the number of addressable blocks and the block size used for formatting the whole media. If multiple formatting for the whole media is possible, each capacity/block size combination shall be reported as a separate descriptor. This Format Type is used to expand a Spare area.	Block length in bytes
02h – 03h	Reserved	
04h	The descriptor shall contain the number of addressable blocks in the zone and zone number used by zoned formatting for a zone of the media, where the size of zone is not constant for each zone. The information for each zone shall be reported as a separate descriptor.	Zone number of the description
05h	The descriptor shall contain the number of addressable blocks per zone and zone number of the highest numbered zone. This descriptor is used for zoned formatting of the media, where the size of zone is constant for each zone.	Zone number of the last zone
06h – 0Fh	Reserved	
10h	The descriptor shall contain the maximum number of addressable blocks and maximum packet size that can be used to fully format CD/DVD-RW media. The packet size and number of addressable blocks may be adjusted downward by the Initiator before sending this descriptor back via the FORMAT UNIT command.	Fixed Packet Size in sectors/ECC block size in sectors
11h	The descriptor shall contain the maximum number of addressable blocks and the packet size that can be used to expand (grow) the last complete session of CD/DVD-RW media. The number of addressable blocks may be adjusted downward by the Initiator before sending this descriptor back via the FORMAT UNIT command.	Fixed Packet Size in sectors/ECC block size in sectors
12h	The descriptor shall contain the maximum number of addressable blocks and the maximum packet size that can be used to add a new session to a CD/DVD-RW media. The packet size and number of addressable blocks may be adjusted downward by the Initiator before sending this descriptor back via the FORMAT UNIT command.	Fixed Packet Size in sectors/ECC block size in sectors

Table 225 – Format Types, continued

Format Type	Description	Type Dependent Parameter
13h	The descriptor shall contain the maximum number of addressable blocks and the ECC block size which can be used to expand (grow) the last complete Session of DVD-RW media as an intermediate state. The number of addressable blocks may be adjusted downward by the initiator before sending this descriptor back via the FORMAT UNIT command.	ECC block size in sectors
14h	The descriptor shall contain the maximum number of addressable blocks and the ECC block size that can be used to add a new intermediate state Session to a DVD-RW media. The number of addressable blocks may be adjusted downward by the initiator before sending this descriptor back via the FORMAT UNIT command.	ECC block size in sectors
15h	The descriptor shall contain the maximum number of addressable blocks and ECC block size that can be used to fully format DVD-RW media as an intermediate state. The number of addressable blocks may be adjusted downward by the initiator before sending this descriptor back via the FORMAT UNIT command.	ECC block size in sectors
16h – 1Fh	Reserved	
20h (Obsolete)	The descriptor shall contain the maximum number of addressable blocks and the sparing parameters to be used.	M and N (sparing parameters
21h-23h	Reserved	
24h	MRW Format, Mandatory for the MRW Feature. The descriptor shall contain the maximum number of DMA addressable blocks.	The Type Dependent Parameter is not used and shall be cleared to zero.
26h	DVD+RW Full Format, Mandatory for the DVD+RW Profile	The Type Dependent Parameter is not used and shall be cleared to zero.
25h - 3Fh	Reserved	

The Number of Blocks field indicates the number of addressable blocks for the capacity defined by each Format Type.

The Type Dependent Parameter contents are as specified for each Format Type in Table 224. In the case of Format Type 20h (Obsolete), M specifies SL where SL = 2^M , $4 \le M \le 15$ or SL = 0 if M = 0 and N identifies SI where SI = 2^N , $4 \le N \le 24$.

The Type Dependent Parameter shall be set to M * 10000h + N, effectively placing M in byte offset 5 and N in byte offset 7, and making byte 8 reserved. The device shall supply its default values for M and N.

The Logical Unit shall only return Formattable Capacity Descriptors that apply to the installed media. If there is no medium installed, the Logical Unit shall return only the Current/Maximum Capacity Descriptor, with the maximum capacity of a medium that the Logical Unit is capable of reading.

A Formattable Capacity Descriptor of Format Type 00h shall be reported if any other Formattable Capacity Descriptor is reported.

The descriptors shall be returned in ascending order of Format Type. For Format Types other than 04h and 05h, if multiple format descriptors exist, they shall be returned in Logical Unit preferred order. For Format Types 04h and 05h, the format descriptors shall be returned in ascending order of Zone number.

Formattable Capacity Descriptors for formats that can be read, but not formatted shall not be reported.

5.28.3 Error Reporting

Recommended error reporting for the READ FORMAT CAPACITIES command is defined in Table 226.

Table 226 – Recommended errors for READ FORMAT CAPACITIES Command

Error	Reference
Deferred Errors	
General Errors	
Media Access Errors	

5.29 READ SUB-CHANNEL Command

The READ SUB-CHANNEL command requests that the Logical Unit return the requested Sub-channel data.

Table 227 shows the Features associated with the READ SUB-CHANNEL command.

Table 227 – Features Associated with the READ SUB-CHANNEL Command

Feature Number	Feature Name	Command Requirement
0103h	CD Audio External Play	Mandatory

5.29.1 The CDB and Its Parameters

The READ SUB-CHANNEL command descriptor block is shown in Table 228.

Table 228 – READ SUB-CHANNEL Command Descriptor Block

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

When TIME is cleared to zero, the address fields in returned data shall be in LBA form. When TIME is set to one, the address fields in returned data shall be in TIME form. For specific cases, see .

When the SUBQ bit is set to one, the Logical Unit shall return the Q Sub-channel data. When the SUBQ bit is cleared to zero, the Logical Unit shall return no Sub-channel data. This shall not be considered an error.

The Sub-channel parameter list (Table 229) field specifies the returned sub channel data.

Table 229 – Sub-channel parameter list codes

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

The Track Number field specifies the track number from which ISRC data is read. This field shall have a value between 01h and 63h (99bcd), 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. The Logical Unit ignores this field when the Format code is not 03h.

The Allocation Length field specifies the maximum number of bytes that may be returned by the Logical Unit. An Allocation Length field of zero shall not be considered an error.

5.29.2 Command Execution

The data returned is formatted as a header followed by zero or more bytes of the requested sub-channel. See Table 230.

Table 230 – Read Sub-Channel Returned Data Format

Byte \ Bit	7	6	5	4	3	2	1	0
0 – 7	Sub-channel Data Header							
8 - n	Sub-channel data							

5.29.2.1 Sub-Channel Data Header

The Sub-channel data header format (Table 231) is four bytes.

Table 231 – Sub-Q Channel Data Header Format

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

The audio status field indicates the status of audio play operations. The audio status values are defined in Table 232. Logical Units that do not support audio play operations shall always report 00h.

For Logical Units that 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 Mode Page (see 6.5) is set to one, the Logical Unit shall report 14h in this audio status byte and shall report no deferred error.

Table 232 – 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. If the CDB SubQ bit is zero, the Logical Unit shall return only the Sub-channel data header. In this case, the Sub-channel data length is 0.

5.29.2.2 CD Current Position

Table 233 defines the response data format for the CD current position data format.

Table 233 – CD current position data format

Byte \ Bit	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 234.

Table 234 – ADR Q Sub-channel field

ADR Code	Description
0h	Q Sub-channel mode information not supplied
1h	Q Sub-channel encodes current position data (i.e., track, index, absolute address, relative address)
2h	Q Sub-channel encodes media catalog number
3h	Q Sub-channel encodes ISRC
4h - Fh	Reserved

The control field is described in Table 235.

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 235 – 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

Table 236 – Q Sub-channel control field for DDCD

Field	Definitions
0100b	Data track, recorded uninterrupted or recorded incremental

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 CDB TIME bit is zero, this field is an LBA. If the TIME bit is one, the address is TIME. See Table 24 for format of the Absolute CD Address field.

The Track Relative CD Address field gives the current location relative to the logical beginning of the current track. If the CDB TIME bit is zero, this field is a track relative LBA. If the current block is in the pre-gap area of a track, this is a negative value, expressed as a two's-complement number. If the TIME bit is set to one, this field is the relative TIME address from the Q Sub-channel formatted according to Table 24.

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.

5.29.2.3 Media Catalog Number

When the Sub-channel format code is 02h, the data returned is the Media Catalog Number (MCN). Table 237 defines the media catalog number returned data format.

Table 237 – Media Catalog 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	MCVAL	Reserved						
5	MCN byte N1 (Most significant)							
6	MCN byte N2							
7	MCN byte N3							
...	...							
16	N12							
17	N13 (Least significant)							
18	Zero							
19	AFRAME							

Sub-channel Data Format Code shall be set to 02h.

If MCN data is found on the media, the MCVAL bit shall be set to one. If no MCN is detected on the media, the MCVAL bit shall be set to zero.

The MCN is formatted as ASCII characters and placed in byte 5 (labelled as N1) through through byte 17 (labelled as N13). Media Catalog Number may be from any block that has MCN Q Sub-channel data. See sub-clause 4.2.3.4.2. If MCVAL is zero, N1 through N13 should be filled with ASCII zeros.

The Zero field shall be filled with 00h.

AFRAME may return the frame number where the MCN was found. This shall be a value from 00h to 4Ah. All other values are reserved.

5.29.2.4 International Standard Recording Code (ISRC)

When the Sub-channel format code is 03h, the data returned is the track ISRC. This field contains the identifying number of the CDB requested track according to the ISRC standards (DIN-31-621) expressed in ASCII. Table 238 defines the Track International Standard Recording Code data format. A unique ISRC may exist for each track.

Table 238 – 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	TCVAL	Reserved						
5	Country Code: I1							
6	I2							
7	Owner Code: I3							
8	I4							
9	I5							
10	Year of Recording: I6							
11	I7							
12	Serial Number: I8							
13	I9							
14	I10							
15	I11							
16	I12							
17	Zero							
18	AFRAME							
19	Reserved							

Sub-channel Data Format Code shall be set to 03h.

The ADR and control fields shall be returned from the ADR and Control fields on the media.

The Track Number shall indicate the track from which the ISRC was requested.

If ISRC data is detected, the TCVAL bit shall set to one. If ISRC data is not detected, the TCVAL bit shall be set to zero.

Track ISRC data may be from any block in the specified track that has ISRC data. The ISRC is 12 characters long (represented by I1 to I12, see Table 238). ISRC data returned is encoded as ASCII characters according to the translation specified in Table 7 where:

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)

The Zero field shall filled with 00h.

AFRAME may return the frame number in that the MCN was found. This shall be a value from 00h to 4Ah. All other values are reserved.

5.29.3 Error Reporting

Recommended error reporting for the READ SUB-CHANNEL command is defined in Table 239.

Table 239 – Recommended errors for READ SUB-CHANNEL Command

Error	Reference
Deferred Errors	
General Errors	
Media Access Errors	

5.30 READ TOC/PMA/ATIP Command

The READ TOC/PMA/ATIP command requests that the Logical Unit read data from a Table of Contents, the Program Memory Area (PMA), or the Absolute Time in Pre-Grove (ATIP) from CD media, format according to CDB parameters and transfer the resulting daat to the Initiator.
For media other than CD, information may be fabricated in order to emulate a CD structure for the specific media.

Table 240 shows the Features associated with the READ TOC/PMA/ATIP command.

Table 240 – Features Associated with the READ TOC/PMA/ATIP Command

Feature Number	Feature Name	Command Requirement
001Eh	CD Read	Format Codes 0, 1, 2 and conditionally 5
001Fh	DVD Read	Format codes 0 and 1
0030h	DDCD Read	Format codes 0, 1, and 2
0103h	CD Audio External Play	Format codes 0 and 1

5.30.1 The CDB and Its Parameters

The READ TOC/PMA/ATIP command descriptor block is shown in Table 241.

Table 241 – READ TOC/PMA/ATIP Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (43h)							
1	Reserved						TIME	Reserved
2	Reserved				Format			
3	Reserved							
4	Reserved							
5	Reserved							
6	Track/Session Number							
7	(MSB) Allocation Length							
8	(LSB)							
9	Control							

When TIME is cleared to zero, the address fields in some returned data formats shall be in LBA form. When TIME is set to one, the address fields in some returned data formats shall be in TIME form. For specific cases, see .

The Format field is used to select specific returned data format. See .

The Track/Session Number field provides a method to restrict the returned of some data formats to a specific session or a track range. See .

The Allocation Length field specifies the maximum number of bytes that may be returned by the Logical Unit. An Allocation Length field of zero shall not be considered an error.

Table 242 – Format Field Values

Format Field	TIME Field	Track/Session Number	Description
0000b	Valid	Valid as a Track Number	The Track/Session Number field specifies starting track number for which the data is returned. For multi-session discs, TOC data is returned for all sessions. Track number AAh is reported only for the Lead-out area of the last complete session.
0001b	Valid	Ignored by Logical Unit	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 235.
0010b	Ignored by Logical Unit	Valid as a Session Number	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 Logical Unit shall support Q Sub-channel POINT field value of A0h, A1h, A2h, Track numbers, B0h, B1h, B2h, B3h, B4h, C0h, and C1h. See Table 236. There is no defined LBA addressing and TIME bit shall be set to one.
0011b	Ignored by Logical Unit	Ignored by Logical Unit	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 241. There is no defined LBA addressing and TIME bit shall be set to one.
0100b	Ignored by Logical Unit	Ignored by Logical Unit	This format returns ATIP data. In this format, the Track/Session Number field is reserved and shall be set to 00h. See Table 242. There is no defined LBA addressing and TIME bit shall be set to one.
0101b	Ignored by Logical Unit	Ignored by Logical Unit	This format returns CD-TEXT information that is recorded in the Lead-in area as R-W Sub-channel Data.
0110b - 1111b	Reserved		

5.30.2 Command Execution

5.30.3 Error Reporting

Recommended error reporting for the READ TOC/PMA/ATIP command is defined in Table 243.

Table 243 – Recommended errors for READ TOC/PMA/ATIP Command

Error	Reference
Deferred Errors	
General Errors	
Media Access Errors	

5.31 READ TRACK INFORMATION Command

Table 244 shows the Features associated with the READ TRACK INFORMATION command.

Table 244 – Features Associated with the READ TRACK INFORMATION Command

Feature Number	Feature Name	Command Requirement
001Dh	Multi-Read	Mandatory
0021h	Incremental Streaming Writable	Mandatory
0026h	Restricted Overwrite	Mandatory
0027h	CD-RW CAV Write	Mandatory
002Bh	DVD+R	Mandatory
002Ch	Rigid Restricted Overwrite	Mandatory
002Dh	CD Track At Once	Mandatory
002Eh	CD Mastering (both SAO and RAW)	Mandatory
002Fh	DVD-R/-RW Write	Mandatory
0031h	DDCD-R Write	Mandatory
0032h	DDCD-RW Write	Mandatory

5.31.1 The CDB and Its Parameters

The READ TRACK INFORMATION command descriptor block is shown in Table 245.

Table 245 – READ TRACK INFORMATION Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code (52h)							
1	Reserved						Address/Number Type	
2	(MSB)							
3	Logical Block Address/							
4	Track/Session Number							
5								(LSB)
6	Reserved							
7	(MSB) Allocation Length							
8								(LSB)
9	Control Byte							

5.31.2 Command Execution

If the currently mounted medium is blank, and the Logical Unit is unable to write to the medium, the Logical Unit should terminate the command with CHECK CONDITION status and set sense bytes SK/ASC/ASCQ to MEDIUM ERROR/UNKNOWN FORMAT.

5.31.3 Error Reporting

Recommended error reporting for the READ TRACK INFORMATION command is defined in Table 246.

Table 246 – Recommended errors for READ TRACK INFORMATION Command

Error	Reference
Deferred Errors	
General Errors	
Media Access Errors	

5.32 REPAIR TRACK Command

A track that has been defined for incremental writing on DVD-R/-RW may be damaged due to an incomplete ECC block at the end of written data. This may be caused by a reset issued or a power-fail condition during a write operation. The REPAIR TRACK command shall fill multiple ECC block lengths with data from beginning of the damaged sector of the ECC block and ending with a link field. The recovery is intended only to allow the track to become writable again.

The REPAIR TRACK command is optional for all MM devices. The REPAIR TRACK command is not mandatory under any Feature defined in this standard.

5.32.1 The CDB and Its Parameters

The REPAIR TRACK command descriptor block is shown in Table 247.

Table 247 – REPAIR TRACK Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code (58h)							
1	Reserved							IMMED
2	Reserved							
3	Reserved							
4	(MSB)			Track Number				
5								(LSB)
6	Reserved							
7	Reserved							
8	Reserved							
9	Control							

If IMMED is zero, the requested repair operation is executed to completion prior to returning status. If IMMED is set to one, status is returned once the CDB has been validated.

The Track Number field specifies the track that requires repair.

5.32.2 Command Execution

Behavior of this command is the same as automatic repair (see the DAMAGE bit description in 5.31.2). This command causes a repair action without an explicit write of data.

5.32.3 Error Reporting

Recommended error reporting for the REPAIR TRACK command is defined in Table 248.

Table 248 – Recommended errors for REPAIR TRACK Command

Error	Reference
Deferred Errors	
General Errors	
Media Access Errors	

5.33 REPORT KEY Command

Table 249 shows the Features associated with the REPORT KEY command.

Table 249 – Features Associated with the REPORT KEY Command

Feature Number	Feature Name	Command Requirement
0106h	DVD CSS	Mandatory
010Bh	DVD CPRM	Mandatory

5.33.1 The CDB and Its Parameters

The REPORT KEY command descriptor block is shown in Table 250.

Table 250 – REPORT KEY Command Descriptor Block

Byte \ Bit	7	6	5	4	3	2	1	0
0	Operation Code (A4h)							
1	Reserved			Reserved				
2	(MSB)							
3	Logical Block Address							
4								
5								(LSB)
6	Reserved							
7	Key Class							
8	(MSB)	Allocation Length						
9								(LSB)
10	AGID		KEY Format					
11	Control							

5.33.2 Command Execution

5.33.3 Error Reporting

Recommended error reporting for the REPORT KEY command is defined in Table 251.

Table 251 – Recommended errors for REPORT KEY Command

Error	Reference
Deferred Errors	
General Errors	
Media Access Errors	

5.34 REQUEST SENSE Command

The REQUEST SENSE command requests that the Logical Unit transfer sense data to the Initatiator.

Table 252 shows the Features associated with the REQUEST SENSE command.

Table 252 – Features Associated with the REQUEST SENSE Command

Feature Number	Feature Name	Command Requirement
0001h	Core	Mandatory
0023h	Formattable	Mandatory

5.34.1 The CDB and Its Parameters

The REQUEST SENSE command descriptor block is shown in Table 253.

Table 253 – REQUEST SENSE Command Descriptor Block

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (03h)							
1	Reserved							
2	Reserved							
3	Reserved							
4	Allocation Length							
5	Control							

MM Logical Units shall be capable of returning eighteen bytes of data in response to a REQUEST SENSE command. If the allocation length is eighteen or greater, and a Logical Unit returns less than eighteen bytes of data, the Initiator should assume that the bytes not transferred would have been zeros had the Logical Unit returned those bytes. Logical Units shall not adjust the additional sense length to reflect truncation if the allocation length is less than the sense data available.

5.34.2 Command Execution

Sense data shall be available and cleared under the conditions defined in SAM-2. If the Logical Unit has no other sense data available to return, it shall set sense bytes SK/ASC to NO SENSE/NO ADDITIONAL SENSE INFORMATION. The ASCQ shall reflect the status of any background function that may be in progress. If the Logical Unit is in the standby power condition or idle power condition when a REQUEST SENSE command is received and there is no ACA or CA condition, the Logical Unit shall set sense bytes SK/ASC to NO SENSE/LOW POWER CONDITION ON. On completion of the command the Logical Unit shall return to the same power condition that was active before the REQUEST SENSE command was received. A REQUEST SENSE command shall not reset any active power condition timers.

The Logical Unit shall return CHECK CONDITION status for a REQUEST SENSE command only to report exception conditions specific to the command itself. For example:

a. An invalid field value is detected in the CDB,
b. An unrecovered parity error is detected by the service delivery subsystem, or
c. A target malfunction that prevents return of the sense data.

If a recovered error occurs during the processing of the REQUEST SENSE command, the Logical Unit shall return the sense data with GOOD status. If a Logical Unit returns CHECK CONDITION status for a REQUEST SENSE command, the sense data may be invalid.

The format of sense data is shown in Table 254.

Table 254 – Sense Data Format

Bit / Byte	7	6	5	4	3	2	1	0
0	Valid	Response Code						
1	Obsolete							
2	FileMark	EOM	ILI	Reserved	Sense Key			
3	(MSB)							
4	Information							
5								
6								(LSB)
7	Additional Sense Length (n - 7)							
8	(MSB)							
9	Command Specific Information							
10								
11								(LSB)
12	Additional Sense Code (ASC)							
13	Additional Sense Code Qualifier (ASCQ)							
14	Field Replacable Unit Code							
15	SKSV	Sense Key Specific Information						
16								
17								
18	Additional Sense Bytes							
...								
n								

5.34.2.1 Valid Bit

A Valid bit of zero indicates that the INFORMATION field is not as defined in this standard. A Valid bit of one indicates the INFORMATION field contains valid information as defined in this standard. Device servers shall implement the Valid bit.

5.34.2.2 Response Code

Response Code values are defined in Table 255.

Table 255 – Response Code

Response Code	Description
00h - 6Eh	Reserved
70h	Sense data contains Current error information.
71h	Sense data contains Deferred Error information.
72h - 7Eh	Reserved
7Fh	Sense data has a Vendor Specific format

5.34.2.3 FileMark Bit

The FileMark bit has no meaning for MM Logical Units and shall be set to zero.

5.34.2.4 EOM Bit

The EOM (End Of Medium) bit has no meaning for MM Logical Units and shall be set to zero.

5.34.2.5 ILI Bit

In MM devices, the ILI (Illegal Length Indicator) bit shall be cleared to zero except for certain error conditions associated with the READ (10) and READ (12) commands. See 5.19.2 and 5.20.2.

5.34.2.6 Sense Key

The Sense Key provides a general category for an error occurance. See .

Table 256 – Sense Key Descriptions

Sense Key	Description
0h	NO SENSE
1h	RECOVERED ERROR
2h	NOT READY
3h	MEDIUM ERROR
4h	HARDWARE ERROR
5h	ILLEGAL REQUEST
6h	UNIT ATTENTION
7h	DATA PROTECT
8h	BLANK CHECK
9h	VENDOR SPECIFIC
Ah	Reserved: MM devices do not use This Sense Key.
Bh	COMMAND ABORTED
Ch	Reserved: MM devices do not use This Sense Key.
Dh	Reserved: MM devices do not use This Sense Key.
Eh	Reserved: MM devices do not use This Sense Key.
Fh	Reserved: MM devices do not use This Sense Key.

5.34.2.7 Information

5.34.2.8 Additional Sense Length

5.34.2.9 Command Specific Information

5.34.2.10 Additional Sense Code

5.34.2.11 Additional Sense Code Qualifier

5.34.2.12 Field Replacable Unit Code

5.34.2.13 SKSV Bit

5.34.2.14 Sense Key Specific Information

5.34.3 Error Reporting

Recommended error reporting for the REQUEST SENSE command is defined in Table 257.

Table 257 – Recommended errors for REQUEST SENSE Command

Error	Reference
Deferred Errors	
General Errors	
Media Access Errors	

5.35 RESERVE TRACK Command

The RESERVE TRACK command allows reservation of disc space for a track.

Table 258 shows the Features associated with the RESERVE TRACK command.

Table 258 – Features Associated with the RESERVE TRACK Command

Feature Number	Feature Name	Command Requirement
0021h	Incremental Streaming Writable	Mandatory
002Bh	DVD+R	Mandatory (when Write bit is set to one)
002Dh	CD Track At Once	Mandatory
002Fh	DVD-R/-RW	Mandatory
0031h	DDCD-R Write	Mandatory
0032h	DDCD-RW Write	Mandatory

5.35.1 The CDB and Its Parameters

The RESERVE TRACK command descriptor block is shown in Table 259.

Table 259 – RESERVE TRACK 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 reservation. The actual number of blocks allocated is calculated according to the currently mounted media and may be influenced by the Write Parameters Mode Page (See 6.4). Rounding is permitted. In all cases, if Reservation Size is larger than available space, the command shall be terminated with CHECK CONDITION status and SK/ASC/ASCQ values shall be set to ILLEGAL REQUEST/INVALID PARAMETER IN CDB.

5.35.2 Command Execution

5.35.2.1 Track Reservation on CD-R/RW Media

If Reservation Size is less than 300 (4 seconds), the command shall be terminated with CHECK CONDITION status and SK/ASC/ASCQ values shall be set to ILLEGAL REQUEST/INVALID PARAMETER IN CDB.

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 Page. Table 260 specifies the PMA stop time, and Track sizing.

Table 260 – Track Reservation on CD-R/-RW Media

Write Parameters Mode Page Write Type Value	Description
Session-at-once	CHECK CONDITION status is returned and SK/ASC/ASCQ is set to ILLEGAL REQUEST/COMMAND SEQUENCE ERROR
Track-at-once	The number of user blocks specified shall be reserved. The PMA stop time shall be $PMAStart + ReservationSize + 2$.
Variable Packet	Reserve behaves as in the Track-At-Once case. The Initiator must be aware that packet linkage overheads will be taken from the user space.
Fixed Packet	Set $p = \frac{ReservationSize}{PacketSize}$ packets, where packet size is taken from the Write Parameters Page. If p is an integer, then the reservation is performed with PMA stop time set to $PMAStart + (PacketSize + 7) \bullet p - 5$. If p is not an integer, the command shall be terminated with CHECK CONDITION status and SK/ASC/ASCQ is set to ILLEGAL REQUEST/INVALID FIELD IN CDB.

5.35.2.2 Track (RZone) Reservation on DVD-R/-RW Media

Reservation Size is given as a count of 2 KB sectors. If this number is not an integral multiple of 16, then the drive shall round to the next integral multiple of 16. This is the value used by the Logical Unit. A track always begins with the first sector of an ECC block.

Table 261 – Track Reservation on DVD-R/-RW Media

Write Parameters Mode Page Write Type Value	Reserved Track Size
Disc-at-once	Reserves the number of user blocks specified. The Reserved Track shall be *ReservedTrackSize = ReservationSize*.
Incremental	Reserves the number of user blocks specified. The Reserved Track Size shall be $ReservedTrack = 16 \bullet \mathrm{Cell}\left\lceil \frac{ReservationSize + (NWA \wedge 0Fh)}{16} \right\rceil - (NWA \wedge 0Fh) + 16$ where *ReservationSize* is a value that is specified in the CDB. *NWA* is a Next Writable Address of invisible Track. ^ means mathematical AND. *+16* means BSGA

5.35.2.3 Track (Fragment) Reservation on DVD+R Media

Reservation Size is given as a count of 2 KB sectors. If this number is not an integral multiple of 16, then the drive shall round to the next integral multiple of 16. This is the value used by the Logical Unit. A track always begins with the first sector of an ECC block. A run-in ECC block shall be written between any two tracks within a session just prior to writing the first ECC block of the following track. The run-in ECC block does not belong to either the previous or the new track. If this track is the first track of a session, then no run-in block shall be allocated.

5.35.2.4 Error Reporting

Recommended error reporting for the RESERVE TRACK command is defined in Table 262.

Table 262 – Recommended errors for RESERVE TRACK Command

Error	Reference
Deferred Errors	
General Errors	
Media Access Errors	

5.36 SCAN Command

The SCAN command requests a fast-forward or fast-reverse scan operation beginning at the Scan Starting Address. The Logical Unit shall respond to this command by scanning to the end of the last audio track on the media.

Table 263 shows the Features associated with the READ SUB-CHANNEL command.

Table 263 – Features Associated with the SCAN Command

Feature Number	Feature Name	Command Requirement
0103h	CD Audio External Play	When Scan bit is set in Feature Descriptor

5.36.1 The CDB and Its Parameters

The SCAN command descriptor block is shown in Table 264.

Table 264 – SCAN Command Descriptor Block

Byte \ Bit	7	6	5	4	3	2	1	0
0	OPERATION CODE (BAh)							
1	Reserved			Direction	Reserved			RelAdr
2	(MSB) Scan Starting Address Field							
3								
4								
5								(LSB)
6	Reserved							
7	Reserved							
8	Reserved							
9	Type		Reserved					
10	Reserved							
11	Control							

If Direction is zero, the Logical Unit shall perform a fast-forward scan operation. If Direction is set to one, the Logical Unit shall perform a fast-reversed scan operation.

The RelAdr bit is not used by MM devices and shall be set to zero.

The Scan Starting Address specifies the address at which the audio scanning operation shall begin.

The Type field (

Table 265) specifies the format of the Scan Starting Address.

Table 265 – Type Field Bit Definitions

Bits 7 - 6	Address Type	Format
0 0	Logical Block Address	
0 1	Time	
1 0	Track Number	
1 1	Reserved	

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 266 below

Table 266 – 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 that the scan operation begins. This field has a range of 01h to 63h.

Scanning is a repeated play and jump operation. An example is the following implementation of forward and reverse scan: Forward scan - Play six CD-DA blocks and then jump 190 CD-DA blocks in the forward direction. Reverse Scan - play six CD-DA blocks and then jump 150 CD-DA blocks (from the last block of the six) in the reverse direction.

5.36.2 Command Execution

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 Logical Unit receives a PAUSE/RESUME command with the resume bit clear, the Logical Unit shall pause. After that, if the Logical Unit receives a PAUSE/RESUME command with the resume bit set, the Logical Unit shall resume audio play, not scan, from the address where the audio pause occurred.

If the Logical Unit receives a SCAN command during play or pause, the Logical Unit shall stop play or pause and perform Scan.

If the Logical Unit encounters a data track, it shall terminate the scan.

Upon receipt of a READ SUB-CHANNEL command during scan, the Logical Unit 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.

5.36.3 Error Reporting

Recommended error reporting for the SCAN command is defined in Table 267.

Table 267 – Recommended errors for SCAN Command

Error	Reference
Deferred Errors	
General Errors	
Media Access Errors	

5.37 SEEK (10) Command

Table 268 shows the Features associated with the SEEK (10) command.

Table 268 – Features Associated with the SEEK (10) Command

Feature Number	Feature Name	Command Requirement
0103h	CD Audio External Play	Mandatory

5.37.1 The CDB and Its Parameters

The SEEK (10) command descriptor block is shown in Table 269.

Table 269 – SEEK (10) Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code (2Bh)							
1	Reserved							
2	(MSB)							
3	Logical Block Address							
4								
5								(LSB)
6	Reserved							
7	Reserved							
8	Reserved							
9	Control Byte							

5.37.2 Command Execution

5.37.3 Error Reporting

Recommended error reporting for the SEEK (10) command is defined in Table 270.

Table 270 – Recommended errors for SEEK (10) Command

Error	Reference
Deferred Errors	
General Errors	
Media Access Errors	

5.38 SEND CUE SHEET Command

Table 271 shows the Features associated with the SEND CUE SHEET command.

Table 271 – Features Associated with the SEND CUE SHEET Command

Feature Number	Feature Name	Command Requirement
002Eh	CD Mastering (SAO)	Mandatory

5.38.1 The CDB and Its Parameters

The SEND CUE SHEET command descriptor block is shown in Table 272.

Table 272 – 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							

5.38.2 Command Execution

5.38.3 Error Reporting

Recommended error reporting for the SEND CUE SHEET command is defined in Table 273.

Table 273 – Recommended errors for SEND CUE SHEET Command

Error	Reference
Deferred Errors	
General Errors	
Media Access Errors	

5.39 SEND DVD STRUCTURE Command

Table 274 shows the Features associated with the SEND DVD STRUCTURE command.

Table 274 – Features Associated with the SEND DVD STRUCTURE Command

Feature Number	Feature Name	Command Requirement
0004h	Write Protect	Format C0h, when SPWP is set.
002Ah	DVD+RW	Format codes 05h and 30h
002Bh	DVD+R	Mandatory (when Write bit is set to one)
002Fh	DVD-R/-RW	Mandatory
010Ah	DCB	Mandatory when writable DCBs supported

5.39.1 The CDB and Its Parameters

The SEND DVD STRUCTURE command descriptor block is shown in Table 275.

Table 275 – SEND DVD STRUCTURE Command Descriptor Block

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (BFh)							
1	Reserved			Reserved				
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	Format							
8	(MSB) Structure Data Length							
9	(LSB)							
10	Reserved							
11	Control							

5.39.2 Command Execution

5.39.3 Error Reporting

Recommended error reporting for the SEND DVD STRUCTURE command is defined in Table 276.

Table 276 – Recommended errors for SEND DVD STRUCTURE Command

Error	Reference
Deferred Errors	
General Errors	
Media Access Errors	

5.40 SEND KEY Command

Table 277 shows the Features associated with the SEND KEY command.

Table 277 – Features Associated with the SEND KEY Command

Feature Number	Feature Name	Command Requirement
0106h	DVD CSS	Mandatory
010Bh	DVD CPRM	Mandatory

5.40.1 The CDB and Its Parameters

The SEND KEY command descriptor block is shown in Table 278.

Table 278 – SEND KEY Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code (A3h)							
1	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							

5.40.2 Command Execution

5.40.3 Error Reporting

Recommended error reporting for the SEND KEY command is defined in Table 279.

Table 279 – Recommended errors for SEND KEY Command

Error	Reference
Deferred Errors	
General Errors	
Media Access Errors	

5.41 SEND OPC INFORMATION Command

Table 280 shows the Features associated with the SEND OPC INFORMATION command.

Table 280 – Features Associated with the SEND OPC INFORMATION Command

Feature Number	Feature Name	Sense Command Requirement
0021h	Incremental Streaming Writable	When OPC is reported in Disc Information
002Dh	CD Track At Once	When OPC is reported in Disc Information
002Eh	CD Mastering	When OPC is reported in Disc Information

5.41.1 The CDB and Its Parameters

The SEND OPC INFORMATION command descriptor block is shown in Table 281.

Table 281 – 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							

5.41.2 Command Execution

5.41.3 Error Reporting

Recommended error reporting for the SEND OPC INFORMATION command is defined in Table 282.

Table 282 – Recommended errors for SEND OPC INFORMATION Command

Error	Reference
Deferred Errors	
General Errors	
Media Access Errors	

5.42 SET SPEED Command

The SET SPEED command provides an Initiator with a method to select a preferred physical speed for the Logical Unit.

Table 283 shows the Features associated with the SET SPEED command.

Table 283 – Features Associated with the SET SPEED Command

Feature Number	Feature Name	Command Requirement
0107h	Real-time Streaming	Optional

5.42.1 The CDB and Its Parameters

The SET SPEED command descriptor block is shown in Table 284.

Table 284 – SET SPEED Command Descriptor Block

<table>
<tr><th>Bit
Byte</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>0</td><td colspan="8">Operation Code (BBh)</td></tr>
<tr><td>1</td><td colspan="6">Reserved</td><td colspan="2">Rotational Control</td></tr>
<tr><td>2</td><td colspan="8">(MSB) Logical Unit Read Speed (Kbytes/sec)</td></tr>
<tr><td>3</td><td colspan="8">(LSB)</td></tr>
<tr><td>4</td><td colspan="8">(MSB) Logical Unit Write Speed (Kbytes/sec)</td></tr>
<tr><td>5</td><td colspan="8">(LSB)</td></tr>
<tr><td>6</td><td colspan="8">Reserved</td></tr>
<tr><td>7</td><td colspan="8">Reserved</td></tr>
<tr><td>8</td><td colspan="8">Reserved</td></tr>
<tr><td>9</td><td colspan="8">Reserved</td></tr>
<tr><td>10</td><td colspan="8">Reserved</td></tr>
<tr><td>11</td><td colspan="8">Control</td></tr>
</table>

5.42.2 Command Execution

5.42.3 Error Reporting

Recommended error reporting for the SET SPEED command is defined in Table 285.

Table 285 – Recommended errors for SET SPEED Command

Error	Reference
Deferred Errors	
General Errors	
Media Access Errors	

5.43 SET READ AHEAD Command

Table 286 shows the Features associated with the SET READ AHEAD command.

Table 286 – Features Associated with the SET READ AHEAD Command

Feature Number	Feature Name	Command Requirement
0107h	Real-time Streaming	Mandatory

5.43.1 The CDB and Its Parameters

The SET READ AHEAD command descriptor block is shown in Table 287.

Table 287 – 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								
9								(LSB)
10	Reserved							
11	Control							

5.43.2 Command Execution

5.43.3 Error Reporting

Recommended error reporting for the SET READ AHEAD command is defined in Table 288.

Table 288 – Recommended errors for SET READ AHEAD Command

Error	Reference
Deferred Errors	
General Errors	
Media Access Errors	

5.44 SET STREAMING Command

Table 289 shows the Features associated with the SET STREAMING command.

Table 289 – Features Associated with the SET STREAMING Command

Feature Number	Feature Name	Command Requirement
0107h	Real-time Streaming	Mandatory

5.44.1 The CDB and Its Parameters

The SET STREAMING command descriptor block is shown in Table 290.

Table 290 – SET STREAMING Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code (B6h)							
1	Reserved			Reserved				
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	Reserved							
8	Reserved							
9	(MSB) Parameter List Length							
10								(LSB)
11	Control							

5.44.2 Command Execution

5.44.3 Error Reporting

Recommended error reporting for the SET STREAMING command is defined in Table 291.

Table 291 – Recommended errors for SET STREAMING Command

Error	Reference
Deferred Errors	
General Errors	
Media Access Errors	

5.45 START STOP UNIT Command

Table 292 shows the Features associated with the START STOP UNIT command.

Table 292 – Features Associated with the START STOP UNIT Command

Feature Number	Feature Name	Command Requirement
0003h	Removable Medium	Mandatory
0100h	Power Management	Mandatory

5.45.1 The CDB and Its Parameters

The START STOP UNIT command descriptor block is shown in Table 293.

Table 293 – START STOP UNIT Command Descriptor Block

<table>
<tr><th>Bit
Byte</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>0</td><td colspan="8">Operation Code (1Bh)</td></tr>
<tr><td>1</td><td colspan="7">Reserved</td><td>IMMED</td></tr>
<tr><td>2</td><td colspan="8">Reserved</td></tr>
<tr><td>3</td><td colspan="8">Reserved</td></tr>
<tr><td>4</td><td colspan="4">Power Conditions</td><td colspan="2">Reserved</td><td>LoEj</td><td>Start</td></tr>
<tr><td>5</td><td colspan="8">Control</td></tr>
</table>

5.45.2 Command Execution

5.45.3 Error Reporting

5.46 STOP PLAY/SCAN Command

Table 294 shows the Features associated with the STOP PLAY/SCAN command.

Table 294 – Features Associated with the STOP PLAY/SCAN Command

Feature Number	Feature Name	Command Requirement
0103h	CD Audio External Play	Mandatory

5.46.1 The CDB and Its Parameters

The STOP PLAY/SCAN command descriptor block is shown in Table 295.

Table 295 – STOP PLAY/SCAN Command Descriptor Block

<table>
<tr><th>Bit
Byte</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>0</td><td colspan="8">Operation Code (4Eh)</td></tr>
<tr><td>1</td><td colspan="3">Reserved</td><td colspan="5">Reserved</td></tr>
<tr><td>2</td><td colspan="8">Reserved</td></tr>
<tr><td>3</td><td colspan="8">Reserved</td></tr>
<tr><td>4</td><td colspan="8">Reserved</td></tr>
<tr><td>5</td><td colspan="8">Reserved</td></tr>
<tr><td>6</td><td colspan="8">Reserved</td></tr>
<tr><td>7</td><td colspan="8">Reserved</td></tr>
<tr><td>8</td><td colspan="8">Reserved</td></tr>
<tr><td>9</td><td colspan="8">Control</td></tr>
</table>

5.46.2 Command Execution

5.46.3 Error Reporting

5.47 SYNCHRONIZE CACHE Command

Table 296 shows the Features associated with the SYNCHRONIZE CACHE command.

Table 296 – Features Associated with the SYNCHRONIZE CACHE Command

Feature Number	Feature Name	Command Requirement
0020h	Random Writable	Mandatory
0021h	Incremental Streaming Writable	Mandatory
0025h	Write Once	Mandatory
0026h	Restricted Overwrite	Mandatory
0027h	CD-RW CAV Write	Mandatory
002Bh	DVD+R	Mandatory (when Write bit is set to one)
002Ch	Rigid Restricted Overwrite	Mandatory
002Dh	CD Track At Once	Mandatory
002Eh	CD Mastering (RAW)	Mandatory

5.47.1 The CDB and Its Parameters

The SYNCHRONIZE CACHE command descriptor block is shown in Table 297.

Table 297 – SYNCHRONIZE CACHE Command Descriptor Block

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							

5.47.2 Command Execution

5.47.3 Error Reporting

5.48 TEST UNIT READY Command

The TEST UNIT READY Command provides a means to check if the Logical Unit is ready. This is not a request for a self-test.

The features associated with this command are shown in Table 298.

Table 298 – Features Associated with the TEST UNIT READY Command

Feature Number	Feature Name	Command Requirement
0001h	Core Feature	Mandatory

5.48.1 The CDB and Its Parameters

The Test Unit Ready CDB is shown in Table 299.

Table 299 – TEST UNIT READY Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code (00h)							
1	Reserved							
2	Reserved							
3	Reserved							
4	Reserved							
5	Control							

The operation code of the Test Unit Ready command is 00h. The Test Unit Ready command has no parameters. All other bytes in the CDB should be zero.

5.48.2 Command Execution

If the Logical Unit would accept an appropriate medium-access command without returning CHECK CONDITION status, this command shall return a GOOD status.

For unformatted writable media, the FORMAT UNIT Command shall be considered an appropriate medium access command.

If the Logical Unit cannot become operational or is in a state such that a Initiator action (e.g. START/STOP UNIT Command with Start = 1) is required to make the unit ready, the Logical Unit shall return CHECK CONDITION Status with a Sense Key of NOT READY.

5.48.3 Error Reporting

5.49 VERIFY (10) Command

Table 300 shows the Features associated with the VERIFY (10) command.

Table 300 – Features Associated with the VERIFY (10) Command

Feature Number	Feature Name	Command Requirement
0022h	Sector Erasable	Mandatory
0023h	Formattable	Mandatory
0028h	MRW	Mandatory
002Ch	Rigid Restricted Overwrite	Mandatory

5.49.1 The CDB and Its Parameters

The VERIFY (10) command descriptor block is shown in Table 301.

Table 301 – VERIFY (10) Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code (2Fh)							
1	Reserved			DPO	Reserved		BytChk	RELADR
2	(MSB)							
3	Logical Block Address							
4								
5								(LSB)
6	Reserved							
7	(MSB) Number of Blocks							
8								(LSB)
9	Control							

5.49.2 Command Execution

5.49.3 Error Reporting

5.50 WRITE (10) Command

Table 302 shows the Features associated with the WRITE (10) command.

Table 302 – Features Associated with the WRITE (10) Command

Feature Number	Feature Name	Command Requirement
0020h	Random Writable	Mandatory
0021h	Incremental Streaming Writable	Mandatory
0022h	Sector Erasable	Mandatory
0025h	Write Once	Mandatory
0026h	Restricted Overwrite	Mandatory
0027h	CD-RW CAV Overwrite	Mandatory
0028h	MRW	Mandatory (when Write bit is set)
002Ah	DVD+RW	Mandatory (when Write bit is set)
002Bh	DVD+R	Mandatory
002Ch	Rigid Restricted Overwrite	Mandatory
002Dh	CD Track At Once	Mandatory
002Eh	CD Mastering (both SAO and RAW)	Mandatory
002Fh	DVD-R/-RW	Mandatory
0031h	DDCD-R Write	Mandatory
0032h	DDCD-RW Write	Mandatory

5.50.1 The CDB and Its Parameters

The WRITE (10) command descriptor block is shown in Table 303.

Table 303 – WRITE (10) Command Descriptor Block

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							

5.50.2 Command Execution

5.50.3 Error Reporting

5.51 WRITE (12) Command

Table 304 shows the Features associated with the WRITE (12) command.

Table 304 – Features Associated with the WRITE (12) Command

Feature Number	Feature Name	Command Requirement
002Ah	DVD+RW	Mandatory (when Write bit is set to one)
0032h	DDCD-RW Write	Mandatory
0031h	DDCD-R Write	Mandatory
0032h	DDCD-RW Write	Mandatory
0107h	Real-time Streaming	Mandatory

5.51.1 The CDB and Its Parameters

The WRITE (12) command descriptor block is shown in Table 305.

Table 305 – WRITE (12) Command Descriptor Block

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)							
7	Transfer Length							
8								
9								(LSB)
10	Streaming	Reserved						
11	Control							

5.51.2 Command Execution

5.51.3 Error Reporting

5.52 WRITE AND VERIFY (10) Command

Table 306 shows the Features associated with the WRITE AND VERIFY (10) command.

Table 306 – Features Associated with the WRITE AND VERIFY (10) Command

Feature Number	Feature Name	Command Requirement
0020h	Random Writable	Mandatory
0025h	Write Once	Mandatory
0028h	MRW	Mandatory (when Write bit is set to one)
002Ah	DVD+RW	Mandatory (when Write bit is set to one)

5.52.1 The CDB and Its Parameters

The WRITE AND VERIFY (10) command descriptor block is shown in Table 307.

Table 307 – WRITE AND VERIFY (10) Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code (2Eh)							
1	Reserved			DPO	Reserved		BytChk	RELADR
2	(MSB)							
3	Logical Block Address							
4								
5								(LSB)
6	Reserved							
7	(MSB)	Transfer Length						
8								(LSB)
9	Control							

5.52.2 Command Execution

5.52.3 Error Reporting

5.53 WRITE BUFFER Command

The WRITE BUFFER Command is used in conjunction with the READ BUFFER Command as a diagnostic function for testing Logical Unit memory in the target device and the integrity of the service delivery subsystem. Additional modes are provided for downloading/saving microcode. This command shall not alter any medium of the Logical Unit when the data mode or the combined header and data mode is specified.

The features associated with this command are shown in Table 308.

Table 308 – Features Associated with the WRITE BUFFER Command

Feature Number	Feature Name	Command Requirement
0104h	Microcode Upgrade	Mode 111b is Mandatory

5.53.1 The CDB and Its Parameters

The WRITE BUFFER CDB is shown in Table 309.

Table 309 – WRITE BUFFER Command Descriptor Block

Byte \ Bit	7	6	5	4	3	2	1	0
0	Operation Code (3Bh)							
1	Reserved					Mode		
2	Buffer ID							
3	(MSB)							
4	Buffer Offset							
5								(LSB)
6	(MSB)							
7	Parameter List Length							
8								(LSB)
9	Control Byte							

The Mode field is a sub-command code. For specific execution details, see 5.53.2.

The meaning of the Buffer ID field is dependent upon the Mode. The vendor assigns Buffer ID codes to buffers within the Logical Unit. Buffer ID zero shall be supported. If more than one buffer is supported, additional Buffer ID codes shall be assigned contiguously, beginning with one.

When Buffer Offset is required by the Mode, it specifies the location at which data are written to the Logical Unit buffer.

When Parameter List Length is required by the Mode, it specifies the number of bytes that shall be available from the Initiator to be stored in the Buffer ID buffer beginning with Buffer Offset. The Initiator should attempt to ensure that the Parameter List Length plus the Buffer offset does not exceed the capacity of the specified buffer. The Initiator may determine the capacity of the buffer from the Buffer Capacity field in the READ BUFFER descriptor.

5.53.2 Command Execution

The function of this command and the precise meaning of Buffer ID, Buffer Offset, and Parameter List Length depend on the contents of the Mode field.

5.53.2.1 Mode 000b: Combined Header and Data

Implementing this mode is not recommended.

In this mode, data to be transferred is preceded by a four-byte header. The four-byte header consists of all reserved bytes.

The Buffer ID and the Buffer offset fields shall be zero. Parameter List Length specifies the number of bytes that shall be available from the Initiator to be stored in the buffer. This number includes four bytes of header. Thus, the data length to be stored in the Logical Unit's buffer is Parameter list length minus four. If the Parameter list length exceeds the buffer capacity, the Logical Unit shall terminate the command with CHECK CONDITION Status and set SK/ASC/ASCQ values to ILLEGAL REQUEST/PARAMETER LIST LENGTH ERROR.

5.53.2.2 Mode 001h: Vendor Specific Mode

Implementing this mode is not recommended.

In this mode, the meaning of the Buffer ID, Buffer offset, and Parameter List Length fields are not specified by this specification.

5.53.2.3 Mode 010b: Data

The Buffer ID field identifies a specific buffer within the Logical Unit. If an unsupported Buffer ID code is selected, the Logical Unit shall terminate the command with CHECK CONDITION Status and set SK/ASC/ASCQ values to ILLEGAL REQUEST/INVALID FIELD IN CDB. The Buffer Offset specifies the location at which data are written to the Logical Unit buffer. The Initiator should conform to the offset boundary requirements returned in the READ BUFFER descriptor. If the Logical Unit is unable to accept the specified Buffer offset, it shall terminate the command with CHECK CONDITION Status and set SK/ASC/ASCQ values to ILLEGAL REQUEST/INVALID FIELD IN CDB.

Parameter List Length specifies the number of bytes that shall be available from the Initiator to be stored in the buffer. If the Buffer Offset and Parameter List Length fields specify a transfer in excess of the buffer capacity, the Logical Unit shall terminate the command with CHECK CONDITION Status and set SK/ASC/ASCQ values to ILLEGAL REQUEST/INVALID FIELD IN CDB.

5.53.2.4 Mode 011b: Reserved

Mode 011b (3) is reserved. If the Logical Unit finds Mode set to 011b, it shall terminate the command with CHECK CONDITION Status and set SK/ASC/ASCQ values to ILLEGAL REQUEST/INVALID FIELD IN CDB.

5.53.2.5 Mode 100b: Download Microcode

In this mode, vendor-specific microcode or control information shall be transferred to the control memory space of the Logical Unit. After a power-cycle or reset, the device operation shall revert to a vendor-specific condition. The meanings of the Buffer ID, Buffer offset, and Parameter list length fields are not specified. It is recommended that these fields be zero-filled. In multi-Initiator systems, when the microcode download has completed successfully the Logical Unit shall generate a unit attention condition for all Initiators except the one that issued the WRITE BUFFER Command. In such cases, the ASC shall be set to MICROCODE HAS BEEN CHANGED. In all systems, the Logical Unit shall generate an Operational Change Event: Operational Event Format = Logical Unit Has Changed Operational State and Operational Report Format = Firmware Changed.

If the Logical Unit cannot accept this command due to some device condition, the Logical Unit shall terminate each WRITE BUFFER Command with this mode (100b) with CHECK CONDITION Status and set SK/ASC/ASCQ values to ILLEGAL REQUEST/COMMAND SEQUENCE ERROR.

5.53.2.6 Mode101b: Download Microcode and Save

In this mode, vendor-specific microcode or control information shall be transferred to the Logical Unit and, if the WRITE BUFFER command has completed successfully, also shall be saved in a non-volatile memory space (semiconductor, disk, or other). The downloaded code shall then be effective after each power-cycle and reset until it is supplanted in another download microcode and save operation. The meanings of the Buffer ID, Buffer offset, and Parameter list length fields are not specified by this specification and are not required to be zero-filled. When the download microcode and save command has completed successfully the Logical Unit shall generate a unit attention condition for all Initiators except the one that issued the WRITE BUFFER Command. When reporting the unit attention condition, the Logical Unit shall set the additional sense code to MICROCODE HAS BEEN CHANGED.

If the Logical Unit cannot accept this command due to some device condition, the Logical Unit shall terminate each WRITE BUFFER Command with this mode (101b) with CHECK CONDITION Status, 5/2C/00 COMMAND SEQUENCE ERROR.

5.53.2.7 Mode 110b: DownloadMicrocode with Offsets

In this mode, the Initiator may split the transfer of the vendor-specific microcode or control information over two or more WRITE BUFFER Commands. If the Logical Unit cannot accept this command because of some device condition, the Logical Unit shall terminate each WRITE BUFFER Command with this mode (110b) with CHECK CONDITION Status, 5/2C/00 COMMAND SEQUENCE ERROR.

If the last WRITE BUFFER Command of a set of one or more commands completes successfully, the microcode or control information shall be transferred to the control memory space of the Logical Unit. After a power-cycle or reset, the device shall revert to a vendor-specific condition. In this mode, the Data-Out Buffer contains vendor-specific, self-describing microcode or control information.

Since the downloaded microcode or control information may be sent using several commands, when the Logical Unit detects the last download microcode with offsets and save mode WRITE BUFFER command has been received, the Logical Unit shall perform any Logical Unit required verification of the complete set of downloaded microcode or control information prior to returning GOOD status for the last command. After the last command completes successfully the Logical Unit shall generate a unit attention condition for all Initiators except the one that issued the set of WRITE BUFFER Commands. When reporting the unit attention condition, the Logical Unit shall set the additional sense code to MICROCODE HAS BEEN CHANGED.

If the complete set of WRITE BUFFER Commands required to effect a microcode or control information change (one or more commands) are not received before a reset or power-on cycle occurs, the change shall not be effective and the new microcode or control information shall be discarded.

The Buffer ID field identifies a specific buffer within the Logical Unit. The vendor assigns Buffer ID codes to buffers within the Logical Unit. A Buffer ID value of zero shall be supported. If more than one buffer is supported, additional Buffer ID codes shall be assigned contiguously, beginning with one. If an unsupported Buffer ID code is identified, the Logical Unit shall return CHECK CONDITION Status, 5/24/00 INVALID FIELD IN CDB.

The microcode or control information are written to the Logical Unit buffer starting at the location specified by the Buffer offset. The Initiator shall send commands that conform to the offset boundary requirements (see 13.18.4, on page 352). If the Logical Unit is unable to accept the specified Buffer offset, it shall return CHECK CONDITION Status, 5/24/00 INVALID FIELD IN CDB.

The Parameter list length specifies the maximum number of bytes that shall be present in the Data-Out Buffer to be stored in the specified buffer beginning at the Buffer offset. The Initiator should attempt to ensure that the Parameter list length plus the Buffer offset does not exceed the capacity of the specified buffer. (The capacity of the buffer may be determined by the Buffer Capacity field in the READ BUFFER descriptor.) If the Buffer offset and Parameter list length fields specify a transfer in excess of the buffer capacity, the Logical Unit shall return CHECK CONDITION Status, 5/24/00 INVALID FIELD IN CDB.

5.53.2.8 Mode 111b: Download Microcode with Offsets and Save

In this mode, the Initiator may split the transfer of the vendor-specific microcode or control information over two or more WRITE BUFFER Commands. If the Logical Unit cannot accept this command because of some device condition, the Logical Unit shall terminate each mode 111b WRITE BUFFER Command with CHECK CONDITION Status, 5/2C/00 COMMAND SEQUENCE ERROR.

If the last WRITE BUFFER Command of a set of one or more commands completes successfully, the microcode or control information shall be saved in a non-volatile memory space (semiconductor, disk, or other). The saved downloaded microcode or control information shall then be effective after each power-cycle and reset until it is supplanted by another download microcode with save operation or download microcode with offsets and save operation.

In this mode, the Data-Out Buffer contains vendor-specific, self-describing microcode or control information.

Since the downloaded microcode or control information may be sent using several commands, when the Logical Unit detects the last download microcode with offsets and save mode WRITE BUFFER Command has been received, the Logical Unit shall perform any Logical Unit required verification of the complete set of downloaded microcode or control information prior to returning GOOD status for the last command. After the last command completes successfully the Logical Unit shall generate a unit attention condition for all Initiators except the one that issued the set of WRITE BUFFER Commands. When reporting the unit attention condition, the Logical Unit shall set the additional sense code to MICROCODE HAS BEEN CHANGED.

If the complete set of WRITE BUFFER Commands required to effect a microcode or control information change (one or more commands) are not received before a reset or power-on cycle occurs, the change shall not be effective and the new microcode or control information shall be discarded. The Buffer ID field identifies a specific buffer within the Logical Unit. The vendor assigns Buffer ID codes to buffers within the Logical Unit. A Buffer ID value of zero shall be supported. If more than one buffer is supported, additional Buffer ID codes shall be assigned contiguously, beginning with one. If an unsupported Buffer ID code is identified, the Logical Unit shall return CHECK CONDITION Status, 5/24/00 INVALID FIELD IN CDB.

The microcode or control information are written to the Logical Unit buffer starting at the location specified by the Buffer offset. The Initiator shall conform to the offset boundary requirements. If the Logical Unit is unable to accept the specified Buffer offset, it shall return CHECK CONDITION Status, 5/24/00 INVALID FIELD IN CDB.

The Parameter List Length specifies the number of bytes that shall be present in the Data-Out Buffer to be stored in the specified buffer beginning at the Buffer offset. The Initiator should attempt to ensure that the Parameter list length plus the Buffer offset does not exceed the capacity of the specified buffer. (The capacity of the buffer may be determined by the Buffer Capacity field in the READ BUFFER descriptor.) If the Buffer offset and Parameter list length fields specify a transfer in excess of the buffer capacity, the Logical Unit shall return CHECK CONDITION Status, 5/24/00 INVALID FIELD IN CDB.

5.53.3 Error Reporting

Table 310 describes errors that may occur during the operation of the Command or which may cause a CHECK CONDITION status to be reported.

Table 310 – WRITE BUFFER Command Errors

6 Mode Parameters for Multi-Media Devices

This clause describes the data structures used with MODE SELECT (10) and MODE SENSE (10) commands that are applicable to Multi-Media devices.

6.1 Mode Parameter List Format

A mode parameter list shall be transferred from the logical unit to the initiator during the execution of the MODE SENSE command. A mode parameter list shall be transferred from the initiator to the logical unit during the execution of the MODE SELECT command.

The mode parameter list shown in Table 311 contains a header followed by zero or more pages of variable-length.

Table 311 – Mode Parameter List

Bit / Byte	7	6	5	4	3	2	1	0
0 - 7	Mode Parameter Header							
8 - n	Page(s)							

6.1.1 Mode Parameter Header Format

The Mode Parameters Header (Table 312) contains information about subsequent mode parameter data.

Table 312 – Mode Parameters Header

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			Mode Data Length				
1								(LSB)
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	(MSB)			Block Descriptor Length = 0				
7								(LSB)

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 does not include the number of bytes in the Mode Data Length field. When using the MODE SELECT command, Mode Data Length is reserved.

6.1.2 Mode Page Format

Table 313 – 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 Parameters							
...	.							
n	.							

6.1.2.1 Parameters Savable bit (PS)

When using the MODE SENSE command, a Parameters Savable (PS) bit of one indicates that the Logical Unit can save the mode page 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.

6.1.2.2 Page Code

The Page Code field identifies the format and parameters defined for the mode page. When using the MODE SENSE command, if page code 00h (vendor specific page) is implemented, the 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 should be sent last.

6.1.2.3 Page Length

The Page Length field specifies the length in bytes of the mode parameters that follow. If, in the MODE SELECT command, the Initiator does not set this value to the value that is returned for the page by the MODE SENSE command, the Logical Unit shall terminate the command with CHECK CONDITION status and SK/ASC/ASCQ values shall be set to ILLEGAL REQUEST/INVALID FIELD IN PARAMETER LIST. The 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.

6.2 Read/Write Error Recovery Parameters Mode Page (Page Code 01h)

The Read/Write Error Recovery Parameters Mode Page (Table 314) specifies the error recovery parameters the Logical Unit shall use during any command that performs a data read or write operation from the media (e.g. READ, READ CD, WRITE, etc.).

Table 314 – Read/Write Error Recovery Parameters Mode Page Format

Bit / Byte	7	6	5	4	3	2	1	0
0	PS	Reserved	Page Code (01h)					
1	Page Length (0Ah)							
2	AWRE	ARRE	TB	RC	Reserved	PER	DTE	DCR
3	Read Retry Count							
4	Reserved							
5	Reserved							
6	Reserved							
7	Reserved							
8	Write Retry Count							
9	Reserved							
10	Reserved							
11	Reserved							

The Parameters Savable (PS) bit is defined in sub-clause 6.1.2.1.

The Page Code field shall be set to 01h, identifying the Read/Write Error Recovery Parameters Mode Page.

The Page Length shall be set to 0Ah.

If the Automatic Write Reallocation Enabled bit (AWRE) is set to one, the Logical Unit shall enable automatic reallocation of defective blocks during write operations. If AWRE bit is cleared to zero, the Logical Unit shall not perform automatic reallocation of defective data blocks during write operations. If the media format is MRW, the default value for AWRE is one (1b). Error reporting as required by the error recovery bits (EER, PER, DTE, and DCR) shall be performed only after completion of the reallocation.

If the Automatic Read Reallocation Enabled bit (ARRE) is set to one, the Logical Unit shall enable automatic reallocation of defective data blocks during read operations. If ARRE is cleared to zero, the Logical Unit shall not perform automatic reallocation of defective data blocks during read operations. All error recovery actions required by the error recovery bits (TB, EER, PER, DTE, and DCR) shall be executed. The automatic reallocation shall then be performed only if the Logical Unit successfully recovers the data. Error reporting as required by the error recovery bits shall be performed only after completion of the reallocation. The reallocation process shall present any failures that occur. When ARRE is set to one, DCR and RC shall be each cleared to zero. When media formatted as MRW is detected, the value of ARRE shall default to zero. When DVD+RW media with the Basic Format is detected, ARRE and AWRE shall default to zero and cannot be set to one by the initiator.

A transfer block (TB) bit of zero indicates that a data block that has not been successfully recovered shall not be transferred to the initiator. A TB bit of one indicates that a data block that is not recovered within the recovery limits specified shall be transferred to the initiator before CHECK CONDITION status is returned. The TB bit does not affect the action taken for recovered data.

A Read Continuous (RC) bit of one indicates 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. The Logical Unit shall assign priority to this bit over conflicting error control bits (EER, DCR, DTE, and PER) within this byte.

> Implementers Note: Fabricated data may be data already in the buffer or any other vendor-specific data. This bit may be used in image processing, audio, or video applications. A read continuous (RC) bit of zero indicates that error recovery operations that cause delays are acceptable during the data transfer. Data shall not be fabricated.

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. In order to enhance data recovery from DVD media, error correction shall always be enabled. Thus, PER shall not apply to error corrected 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 only to report when the Layered Error correction has been used to recover the data.

A Disable Transfer on Error (DTE) bit of one indicates that the Logical Unit shall terminate the data transfer to the Initiator 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. In order to enhance data recovery from DVD media, error correction shall always be enabled regardless of the setting of DCR.

The Read Retry Count field specifies the number of times that the Logical Unit shall attempt its read recovery algorithm.

The Write Retry Count field specifies the number of times that the Logical Unit shall attempt its write recovery algorithm.

An interpretation of the bits 5-0 in byte 2 for CD-ROM Logical Units is given in Table 315. An interpretation of the bits 5-0 in byte 2 for DVD-ROM Logical Units is given in Table 316.

Table 315 – CD-ROM Devices, error recovery description

Error code	Description
00h	The maximum error recovery procedures available are used. If an error occurs that 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 un-recovered 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 un-recovered data errors are reported. If an CIRC un-recovered 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 un-recovered 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 un-recovered 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 un-recovered 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.
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 un-recovered 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 that 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 un-recovered error was detected. Recovered errors are not reported.

Table 315– CD-ROM Devices, error recovery description (cont.)

Error Code	Description
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 un-recovered data errors are reported. If a CIRC un-recovered 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 un-recovered 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 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 un-recovered error was detected. Reporting un-recovered 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 un-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 MEDIUM ERROR. The information bytes give the address of the block where the un-recovered error was detected. Recovered errors are not reported.
20h	The maximum error recovery procedures available are used. If an error occurs that 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 un-recovered 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 un-recovered data errors are reported. If an CIRC un-recovered 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 un-recovered 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.

Table 315– CD-ROM Devices, error recovery description (cont.)

Error Code	Description
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 un-recovered 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 un-recovered 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.
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 un-recovered 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 un-recovered error was detected.
30h	Same as code 10h
31h	Same as code 11h
34h	Same as code 14h
35h	Same as code 15h

Notes:

1. A CIRC Recovered Data Error is defined as a block that 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.
2. A CIRC Un-recovered Data Error is defined as a block that the CIRC based error correction algorithm was unsuccessful on all read attempts up to the read retry count. Layered error correction was not used.
3. An L-EC Recovered Data Error is defined as a block that the CIRC based error correction algorithm was unsuccessful, but the layered error correction was able to correct the block within the read retry count.
4. An L-EC Un-correctable Data Error is defined as a block that could not be corrected by layered error correction within the read retry count.

Table 316 – DVD Devices, Error Recovery Description

Code	Error Recovery 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 un-recovered 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. The only possible recovered errors are when a block is automatically reassigned using ARRE.
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 correction 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.
20h	The maximum error recovery procedures available are used. If an error occurs that 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 un-recovered 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. The only possible recovered errors are when a block is automatically reassigned using ARRE.

6.3 MRW Mode Page (Page Code 03h)

The MRW Mode Page (Table 317) provides a method by which the initiator can control the special features of a MRW CD-RW Logical Unit.

Table 317 – MRW Mode Page

Byte \ Bit	7	6	5	4	3	2	1	0
0	PS	Resvd	Page Code (03h)					
1	Page Length (06h)							
2	Reserved							
3	Reserved							LBA Space
4	Reserved							
5	Reserved							
6	Reserved							
7	Reserved							

Note: This mode page may be implemented as Page Code 2Ch, a vendor unique code. Use of Page Code 2Ch is obsolete. In order to avoid compatibility problems, it is strongly recommended that both Logical Units and Initiators implement both codes.

If the currently mounted medium is a MRW disc, then the value of LBA Space defines the current address space available to the initiator. If LBA Space is cleared to 0, the Logical Unit shall reference the DMA for all LBA space reads and writes. If LBA Space is set to 1, the Logical Unit shall reference the GAA for all LBA space reads and writes.

After power-on, any reset, or a medium change, the LBA Space value shall be cleared to zero. This assures that the default LBA Space is always the DMA.

Whenever Initiator changes the LBA Space bit, the drive shall generate a Morph Event to indicate that the currency of features has changed.

All commands which refer to the LBA space of the medium is restricted to the LBA space selected by this mode page.

6.4 Write Parameters Mode Page (Page Code 05h)

The Write Parameters Mode Page (Table 318) provides parameters that are often needed in the execution of commands that write to the media. After power-on or hard reset, the Logical Unit shall assign default values according to some supported medium.

6.4.1 Applicable Media

This mode page is useful for CD-R, CD-RW (not MRW formatted), DDCD-R, DDCD-RW, DVD-R, and DVD-RW media.

For DVD-RW media, if a medium is in Sequential recording mode, usage of this mode page shall conform to descriptions for DVD-R unless otherwise specified. If a medium is in Restricted overwrite mode, this mode page shall not be used.

The values in this page do not necessarily reflect the status on a given medium.

If any parameter value is incompatible with the current medium, the Logical Unit shall terminate any write type command with CHECK CONDITION status and set SK/ASC/ASCQ values to ILLEGAL REQUEST/ILLEGAL MODE FOR THIS TRACK. Fields not required or ignored for the current medium may contain 0 for the default mode parameter value.

6.4.2 Exempted Media

The parameters specified in this mode page are not applicable to DVD-RAM, DVD+R, DVD+RW, and any media that is formatted as MRW. When any of these media is mounted and recognized by the Logical Unit, it shall set write speed and internal write parameters as needed to properly access the medium. This shall be done without initiator intervention. Furthermore, the Logical Unit shall not modify the current parameters of the Write Parameters Mode Page.

If the initiator changes the Write Parameters Mode Page, operation with the medium shall not be affected. When a CD-RW disc is mounted that does not have the MRW format and a FORMAT UNIT command is sent for the purpose of formatting the disc as MRW, the same rule applies. Specifically, the initiator is not required to set the Write Parameters Mode Page prior to sending the FORMAT UNIT command when specifying format type 24h (MRW). Furthermore, the Logical Unit shall not alter current the Write Parameters Page in performing the format.

Table 318 – Write Parameters Page

Bit / Byte	7	6	5	4	3	2	1	0
0	PS	Reserved	Page Code (05h)					
1	Page Length (32h/36h)							
2	Reserved	BUFE	LS_V	Test Write	Write Type			
3	Multi-session		FP	Copy	Track Mode			
4	Reserved				Data Block Type			
5	Link Size							
6	Reserved							
7	Reserved		Initiator Application Code					
8	Session Format							
9	Reserved							
10	(MSB)							
11	Packet Size							
12								
13								(LSB)
14	(MSB)			Audio Pause Length				
15								(LSB)
16	(MSB)							
17	...							
...	Media Catalog Number							
30	...							
31								(LSB)
32	(MSB)							
33	...							
...	International Standard Recording Code							
46	...							
47								(LSB)
48	Sub-header Byte 0							
49	Sub-header Byte 1							
50	Sub-header Byte 2							
51	Sub-header Byte 3							
52 - 55	Vendor Specific							

The Parameters Savable (PS) bit is defined in sub-clause 6.1.2.1.

The Page Code field shall be set to 05h, identifying the Write Parameters Mode Page.

The Page Length shall be set to 32h unless both the Initiator and the Logical Unit support the Vendor Specific field. In that case, Page Length shall be set to 36h.

The meaning and use of the BUFE (Buffer Under-run Free recording enable) bit is described in Table 319.

Table 319 – Use of BUFE bit

Logical Unit action with BUFE bit as applied to...		
CD-R and CD-RW	0	Buffer Under-run Free recording is disabled. When performing sequential recording and Logical Unit's write buffer becomes empty, it shall perform linking and terminate writing.
	1	Buffer Under-run Free recording is enabled for sequential recording. The Logical Unit shall perform zero-loss linking and continue writing when the buffer becomes non-empty.
DVD-RAM	0	The setting of BUFE has no meaning for DVD-RAM media and shall be ignored.
	1	
DVD-R and DVD-RW	0	
	1	

The meaning and use of the LS_V bit and the Link Size field is described in .

Logical Unit action with LS_V bit and Link Size field as applied to...		
CD-R and CD-RW	0	The Logical Unit shall view Link Size = 7.
	1	If command is MODE SELECT and Link Size is not 7, the Logical Unit shall terminate the command with CHECK CONDITION and set SK/ASC/ASCQ values to ILLEGAL REQUEST/INVALID FIELD IN PARAMETER LIST.
DVD-RAM	0	The setting of BUFE has no meaning for DVD-RAM media and shall be ignored.
	1	
DVD-R and DVD-RW	0	
	1	

If the LS_V (Link Size Valid) bit is set to one, the value in the Link Size field is valid. If the LS_V bit is cleared to zero, the Link Size field shall be assumed to contain 7.

The Link Size field specifies the Linking Loss area size in sectors. The Link Size field is valid only for Write Type "Packet/Incremental." When another Write Type is specified, the Logical Unit shall ignore both LS_V bit and Link Size field. The Logical Unit shall accept values that are valid for the Logical Unit but not valid for the current medium. If writing is attempted when an invalid Link Size is set, the Logical Unit shall generate CHECK CONDITION status and set SK/ASC/ASCQ values to ILLEGAL REQUEST/ILLEGAL MODE FOR THIS TRACK.

On CD-R/RW media the Test Write bit is valid only for Write Type 1 or 2 (Track at Once or Session at Once). On DDCD-R/RW media the Test Write bit is valid only for Write Type 1 or 2 (Track at Once or Session at Once). On DVD-R media, the Test Write bit is valid only for Write Type 0 or 2 (Incremental or Disc-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 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 320) specifies the stream type to be used during writing. Write Type values are shown in Table 320.

Table 320 – Write Type Field

Value	Definition
00h	Packet/Incremental
01h	Track-at-once
02h	Session-at-once
03h	RAW
04h - 0Fh	Reserved

Packet/Incremental - the device shall perform Packet/Incremental 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. For CD, 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. The Initiator shall 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 (this shall be a negative LBA on a blank disc).

> NOTE: In RAW record mode the Logical Unit shall not generate run-in and run-out blocks (main and Sub-channel 1 data) but shall generate and record the link block. Write Type of Track-at-once and RAW are invalid when DVD-R media is present.

The Multi-session field defines how session closure affects the opening of the next session. See Table 321.

Table 321 – Multi-session Field Definition

Multi-session Field	Action Upon Session Closure
00b	No B0 pointer. Next Session not allowed
01b	For the CD media, B0 pointer = FF:FF:FF. Next session not allowed. For the DDCD media, B0 pointer = F:FF:FF:FF. Field reserved for non-CD media
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). For DVD-R, this bit shall default to one.

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.

For DDCD, this bit shall be set to zero.

Track Mode is the Control nibble in all Mode 1 Q Sub-channel in the track. The default value of this field for DVD-R Logical Units shall be 5. The default value of this field for DDCD-R/RW Logical Units shall be 5.

Data Block Type defines both the specific data fields in a user data block and its size. The Data Block Type codes are defined in Table 322. This size is used for writing instead of the block size set in the mode select header. The default value of this field for DVD-R Logical Units shall be 8. The default value of this field for DDCD-R/RW Logical Units shall be 8.

Table 322 – Data Block Type Codes

Value	Block Size	Definition	Requirement
0	2 352	Raw data 2 352 bytes of raw data (not valid for write type = packet)	Optional
1	2 368	Raw data with P and Q Sub-channel 2 352 bytes of raw data, 16 bytes for P & Q Sub-channel (see Table 199): 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	2 448	Raw data with P-W Sub-channel appended: 2 352 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	2 448	Raw data with raw P-W Sub-channel appended: 2 352 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	2 048	Mode 1 (ISO/IEC 10149): 2 048 bytes of user data	Mandatory
9	2 336	Mode 2 (ISO/IEC 10149): 2 336 bytes of user data.	Optional
10	2 048	Mode 2 (CD-ROM XA, form 1): 2 048 bytes of user data, sub-header from write parameters.	Mandatory
11	2 056	Mode 2 (CD-ROM XA, form 1): 8 bytes of sub-header, 2 048 bytes of user data	Optional
12	2 324	Mode 2 (CD-ROM XA, form 2): 2 324 bytes of user data. Sub-header is taken from write parameters.	Optional
13	2 332	Mode 2 (CD-ROM XA, form 1, form 2, or mixed form): 8 bytes of sub-header 2 324 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.
7. Only Type 10 is valid for DDCD media.

The Initiator Application Code field typically has the value zero. When the unrestricted Use Disc bit in the Disc Information Block (**Error! Reference source not found.**) is set to one, the Initiator Application Code field shall be ignored by the device. If the Unrestricted Use Disc bit is zero, then the Initiator Application Code shall be set to the appropriate value for the medium in order that writing be allowed. An Initiator 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. For DDCD media, this is always set to 20h.

Table 323 – Session Format Codes

Session Format Codes	**Session Format**
00h	CD-DA, or CD-ROM or other data discs
10h	CD-I Disc
20h	CD-ROM XA Disc, DDCD Disc
All Other Values	Reserved

The Packet Size field, if FP bit is set to one, specifies the number of User Data Blocks per fixed packet. The Packet Size field, if FP bit is set to 0, shall be ignored. For DVD-R media, the default Packet Size shall be 16. Audio Pause Length is the number of blocks from the beginning of the track that 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) shall be written in the mode 2 Q Sub-channel in at least one out of every 100 blocks in the program area. The Initiator may include bytes 14 & 15, however, the Logical Unit shall ignore these bytes and insert the appropriate Zero and AFRAME values. When the MCN is returned to the Initiator the Media Catalog Number (MCN) is formatted as in **Error! Reference source not found.**.

The International Standard Recording Code (ISRC) is formatted as in **Error! Reference source not found.**.

For the DDCD, this field is ignored.

6.5 CD Audio Control Page (Page Code 0Eh)

The CD Audio Control Page (Table 324) sets the playback modes and output controls for subsequent PLAY AUDIO commands and any current audio playback operation.

Table 324 – CD Audio Control Page Format

Bit / Byte	7	6	5	4	3	2	1	0
0	PS	Reserved	Page Code (0Eh)					
1	Page Length (0Eh)							
2	Reserved					IMMED	SOTC	Reserved
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	Reserved							
8	Reserved				CDDA Output Port 0 Channel Selection			
9	Output Port 0 Volume Default FFh							
10	Reserved				CDDA Output Port 1 Channel Selection			
11	Output Port 1 Volume Default FFh							
12	Reserved				CDDA Output Port 2 Channel Selection			
13	Output Port 2 Volume Default 00h							
14	Reserved				CDDA Output Port 3 Channel Selection			
15	Output Port 3 Volume Default 00h							

The Parameter Savable bit is defined in sub-clause 6.1.2.1.

The Immediate Bit (IMMED) is used for information purposes only; audio play commands shall send completion status as soon as the playback operation has been started. This bit shall be set to 1.

A Stop On Track Crossing (SOTC) bit of zero indicates the 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 Logical Unit shall terminate the audio playback operation when the beginning of a following track is encountered. The default value for the SOTC bit is zero.

The CDDA Output Port Channel Selection field (Table 325) specifies the Red Book audio channels that 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 325 – CDDA Output Port Channel Selection Codes

Code	Description
0000b	Output port muted
0001b	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 326. 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 +1)/ 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 326 – Attenuation Levels for Audio

Binary Level	Attenuation
FFh	0db (0n)
F0h	-0.52
E0h	-1.12
C0h	-2.45
80h	-5.95
40h	-11.9
20h	-17.8
10h	-23.6
0Fh	-24.1
0Eh	-24.6
0Ch	-25.9
08h	-29.1
04h	-34.2
02h	-38.6
01h	-42.1
00h	Mute (Off)

6.6 Power Condition Page (Page Code 1Ah)

The power condition page (Table 327) provides the initiator with a means to control the length of time a Logical Unit delays before changing its power requirements. There are notification events to the Initiator that a Logical Unit has changed power conditions.

On the receipt of a command the Logical Unit shall adjust itself to the power condition that allows the command to execute. The timer that 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.

Table 327 – 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)							
5	Idle Timer							
6								
7								(LSB)
8	(MSB)							
9	Standby Timer							
10								
11								(LSB)

The Parameter Savable bit is defined in sub-clause 6.1.2.1.

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 the Idle Timer has a value of zero, the Logical Unit shall disable the Idle Timer.

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. If the Standby bit is zero or the Standby Timer has a value of zero, the Logical Unit shall disable the Standby Timer.

The Idle Timer field indicates the inactivity time in 100 millisecond increments that the Logical Unit shall wait before entering the Idle condition.

The Standby Timer field indicates the inactivity time in 100 millisecond increments that the Logical Unit shall wait before entering the Standby condition.

6.7 Fault / Failure Reporting Control Page (Page Code 1Ch)

The Fault / Failure Reporting Control page (Table 328) 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 exceptions when CHECK CONDITION status is reported and ASC set to FAILURE PREDICTION THRESHOLD EXCEEDED to the Initiator.

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 Initiator.

Table 328 – Fault/ Failure Reporting Control Page

Bit / Byte	7	6	5	4	3	2	1	0
0	PS	Reserved	Page Code (1Ch)					
1	Page Length (0Ah)							
2	Perf	Reserved			DExcpt	Test	Reserved	LogErr (0)
3	Reserved				MRIE			
4	(MSB) Interval Timer							
5								
6								
7								(LSB)
8	(MSB) Report Count							
9								
10								
11								(LSB)

The Parameter Savable bit is defined in sub-clause 6.1.2.1.

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.

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 MRIE field. A DExcpt bit of one indicates the Logical Unit shall disable all information exception operations. The MRIE 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 ASC 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 and set SK/ASC/ASCQ values to ILLEGAL REQUEST/INVALID FIELD IN PARAMETER LIST. A Test bit of zero shall instruct the Logical Unit not to generate any false Logical Unit failure notifications.

The log errors bit (LogErr) of zero indicates that the logging of informational exception conditions within a Logical Unit is vendor specific.

The Method of Reporting Informational Exceptions field (MRIE) (see Table 329) indicates the methods that shall be used by the Logical Unit to report informational exception conditions. The priority of reporting multiple information exceptions is vendor specific.

Table 329 – Method of Reporting Informational Exceptions 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 Per bit of the error recovery parameters mode page, by returning a CHECK CONDITION status on any command. SK shall be set to RECOVERED ERROR and the ASC 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 or FFFFFFFFh in the Interval Timer field shall indicate the timer interval is vendor specific.

The Report Count field indicates the number of times to report an informational exception condition to the Initiator. A value of zero in the Report Count field indicates there is no limit to the number of times the Logical Unit shall report an informational exception condition. The default value of this field shall be zero.

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.

6.8 Time-out and Protect Page (Page Code 1Dh)

The Time-out and Protect page (Table 330) specifies parameters that affect Logical Unit operation.

Table 330 – Time-out & Protect Page

Byte \ Bit	7	6	5	4	3	2	1	0
0	PS	Reserved	Page Code (1Dh)					
1	Page Length (08h)							
2	Reserved							
3	Reserved							
4	Reserved					TMOE	DISP	SWPP
5	Reserved							
6	(MSB) Group 1 Minimum Time-out (Seconds)							
7								(LSB)
8	(MSB) Group 2 Minimum Time-out (Seconds)							
9								(LSB)

The Parameter Savable bit is defined in sub-clause 6.1.2.1.

The Time Out Enable bit (TMOE), when set to one, indicates the time out parameters are in effect. When set to zero, indicates the command shall not time out. The default value for TMOE shall be 0.

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 default value for DISP shall be 0.

The SWPP bit provides a Software Write Protect until power has been removed and then reapplied. 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. The default value for SWPP shall be 0.

See the Time-out model for more information on the Group 1 & 2 Minimum Time-out fields.

7 Features and Profiles for Multi-Media Devices

7.1 Introduction

A Multimedia Logical Unit may look different to Initiators depending on the type of media that is currently installed. In order to provide the Initiator with information about which commands and mode pages are needed to properly utilize the Logical Unit, the GET CONFIGURATION command returns a detailed list of descriptors that describe the situational capabilities and behaviors of the Logical Unit. These descriptors are referred to as "Features" and "Profiles".

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 shall implement all of the commands and mode parameters of that Feature.

Profiles define a base set of Features for Logical Units. Logical Units that list a Profile as current shall support all Features required by that Profile, however, not all Features may be current. Logical Units may support Features in addition to those required by the Profile. A single device may implement more than one Profile, and more than one Profile may be active at any given time. All required Features might not be current, depending on the medium installed. If a Not Ready response would be given to a TEST UNIT READY command, no Profile shall be current.

7.2 FEATURES

To determine the Features supported by the Logical Unit, the Initiator shall issue a GET CONFIGURATION command (See sub-clause 5.6). In response to this GET CONFIGURATION command the Logical Unit shall respond with data as shown in Table 331. Response data consists of a header field and zero or more variable length Feature descriptors. The format of the Feature Header is shown in Table 332.

Table 331 – GET CONFIGURATION response data format

Bit / Byte	7	6	5	4	3	2	1	0
0 - 7	Feature Header							
8 - n	Feature Descriptor(s)							

Table 332 – Feature Header

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB) Data Length							
1								
2								
3								(LSB)
4	Reserved							
5	Reserved							
6	(MSB) Current Profile							
7								(LSB)

The Data Length field indicates the amount of data available given a sufficient allocation length following this field. This length shall not be truncated due to an insufficient Allocation Length. If the Data Length is greater than 65530 bytes, multiple GET CONFIGURATION commands with different Starting Feature Numbers are required for the Initiator to read all configuration data. This field is adjusted as appropriate for the given Starting Feature Number.

The Current Profile field shall indicate the Logical Unit's current Profile. The Logical Unit shall choose the most appropriate current Profile from the list of Profiles (see

Table 337) with their CurrentP bit set. If there are no Profiles currently active, this field shall contain zero.

A Feature Descriptor shall describe each Feature supported by a Logical Unit. All Feature descriptors shall be a multiple of four bytes. The Feature Descriptor(s) generic format returned is defined in Table 333. Each individual Feature description is defined in the appropriate sub-clause.

Table 333 – Feature Descriptor generic format

Byte \ Bit	7	6	5	4	3	2	1	0
0	(MSB)			Feature Code				
1								(LSB)
2	Reserved		Version				Persistent	Current
3	Additional Length							
4 - n	Feature Dependent Data							

The Feature Code field shall identify a Feature supported by the Logical Unit.

7.2.1 Version field

The Version field is reserved and shall be set to zero unless otherwise specified within the Feature Description. Future versions of a Feature shall be backward compatible; incompatible changes shall be included in a different Feature.

7.2.2 Persistent Bit

The Persistent bit, when set to zero, shall indicate that this Feature may change its current status. When set to one, shall indicate that this Feature is always active. The Logical Unit shall not set this bit to one if the Current bit is, or may become, zero.

For example, suppose that the feature is uniquely associated with a group of media types, each of which is removable. In that case, the Current bit shall become zero whenever the type of media mounted is NOT associated with the feature. For such a feature, the Persistent bit shall be set to zero.

7.2.3 Current Bit

The Current bit, when set to zero, indicates that this Feature is not currently active and that the Feature Dependent Data may not be valid. When set to one, this Feature is currently active and the Feature Dependent Data is valid.

For example, suppose that the feature is uniquely associated with a group of media types, each of which is removable. In that case, the Current bit shall become zero whenever the type of media mounted is NOT associated with the feature.

7.2.4 Additional Length Field

The Additional Length field indicates the number of Feature specific bytes that follow this header. This field shall be an integral multiple of 4.

7.2.5 Feature Codes

Features are the smallest set of commands, pages, and behavior that may be implemented. Each Feature is assigned a unique code or number to identify the Feature. Feature codes are shown in Table 334. The maximum number of Feature sets is 65536 and the Feature code value of 0000h is reserved for the list of Profiles supported by the Logical Unit.

Table 334 – Feature Codes

Feature Code	Feature Name	Description
0000h	Profile List	A list of all Profiles supported by the Logical Unit
0001h	Core	Mandatory behavior for all devices
0002h	Morphing	Ability to notify Initiator about operational changes and accept Initiator requests to prevent operational changes.
0003h	Removable Medium	The medium may be removed from the device
0004h	Write Protect	The ability to control Write Protection status
0005h - 000Fh	Reserved	
0010h	Random Readable	Read ability for storage devices with random addressing
0011h - 001Ch	Reserved	-
001Dh	Multi-Read	The Logical Unit can read all CD media types; based on OSTA MultiRead
001Eh	CD Read	The ability to read CD specific structures
001Fh	DVD Read	The ability to read DVD specific structures
0020h	Random Writable	Write support for randomly addressed writes
0021h	Incremental Streaming Writable	Write support for sequential recording
0022h	Sector erasable	Write support for erasable media and media that requires an erase pass before overwrite.
0023h	Formattable	Support for formatting of media.
0024h	Defect Management	Ability of the Logical Unit/media system to provide an apparently defect-free space.
0025h	Write Once	Write support for write once media that can be written in random order.
0026h	Restricted Overwrite	Write support for media that shall be written from Blocking boundaries only.
0027h	CD-RW CAV Write	The ability to write high speed CD-RW media
0028h	MRW	The ability to recognize and read and optionally write MRW formatted media
0029h	Reserved	-
002Ah	DVD+RW	The ability to recognize, read and optionally write DVD+RW media
002Bh	DVD+R	The ability to read DVD+R recorded media formats
002Ch	Rigid Restricted Overwrite	Write support for media that is required to be written from Blocking boundaries with length of integral multiple of Blocking size only.
002Dh	CD Track at Once	Ability to write CD with Track at Once recording
002Eh	CD Mastering	The ability to write CD with Session at Once or Raw write methods.

Table 334 – Feature Codes (cont)

Feature Code	Feature Name	Description
002Fh	DVD-R/-RW Write	The ability to write DVD specific structures
0030h	DDCD Read	The ability to read user data from DDCD blocks.
0031h	DDCD-R Write	The ability to write and read DDCD-R media.
0032h	DDCD-RW Write	The ability to write and read DDCD-RW media
0033h - 00FFh	Reserved	-
0100h	Power Management	Initiator and device directed power management
0101h	Reserved	-
0102h	Embedded Changer	Single mechanism multiple disc changer
0103h	CD Audio analog play	Ability to play audio CDs via the Logical Unit's own analog output
0104h	Microcode Upgrade	Ability for the device to accept new microcode via the interface
0105h	Time-out	Ability to respond to all commands within a specific time
0106h	DVD-CSS	Ability to perform DVD CSS/CPPM authentication and RPC
0107h	Real Time Streaming	Ability to read and write using Initiator requested performance parameters
0108h	Logical Unit serial number	The Logical Unit has a unique identifier.
0109h	Reserved	-
010Ah	Disc Control Blocks	The ability to read and/or write Disc Control Blocks
010Bh	DVD CPRM	The Logical Unit supports DVD CPRM authentication
010Ch – 01FEh	Reserved	-
01FFh	Firmware Date	Firmware creation date report
0200h – FEFFh	Reserved	-
FF00h – FFFFh	Vendor Specific	-

7.3 Feature Definitions

The following sub-clauses define the Feature sets and the commands supported by each Feature.

7.3.1 Profile List Feature (0000h)

This Feature identifies Profiles supported by the Logical Unit. The Profile List descriptor returned is defined in Table 335. Profiles are defined as collections of Features and provide a method to quickly determine the Logical Unit's type. This Feature is always current, even if none of the Profiles listed are current.

Table 335 – Profile List Descriptor Format

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			Feature Code = 0000h				
1								(LSB)
2	Reserved		Version				Persistent	Current
3	Additional Length							
4 - n	Profile Descriptor(s)							

The Feature Code field shall be set to 0000h.

The Version field is reserved and shall be set to zero. Future versions of a Feature shall be backward compatible; incompatible changes shall be included in a different Feature.

The Persistent bit shall be set to one to indicate that the reporting of the Profile list is always supported.

The Current bit shall be set to one.

The Additional Length field shall be set to ((number of Profile Descriptors) * 4).

The Profile Descriptors are shown in Table 336. All Profiles supported by the Logical Unit shall always be reported. Profile descriptors are returned in the order of preferred operation - most desirable to least desirable. E.g. a DVD-ROM that could also read CD-ROM would list the DVD-ROM Profile first and the CD-ROM Profile second.

Table 336 – Profile Descriptor

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			Profile Number				
1								(LSB)
2	Reserved							CurrentP
3	Reserved							

The Profile Number identifies a Profile the Logical Unit conforms to, see Table 337.

The CurrentP bit, when set to one, shall indicate that this Profile is currently active. If no medium is present, no Profile should be active. Multifunction devices shall select the most appropriate Profile(s), if any, to set as current. The most appropriate current Profile is also reported in the Feature Header (See Table 332).

Table 337 – Profile List

Profile Number	Profile Name	Description	Reference
0000h	Reserved	—	
0001h	Non-removable disk	Re-writable disk, capable of changing behavior	7.4.1
0002h	Removable disk	Re-writable; with removable media	0
0003h	MO Erasable	Magneto-Optical disk with sector erase capability	7.4.3
0004h	MO Write Once	Magneto-Optical write once	0
0005h	AS-MO	Advance Storage – Magneto-Optical	7.4.5
0006h – 0007h	Reserved	—	
0008h	CD-ROM	Read only Compact Disc capable	7.4.6
0009h	CD-R	Write once Compact Disc capable	7.4.7
000Ah	CD-RW	Re-writable Compact Disc capable	7.4.8
000Bh - 000Fh	Reserved	—	
0010h	DVD-ROM	Read only DVD	7.4.9
0011h	DVD-R Sequential Recording	Write once DVD using Sequential recording	7.4.10
0012h	DVD-RAM	Re-writable DVD	7.4.11
0013h	DVD-RW Restricted Overwrite	Re-recordable DVD using Restricted Overwrite	7.4.12
0014h	DVD-RW Sequential recording	Re-recordable DVD using Sequential recording	7.4.13
0015h – 0019h	Reserved	—	
001Ah	DVD+RW	DVD ReWritable	7.4.14
001Bh	DVD+R	DVD Recordable	
001Ch - 001Fh	Reserved	—	
0020h	DDCD-ROM	Read only DDCD	7.4.15
0021h	DDCD-R	Write only DDCD	0
0022h	DDCD-RW	Re-Write only DDCD	7.4.18
0023h-002Fh	Reserved	—	
0030h-FFFEh	Reserved	—	
FFFFh	Logical Units Not Conforming to a Standard Profile	The Logical Unit does not conform to any Profile.	7.4.19

7.3.2 Core Feature (0001h)

This Feature identifies a Logical Unit that supports functionality common to all devices. The Feature descriptor response data to be returned to the Initiator is defined in Table 338.

Table 338 – Core Feature Descriptor Format

Byte \ Bit	7	6	5	4	3	2	1	0
0	(MSB)			Feature Code = 0001h				
1								(LSB)
2	Reserved		Version = 0h				Persistent	Current
3				Additional Length = 4				
4	(MSB)							
5				Physical Interface Standard				
6								
7								(LSB)

The Feature Code field shall be set to 0000h.

The Version Field shall be set to 0h.

The Persistent bit shall be set to one.

The Current bit shall be set to one.

The Additional Length field shall be set to 4.

All Logical Units that conform to this standard shall implement the Core Feature set of commands specified in Table 339.

Table 339 – Core Feature Commands

Op Code	Command Description	Reference
12h	INQUIRY	
46h	GET CONFIGURATION	
4Ah	GET EVENT/STATUS NOTIFICATION	
55h	MODE SELECT (10)	
5Ah	MODE SENSE (10)	
03h	REQUEST SENSE (Note 1)	
00h	TEST UNIT READY	
Note: Logical Units shall be able to report sense to the Initiator. For transports that implement automatic delivery of Logical Unit Sense Information to the Initiator, it shall use the transport's mechanism. For other transports, the REQUEST SENSE command shall be supported.		

The Physical Interface Standard field shall be set to a value selected from Table 340.

> Note: It is possible that more than one physical interface exists between the initiator and logical unit; e.g. a 1394 to ATAPI bridge. A SCSI target device doesn't know anything but its own physical interface. That is what should be reported here.

Table 340 – Physical Interface Standard

Physical Interface Standard	Description	Application
00000000h	Unspecified	
00000001h	SCSI Family	See SCSI implementation
00000002h	ATAPI	See ATAPI implementation
00000003h	IEEE 1394 - 1995	See 1394 implementation
00000004h	IEEE 1394A	See 1394 implementation
00000005h	Fibre Channel	See Fibre Channel (FCP) Implementation
00000006h – 0000FFFEh	Reserved	
0000FFFFh	Vendor Unique	
00010000h - 0001FFFFh	Defined by INCITS	
00020000h - 0002FFFFh	Defined by SFF	
00030000h - 0003FFFFh	Defined by IEEE	
00040000h – FFFFFFFFh	Reserved	

7.3.3 Morphing Feature (0002h)

This Feature identifies the ability of the Logical Unit to notify an Initiator about operational changes and accept Initiator requests to prevent operational changes.

Support for this Feature is enabled using the PREVENT ALLOW MEDIUM REMOVAL command (Persistent Bit), and the media status is retrieved using the GET EVENT/STATUS NOTIFICATION command.

The Feature descriptor response data to be returned to the Initiator is defined in Table 341.

Table 341 – Morphing Descriptor Format

Byte \ Bit	7	6	5	4	3	2	1	0
0	(MSB)			Feature Code = 00002h				
1								(LSB)
2	Reserved		Version				Persistent	Current
3	Additional Length = 04h							
4	Reserved							ASYNC
5	Reserved							
6	Reserved							
7	Reserved							

The Feature Code field shall be set to 0002h.

The Version Field shall be set to 1h.

The Persistent bit shall be set to one.

The Current bit shall be set to one.

The Additional Length field shall be set to 4.

The ASYNC bit, when set to zero, indicates that the Logical Unit supports only the polling implementation of GET EVENT/STATUS NOTIFICATION. When set to one, indicates that the Logical Unit supports both polling and asynchronous GET EVENT/STATUS NOTIFICATION. ATAPI implementations shall set ASYNC to 1.

Logical Units that support this Feature shall implement the commands specified in Table 342.

Table 342 – Morphing Feature Commands

Op Code	Command Description	Reference
46h	GET CONFIGURATION	5.6
4Ah	GET EVENT/STATUS NOTIFICATION	5.7
1Eh	PREVENT ALLOW MEDIUM REMOVAL (with Persistent bit set to one)	5.18

7.3.4 Removable Medium Feature (0003h)

This Feature identifies a Logical Unit that has a medium that is removable. Implementing this Feature, Logical Units shall have a means of communicating to the Initiator that the user wants to eject the medium or has inserted a new medium.

The Feature descriptor response data to be returned is defined in Table 343.

Table 343 – Removable Medium Feature Descriptor Format

Byte \ Bit	7	6	5	4	3	2	1	0
0	(MSB)			Feature Code = 0003h				
1								(LSB)
2	Reserved		Version				Persistent	Current
3	Additional Length = 04h							
4	Loading Mechanism Type			Reserved	Eject	Pvnt Jmpr	Reserved	Lock
5	Reserved							
6	Reserved							
7	Reserved							

The Feature Code field shall be set to 0003h.

The Version Field shall be set to 0h.

The Persistent bit shall be set to one.

The Current bit shall be set to one.

Event Class 4 shall be supported.

The Additional Length field shall be set to 4.

The Loading Mechanism Type field (Table 344) shall be set according to the Eject bit. The Eject bit, when set to zero, indicates that the device cannot eject the medium or magazine via the normal START/STOP command with the LoEj bit set. When set to one, indicates that the device can eject the medium or magazine.

The Pvnt Jmpr bit, when set to zero, shall indicate that the Prevent Jumper is present. The Logical Unit shall power up to the allow state and locking the Logical Unit with the PREVENT ALLOW MEDIUM REMOVAL command shall not prevent insertion of the media. When set to one, the Prevent Jumper is not present. The Logical Unit shall power up to the prevent state (locked) and shall not accept new media or allow the ejection of media already loaded until a PREVENT ALLOW MEDIUM REMOVAL (allow) command is issued. The Pvnt Jmpr bit shall not change state, even if the physical jumper is added or removed during operation. Logical Units that do not have a Prevent Jumper available should set this bit to 0 to indicate that the Logical Unit behaves as described for a jumper being present.

The Lock bit, when set to zero, shall indicate that the medium cannot be locked into the Logical Unit. When set to one, shall indicate that the PREVENT ALLOW MEDIUM REMOVAL command is capable of actually locking the media into the Logical Unit.

Table 344 – Loading Mechanism Type

Loading Mechanism Type	Description
000b	Caddy/Slot type loading mechanism
001b	Tray type loading mechanism
010b	Pop-up type loading mechanism
011b	Reserved
100b	Embedded changer with individually changeable discs
101b	Embedded changer using a magazine mechanism
110b - 111b	Reserved

Logical Units that support the Removable Medium Feature shall implement the commands specified in Table 345.

Table 345 – Removable Medium Feature Commands

Op Code	Command Description	Reference
BDh	MECHANISM STATUS	5.11
1Eh	PREVENT ALLOW MEDIUM REMOVAL with the Persistent Prevent bit set to zero.	5.18
1Bh	START STOP UNIT and load eject (LOEJ) bit	5.45

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 magazine load mechanism, the slot fields shall be set to the start and end slot numbers present in the magazine.

For non-immediate GET EVENT/STATUS NOTIFICATION commands, the Initiator 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.

7.3.5 Write Protect Feature (0004h)

This Feature identifies reporting capability and changing capability for Write protection status of the Logical Unit.

The Write Protect Feature descriptor response data to be returned to the Initiator is defined in Table 346.

Table 346 – Write Protect Feature Descriptor

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			Feature Code = 0004h				
1								(LSB)
2	Reserved		Version				Persistent	Current
3	Additional Length = 04h							
4	Reserved						SPWP	SSWPP
5	Reserved							
6	Reserved							
7	Reserved							

The Feature Code field shall be set to 0004h.

The Version Field shall be set to 0h.

The Persistent bit shall be defined as in sub-clause 7.2.2.

The Current bit, when set to one, indicates that Logical Unit is capable of changing PWP status on the medium surface. This bit shall be set to zero if the Logical Unit cannot set/release the PWP status. The reporting capability of the Write Protect status is persistent and shall be supported regardless of the setting of the Current bit.

The Additional Length field shall be set to 04h.

The Supports PWP (SPWP) bit indicates that the Logical Unit supports set/release PWP status. If SPWP bit is set to one, the SEND DVD STRUCTURE command with Format = C0h shall be supported.

The Supports SWPP (SSWPP) bit indicates that the Logical Unit supports SWPP bit of Time-out & Protect Mode Page (1Dh). This bit does not affect Current bit of this Feature Descriptor. If SSWPP bit is set to one, the Logical Unit shall support SWPP bit of Time-out & Protect Mode Page.

> Note: If Logical Unit supports reporting Write Protection status but does not support changing, Logical Unit returns this Feature descriptor. But Current bit is never set to one in the descriptor.

Logical Units with installed medium that support this Feature shall implement the commands listed in

Table 347 – Write Protect Feature Commands

Op Code	Command Description	Reference
ADh	READ DVD STRUCTURE with Format code C0h, FFh	5.27
BFh	SEND DVD STRUCTURE with Format code C0h, when SPWP bit is one	5.39

7.3.6 Random Readable Feature (0010h)

This Feature identifies a Logical Unit that can read data from logical blocks specified by Logical Block Addresses. There is no requirement that the addresses, in sequences of reads, occur in any particular order.

The Feature descriptor response data to be returned to the Initiator is defined in Table 348.

Table 348 – Random Readable Feature Descriptor Format

Byte \ Bit	7	6	5	4	3	2	1	0
0	(MSB)			Feature Code = 0010h				
1								(LSB)
2	Reserved		Version				Persistent	Current
3	Additional Length = 08h							
4	(MSB)							
5				Logical Block Size				
6								
7								(LSB)
8	(MSB)			Blocking				
9								(LSB)
10	Reserved							PP
11	Reserved							

The Feature Code field shall be set to 0010h.

The Version Field shall be set to 0h.

The Persistent bit shall be defined as in sub-clause 7.2.2.

The Current bit shall be defined as in sub-clause 7.2.3.

The Additional Length field shall be set to 8.

The Logical Block Size shall be set to the number of bytes per logical block.

The Blocking field shall indicate the number of logical blocks per device readable unit. For most hard disks, this value is 1. For DVD devices, this number is 10h. Reads of any sector or sector count, shall be allowed. If there is more than one Blocking on the medium possible, the Blocking field shall be set to zero. See the READ TRACK INFORMATION command for more information.

The PP (Page Present) bit, when set to zero, shall indicate that the Read/Write Error Recovery Mode Page may not be present. When set to one, shall indicate that the Read/Write Error Recovery Mode Page is present.

If the PP bit in the Feature Descriptor is set, the TB, RC, PER, DTE, and DCR bits of the Read/Write Error Recovery Mode Page shall be supported. An Error Recovery Parameter field of 0 in the Read/Write Error Recovery Mode Page shall be supported. Support for other bits and values in the Page is optional.

Logical Units that claim the Random Readable Feature shall implement the commands specified in Table 349.

Table 349 – Random Readable Feature Commands

Op Code	Command Description	Reference
25h	READ CAPACITY	5.23
28h	READ (10)	5.19

7.3.7 Multi-Read Feature (001Dh)

The Logical Unit shall conform to the OSTA Multi-Read specification 1.00, with the exception of CD Play capability (the CD Audio Feature is not required).

The Feature descriptor response data to be returned to the Initiator is defined in Table 350.

Table 350 – Multi-Read Feature Descriptor Format

Byte \ Bit	7	6	5	4	3	2	1	0
0	(MSB)			Feature Code = 001Dh				
1								(LSB)
2	Reserved		Version				Persistent	Current
3				Additional Length = 00h				

The Feature Code field shall be set to 001Dh.

The Version Field shall be set to 0h.

The Persistent bit shall be defined as in sub-clause 7.2.2.

The Current bit shall be defined as in sub-clause 7.2.3.

The Additional Length field shall be set to 00h.

Logical Units that support the Multi-Read Feature shall implement the commands specified in Table 351

Table 351 – Multi-Read Feature Commands

Op Code	Command Description	Reference
28h	READ (10)	5.19
BEh	READ CD	5.24
51h	READ DISC INFOROMATION	5.26
52h	READ TRACK INFORMATION	5.31

7.3.8 CD Read Feature (001Eh)

This Feature identifies a Logical Unit that can read CD specific information from the media and can read user data from all types of CD blocks.

The Feature descriptor response data to be returned to the Initiator is defined in Table 352.

Table 352 – CD Read Feature Descriptor Format

Byte \ Bit	7	6	5	4	3	2	1	0
0	(MSB)			Feature Code = 001Eh				
1								(LSB)
2	Reserved		Version				Persistent	Current
3	Additional Length = 04h							
4	Reserved						C2 Flags	CD-Text
5	Reserved							
6	Reserved							
7	Reserved							

The Feature Code field shall be set to 001Eh.

The Version field shall be set to 1h.

The Persistent bit shall be defined as in sub-clause 7.2.2.

The Current bit shall be defined as in sub-clause 7.2.3.

The Additional Length field shall be set to 04h.

The C2 Flag, when set to one, indicates the Logical Unit supports the C2 Error Pointers. When set to zero the Logical Unit does not support C2 Error Pointers.

The CD-Text bit, when set to one, indicates the Logical Unit supports Format Code 5h of the READ TOC/PMA/ATIP command. When set to zero, CD-Text is not supported.

Logical Units that read CD-ROM media shall support the commands specified in Table 353.

Table 353 – CD READ Feature Commands

Op Code	Command Description	Reference
BEh	READ CD	5.24
B9h	READ CD MSF	5.25
43h	READ TOC/PMA/ATIP Supports Format codes 0h, 1h, and 2h. If the CD-TEXT bit is set to one, Format code 5h shall also be supported.	5.30

7.3.9 DVD Read Feature (001Fh)

This Feature identifies a Logical Unit that can read DVD specific information from the media.

The Feature descriptor response data to be returned to the Initiator is defined in Table 354.

Table 354 – DVD Read Feature Descriptor Format

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			Feature Code = 001Fh				
1								(LSB)
2	Reserved		Version				Persistent	Current
3	Additional Length = 00h							

The Feature Code field shall be set to 001Fh.

The Version Field shall be set to 0h.

The Persistent bit shall be defined as in sub-clause 7.2.2.

The Current bit shall be defined as in sub-clause 7.2.3.

The Additional Length field shall be set to 0.

Logical Units that read DVD-ROM media shall support the commands specified in Table 355.

Table 355 – DVD READ Feature Commands

Op Code	Command Description	Reference
18h	READ(10)	
A8h	READ(12)	
ADh	READ DVD STRUCTURE	
43h	READ TOC/PMA/ATIP	

7.3.10 Random Writable Feature (0020h)

This Feature identifies a Logical Unit that can write data to logical blocks specified by Logical Block Addresses. There is no requirement that the addresses in sequences of writes occur in any particular order.

The Feature descriptor response data to be returned to the Initiator is defined in Table 356

Table 356 – Random Writable Feature Descriptor Format

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			Feature Code = 0020h				
1								(LSB)
2	Reserved		Version				Persistent	Current
3				Additional Length = 0Ch				
4	(MSB)							
5				Last Logical Block Address				
6								
7								(LSB)
8	(MSB)							
9				Logical Block Size				
10								
11								(LSB)
12	(MSB)			Blocking				
13								(LSB)
14				Reserved				PP
15				Reserved				

The Feature Code field shall be set to 0020h.

The Version field shall be set to 1h.

The Persistent bit shall be defined as in sub-clause 7.2.2.

The Current bit shall be defined as in sub-clause 7.2.3.

The Additional Length field shall be set to 0Ch.

The Last Logical Block Address is the logical block address of the last addressable block on the medium.

The Logical Block Size field specifies the number of bytes per logical block. This value shall be the same as reported by the Random Readable Feature and the READ CAPACITY command.

The Blocking field shall indicate the number of logical blocks per writable Logical Unit. For DVD devices, this number is 10h. Writes of any sector or sector count, shall be allowed. If there is more than one Blocking on the medium possible, the Blocking field shall be set to zero. See the READ TRACK INFORMATION command for more information.

The PP (Page Present) bit, when set to zero, shall indicate that the Read/Write Error Recovery Mode Page may not be present. When set to one, shall indicate that the Read/Write Error Recovery Mode Page is present.

Logical Units that may be used as a random writable block device shall implement the commands as specified in Table 357.

Table 357 – Random Writable Feature Commands

Op Code	Command Description	Reference
25h	READ CAPACITY	5.23
2Ah	WRITE (10)	5.50
2Eh	WRITE AND VERIFY (10)	5.52
35h	SYNCHRONIZE CACHE The Immediate bit shall be supported.	5.47

7.3.11 Incremental Streaming Writable (0021h)

This Feature identifies a Logical Unit that can write data to a contiguous region, and can append data to a limited number of locations on the media. On CD media, this is known as packet recording and on DVD media it is known as Incremental Recording.

The Feature descriptor response data is defined in Table 358.

Table 358 – Incremental Streaming Writable Feature Descriptor Format

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			Feature Code = 0021h				
1								(LSB)
2	Reserved		Version				Persistent	Current
3				Additional Length				
4	(MSB)			Data Block Types Supported				
5								(LSB)
6				Reserved				BUF
7				Number of Link Sizes				
8 - n				Link Size				
n - ?				Pad				

The Feature Code field shall be set to 0021h.

The Version field is set to 1h.

The Persistent bit shall be defined as in sub-clause 7.2.2.

The Current bit shall be defined as in sub-clause 7.2.3.

The Additional Length field shall be set to 4 + (Number of Link Sizes) + (Number of Pad bytes).

The Data Type Supported field is a bit field that identifies the supported Data Type. A bit set to zero indicates the Data Type is not supported. A bit set to one indicates the Data Type is supported. Bit 0 equates to Data Type 0 and bit 15 equates to Data Type 15, etc.

The BUF bit, if set to 1, shall indicate that the Logical Unit is capable of zero loss linking.

The Number of Link Sizes shall specify the number of link sizes available for the current media. For CD and DDCD media, this field should be 1. For DVD-R, this field should be 2.

Each Link Size field shall indicate the number of logical blocks per link. Links occur on sequentially written media between independent write operations. The link size does not include any logical blocks written by the Logical Unit to satisfy the writable unit specified by the Blocking field in the Random Readable Feature. This field is 7 for CD-R and DDCD-R media, and may be 0, 1, or 16 for DVD media. Link Size fields are reported by the Logical Unit in the Logical Unit's preferred order, most desirable first.

The Pad field shall contain zeros. The number of Pad bytes shall be 4 * IP((Number of Link Sizes + 3)/4) - (Number of Link Sizes), where IP() is the integer part of the number. The Pad field is present to make the length of the Feature Descriptor a multiple of 4 bytes.

Logical Units that support this Feature shall implement the commands shown in Table 359.

Table 359 – Incremental Streaming Writable Feature Commands

Op Code	Command Description	Reference
A1h	BLANK (Note 1)	
5Bh	CLOSE TRACK/SESSION	
51h	READ DISC INFORMATION	
52h	READ TRACK INFORMATION	
53h	RESERVE TRACK	
54h	SEND OPC INFORMATION (Note 2)	
2Ah	WRITE (10)	
35h	SYNCHRONIZE CACHE	

Notes:
1. Shall be supported if either the Restricted Overwrite Feature or the Rigid Restricted Overwrite Feature is current when this feature is current. If supported, Blanking Types 000b, 001b, and 100b are mandatory for CD-RW and Blanking Types 000b and 001b mandatory for DVD-RW.

2. Shall be supported if OPC information is ever returned in the READ DISC INFORMATION return data.

Table 360 – Incremental Streaming Writable Feature Parameters

Page Code	Mode page	Reference
05h	Write Parameters	6.4

7.3.12 Sector Erasable Feature (0022h) (Obsolete)

This Feature identifies a Logical Unit that supports erasable media and media that requires an erase pass before overwrite, such as some magneto-optical technologies. This Feature does not apply to media with direct overwrite technology (i.e. CD-RW, DDCD-RW, DVD-RAM, DVD-RW and DVD+RW).

The Feature descriptor response data to be returned to the Initiator is defined in Table 361.

Table 361 – Sector Erasable Feature Descriptor Format

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			Feature Code = 0022h				
1								(LSB)
2	Reserved		Version				Persistent	Current
3				Additional Length				

The Feature Code field shall be set to 0022h.

The Version field shall be set to 0h.

The Persistent bit shall be defined as in sub-clause 7.2.2.

The Current bit shall be defined as in sub-clause 7.2.3.

The Additional Length field shall be set to 00h.

Logical Units that support this Feature shall implement the commands listed in Table 362.

Table 362 – Sector Erasable Feature Commands

Op Code	Command Description	Reference
2Ch	ERASE(10)	5.4
2Fh	VERIFY (10) (Note 1)	5.49
2Ah	WRITE (10) (Note 2)	5.50
Notes: 1. The BLKVFY bit shall be supported 2. The EBP bit shall be supported		

7.3.13 Formattable Feature (0023h)

This Feature identifies a Logical Unit that can format media into logical blocks. The Feature descriptor response data to be returned to the Initiator is defined in Table 363.

Table 363 – Formattable Feature Descriptor Format

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			Feature Code = 0023h				
1								(LSB)
2	Reserved		Version				Persistent	Current
3	Additional Length = 00h							

The Feature Code field shall be set to 0023h.

The Version field shall be set to 0h.

The Persistent bit shall be defined as in sub-clause 7.2.2.

The Current bit shall be defined as in sub-clause 7.2.3.

The Additional Length field shall be set to 0.

Logical Units that support this Feature shall implement the commands listed in Table 364.

Table 364 – Formattable Feature Commands

Op Code	Command Description	Reference
04h	FORMAT UNIT with a Format Code of 001b	5.5
23h	READ FORMAT CAPACITIES	5.28
03h	REQUEST SENSE	5.34
2Fh	VERIFY(10)	5.49

7.3.14 Defect Management Feature (0024h)

This Feature identifies a Logical Unit that shall have defect management available to provide a defect-free contiguous address space.

The Feature descriptor response data to be returned to the Initiator is defined in Table 365.

Table 365 – Defect Management Feature Descriptor Format

Byte \ Bit	7	6	5	4	3	2	1	0
0	(MSB)			Feature Code = 0024h				
1								(LSB)
2	Reserved		Version				Persistent	Current
3	Additional Length = 04h							
4	SSA	Reserved						
5	Reserved							
6	Reserved							
7	Reserved							

The Feature Code field shall be set to 0024h.

The Version Field shall be set to 1h.

The Persistent bit shall be defined as in sub-clause 7.2.2.

The Current bit shall be defined as in sub-clause 7.2.3.

The Additional Length field shall be set to 4h.

An SSA bit of one shall indicate that the Logical Unit supports the READ DVD STRUCTURE command with Format Code 0Ah (Spare Area Information).

Logical Units that support this Feature shall implement the mode pages listed in Table 366.

Table 366 – Defect Management Feature Mode Pages

Page Code	Mode Page	Reference
01h	Read/Write Error Recovery Parameters	6.2

Note: The AWRE and ARRE shall be supported if medium is Writable.

7.3.15 Write Once Feature (0025h)

This Feature identifies a Logical Unit that shall have the ability to record to any previously unrecorded logical block. The recording of logical blocks may occur in any order. Previously recorded blocks shall not be overwritten.

The Feature descriptor response data to be returned to the Initiator is defined in Table 367.

Table 367 – Write Once Feature Descriptor Format

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			Feature Code = 00025h				
1								(LSB)
2	Reserved		Version				Persistent	Current
3				Additional Length = 08h				
4	(MSB)							
5				Logical Block Size				
6								
7								(LSB)
8	(MSB)			Blocking				
9								(LSB)
10				Reserved				PP
11				Reserved				

The Feature Code field shall be set to 25h.

The Version field shall be set to 0h.

The Persistent bit shall be defined as in sub-clause 7.2.2.

The Current bit shall be defined as in sub-clause 7.2.3.

The Additional Length field shall be set to 08h.

The Logical Block Size is the number of bytes per logical block. This value shall be the same as reported by the Random Readable Feature and the READ CAPACITY command.

The Blocking field shall indicate the number of logical blocks per Logical Unit writable unit. For most hard disks, this value is 1. For DVD devices, this number is 10h. The Blocking field reported in the Feature Descriptor is for performance optimization only. A write of any sector or sector count shall be allowed.

If there is more than one Blocking on the medium possible, the Blocking field shall be set to zero. See the READ TRACK INFORMATION command for more information.

The PP (Page Present) bit, when set to zero, shall indicate that the Read/Write Error Recovery Mode Page may not be present. When set to one, shall indicate that the Read/Write Error Recovery Mode Page is present.

Logical Units that support this Feature shall implement the commands listed in Table 368.

Table 368 – Write Once Feature Commands

Op Code	Command Description	Reference
25h	READ CAPACITY	5.23
35h	SYNCHRONIZE CACHE	5.47
2Ah	WRITE(10)	5.50
2Eh	WRITE AND VERIFY (10)	5.52

Logical Units that support this Feature shall implement the mode pages listed in Table 369.

Table 369 – Write Once Feature Mode Pages

Page Code	Mode Page	Reference
01h	MM Read/Write Error Recovery Parameters	6.2

7.3.16 Restricted Overwrite Feature (0026h)

This Feature identifies a Logical Unit that shall have the ability to overwrite logical blocks only in fixed sets at a time.

The Feature descriptor response data to be returned to the Initiator is defined in Table 370.

Table 370 – Restricted Overwrite Feature Descriptor Format

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			Feature Code = 0026h				
1								(LSB)
2	Reserved		Version				Persistent	Current
3				Additional Length = 00h				

The Feature Code field shall be set to 0026h.

The Version field shall be set to 0h.

The Persistent bit shall be defined as in sub-clause 7.2.2. This bit shall be set to zero if the medium is removable.

The Current bit shall be defined as in sub-clause 7.2.3. This bit shall be set to zero if Restricted Overwrite medium is not present.

The Additional Length field shall be set to 0.

Logical Units that claim this Feature shall support the commands specified in Table 371.

Table 371 – Restricted Overwrite Feature Commands

Op Code	Command Description	Reference
25h	READ CAPACITY	5.23
51h	READ DISC INFORMATION	5.26
52h	READ TRACK INFORMATION	5.31
35h	SYNCHRONIZE CACHE	5.47
2Ah	WRITE (10)	5.50

Logical Units that claim this Feature shall support the mode pages specified in Table 372.

Table 372 – Restricted Overwrite Feature Mode Pages

Page Code	Mode Page	Reference
05h	Write Parameters	6.4

7.3.17 CD-RW Media Write Support Feature (0027h)

This Feature identifies a Logical Unit that has the ability to perform writing CD-RW media. This Feature shall not be current if CD-RW media is not mounted.

The CD-RW Media Write Support Feature descriptor response data to be returned to the Initiator is defined in Table 373.

Table 373 – CD-RW Media Write Support Feature Descriptor

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			Feature Code = 0027h				
1								(LSB)
2	Reserved		Version				Persistent	Current
3	Additional Length = 04h							
4	Reserved							
5	CD-RW media sub-type support (when Disc Type = 1)							
	Subtype7	Subtype6	Subtype5	Subtype4	Subtype3	Subtype2	Subtype1	Subtype0
6	Reserved							
7	Reserved							

The Feature Code field shall be set to 0027h.

The Version field shall be set to 0001b.

The Persistent bit shall be defined as in sub-clause 7.2.2.

The Current bit shall be defined as in sub-clause 7.2.3.

The Additional Length field shall be set to 04h.

CD-RW media is identified in the media lead-in ATIP when Disc Type = 1. The specific CD-RW media type is identified in the Disc sub-type code, a 3 bit value. Byte 5 identifies the sub-types supported by the Logical Unit. If SubtypeX = 0, then the Logical Unit does not support writing SubtypeX. If SubtypeX = 1, then the Logical Unit supports writing SubtypeX. Refer to System Description ReWritable Compact Disc Systems, part III Volume 2: CD-RW (see 2.2) for details of the specific media identified by Disc Type and Disc Sub-type codes.

Logical Units with installed medium that support this Feature shall implement the commands listed in Table 374.

Table 374 – CD-RW CAV Write Feature Commands

Op Code	Command Description	Reference
25h	READ CAPACITY	5.23
51h	READ DISK INFORMATION	5.26
52h	READ TOC/PMA/ATIP, format = 4	5.30
52h	READ TRACK INFORMATION	5.31
35h	SYNCHRONIZE CACHE	5.47
2Ah	WRITE (10)	5.50

Logical Units with installed medium that support this Feature shall implement the mode pages listed in Table 374.

Table 375 – CD-RW CAV Write Feature Mode Pages

Page Code	Mode Page	Reference
05h	Write Parameters	6.4

7.3.18 The MRW Feature (0028h)

The presence of the MRW Feature indicates that the Logical Unit is capable of reading a disc with the MRW format.

Table 376 – MRW Feature Descriptor

Byte \ Bit	7	6	5	4	3	2	1	0
0	Feature Code = 0028h							
1								
2	Reserved		Version				Persistent	Current
3	Additional Length = 4							
4	Reserved							Write
5	Reserved							
6	Reserved							
7	Reserved							

The Version field shall be set to 0.

The Persistent bit shall be defined as in sub-clause 7.2.2.

The Current bit shall be defined as in sub-clause 7.2.3.

Note: Since MRW medium is removable, Persistent is cleared to zero. When Current is cleared to zero, either no disc is mounted or the disc currently mounted is not a MRW disc. When Current is set to 1, a disc is mounted and it is a MRW disc.

The Additional Length field shall be set to 04h.

If the Write bit is cleared to zero, then no additional capability is claimed.

If the Write bit is set to one, then the Logical Unit is also capable of formatting discs in the MRW format and is capable of writing discs that have been MRW formatted. When the Write bit is set to one, then the Logical Unit shall include the Removable Disk Profile and list all features required of that profile.

Logical Units that support this feature shall implement the commands listed in Table 377.

Table 377 – MRW Feature Commands

Op Code	Command Description	Reference
25h	READ CAPACITY	5.23
4Ah	GET EVENT/STATUS NOTIFICATION	5.7
51h	READ DISK INFORMATION	5.26
28h	READ (10)	5.19

Logical Units that support this feature shall implement the mode pages listed in Table 377.

Table 378 – MRW Feature Parameters

Page Code	Parameter	Reference
03h	MRW Mode Page	6.3

Logical Units that support this feature and its write capabilities shall implement the commands listed in Table 379 in addition to the commands listed in Table 377.

Table 379 – MRW Write Feature Commands

Op Code	Command Description	Reference
5Bh	CLOSE TRACK/SESSION	5.3
04h	FORMAT UNIT	5.5
28h	WRITE (10)	5.50
2Eh	WRITE AND VERIFY (10)	5.52
2Fh	VERIFY (10)	5.49
23h	READ FORMAT CAPACITIES	5.28

7.3.19 DVD+RW Feature (002Ah)

The presence of the DVD+RW Feature indicates that the Logical Unit is capable of reading a recorded DVD+RW disc that is formatted according to *DVD+RW 4.7 Gbytes Basic Format Specifications.* The DVD+RW Feature descriptor is shown in Table 380.

Table 380 – DVD+RW Feature Descriptor

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			Feature Code = 002Ah				
1								(LSB)
2	Reserved		Version				Persistent	Current
3	Additional Length							
4	Reserved							Write
5	Reserved							Close Only
6	Reserved							
7	Reserved							

The Version field shall be set to 0h.

The Persistent bit shall be defined as in sub-clause 7.2.2.

The Current bit shall be defined as in sub-clause 7.2.3.

The Additional Length field shall be set to 04h.

This feature may be present only to represent additional capability for the DVD-ROM Profile. If the Write bit is cleared to zero, then no additional capability is claimed. A device may report this feature only when Profile 10h (DVD-ROM) is reported. No additional commands or mode parameters are required.

If the Write bit is set to one, then the Logical Unit is also capable of background formatting DVD+RW discs according to *DVD+RW 4.7 Gbytes Basic Format Specifications* and is capable of writing DVD+RW discs that have been formatted according to *DVD+RW 4.7 Gbytes Basic Format Specifications*.

If the Close Only bit is cleared to zero, then the drive supports both forms of background format stop. If the Close Only bit is set to one, then the drive supports only the read compatibility stop.

If a Logical Unit reports this feature with the Write bit is set to one, then it shall support the commands shown in Table 381.

Table 381 – Command Support Required by the DVD+RW Feature with Write

Op Code	Command Description	Reference
5Bh	CLOSE TRACK/SESSION	5.3
04h	FORMAT UNIT	5.5
BFh	SEND DVD STRUCTURE	5.39
2Ah	WRITE (10)	5.50
2Eh	WRITE AND VERIFY (10)	5.52
AAh	WRITE (12)	5.51

The Send DVD Structure Command shall support format field value 05h.

7.3.20 DVD+R Feature (002Bh)

The presence of the DVD+R Feature indicates that the drive is capable of reading a recorded DVD+R disc that is written according to *DVD+R 4.7 Gbytes Basic Format Specifications.* Specifically, this includes the capability of reading DCBs. The DVD+R Feature descriptor is shown in Table 382.

Table 382 - DVD+R Feature Descriptor

Bit / Byte	7	6	5	4	3	2	1	0
0	Feature Code = 002Bh							
1								
2	Reserved		Feature Version				Persistent	Current
3	Additional Length							
4	Reserved							Write
5	Reserved							
6	Reserved							
7	Reserved							

The Version field shall be set to 0h.

The Persistent bit shall be set to zero, indicating that this Feature may change its current status.

The Current bit, when set to zero, indicates that this Feature is not currently active and that the Feature Dependent Data may not be valid. When set to one, this Feature is currently active and the Feature Dependent Data is valid.

Note: When Current = 0, either no disc is mounted or the disc currently mounted is not a DVD+R disc. When Current = 1, a disc is mounted and it is a DVD+R disc.

The Additional Length field shall be set to 04h.

This feature may be present only to represent additional capability to the DVD-ROM Profile. If the Write bit is cleared to zero, then no additional capability is claimed. A device may report this feature only when Profile 10h (DVD-ROM) is reported. No additional commands or mode parameters are required.

If the Write bit is set to one, then the drive is also capable of writing DVD+R discs according to *DVD+R 4.7 Gbytes Basic Format Specifications.*

If a device reports this feature with the Write bit is set to one, then the drive shall support the commands shown in Table 381.

Table 383 - Command Support Required by the DVD+R Feature with Write

Op Code	Command Description	Reference
5Bh	Close Track/Session	
51h	Read Disc Information	
52h	Read Track Infomation	
53h	Reserve Track	
BFh	Send DVD Structure	
35h	Synchronize Cache	
2Ah	Write (10)	
AAh	Write (12)	

Due to the lower complexity of the DVD+R format as compared to CD-R, the DVD+R Feature does not require the use of the Write Parameters Mode Page.

Note: If the Write Parameters Mode Page is supported for other media types, the drive must accept valid mode selects to the Write Parameters Mode Page. The Initiator must be aware that the drive will always ignore the Write Parameters Mode Page when the DVD+R Feature is current.

7.3.21 Rigid Restricted Overwrite Feature (002Ch)

This Feature identifies a Logical Unit that has the ability to perform writing only on Blocking boundaries. This Feature is different from the Restricted Overwrite Feature (0026h) because each Write command is also required to end on a Blocking boundary. This Feature replaces the Random Writable Feature for Logical Units that do not perform read-modify-write operations on write requests smaller than Blocking. This Feature may be present when DVD-RW Restricted Over writable media is loaded. Logical Units with write protected media shall not have this Feature current. This Feature shall not be current if the Random Writable Feature is current. If this Feature is current, the Random Writable Feature shall not be current.

Table 384 – Rigid Restricted Overwrite Feature Descriptor Format

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			Feature Code = 002Ch				
1								(LSB)
2	Reserved		Version				Persistent	Current
3				Additional Length = 04h				
4	Reserved				DSDG	DSDR	Inter-mediate	Blank
5				Reserved				
6				Reserved				
7				Reserved				

The Feature Code field shall be set to 002Ch.

The Version field shall be set to 0h.

The Persistent bit shall be defined as in sub-clause 7.2.2.

The Current bit shall be defined as in sub-clause 7.2.3.

The Additional Length field shall be set to 04h.

The Defect Status Data Generate (DSDG) bit, if set to 1, shall indicate that the Logical Unit supports to generate Defect Status data during formatting. A disable certification (DCRT) bit (Table 71) shall be supported. If DSDG is set to 0, the Logical Unit does not support generating of Defect Status Bitmap.

The Defect Status Data Read (DSDR) bit, if set to 1, shall indicate that the Logical Unit supports to read Defect Status data recorded on a medium. A disable certification (DCRT) bit (Table 71) shall be supported. If DSDR is set to 0, the Logical Unit does not support reading of Defect Status data.

The Intermediate bit, if set to 1, shall indicate that the Logical Unit supports writing on an intermediate state Session and quick formatting (Format Type of 15h - Quick Format). If Intermediate is set to 0, the Logical Unit does not support writing on an intermediate state Session and quick formatting.

The Blank bit, if set to 1, shall indicate that the Logical Unit supports BLANK command with Blanking Type 00h and 01h. If Blank is set to 0, the Logical Unit does not support BLANK command.

If more than one Track/Session is present on the media, the initiator should use the READ DISC INFORMATION and READ TRACK INFORMATION commands to obtain a description of the medium such as Blocking factor.

Writing from the initiator into the media shall be in units of Blocking. Writing shall begin and shall stop at Blocking boundaries. The writable units may be sent via multiple WRITE (10) commands. If a Write does not begin on a Blocking boundary, the Logical Unit shall return CHECK CONDITION status and set SK/ASC/ASCQ values to ILLEGAL REQUEST/INVALID ADDRESS FOR WRITE. If a Write does not end on a Blocking boundary the Logical Unit shall return CHECK CONDITION status and set SK/ASC/ASCQ values to ILLEGAL REQUEST/INVALID FIELD IN CDB.

Logical Units that support this Feature shall implement the commands identified in Table 385.

Table 385 – Rigid Restricted Overwrite Feature Commands

Op Code	Command Description	Reference
A1h	BLANK with Blanking Type = 00h, 01h (Note 1)	5.2
ACh	GET PERFORMANCE with Type =2 (Note 2)	5.8
51h	READ DISC INFORMATION	5.26
52h	READ TRACK INFORMATION	5.31
25h	READ CAPACITY	5.23
35h	SYNCHRONIZE CACHE	5.47
2Fh	VERIFY (10)	5.49
2Ah	WRITE (10)	5.50
Notes: 1. Shall be implemented if the Blank bit = 1. 2. Shall be implemented if the DSDR bit = 1.		

The Feature descriptor response data is defined in Table 384.

7.3.22 CD Track at Once Feature (002Dh)

This Feature identifies a Logical Unit that can write data to a CD track.

The Feature descriptor response data to be returned to the Initiator is defined in Table 386.

Table 386 – CD Track at Once Feature Descriptor Format

Byte \ Bit	7	6	5	4	3	2	1	0
0	(MSB)			Feature Code = 002Dh				
1								(LSB)
2	Reserved		Version = 2h				Persistent	Current
3				Additional Length = 04h				
4	Resvd	BUF	Resvd	R-W Raw	R-W Pack	Test Write	CD-RW	R-W Sub-code
5				Reserved				
6	(MSB)			Data Type Supported				
7								(LSB)

The Feature Code field shall be set to 002Dh.

The Version Field shall be set to 2h.

The Persistent bit shall be defined as in sub-clause 7.2.2.

The Current bit shall be defined as in sub-clause 7.2.3.

The Additional Length field shall be set to 04h.

The following bits indicate Feature support. If set to zero, the Feature is not supported. If set to one, the Feature is supported.

The BUF bit, if set to 1, shall indicate that the Logical Unit is capable of zero loss linking.

The R-W Raw bit, if set to 1, shall indicate that the Logical Unit supports writing R-W Sub code in the Raw mode. The R-W Sub-code bit shall be set if this bit is set.

The R-W Pack bit, if set to 1, shall indicate that the Logical Unit supports writing R-W Sub code in the Packed mode. The R-W Sub-code bit shall be set if this bit is set.

The Test Write bit indicates that the Logical Unit can perform test writes. See sub-clause 6.4. The CD-RW bit indicates support for overwriting a Track at Once track with another.

The R-W Sub-code bit indicates that the Logical Unit can record the R-W Sub-channels with user supplied data.

The Data Type Supported field is defined in sub-clause 7.3.11.

Logical Units that support this Feature shall implement the commands and Features identified in Table 387.

Table 387 – CD Track at Once Feature Commands

Op Code	Command Description	Reference
A1h	BLANK (Note 1)	5.2
5Bh	CLOSE TRACK/SESSION	5.3
51h	READ DISC INFORMATION	5.26
52h	READ TRACK INFORMATION	5.31
53h	RESERVE TRACK	5.35
54h	SEND OPC INFORMATION (Note 2)	5.41
35h	SYNCHRONIZE CACHE	5.47
2Ah	WRITE (10)	5.50
Notes: 1. Blanking Type 000b, 001b, and 100b shall be implemented if the currently mounted media is CD-RW. 2. Shall be implemented if OPC Information is returned in the READ DISC INFORMATION returned data.		

Logical Units that support this Feature shall implement the mode pages identified in .

Table 388 – CD Track at Once Feature Parameters

Page Code	Mode Page	Reference
05h	Write Parameters	6.4

7.3.23 CD Mastering (Session at Once) Feature (002Eh)

This Feature identifies a Logical Unit that can write a CD in Session at Once or Raw mode.

The Feature descriptor response data to be returned to the Initiator is defined in Table 389.

Table 389 – CD Mastering Feature Descriptor

Byte \ Bit	7	6	5	4	3	2	1	0
0	(MSB)			Feature Code = 002Eh				
1								(LSB)
2	Reserved		Version				Persistent	Current
3	Additional Length = 04h							
4	Resvd	BUF	SAO	RAW MS	RAW	TEST WRITE	CD_RW	R-W
5	(MSB)							
6				Maximum Cue Sheet Length				
7								(LSB)

The Feature Code field shall be set to 002Eh.

The Version Field shall be set to 1h.

The Persistent bit shall be defined as in sub-clause 7.2.2.

The Current bit shall be defined as in sub-clause 7.2.3.

The Additional Length field shall be set to 04h.

The following bits indicate Feature support. If set to zero, the Feature is not supported. If set to one, the Feature is supported.

The BUF bit, if set to 1, shall indicate that the Logical Unit is capable of zero loss linking.

The SAO bit shall indicate that the Logical Unit can record using the Session at Once write type.

The Raw MS bit shall indicate that the Logical Unit can record multi-session in raw mode.

The Raw bit shall indicate that the Logical Unit can record using the raw write type.

The Test Write bit shall indicate that the Logical Unit can perform test writes.

The CD-RW bit shall indicate that the Logical Unit can overwrite previously recorded data.

The R-W bit shall indicate that the Logical Unit can record the R-W Sub-channels with user supplied information.

The Maximum Cue Sheet Length field indicates the maximum length of a Cue Sheet that can be accepted by the Logical Unit for Session at Once recording. If the SAO bit is zero, this field shall be set to zero.

Logical Units that support Session at Once mastering shall implement the commands listed in Table 390.

Table 390 – CD Mastering (Session at Once) Feature Commands

Op Code	Command Description	Reference
51h	READ DISC INFORMATION	5.26
52h	READ TRACK INFORMATION	5.31
5Dh	SEND CUE SHEET	5.38
54h	SEND OPC INFORMATION (Note 1)	5.41
2Ah	WRITE (10)	5.50
Notes: 1. Shall be implemented if OPC Information is returned in the READ DISC INFORMATION returned data.		

Logical Units that support Session at Once mastering shall implement the parameters listed in Table 391.

Table 391 – CD Mastering (Session at Once) Feature Parameter

Page Code	Parameter	Reference
05h	Write Parameters – Session-At-Once Write type shall be supported.	6.4

Logical Units that support mastering in RAW mode shall implement the commands listed in Table 392.

Table 392 – CD Mastering (RAW) Feature Commands

Op-Code	Command	Reference
51h	READ DISC INFORMATION	5.26
52h	READ TRACK INFORMATION	5.31
35h	SYNCHRONIZE CACHE	5.47
2Ah	WRITE (10)	5.50

Logical Units that support mastering in RAW mode shall implement the parameters listed in Table 393.

Table 393 – CD Mastering (RAW) Feature Parameters

Page Code	Parameter	Reference
05h	Write Parameters Page • RAW Write Type shall be supported • Data Block Type 2 and 3 shall be supported when R-W bit is set to one.	6.4

7.3.24 DVD-R/-RW Write Feature (002Fh)

This Feature identifies a Logical Unit that can write data to DVD-R/-RW in Disc at Once mode.

The DVD-R/-RW Write Feature descriptor response data to be returned to the Initiator is defined in Table 394.

Table 394 – DVD-R/-RW Write Feature Descriptor Format

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			Feature Code = 002Fh				
1								(LSB)
2	Reserved		Version = 1h				Persistent	Current
3	Additional Length = 04h							
4	Reserved	BUF	Reserved			Test Write	DVD-RW	Reserved
5	Reserved							
6	Reserved							
7	Reserved							

The Feature Code field shall be set to 002Fh.

The Version Field shall be set to 1h.

The Persistent bit shall be defined as in sub-clause 7.2.2. This bit shall be set to zero if the medium is removable.

The Current bit shall be defined as in sub-clause 7.2.3. This bit shall be set to zero if DVD-R/-RW media is not present.

The Additional Length field shall be set to 04h.

The BUF bit, when set to one, indicates the Logical Unit can perform Buffer Under-run Free recording.

The Test Write bit, when set to zero, shall indicate that the Logical Unit is not capable of performing test writes. When set to one, the Logical Unit is capable of performing test writes.

The DVD-RW bit indicates support for writing and erasing on DVD-RW media. If this bit set to one, shall indicate that the Logical Unit supports BLANK command, Blanking Type 00h and 01h.

Logical Units that write and read DVD-R/-RW media shall support the commands specified in Table 395.

Table 395 – DVD-R/-RW Write Feature Commands

Op Code	Command Description	Reference
A1h	BLANK with Blanking Type 00h and 01h (Note)	5.2
51h	READ DISC INFORMATION	5.26
52h	READ TRACK INFORMATION	5.31
53h	RESERVE TRACK	5.35
BFh	SEND DVD STRUCTURE	5.39
2Ah	WRITE (10)	5.50
Note: Shall be implemented if DVD-RW bit = 1.		

Logical Units that write and read DVD-R/-RW media shall support the parameters identified in Table 396.

Table 396 – DVD-R/-RW Write Feature Parameters

Page Code	Parameter	Sub-Reference
05h	Write Parameter - Session at Once Write Type shall be supported	6.4

7.3.25 Double Density CD Read Feature (0030h)

This Feature identifies a Logical Unit that can read DDCD specific information from the media and can read user data from DDCD blocks.

The DDCD Read Feature descriptor response data to be returned to the Initiator is defined in Table 397.

Table 397 – DDCD Read Feature Descriptor Format

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			Feature Code = 0030h				
1								(LSB)
2	Reserved		Version				Persistent	Current
3				Additional Length = 00h				

The Feature Code field shall be set to 0030h.

Version shall be set to 0h.

The Persistent bit shall be defined as in sub-clause 7.2.2.

The Current bit shall be defined as in sub-clause 7.2.3.

The Additional Length field shall be set to 0h.

A Logical Unit that supports this Feature shall support the commands specified in Table 398.

Table 398 – DDCD Read Feature Commands

Op Code	Command Description	Reference
BEh	READ CD	5.24
43h	READ TOC/PMA/ATIP Supports Format codes 0h, 1h, and 2h.	5.30

7.3.26 Double Density CD-R Write Feature (0031h)

This Feature identifies a Logical Unit that can write data to DDCD-R.

The DDCD-R Write Feature descriptor response data to be returned to the Initiator is defined in Table 399.

Table 399 – DDCD-R Write Feature Descriptor Format

Bit / Byte	7	6	5	4	3	2	1	0
0	Feature Code = 0031h							
1								
2	Reserved		Version				Persistent	Current
3	Additional Length = 4							
4	Reserved					TestWR	Reserved	
5	Reserved							
6	Reserved							
7	Reserved							

The Feature Code field shall be set to 0031h.

The Version field shall be set to 0h.

The Persistent bit shall be defined as in sub-clause 7.2.2.

The Current bit shall be defined as in sub-clause 7.2.3.

The Additional Length field shall be set to 04h.

The TestWR bit, when set to zero, shall indicate that the Logical Unit is not capable of performing test writes. When set to one, the Logical Unit shall be capable of performing test writes.

A Logical Unit that writes and reads DDCD-R media shall support the commands specified in Table 400.

Table 400 – DDCD-R Write Feature Commands

Op Code	Command Description	Reference
51h	READ DISC INFORMATION	5.26
52h	READ TRACK INFORMATION	5.31
53h	RESERVE TRACK	5.35
2Ah	WRITE (10)	5.50
AAh	WRITE (12)	5.51

7.3.27 Double Density CD-RW Write Feature (0032h)

This Feature identifies a Logical Unit that can write data to DDCD-RW.

The DDCD-RW Write Feature descriptor response data to be returned to the Initiator is defined in Table 401.

Table 401 – DDCD-RW Write Feature Descriptor Format

<table>
<tr><th>Bit
Byte</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>0</td><td colspan="8">(MSB) Feature Code = 0032h</td></tr>
<tr><td>1</td><td colspan="8">(LSB)</td></tr>
<tr><td>2</td><td colspan="2">Reserved</td><td colspan="4">Version</td><td>Persistent</td><td>Current</td></tr>
<tr><td>3</td><td colspan="8">Additional Length = 4</td></tr>
<tr><td>4</td><td colspan="6">Reserved</td><td>Intermed-iate</td><td>Blank</td></tr>
<tr><td>5</td><td colspan="8">Reserved</td></tr>
<tr><td>6</td><td colspan="8">Reserved</td></tr>
<tr><td>7</td><td colspan="8">Reserved</td></tr>
</table>

The Feature Code field shall be set to 0032h.

The Version field shall be set to 0h.

The Persistent bit shall be defined as in sub-clause 7.2.2.

The Current bit shall be defined as in sub-clause 7.2.3.

The Additional Length field shall be set to 04h.

The Intermediate bit, if set to 1, shall indicate that the Logical Unit supports quick formatting (Format Type of 28h - Quick Format). If set to 0, shall indicate that the Logical Unit does not support and quick formatting.

The Blank bit, if set to 1, shall indicate that the Logical Unit supports BLANK command, Blanking Type 00h and 01h. If set to 0, shall indicate that the Logical Unit does not support BLANK command.

Logical Unit that write and read DDCD-RW media shall support the commands specified in Table 402.

Table 402 – DDCD-RW Write Feature Commands

Op Code	Command Description	Reference
51h	READ DISC INFORMATION	5.26
52h	READ TRACK INFORMATION	5.31
53h	RESERVE TRACK	5.35
2Ah	WRITE (10)	5.50
AAh	WRITE (12)	5.51

7.3.28 Power Management Feature (0100h)

This Feature identifies a Logical Unit that can perform Initiator and Logical Unit directed power management.

The Feature descriptor response data to be returned to the Initiator is defined in Table 403.

Table 403 – Power Management Feature Descriptor Format

Byte \ Bit	7	6	5	4	3	2	1	0
0	(MSB)			Feature Code = 0100h				
1								(LSB)
2	Reserved		Version				Persistent	Current
3				Additional Length = 00h				

The Feature Code field shall be set to 0100h.

The Version field shall be set to 0h.

The Persistent bit shall be set to one.

The Current bit shall be set to one.

The Additional Length field shall be set to 0.

Logical Units that support this Feature shall implement the commands specified in Table 404 and the mode parameters specified in Table 405.

Table 404 – Power Management Feature Commands

Op Code	Command Description	Reference
4Ah	GET EVENT/STATUS NOTIFICATION (Note 1)	5.7
1Bh	START STOP UNIT (Note 2)	5.45
Note: 1. Power Management Class events shall be supported 2. Power Condition field shall be supported		

Table 405 – Power Management Feature Parameters

Page Code	Page Description	Reference
1Ah	Power Condition Page	6.6

7.3.29 S.M.A.R.T. Feature (0102h)

This Feature identifies a Logical Unit that can perform Self-Monitoring Analysis and Reporting Technology. S.M.A.R.T. was developed to manage the reliability of data storage Logical Units. S.M.A.R.T.

Peripheral data storage Logical Units 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 shall not predict all future Logical Unit failures.

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.

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			Feature Code = 0101h				
1								(LSB)
2	Reserved		Version				Persistent	Current
3				Additional Length = 04h				
4				Reserved				PP
5				Reserved				
6				Reserved				
7				Reserved				

The Feature Code field shall be set to 0101h.

The Version field shall be set to 0h.

The Persistent bit shall be defined as in sub-clause 7.2.2.

The Current bit shall be defined as in sub-clause 7.2.3.

The Additional Length field shall be set to 04h.

If the Page Present (PP) bit is cleared to zero, then the Fault/Failure Reporting Mode Page (1Ch) is not supported by this Logical Unit.

If the Page Present (PP) bit is set to one, then the Fault/Failure Reporting Mode Page (1Ch) is supported by this Logical Unit.

If the Fault / Failure Reporting Mode Page is not supported the Logical Unit shall use the following default values:

1. Performance (Perf) bit shall be 0 (Delays are acceptable).
2. Enable Warning (EWasc) bit shall be 0 (Disable WARNING Sense Code reporting).
3. Disable Exception Control (DExcept) bit shall be 0 (Do not Disable reporting of exception conditions). Test bit shall be 0.
4. Method of Reporting Informational Exceptions (MRIE) shall be 4 (Unconditionally generate recovered error).
5. Interval Timer shall be set to 6 000.

7.3.30 Embedded Changer Feature (0102h)

This Feature identifies a Logical Unit that can move media from a storage area to a mechanism and back.

The Feature descriptor response data to be returned to the Initiator is defined in Table 406.

Table 406 – Embedded Changer Feature Descriptor Format

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			Feature Code = 0102h				
1								(LSB)
2	Reserved		Version				Persistent	Current
3	Additional Length = 04h							
4	Reserved			SCC	Reserved	SDP	Reserved	
5	Reserved							
6	Reserved							
7	Reserved			Highest Slot Number				

The Feature Code field shall be set to 0102h.

The Version field shall be set to 0h.

The Persistent bit shall be defined as in sub-clause 7.2.2.

The Current bit shall be defined as in sub-clause 7.2.3.

The Additional Length field shall be set to 4.

The SCC (Side Change Capable) bit, when set to zero, shall indicate that the Logical Unit is not capable of selecting both sides of the media. When set to one, shall indicate that the Logical Unit is capable of selecting both sides of the media.

The SDP (Supports Disc Present) bit, when set to zero, shall indicate that the Logical Unit cannot report the contents of the slots after a reset or magazine change. When set to one, shall indicate that the Logical Unit can report the contents of the slots after a reset or magazine change and that the response to the Mechanism Status command shall contain valid Disc is Present status information for all slots.

Highest Slot Number shall be set to the number of slots minus one.

If this Feature is current, the Removable Medium Feature shall be current. Logical Units that support an embedded changer shall implement the commands specified in Table 407.

Table 407 – Embedded Changer Feature Command

Op Code	Command Description	Reference
A6h	LOAD/UNLOAD MEDIUM	5.10
BDh	MECHANISM STATUS (Note)	5.11
Note: If Logical Unit supports Write Protect Feature (0004h), the Media Cartridge Write Protection status bits (CWP_V, CWP) of the MECHANISM STATUS command shall be supported.		

7.3.31 CD Audio External Play Feature (0103h)

This Feature identifies a Logical Unit that can play CD Audio data directly to an external output.

The Feature descriptor response data to be returned to the Initiator is defined in Table 408.

Table 408 – CD Audio External Play Feature Descriptor Format

Byte \ Bit	7	6	5	4	3	2	1	0
0	(MSB)			Feature Code = 0103h				
1								(LSB)
2	Reserved		Version				Persistent	Current
3	Additional Length = 04h							
4	Reserved					Scan	SCM	SV
5	Reserved							
6	(MSB)			Number of Volume Levels				
7								(LSB)

The Feature Code field shall be set to 0103h.

The Version field shall be set to 1h.

The Persistent bit shall be defined as in sub-clause 7.2.2.

The Current bit shall be defined as in sub-clause 7.2.3.

The Additional Length field shall be set to 4.

The Scan bit, when set to one, indicates the SCAN command is supported.

The SCM (Separate Channel Mute) bit, when set to zero, shall indicate that all audio channels are muted simultaneously.

When set to one, shall indicate that each audio channel can be independently muted.

The SV (Separate Volume) bit, when set to zero, shall indicate that all audio channels have the same volume level. When set to one, shall indicate that audio channel volume may be set independently.

The Number of Volume Levels shall indicate the number of discrete volume levels supported by the Logical Unit. If the Logical Unit supports only turning audio on and off, the Number of Volume Levels field shall be set to 2.

Logical Units that have a CD-Audio external output shall support the commands specified by Table 409 and the mode pages specified in Table 410.

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

Table 409 – CD-Audio External Play Feature Commands

OpCode	Command Description	Reference
BDh	MECHANISM STATUS	5.11
45h	PLAY AUDIO (10)	5.15
47h	PLAY AUDIO MSF	5.17
43h	READ TOC/PMA/ATIP	5.30
42h	READ SUBCHANNEL	5.29
2Bh	SEEK	5.37
4Eh	STOP PLAY/SCAN	5.46

Table 410 – CD-Audio External Play Feature Parameters

Page Code	Page Description	Reference
0Eh	CD Audio Control Page	6.5

7.3.32 Microcode Upgrade Feature (0104h)

This Feature identifies a Logical Unit that can upgrade its internal microcode via the interface. Logical Units that support microcode upgrades shall implement the commands specified in Table 411.

Table 411 – Microcode Upgrade Feature Command

Op Code	Command Description	Reference
3Ch	READ BUFFER with Mode 011b set	5.21
3Bh	WRITE BUFFER with Mode 111b (Download microcode with offset and save)	5.53

The Feature descriptor response data to be returned to the Initiator is defined in Table 412.

Table 412 – Microcode Upgrade Feature Descriptor Format

Byte \ Bit	7	6	5	4	3	2	1	0
0	(MSB)			Feature Code = 0104h				
1								(LSB)
2	Reserved		Version				Persistent	Current
3	Additional Length = 00h							

The Feature Code field shall be set to 0104h.

The Version field shall be set to 0h.

The Persistent bit shall be defined as in sub-clause 7.2.2.

The Current bit shall be defined as in sub-clause 7.2.3.

The Additional Length field shall be set to 0.

7.3.33 Time-Out Feature (0105h)

This Feature identifies a Logical Unit that can always respond to commands within a set time period. If a command cannot complete normally within the allotted time, it completes with an error.

The Feature descriptor response data to be returned to the Initiator is defined in Table 413.

Table 413 – Time-Out Feature Descriptor Format

Byte \ Bit	7	6	5	4	3	2	1	0
0	(MSB)			Feature Code = 0105h				
1								(LSB)
2	Reserved		Version				Persistent	Current
3	Additional Length = 00h							

The Feature Code field shall be set to 0105h.

The Version field shall be set to 0h.

The Persistent bit shall be defined as in sub-clause 7.2.2.

The Current bit shall be defined as in sub-clause 7.2.3.

The Additional Length field shall be set to 00h.

Logical Units that support this Feature shall support the parameters listed in Table 414.

Table 414 – Time-Out Feature Parameter

Page Code	Parameter	Reference
1Dh	Time-out and Protect Page	6.8

Logical Units that support queuing shall support Event Notification Class 6. If queuing is not supported, the current command shall be terminated with CHECK CONDITION status and SK/ASC/ASCQ values shall be set to ILLEGAL REQUEST/INSUFFICIENT TIME FOR OPERATION.

Event Notification Class 6 (Device Busy) shall be supported if queuing is supported.

7.3.34 DVD CSS Feature (0106h)

This Feature identifies a Logical Unit that can perform DVD CSS/CPPM authentication and key management. This Feature identifies Logical Units that support CSS for DVD-Video and CPPM for DVD-Audio. The Logical Unit shall maintain the integrity of the keys by only using DVD CSS authentication and key management procedures. This Feature shall be current only if a media containing CSS-protected DVD-Video and/or CPPM-protected DVD-Audio content is loaded.

The Feature descriptor response data to be returned to the Initiator is defined in Table 415.

Table 415 – DVD CSS Feature Descriptor Format

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			Feature Code 0106h				
1								(LSB)
2	Reserved		Version				Persistent	Current
3	Additional Length = 04h							
4	Reserved							
5	Reserved							
6	Reserved							
7	CSS Version							

The Feature Code field shall be set to 0106h.

The Version field shall be set to 0h.

The Persistent bit shall be defined as in sub-clause 7.2.2.

The Current bit shall be set to zero if DVD CSS/CPPM media is not present. Otherwise, this bit shall be defined as in sub-clause 7.2.3.

The Additional Length field shall be set to 4.

The CSS version shall be set to 01h.

Logical Units that support this Feature shall implement the commands specified by Table 416.

Table 416 – DVD CSS Feature Commands

Op Code	Command Description	Reference
A2h	REPORT KEY except KEY Format 010001b (Note)	5.33
A3h	SEND KEY	5.40
ADh	READ DVD STRUCTURE with Format Code 02h	5.27
Note: The KEY Format 000100b (TITLE KEY) does not succeed for CPPM protected sectors, since they do not contain a Title Key.		

7.3.35 Real Time Streaming Feature (0107h)

This Feature identifies a Logical Unit that can perform reading and writing within Initiator specified (and Logical Unit verified) performance ranges. This Feature also indicates whether the Logical Unit supports the Stream playback operation.

The Feature descriptor response data to be returned to the Initiator is defined in Table 417.

Table 417 – Real Time Streaming Feature Descriptor Format

Byte \ Bit	7	6	5	4	3	2	1	0
0	(MSB)			Feature Code = 0107h				
1								(LSB)
2	Reserved		Version				Persistent	Current
3	Additional Length =04h							
4	Reserved			RBCB	SCS	MP2A	WSPD	SW
5	Reserved							
6	Reserved							
7	Reserved							

The Feature Code field shall be set to 0107h.

The Version Field shall be set to 3h.

The Persistent bit shall be defined as in sub-clause .

The Current bit shall be defined as in sub-clause 7.2.3.

The Additional Length field shall be set to 04h.

The Read Buffer Capacity Block (RBCB) bit indicates that the Logical Unit supports the READ BUFFER CAPACITY command and its Block bit.

The Set CD Speed (SCS) bit of one indicates that the Logical Unit supports the SET CD SPEED command. Otherwise, the Logical Unit does not support the SET CD SPEED command.

The Mode Page 2A (MP2A) bit of one indicates that the MM Capabilities & Mechanical Status Mode Page (2Ah) with the Logical Unit Write Speed Performance Descriptor Blocks are supported. Otherwise, the MM Capabilities & Mechanical Status Mode Page (2Ah), with the Logical Unit Write Speed Performance Descriptor Blocks are not supported by the Logical Unit.

A Write Speed Performance Descriptor (WSPD) bit of one indicates that the Logical Unit supports the Write Speed (Type field = 03h) data of GET PERFORMANCE command and the WRC field of SET STREAMING command. This bit shall be set to one, if Logical Unit supports writing speed selection.

A Stream Writing (SW) bit of one indicates that the Logical Unit supports the Stream recording operation. A SW bit of zero indicates that the Logical Unit may not support the Stream recording operation (see 4.6.1)

Logical Units that support this Feature shall implement the commands listed in Table 418.

Table 418 – Real Time Streaming Feature Commands

Op Code	Command Description	Reference
ACh	GET PERFORMANCE with Type field of 00h, and Type field 01h when SW bit is set to one and Type field of 03h when WSPD bit is set to one	5.8
A8h	READ (12)	5.20
5Ch	READ BUFFER CAPACITY with Block bit of 1 (Note 1)	5.22
B6h	SET STREAMING (Note 2)	5.44
A7h	SET READ AHEAD	5.43
AAh	WRITE (12) with Streaming bit when SW bit is set to one	5.51
Note: 1 – Shall be implemented if RBCB set to 1 2 - WRC field of SET STREAMING command shall be supported if WSPD bit is set to one.		

7.3.36 Logical Unit Serial Number Feature (0108h)

This Feature identifies a Logical Unit that has a unique serial number. The vendor ID, model ID, and serial number can uniquely identify a Logical Unit that has this feature.

Table 419 – Logical Unit Serial Number Feature Descriptor

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			Feature Code = 0108h				
1								(LSB)
2	Reserved		Version				Persistent	Current
3	Additional Length							
4 - n	Serial Number							

The Feature Code field shall be set to 0108h.

The Version Field shall be set to 0h.

The Persistent bit shall be set to one.

The Current bit shall be set to one.

The Additional Length field shall be set to a multiple of 4.

The Serial Number shall be ASCII graphic codes (i.e. codes 20h - 7Eh). Any unused bytes in the Serial Number shall be padded with spaces (20h). There should not be more than three pad bytes.

7.3.37 Feature 010Ah: Disc Control Blocks

This Feature identifies a Logical Unit that can read and/or write Disc Control Blocks from or to the media.

Table 420 – Disc Control Blocks Feature Descriptor

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			Feature Code = 010Ah				
1								(LSB)
2	Reserved		Version				Persistent	Current
3	Additional Length							
4	(MSB)							
5				Supported DCB entry 0				
6								
7								(LSB)
n*4 + 4	(MSB)							
n*4 + 5				Supported DCB entry n				
n*4 + 6								
n*4 + 7								(LSB)

The Feature Code field shall be set to 010Ah.

The Version Field shall be set to 0h.

The Persistent bit shall be defined as in sub-clause 7.2.2.

The Current bit shall be defined as in sub-clause 7.2.3.

The Additional Length field shall be set to N * 4, where n is the number of Supported DCB entries. The Supported DCB entry n fields shall each contain the Content Descriptor of a supported DCB. Entries shall be sorted in ascending order.

Logical Units that support this Feature shall implement the commands listed in Table 421.

Table 421 – Disc Control Blocks Feature Commands

Op Code	Command Description	Reference
ADh	READ DVD STRUCTURE Format Code 30h shall be supported.	5.27
BFh	SEND DVD STRUCTURE If any DCB's are identified as writable, this command shall be supported.	5.39

7.3.38 Feature 010Bh: DVD CPRM

This Feature identifies a Logical Unit that can perform DVD CPRM and can perform CPRM authentication and key management. This Feature shall be current only if a DVD CPRM recordable or rewritable medium is loaded.

The Feature descriptor response data to be returned to the Initiator is defined in Table 422.

Table 422 – DVD CPRM Feature Descriptor Format

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			Feature Code = 010Bh				
1								(LSB)
2	Reserved		Version				Persistent	Current
3				Additional Length = 04h				
4				Reserved				
5				Reserved				
6				Reserved				
7				CPRM version				

The Feature Code field shall be set to 010Bh.

The Version Field shall be set to zero (0h).

The Persistent bit shall be defined as in sub-clause 7.2.2.

The Current bit shall be defined as in sub-clause 7.2.3.

The Additional Length field shall be set 04h.

The CPRM version field shall be set to 01h.

Logical Units that support this Feature shall implement the commands listed in Table 423.

Table 423 – DVD CPRM Feature Commands

Op Code	Command Description	Reference
A2h	REPORT KEY	5.33
A3h	SEND KEY	5.40
ADh	READ DVD STRUCTURE	5.27

7.3.39 Feature 01FFh: Firmware Information

This Feature shall indicate that the Logical Unit provides the date and time of the creation of the current firmware revision loaded on the device. The date and time shall be the date and time of creation of the firmware version. The date and time shall be GMT. The date and time shall not change for a given firmware revision. The date and time shall be later on "newer" firmware for a given device. This Feature shall be persistent and current if present. No commands are required for this Feature.

Table 424 – Firmware Information

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			Feature Code = 01FFh				
1								(LSB)
2	Reserved		Version				Persistent	Current
3				Additional Length = 0Ch				
4	(MSB)			Century				
5								(LSB)
6	(MSB)			Year				
7								(LSB)
8	(MSB)			Month				
9								(LSB)
10	(MSB)			Day				
11								(LSB)
12	(MSB)			Hour				
13								(LSB)
14	(MSB)			Minute				
15								(LSB)

Note: This feature can be used to help switch default software behavior for drives with firmware produced after a certain date.

7.4 Profile Definitions

Profiles define a base set of functions for Logical Units. Logical Units that list a Profile as current shall support all Features required by that Profile, but not all Features may be current. Logical Units may support Features in addition to those required by the Profile. A single device may implement more than one Profile, and more than one Profile may be active at any given time. All required Features may not be current, depending on the medium installed. If a Not Ready response would be given to a TEST UNIT READY command, no Profile shall be current.

For example, a Logical Unit, with unformatted media, may not be able to read or write and the corresponding Features would not be current. But the Profile corresponding to the Logical Unit/media system may be current, i.e., a DVD-RAM Logical Unit with unformatted media loaded may claim compliance to the DVD-RAM Profile; a DVD-RAM Logical Unit with no media loaded shall claim no Profile as current.

Table 337 shows the list of profiles defined in this document.

7.4.1 Profile 1h: Non-Removable Disk

Logical Units identifying Profile 1 as current shall support the Features listed in Table 425.

Table 425 – Mandatory Features for Non-removable Disks

Feature Number	Feature Name	Description
0000h	Profile List	A list of all Profiles supported by the device
0001h	Core	Basic Functionality
0010h	Random Readable, PP=1	Read ability for storage devices with random addressing.
0020h	Random Writable	Write support for randomly addressed writes
0024h	Defect Management	Ability of the Logical Unit/media system to provide an apparently defect-free space
0100h	Power Management	Initiator and device directed power management
0101h	SMART	Self Monitoring Analysis and Reporting Technology (Failure prediction)

7.4.2 Profile 2h: Removable Disk

Logical Units identifying Profile 2 as current shall support the Features listed in Table 426.

Table 426 – Mandatory Features for Removable Disks

Feature Number	Feature Name	Description
0000h	Profile List	A list of all Profiles supported by the device
0001h	Core	Basic Functionality
0002h	Morphing	The device changes its operational behavior due to external events
0003h	Removable Medium	The medium may be removed from the device
0010h	Random Readable, PP=1	Read ability for storage devices with random addressing.
0020h	Random Writable	Write support for randomly addressed writes
0023h	Formattable	Support for formatting of media
0024h	Defect Management	Ability of the Logical Unit/media system to provide an apparently defect-free space
0100h	Power Management	Initiator and device directed power management
0105h	Timeout	Ability to respond to all commands within a specific time

7.4.3 Profile 3h: Magneto-Optical Erasable

Logical Units identifying Profile 3 as current shall support the Features listed in Table 427:

Table 427 – Mandatory Features for Magneto-Optical Erasable

Feature Number	Feature Name	Description
0000h	Profile List	A list of all Profiles supported by the device
0001h	Core	Basic Functionality
0002h	Morphing	The device changes its operational behavior due to external events
0003h	Removable Medium	The medium may be removed from the device
0010h	Random Readable, PP = 1	Read ability for storage with random addressing
0020h	Random Writable	Write support for randomly addressed writes
0022h	Sector Erasable	Write support for erasable media and media that require an erase pass before overwrite.
0023h	Formattable	Support for formatting of media
0024h	Defect Management	Ability of the Logical Unit/media system to provide an apparently defect free space.
0100h	Power Management	Initiator and Logical Unit power management
0105h	Time-out	Ability to response to all commands within a specific time

7.4.4 Profile 4h: Optical Write Once

Logical Units identifying Profile 4 as current shall support the Features listed in Table 428:

Table 428 – Mandatory Features for Optical Write Once

Feature Number	Feature Name	Description
0000h	Profile List	A list of all Profiles supported by the device
0001h	Core	Basic Functionality
0002h	Morphing	The device changes its operational behavior due to external events
0003h	Removable Medium	The medium may be removed from the device
0010h	Random Readable, PP = 1	Read ability for storage with random addressing
0024h	Defect Management	Ability of the Logical Unit/media system to provide an apparently defect free space.
0025h	Write Once	Write support for write once media that can be written in random order.
0100h	Power Management	Initiator and Logical Unit power management
0105h	Time-out	Ability to response to all commands within a specific time

7.4.5 Profile 5h: AS-MO

Logical Units identifying Profile 5 shall support the Features listed in Table 429.

Table 429 – Mandatory Features for AS-MO

Feature Number	Feature Name	Description
0000h	Profile List	A list of all Profiles supported by the device
0001h	Core	Basic Functionality
0002h	Morphing	The device changes its operational behavior due to external events
0003h	Removable Medium	The medium may be removed from the device
0010h	Random Readable, PP=1	Read ability for storage devices with random addressing.
0020h	Random Writable	Write support for randomly addressed writes
0023h	Formattable	Support for formatting of media
0024h	Defect Management	Ability of the Logical Unit/media system to provide an apparently defect-free space
0100h	Power Management	Initiator and device directed power management
0105h	Timeout	Ability to respond to all commands within a specific time
0107h	Real-Time Streaming	Ability to read and write using Initiator requested performance parameters

7.4.6 Profile 8h: CD-ROM

Logical Units identifying Profile 8 as current shall support the Features listed in Table 430.

Table 430 – Mandatory Features for CD-ROM

Feature Number	Feature Name	Description
0000h	Profile List	A list of all Profiles supported by the device
0001h	Core	Basic Functionality
0002h	Morphing	The device changes its operational behavior due to external events
0003h	Removable Medium	The medium may be removed from the device
0010h	Random Readable, PP=1	Read ability for storage devices with random addressing.
001Eh	CD Read	The ability to read CD specific structures
0100h	Power Management	Initiator and device directed power management
0105h	Timeout	Ability to respond to all commands within a specific time

7.4.7 Profile 9h: CD-R

Logical Units identifying Profile 9 as current shall support the Features listed in Table 431:

Table 431 – Mandatory Features for CD-R

Feature Number	Feature Name	Description
0000h	Profile List	A list of all Profiles supported by the device
0001h	Core	Basic Functionality
0002h	Morphing	Ability to notify initiator about operational changes and accept initiator requests to prevent operational changes
0003h	Removable Medium	The medium may be removed from the device
0010h	Random Readable, PP = 1	Read ability for storage with random addressing
001Eh	CD Read	The ability to read CD specific structures
0021h	Incremental Streaming Writable	Write support of sequential recording
002Dh	CD Track at Once	Ability to write CD with Track at Once recording
0100h	Power Management	Initiator and Logical Unit power management
0105h	Time-out	Ability to response to all commands within a specific time
0107h	Real-Time Streaming	Ability to read and write using Initiator requested performance parameters

7.4.8 Profile Ah: CD-RW

Logical Units identifying Profile Ah as current shall support the Features listed in Table 432.

Table 432 – Mandatory Features for CD-RW

Feature Number	Feature Name	Description
0000h	Profile List	A list of all Profiles supported by the device
0001h	Core	Basic Functionality
0002h	Morphing	The device changes its operational behavior due to external events
0003h	Removable Medium	The medium may be removed from the device
0010h	Random Readable, PP = 1	Read ability for storage with random addressing
001Dh	Multi-Read	The Logical Unit complies with OSTA Multi-Read
001Eh	CD Read	The ability to read CD specific structure
0021h	Incremental Streaming Writable	Write support of sequential recording
0023h	Formattable	Support for formatting of media
0026h	Restricted Overwrite	Write support for media that shall be written in multiples of logical blocks
002Dh	CD Track at Once	Ability to write CD with Track at Once recording
0100h	Power Management	Initiator and Logical Unit power management
0105h	Time-out	Ability to response to all commands within a specific time
0107h	Real-Time Streaming	Ability to read and write using Initiator requested performance parameters

7.4.9 Profile 10h: DVD-ROM

Logical Units identifying Profile 10h as current shall support the Features listed in Table 433.

Table 433 – Mandatory Features for DVD-ROM

Feature Number	Feature Name	Description
0000h	Profile List	A list of all Profiles supported by the device
0001h	Core	Basic Functionality
0002h	Morphing	The device changes its operational behavior due to external events
0003h	Removable Medium	The medium may be removed from the device
0010h	Random Readable, PP=1	Read ability for storage devices with random addressing.
001Fh	DVD Read	The ability to read DVD specific structures
0100h	Power Management	Initiator and device directed power management
0105h	Timeout	Ability to respond to all commands within a specific time
0107h	Real-Time Streaming	Ability to read using Initiator requested performance parameters

7.4.10 Profile 11h: DVD-R Sequential recording

Logical Units identifying Profile 11h as current shall support the Features listed in Table 434:

Table 434 – Mandatory Features for DVD-R Sequential recording

Feature Number	Feature Name	Description
0000h	Profile List	A list of all Profiles supported by the device
0001h	Core	Basic Functionality
0002h	Morphing	The device changes its operational behavior due to external events
0003h	Removable Medium	The medium may be removed from the device
0010h	Random Readable, PP = 1	Read ability for storage with random addressing
001Fh	DVD Read	The ability to respond to all commands within a specific time
0021h	Incremental Streaming Writable	Write support for sequential recording
002Fh	DVD-R/-RW Write	Ability to write data in Disc At Once mode
0100h	Power Management	Initiator and Logical Unit power management
0105h	Time-out	Ability to response to all commands within a specific time
0107h	Real-Time Streaming	Ability to read and write using initiator requested performance parameters
0108h	Logical Unit Serial Number	Ability to provide Logical Unit serial number

7.4.11 Profile 12h: DVD-RAM

Logical Units identifying Profile 12h as current shall support the Features listed in Table 435.

Table 435 – Mandatory Features for DVD-RAM

Feature Number	Feature Name	Description
0000h	Profile List	A list of all Profiles supported by the device
0001h	Core	Basic Functionality
0002h	Morphing	The device changes its operational behavior due to external events
0003h	Removable Medium	The medium may be removed from the device
0010h	Random Readable, PP=1	Read ability for storage devices with random addressing.
001Fh	DVD Read	The ability to read DVD specific structures.
0020h	Random Writable	Write support for randomly addressed writes
0023h	Formattable	Support for formatting of media
0024h	Defect Management	Ability of the Logical Unit/media system to provide an apparently defect-free space
0100h	Power Management	Initiator and device directed power management
0105h	Timeout	Ability to respond to all commands within a specific time
0107h	Real-Time Streaming	Ability to read and write using Initiator requested performance parameters.

7.4.12 Profile 13h: DVD-RW Restricted Overwrite

Logical Units identifying Profile 13h as current shall support the Features listed in Table 436.

Table 436 – Mandatory Features for DVD-RW Restricted Overwrite

Feature Number	Feature Name	Description
0000h	Profile List	A list of all Profiles supported by the device
0001h	Core	Basic Functionality
0002h	Morphing	The device changes its operational behavior due to external events
0003h	Removable Medium	The medium may be removed from the device
0010h	Random Readable, PP=1	Read ability for storage devices with random addressing.
001Fh	DVD Read	The ability to read DVD specific structures.
0023h	Formattable	Support for formatting of media
002Ch	Rigid Restricted Overwrite	Ability to write DVD-RW specific structure
0100h	Power Management	Initiator and device directed power management
0105h	Timeout	Ability to respond to all commands within a specific time
0107h	Real-Time Streaming	Ability to read and write using Initiator requested performance parameters.
0108h	Logical Unit Serial Number	Ability to provide Logical Unit serial number

7.4.13 Profile 14h: DVD-RW Sequential recording

Logical Units identifying Profile 14h as current shall support the Features listed in Table 434:

Table 437 – Mandatory Features for DVD-RW Sequential recording

Feature Number	Feature Name	Description
0000h	Profile List	A list of all Profiles supported by the device
0001h	Core	Basic Functionality
0002h	Morphing	The device changes its operational behavior due to external events
0003h	Removable Medium	The medium may be removed from the device
0010h	Random Readable, PP = 1	Read ability for storage with random addressing
001Fh	DVD Read	The ability to respond to all commands within a specific time
0021h	Incremental Streaming Writable	Write support for sequential recording
002Fh	DVD-R/-RW Write	Ability to write data in Disc At Once mode
0100h	Power Management	Initiator and Logical Unit power management
0105h	Time-out	Ability to response to all commands within a specific time
0107h	Real-Time Streaming	Ability to read and write using initiator requested performance parameters
0108h	Logical Unit Serial Number	Ability to provide Logical Unit serial number

7.4.14 Profile 1Ah: DVD+RW

Logical Units identifying Profile 001Ah as current shall support the features listed in Table 438.

Table 438 – Mandatory Features for DVD+RW

Feature Number	Feature Name	Description
0000h	Profile List	A list of all Profiles supported by the device
0001h	Core	Mandatory behavior for all devices
0002h	Morphing	The device changes its operational behavior due to external events
0003h	Removable Medium	The medium may be removed from the device
0010h	Random Readable, PP=1	Read ability for storage devices with random addressing
001Fh	DVD Read	The ability to read DVD specific structures
0020h	Random Writable	Write support for randomly addressed writes
0023h	Formattable	Support for formatting of media
002Ah	DVD+RW	Support for reading and optionally writing DVD+RW Media
0100h	Power Management	Initiator and device directed power management
0105h	Time-Out	Ability to respond to all commands within a specific time
0107h	Real-time Streaming	Ability to read and write using Initiator requested performance parameters
010Ah	DCBs	The ability to read and optionally write DCBs.

7.4.15 Profile 1Bh: DVD+R

Logical units identifying Profile 001B as current shall support the features listed in Table 439.

Table 439 - Mandatory Features for DVD+R

Feature Number	Feature Name	Description
0000h	Profile List	A list of all Profiles supported by the device
0001h	Core	Mandatory behavior for all devices
0002h	Morphing	The device changes its operational behavior due to events external to the Host
0003h	Removable Medium	The medium may be removed from the device
0010h	Random Readable, PP=1	Read ability for storage devices with random addressing
001Fh	DVD Read	The ability to read DVD specific structures
002Bh	DVD+R	Support for reading and optionally writing DVD+R Media
0100h	Power Management	Host and device directed power management
0105h	Time-Out	Ability to respond to all commands within a specific time
0107h	Real-time Streaming	Ability to read and write using Host requested performance parameters

The presence of the DVD+R Profile indicates that the drive is capable of reading a DVD+R disc that has been recorded according to *DVD+R 4.7 Gbytes Basic Format Specifications.* In addition, the presence of the DVD+R Profile indicates that the WRITE bit in the DVD+R feature must be set to one.

7.4.16 Profile 20h: DDCD-ROM

Logical Units identifying Profile 20h as current shall support the Features listed in Table 440.

Table 440 – Mandatory Feature List for the DDCD-ROM

Feature Number	Feature Name	Description
0000h	Profile List	A list of all Profiles supported by the device
0001h	Core	Basic Functionality
0002h	Morphing	The device changes its operational behavior due to external events
0003h	Removable Medium	The medium may be removed from the device
0010h	Random Readable, PP = 1	Read ability for storage with random addressing
0030h	DDCD Read	The ability to read DDCD specific structure
0100h	Power Management	Initiator and device directed power management.
0105h	Time-out	Ability to response to all commands within a specific time

7.4.17 Profile 21h: DDCD-R

Logical Units identifying Profile 20h as current shall support the Features listed in Table 441.

Table 441 – Mandatory Feature List for the DDCD-R

Feature Number	Feature Name	Description
0000h	Profile List	A list of all Profiles supported by the device
0001h	Core	Basic Functionality
0002h	Morphing	The device changes its operational behavior due to external events
0003h	Removable Medium	The medium may be removed from the device
0010h	Random Readable, PP = 1	Read ability for storage with random addressing
0021h	Incremental Streaming Writable	Write support of sequential recording
0030h	DDCD Read	The ability to read DDCD specific structure
0031h	DDCD-R Write	The ability to write DDCD-R specific structure
0100h	Power Management	Initiator and Logical Unit power management.
0105h	Time-out	Ability to response to all commands within a specific time
0107h	Real-Time Streaming	Ability to read and write using Initiator requested performance parameters

7.4.18 Profile 22h: DDCD-RW

Logical Units identifying Profile 20h as current shall support the Features listed in Table 442.

Table 442 – Mandatory Feature List for the DDCD-R/RW

Feature Number	Feature Name	Description
0000h	Profile List	A list of all Profiles supported by the device
0001h	Core	Basic Functionality
0002h	Morphing	The device changes its operational behavior due to external events
0003h	Removable Medium	The medium may be removed from the device
0010h	Random Readable, PP = 1	Read ability for storage with random addressing
0020h	Random Writable	Write support for randomly addressed writes
0021h	Incremental Streaming Writable	Write support of sequential recording
0023h	Formattable	Support for formatting of media
0026h	Restricted Overwrite	Write support for media that shall be written in multiples of logical blocks
0030h	DDCD Read	The ability to read DDCD specific structure
0031h	DDCD-R Write	The ability to write DDCD-R specific structure
0032h	DDCD-RW Write	The ability to write DDCD-RW specific structure
0100h	Power Management	Initiator and Logical Unit power management.
0105h	Time-out	Ability to response to all commands within a specific time
0107h	Real-Time Streaming	Ability to read and write using Initiator requested performance parameters

7.4.19 Profile FFFFh: Logical Units Not Conforming to a Standard Profile

Logical Units identifying Profile FFFFh as current shall support the Features listed in Table 443.

Table 443 – Mandatory Features for Logical Units Not Conforming to a Standard Profile

Feature Number	Feature Name	Description
0000h	Profile List	A list of all Profiles supported by the device
0001h	Core	Basic Functionality

Annex A Implementation Notes: ATA Layer of ATAPI (Normative)

A.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 may be desired that a common device driver exist to control both SCSI and ATAPI devices.

A.2 General

ATAPI devices implement a subset of SCSI behavior. Certain errors and conditions that exist in SCSI do not 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-3 does not directly specify any of these mechanisms; the command and data layer definition may be layered on either transport.

A.2.1 Terms

A.2.1.1 Initiator

the ATAPI equivalent for the SCSI term “Initiator.”

A.2.1.2 Device

the ATAPI equivalent for the SCSI term “Target” or “Logical Unit.”

A.2.1.3 Command Packet

the ATAPI equivalent for the SCSI term “Command Descriptor Block.”

A.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 2 048 bytes per block. The WRITE command shall send the number of bytes per block as determined by the Write Parameters Page. The READ CD and READ CD MSF commands shall return the number of bytes per block as specified by the command.

A.2.3 CD Audio error reporting

PLAY AUDIO Commands with the immediate bit set in the audio control mode return status as soon as the command has been validated (that 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 Initiator 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.

A.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.

A.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.

A.2.6 Mapping of reset functions

shows how the different reset functions specified in the SCSI standards are used in this standard. Note that this table is not intended to show all possible resets or their mapping.

Table B.1 – Example Reset Function Mapping in ATAPI

Reset Type	ATAPI
Power-On Reset	Same as Power-On Reset
Hard Reset	Hard Reset
	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.
Device Reset	Device Reset in ATA/ATAPI-4

Annex B Implementation Notes: SCSI Parallel Interface (Normative)

B.1 Introduction

This standard is intended to be used in conjunction with the SCSI Architecture Model (SAM), the SCSI Primary Command Set (SPC-2) standard, and the SCSI Block Command Set (SBC) standard. See the NCITS/T10 SCSI Standards for information on the physical connection and protocol to be used for attachment of a SCSI Logical Unit.

B.2 SCSI Signal Utilization

Logical Unit shall utilize the same signals and timing from the SCSI Standard and Extensions.

B.3 SCSI Compatibility

B.3.1 Additions to the SCSI Standard

New requirements:

- GET EVENT/STATUS NOTIFICATION command in addition to the AEN capability in SCSI.
- Features are introduced and added.
- CHANGE DEFINITION is not required.
- The Mechanism State in this specification uses a value of 3h for the data port in use and not 1h as is specified in the SCSI Standard.
- The power model for this specification is different from that described for SCSI.
- The Information Exceptions Mode Page is called the Fault / Failure Reporting page in this standard.

B.4 Reset Functionality

This sub-clause describes the functionality of the various resets implemented in SCSI.

B.4.1 Power On Reset

The Power On Reset is an event that causes the Power On condition in SCSI. See “Task and Command Lifetimes” in the SCSI Architecture Model standard (SAM).

B.4.2 Hard Reset

Hard Reset is described in the SCSI Architecture Model. See “Hard Reset” in SAM.

A Hard Reset for a SCSI Device shall:

• Abort all tasks in all task sets;

• Clear all auto contingent allegiance conditions;

• Release all SCSI device reservations;

• Return any device operating modes to their appropriate initial conditions, similar to those conditions that would be found following device power-on. The MODE SELECT conditions shall be restored to their last saved values if saved values have been established. MODE SELECT conditions for which no saved values, have been established, shall be returned to their default values;

• Unit Attention condition shall be set.

B.4.3 TARGET RESET task management function

The TARGET RESET function may be used to reset all Logical Units in the Target.Note: The TARGET RESET task management function was called a “Bus Device Reset” in SCSI-2.

If the Initiator issues the LOGICAL UNIT RESET function to a Logical Unit, the response of the Logical Unit shall be the same as the response to a TARGET RESET task management function.

B.4.4 Device Reset

There are two possible Device Reset alternatives, ABORT TASK SET and CLEAR TASK SET. The ABORT TASK SET is mandatory for all SCSI Logical Units. SCSI Logical Units that do not support tagged tasks may support CLEAR TASK SET.

CLEAR TASK SET is different from ABORT TASK SET in that CLEAR TASK SET clears all of the queued tasks for all Initiators. If the Logical Unit is in a single Initiator environment, ABORT and CLEAR TASK SET functions in the same manner.

The ABORT/CLEAR TASK SET:

• Does not immediately reset SCSI bus protocol.

• Does not reset parameters in mode page to default values

• Always keep the disc information such as disc TOC information

• Does not change the Persistent Prevent state

B.4.5 Power Management and Device Reset in SCSI

When a SCSI Device is in the Power Managed Sleep state, a reset through the service delivery subsystem shall be used to wake the device.

B.4.6 Mapping of reset functions

Error! Reference source not found. shows how the different reset functions specified in the various ATAPI specifications are used in this standard. Note that this table is not intended to show all possible resets or their mapping.

Table E.1 – Example Reset Function Mapping in SCSI

Reset Type	SCSI
Power-On Reset	Same as Power-On Reset
Hard Reset	TARGET RESET task management function
	SAM Reset events. Note that this is SCSI protocol dependent.
	SPI Reset Signal
Device Reset	TARGET RESET

Annex C Implementation Notes: SCSI Serial Bus Protocol (Normative)

C.1 SBP-2 Definitions

C.1.1 command block

Space reserved within an ORB to describe a command intended for a Logical Unit that controls device functions or the transfer of data to or from device medium.

C.1.2 IEEE 1394

shall be understood as a reference to IEEE Std 1394-1995 as amended by IEEE Std 1394a-2000

C.1.3 login

The process by which an Initiator obtains access to a set of device fetch agents. The device fetch agents and their control and status registers provide a mechanism for an Initiator to signal ORB's to the device.

C.1.4 quadlet

Four bytes, or 32 bits, of data.

C.1.5 register

A term used to describe quadlet aligned addresses that may be read or written by IEEE 1394 transactions. In the context of this standard, the use of the term register does not imply a specific hardware implementation. For example, a processor may emulate the behavior of registers.

C.1.6 status block

A data structure written to system memory by a device when an operation request block has been completed.

C.1.7 system memory

The portions of any node's memory that are directly addressable by a IEEE 1394 address and which accepts, at a minimum, quadlet read and write access. Computers are the most common example of nodes that make system memory addressable from IEEE 1394, but any node, including those usually thought of as peripheral devices, may have system memory.

C.1.8 transaction

An exchange between a requester and a responder that consists of a request and a response sub-action. The request sub-action transmits a IEEE 1394 transaction such as quadlet read, block write or lock, from the requesting node to the node intended to respond. Some IEEE 1394 commands include data as well as transaction codes. The response sub-action returns completion status and sometimes data from the responding node to the requesting node.

C.1.9 unit

A component of a IEEE 1394 node that provides processing, memory, I/O or some other functionality. Once the node is initialized, the unit provides a CSR interface that is typically accessed by device driver software at an Initiator. A node may have multiple units, which normally operate independently of each other. Within this standard, a unit is equivalent to a device.

C.1.10 unit architecture

The specification of the interface to and the services provided by a unit implemented within an IEEE 1394 node.

C.1.11 unit attention

A state that a Logical Unit maintains while it has unsolicited status information to report to one or more logged-in Initiators. A unit attention condition shall be created as described elsewhere in this standard or in the applicable command set- and device-dependent documents.

C.2 SBP-2 Storage Model

The SBP-2 Storage Model describes general characteristics and functions of MMC3 Logical Units when implemented using SBP-2. It is intended to provide design information and lead to a better understanding of MMC3 Logical Unit functionality.

C.2.1 Model configuration

This configuration is used only as an example of a common implementation. The following assumptions are made for this model configuration.

- The device supports a single Logical Unit.
- The device does not support multiple Initiators.
- The device does not support isochronous data transfers.

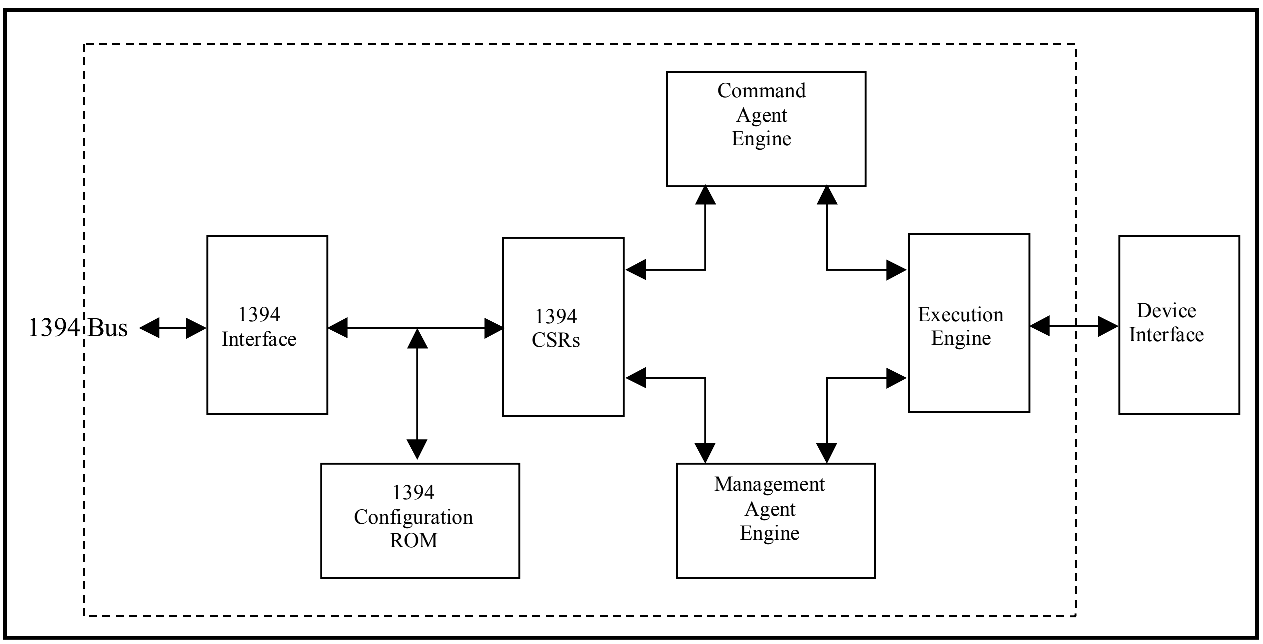


Figure C.1 – Mass storage interface block diagram

C.2.2 Model operation

The block diagram in Figure C.1 indicates the functional blocks contained in an MMC3 device that supports SBP-2. This section describes the function of those blocks when processing a list of ORBs. The ORBs contain READ commands in this example.

After power-on or bus reset, the Command_Agent and Management_Agent engines are in the Reset state.

The Initiator reads the MMC3 device's Configuration ROM data in order to determine its 1394 capabilities, SBP-2 capabilities, EUI-64 value, command set identifiers, software versions, and Management_Agent CSR address.

The Initiator performs a Login operation prior to any request to the MMC2 device. To perform a Login, the Initiator writes its Login ORB address to the Management_Agent register. The Login ORB should contain either the current or master password for the Login to be successful. The MMC3 device returns the Login response to the bus address specified in the Login ORB. One field of the Login response contains the Command_Agent's CSR base address.

Prior to initiating command transfers, the Initiator builds a list of Command_Block ORBs in system memory. The list may be as short as one ORB, but this example assumes a list length of more than one. The last ORB in the list contains a NULL Next_ORB pointer which indicates the end of the list to the MMC3 device's Command_Agent fetch engine.

To transition the Command_Agent state from Reset to Active the Initiator writes the offset of the first ORB in the ORB list to the MMC3 device's ORB_Pointer CSR address. This allows the Command_Agent fetch engine to begin fetching ORBs from Initiator memory. If the Initiator writes to the Doorbell CSR, the MMC3 device shall ignore the Doorbell at this time.

The MMC3 device fetches ORBs until its ORB space is full or until an ORB containing a NULL Next_ORB pointer is fetched. Fetched ORBs are routed to the Execution engine. The Execution engine may reorder the commands contained in the ORBs for best performance.

As each READ command is executed the MMC3 device transfers READ data to the Initiator's memory space via block write requests.

Following the data transfer portion of each command the MMC3 device writes a Status_Block to the Initiator's Status_FIFO address. The Status_FIFO address for Command Block ORBs is contained in the Login ORB. The status block contains SBP-2 specific command information, such as the ORB_offset of the Command_Block ORB associated with this status, as well as general sense information.

Note: ORBs contain a NOTIFY bit that is to be set if a Status_Block is to be written to Initiator memory after every ORB is executed or cleared if a Status_Block is to be written only after ORB execution encounters an error. This bit is advisory only. MMC3 Logical Units shall return a Status_Block for all ORBs executed.

If an ORB containing a Null Next_ORB pointer is fetched the Execution engine completes all fetched commands, including the one in the just fetched ORB, before the Command_Agent transitions to the Suspended state.

If additional commands are to be executed, the Initiator creates a new list of Command_Block ORBs; changes the Next_ORB pointer in the last ORB of the old list from NULL to the offset of the first ORB in the new list; then writes to the MMC3 device's Doorbell CSR address. This transitions the Command_Agent to the Active state.

The MMC3 device fetches the new Next_ORB pointer value from the last ORB of the old list and begins fetching ORBS from the new list at that offset.

If the Command_Agent fetch engine has not reached the ORB containing a Null Next_ORB pointer (and is still in the Active state), the MMC3 device ignores any writes to the Doorbell CSR address.

This sequence may continue until the MMC3 device is reset, power is removed, or an error occurs.

C.2.3 Reconnect /Power reset support (normative)

MMC3 Logical Units shall support the Reconnect management function following a bus reset, as described in SBP-2. However, in the case that a Reconnect request occurs following a power reset, MMC3 Logical Units shall perform as follows:

1. Following a power reset, any previous login information shall be discarded and the device shall transition to the Reset state.
2. If an Initiator sends a Reconnect ORB to the device, the device shall return status with RESP set to 0, REQUEST COMPLETE, and sbp_status set to A_{16}, LOGIN ID NOT RECOGNIZED.

C.3 Configuration ROM support (normative)

Although most Configuration ROM entries are generic, several contain information that is specific to each device type. Hard disk Logical Unit specific Configuration ROM information is defined in this section.

C.3.1 Unit Directory - Command_Set_Spec_ID

The COMMAND_SET_SPEC_ID entry (key - 38_{16}) is an immediate entry that specifies the organization responsible for the command set definition for the device. SCSI targets shall have a command_set_spec_ID of 00 609Eh, which indicates that NCITS is responsible for the command set definition.

38h	Command_set_spec_ID = 00

C.3.2 Unit Directory - Command_Set

The COMMAND_SET entry (key – 39h) is an immediate entry that, in combination with the COMMAND_SET_SPEC_ID entry specifies the command set supported by the unit. SCSI targets shall have a command_set value of 01 04D8h, which indicates that the target's command set is specified by SCSI Primary Commands 2 (SPC-2) and related command set standard(s), as determined by the targets peripheral device type(s).

39h	Command_set = 01

C.3.3 Unit Directory - Command_Set_Revision

The COMMAND_SET_REVISION entry (key - 3Bh) is an immediate entry that specifies the current revision level of the command set implemented by the unit.

3Bh	Command_set_revision

C.3.4 Unit Directory - Logical_Unit_Number

The LOGICAL_UNIT_NUMBER entry (key – 14h) is an immediate entry that specifies the device type and the Logical Unit number of a Logical Unit supported by the device. The format of this entry is defined in SBP-2 and duplicated here with additional field information for hard disk drives.

14h	R	O	device_type (05h)	Logical_unit_number

R in the figure above indicates reserved bits.

The ordered bit (abbreviated as O in the figure above) specifies the manner in which the Logical Unit executes tasks signaled to the command block agent. If the Logical Unit executes and reports completion status without any ordering constraints, the ordered bit shall be zero. Otherwise, if the Logical Unit both executes all tasks in order and reports their completion status in the same order, the ordered bit shall be one.

The Device_Type field indicates the peripheral device type implemented by the Logical Unit. The value defined for MMC3 Logical Units is 05h.

Logical_Unit_Number field shall identify the Logical Unit to which the information in the LOGICAL_UNIT_NUMBER entry applies.

C.4 Login support (normative)

MMC3 Logical Units shall implement the Login support as defined in SBP-2.

C.5 Security support (normative)

MMC3 Logical Units shall implement security against unauthorized media access as defined in the security annex of SBP-2.

The master password, referenced in SBP-2, is contained in the INQUIRY command, Vital Product Data, page 80h. Following a successful Login operation, the Initiator shall request that the Logical Unit perform the INQUIRY command, in order to obtain the Logical Unit's serial number.

C.6 Status block support (normative)

The status block for MMC3 Logical Units shall be implemented as described in the following text and figure. Refer to SBP-2, Annex B, for a complete description of all bits and fields.

If no exception status is generated, only the first two quadlets (LEN =1) shall be written to the Initiator's STATUS_FIFO address.

If exception status is generated, the device shall write, at a minimum, the four quadlets (len = 2) shown below. This format is required for unsolicited status as well as command status.

src	resp	d	len	sbp_status				ORB-offset_hi
ORB_offset_lo								
sfmt	status	v	m	e	i	sense key	sense code	sense qualifier
information								

C.7 Unsolicited Status support (normative)

MMC3 Logical Units that support the SBP-2 transport protocol shall implement the generation of unsolicited status. Devices shall notify Initiators of unsolicited status support by setting the ASYNCHRONOUS EVENT REPORTING CAPABILITY (AERC) bit to one in the standard data format of the INQUIRY command (see SPC-2)

As stated in SBP-2, unsolicited status is enabled when the Initiator writes to the Unsolicited_Status_Enable CSR. Devices default to unsolicited status disabled and only send unsolicited status following a write to the Unsolicited_Status_Enable CSR. The Unsolicited_Status_Enable CSR is a handshake mechanism and shall be written after every unsolicited status event in order to enable another such event.

C.8 Unit attention condition

A unit attention condition shall persist for a logged-in Initiator until

a) unsolicited status, that reports the unit attention condition, is successfully written to the Initiator's status FIFO address, or

b) the Initiator's login becomes invalid or is released. Logical Units may queue unit attention conditions; more than one unit attention condition may exist at the same time.

Annex D Implementation Notes: Universal Serial Bus (Normative)

Annex E Legacy Specifications

There are commands, command options, mode pages, and fields within structures defined in earlier versions of the MMC that are no longer recommended for use in multi-media devices. Due to the prevalence of installed systems that require continued use of these capabilities, the formal path of obsolescence may have undesirable results. For this reason, MMC preserves these definitions in this annex. These specifications are unchanged from their former state in previous versions of MMC.

E.1 Commands

E.1.1 FORMAT UNIT Command, Format Code = 111b

If the Format Code in the CDB is 111b the CD-RW Format Descriptor defined in Table 2 shall be sent. Use of this Format Code is defined only for CD-RW.

Table 2 – 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)							
5	Format Size							
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 shall be integrally divisible by the Packet Size field in the Write Parameters 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 exists 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 shall be integrally divisible by the Packet Size field in the Write Parameters Page. If the last session on the disc is not closed 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.

E.1.2 SEND EVENT Command

The SEND EVENT command requests the Logical Unit to process an event on behalf of the Initiator. Features associated with this command are listed in Table 3.

Table 3 – Features Associated with the SEND EVENT Command

Feature Number	Feature Name	Command Requirement
0002h	Morphing, version 0	Mandatory when Event Class 3 is supported

The event should be one that the Initiator had received from an earlier GET EVENT/STATUS NOTIFICATION command. If a Logical Unit has received a persistent prevent, it shall report events via the GET EVENT/STATUS NOTIFICATION command instead of processing them directly. When such a request is received by the Initiator, it should complete any operations in progress and process the event by emulating the button's functionality via commands or by sending the event back to the Logical Unit using the SEND EVENT command.

The Media Status Class Events reported to the Initiator shall not be returned to the Logical Unit using the SEND EVENT command. Only events of Class External Request (Class 3) shall be sent via the SEND EVENT command.

The SEND EVENT command descriptor block is defined in Table 4.

Table 4 – SEND EVENT Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code (5Dh)							
1	Reserved			Reserved				IMMED
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	Reserved							
8	(MSB)			Parameter List Length				
9								(LSB)
10	Reserved							
11	Control Byte							

An Immediate (IMMED) bit of one indicates that status shall be returned as soon as the Command Packet has been validated. The actual operation specified by the Event Parameter shall be processed after the status has been reported to the Initiator. The IMMED bit shall be set to 1h.

The Parameter List Length field specifies the length in bytes of the Event parameter list that shall be transferred from the Initiator to the Logical Unit after the Command Packet is transferred. A parameter list length of zero indicates that no data shall be transferred. This condition shall not be considered as an error.

If the Event parameter list length results in the truncation of Event parameter data, the Logical Unit shall terminate the command with CHECK CONDITION status and set SK/ASC/ASCQ values to ILLEGAL REQUEST/PARAMETER LIST LENGTH ERROR.

The Logical Unit shall terminate the command with CHECK CONDITION status and SK/ASC/ASCQ values are set to ILLEGAL REQUEST/INVALID FIELD IN PARAMETER LIST, and shall not take any action directed by the event specified for the following conditions:

1. If the Initiator sets any unreserved field in the Event parameter header to an unsupported value.
2. If an Initiator sends an Event parameter list with a Event Data Length not equal to the length returned by the GET EVENT/STATUS NOTIFICATION command for the specified event class.
3. If the Initiator sends an invalid value for any Event parameter.

Table 5 – Event Parameter Header

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			Event Parameter Length				
1								(LSB)
2	Reserved	Reserved				Notification Class (1h)		
3				Reserved				

The Event Parameter Length field specifies the number of bytes that follow the Event Parameter Length field. Notification Class field specifies the class of Event being sent to the Logical Unit. This field shall contain a 1h.

Table 6 – Operational Change/Notification Parameter Data

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

The Operational Event field indicates the type of operation to be performed.

Table 7 – Operational Event Field

Code	Event	Description
0h	No Change (NoCHge)	No request shall be processed by the Logical Unit
1h	Operational Change Request	Initiator requests Logical Unit to process the Operational Request
2h - Fh	Reserved	

The Persistent Prevented bit is reserved and shall be ignored.

The Operational Status field is reserved and shall be ignored. This field may contain the non-zero value reported to the Initiator.

Operational Request Code field contains the actual requested operation. See **Table 96** for code descriptions.

Recommended error reporting is listed in Table 8.

Table 8 – Recommended errors for SEND EVENT Command

Error	Reference
Deferred Errors	A.2
General Errors	
Media Access Errors	

E.2 MODE PAGES

E.2.1 CD Device Parameters Mode Page (Page 0Dh)

The CD Parameters page (Table 9) specifies parameters that affect all CD-ROM data types.

Table 9 – 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 Parameter Savable bit is defined in sub-clause 6.1.2.1.

The inactivity timer multiplier value specifies the length of time that the Logical Unit shall remain in the hold track state after completion of a seek or read operation (Table 10).

Table 10 – Inactivity timer multiplier values

Inactivity timer multiplier value	minimum time in hold track state	Inactivity timer multiplier 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.

E.2.2 CD/DVD Capabilities and Mechanical Status Page (Page Code 2Ah)

The CD/DVD Capabilities and Mechanical Status Page (Table 11) is read only and shall not be set with Mode Select.

Table 11 – CD/DVD Capabilities and Mechanical Status Page

Bit / Byte	7	6	5	4	3	2	1	0
0	PS	Reserved	Page Code (2Ah)					
1	Page Length (28+4*(maximum number of n))							
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-R/RW Write	CD-R Write
4	BUF	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 Cmds Supported
6	Loading Mechanism Type			Reserved	Eject (Individual or Magazine)	Prevent Jumper	Lock State	Lock
7	Reserved		R-W in Lead-In	Side Change Capable	S/W Slot Selection (SSS)	Changer Supports Disc Present	Separate Channel Mute	Separate volume levels
8	(MSB) Obsolete							
9								(LSB)
10	(MSB) Number of Volume Levels Supported							
11								(LSB)
12	(MSB) Buffer Size Supported							
13								(LSB)
14	(MSB) Obsolete							
15								(LSB)
16	Reserved							
17	Reserved		Length		LSBF	RCK	BCKF	Reserved
18 - 21	Obsolete							
22	(MSB) Copy Management Revision Supported							
23								(LSB)
24 - 26	Reserved							
27	Reserved						Rotation Control Selected	
28	(MSB) Current Write Speed Selected							
29								(LSB)
30	(MSB) Number of Logical Unit Write Speed Performance Descriptor Tables (n)							
31								(LSB)
32 - 35	Logical Unit Write Speed Performance Descriptor Block #1							
36 - 39	Logical Unit Write Speed Performance Descriptor Block #2							
:	:							
n*4+28 ~ n*4+31	Logical Unit Write Speed Performance Descriptor Block #n							
	Padding							

The Parameter Savable bit is defined in sub-clause 6.1.2.1.

The Page Length field shall be set to a maximum length that contains the maximum number of Logical Unit Write Speed Performance Descriptor Blocks. The Page Length is fixed for a Logical Unit, but may be different from one Logical Unit to another. If the Logical Unit Write Speed Performance Descriptor Block for mounted media is shorter than the maximum length of the Logical Unit Write Speed Performance Descriptor Block, then the rest of the field shall be padded with zeros. If a Logical Unit does not support high speed CD-R/RW recording, the Logical Unit shall not return mode page data after byte 26.

When DVD-RAM Read is set to one, the Logical Unit shall support reading DVD-RAM media.

When DVD-R Read is set to one, the Logical Unit shall support reading DVD-R media.

When DVD-ROM Read bit is set to one, the Logical Unit shall support reading DVD-ROM media.

When Method 2 is set to one, the Logical Unit shall support the reading fixed packet tracks on CD-R/RW media where the Addressing type is Method 2.

When CD-RW Read is set to one, the Logical Unit shall support reading CD-RW media.

When CD-R Read is set to one, the Logical Unit shall support the read function of CD-R disc.

When DVD-RAM Write is set to one, the Logical Unit shall support writing DVD-RAM media.

When DVD-R Write is set to one, the Logical Unit shall support writing DVD-R media.

When Test Write is set to one, the Logical Unit shall support the Test Write function described in sub-clause 6.4.

When CD-R/RW Write is set to one, the Logical Unit shall support writing CD-R/RW media.

When CD-R Write is set to one, the Logical Unit shall support the writing CD-R media.

When Audio Play is set to one, the Logical Unit shall be capable of analog Audio Play.

When Composite is set to one, the Logical Unit shall be capable of delivering a composite Audio and Video data stream from an independent digital port.

When Digital Port (1) is set to one, the Logical Unit shall support digital output (IEC958) on port 1.

When Digital Port (2) is set to one, the Logical Unit shall support digital output(IEC958) on port 2.

When Mode 2 Form 1 is set to one, the Logical Unit shall support reading CD sectors in Mode 2 Form 1 format.

When Mode 2 Form 2 is set to one, the Logical Unit shall support reading CD sectors in Mode 2 Form 2 format.

When Multi Session is set to one, the Logical Unit shall support reading multiple session CD discs.

When BUF is set to one, the Logical Unit shall support buffer under-run free recording on CD-R/RW media. For non-CD Logical Units, this bit is reserved.

When CD-DA Commands Supported is set to one, the Logical Unit shall support reading CD Audio sectors via the READ CD command (see 5.24).

When CD-DA Stream is Accurate is set to one, the Logical Unit shall support an audio location without losing place to continue the READ CD command. If 0, the Logical Unit is incapable of accurately restarting the CD-DA read operation. If the audio read stream is lost, the READ CD command shall be terminated with CHECK CONDITION status and SK/ASC/ASCQ values shall be set to ABORTED COMMAND/READ ERROR - LOSS OF STREAMING. Since the Logical Unit cannot provide properly aligned data, the initiator may choose to supply data realignment procedures. If 1, the Logical Unit can continue from a loss of streaming condition and no error shall be generated.

When Sub-channels R-W Reading Supported is set to one, the Logical Unit shall support reading R-W sub-channel via the READ CD command (see 5.24).

When R-W Sub-channels De-interleaved & Corrected is set to one, the Logical Unit shall support reading R-W sub-channel via the READ CD command with the returned data de-interleaved and error corrected.

When C2 Pointers Supported is set to one, the Logical Unit shall support reading C2 Error Pointers and C2 Block Error flags via the READ CD command.

When ISRC is set to one, the Logical Unit shall support reading International Standard Recording Code Information via the READ SUB-CHANNEL command.

When UPC is set to one, the Logical Unit shall support reading Media Catalog Number (also known as Uniform Product Code) via the READ SUB-CHANNEL command.

When Read Bar Code is set to one, the Logical Unit shall support reading the disc bar code and returning the information via the READ DISC INFORMATION command.

When Lock is set to one, the Logical Unit shall support locking the media within the physical Logical Unit via the PREVENT ALLOW MEDIUM REMOVAL command.

When Lock is set to one and Lock State is cleared to zero, the Logical Unit is currently in the allow (unlocked) state. When Lock is set to one and Lock is set to one, the Logical Unit is currently in the prevent (locked) state. When Lock is cleared to zero, Lock State has no meaning.

When Prevent Jumper is cleared to zero, the Logical Unit has a physical jumper named the Prevent/Allow Jumper and the jumper is present. At power-on time, the default loading mechanism state shall be allow (unlocked). Locking the Logical Unit with the PREVENT ALLOW MEDIUM REMOVAL command shall not prevent the insertion of media.

When Prevent Jumper is set to one, the Logical Unit has a physical jumper named the Prevent/Allow Jumper and the jumper is not present. At power-on time, the default loading mechanism state shall be prevent (locked). The Logical Unit shall not accept new media or allow the ejection of media already loaded until an allow command is issued.

> Implementers Note: The Prevent Jumper is optional. If the Logical Unit does not implement the prevent Jumper, then it shall respond as if the jumper was present.

When Eject command is set to one, the Logical Unit shall support media eject via the START STOP UNIT command with the LoEj bit set. If the mechanism is a Changer that uses a Magazine, then this bit indicates that the Magazine can be ejected.

Loading Mechanism Type (Byte 6, bits 7 - 5) shall specify the type of disc loading the Logical Unit supports. The meanings of values in this field are shown in Table 12.

Table 12 – Loading Mechanism Type

Byte 6, Bits			Loading Mechanism Type
7	6	5	
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 Magazine mechanism
1	1	0	Reserved
1	1	1	Reserved

When Separate Volume Levels is set to one, the Logical Unit shall support separately controllable audio levels for each supported channel via the CD Audio Control Page (see 6.5).

When Separate Channel Mute is set to one, the Logical Unit shall support independently muting each audio channel via the CD Audio Control Page (see 6.5).

When Supports Disc Present (SDP) is set to one, the Logical Unit contains an embedded changer, and after a reset condition or a magazine change, the Logical Unit is capable of reporting the exact contents of the slots. The response to the MECHANISM STATUS command shall contain valid "Disc is Present" status information for all slots.

When Software Slot Selection (SSS) is set to one, This bit controls the behavior of the LOAD/UNLOAD MEDIUM command when trying to load a Slot with no Disc present.

When Side Change Capable is set to one, the Logical Unit is capable of selecting both sides of Discs. This capability is typically reported only for Logical Units that have changer functions.

When R through W in Lead-in is set to one, the Logical Unit is capable of reading the raw R-W Sub-channel information from the Lead-in.

In an earlier version of this standard, bytes 8 and 9 were assigned to Maximum Read Speed Supported (in kBps). This field has been obsoleted.

The Number of Volume Levels Supported field is the number of discrete volume levels supported by the Logical Unit. If the Logical Unit only supports audio on and audio off, the Number of Volume Levels field shall be set to 2.

The Buffer Size Supported field is the number of bytes of buffer dedicated to the data stream returned to the Initiator. This value is returned in Kbytes (Size/1024). If the Logical Unit does not have a buffer cache, the value returned shall be zero.

In an earlier version of this standard, bytes 14 and 15 were assigned to Current Read Speed Selected (in kBps). This field has been obsoleted.

If both Digital Port (1) and Digital Port (2) are cleared to zero, then the content of byte 17 is unspecified.

If either Digital Port (1) or Digital Port (2) is set to one, the Logical Unit shall specify in Byte 17 the format of the Logical Unit's digital output as follows:

When BCKF is cleared to zero, data is valid on the rising edge of the BCK signal.

When BCKF is set to one, data is valid on the falling edge of the BCK signal.

When RCK is cleared to zero, HIGH on LRCK indicates right channel.

When RCK is set to one, HIGH on LRCK indicates left channel.

When LSBF is cleared to zero, most significant bit is first in data words.

When LSBF is set to one, least significant bit is first in data words.

Bits 5, 4 - Describes the bit length of IEC958 words (Table 13).

Table 13 – Bit Length of IEC958 Words

Bits 5, 4	Word Length
00	32
01	16
10	24
11	24 (I^2S)

In an earlier version of this standard, bytes 18 and 19 were assigned to Maximum Write Speed (in kBps). This field has been obsoleted.

In an earlier version of this standard, bytes 20 and 21 were assigned to Current Write Speed Selected (in kBps). This field has been obsoleted.

The Copy Management Revision Supported Field specifies the version of the DVD Content Protection scheme supported by the Logical Unit. For DVD this field shall be set to 0001h, if either DVD CSS or CPPM is implemented. Otherwise, this field shall be set this field to 0000h.

The Rotation Control Selected field specifies the current Rotation Control applied to the currently mounted disc as shown in Table 15.

The Current Write Speed Selected field indicates the data rate currently in use by the Logical Unit.

The Number of Logical Unit Write Speed Performance Descriptor Tables field specifies the number of Logical Unit Write Speed Performance Descriptor Blocks that follow this field.

Each Logical Unit Write Speed Performance Descriptor Block shall contain rotation control information and write speed that is supported by the Logical Unit.

The Logical Unit Write Speed Performance Descriptor Block is structured as shown in Table 14.

Table 14 – Logical Unit Write Speed Performance Descriptor Table Format

Byte \ Bit	7	6	5	4	3	2	1	0
0	Reserved							
1	Reserved					Rotation Control		
2	(MSB) Write Speed Supported (kbytes/sec)							
3								(LSB)

Table 15 – Rotation Control Selected field definition

Value	Definition
00b	CLV
01b	CAV (pure)
10b	Reserved
11b	Reserved

The Write Speed Supported field indicates the write speed that is supported by the Logical Unit. In the case of CAV recording, the returned value shall indicate the speed at most inner program area of the disc. Assume that the outermost radius: 79 min, 59 sec, 74 frames.

The Logical Unit shall report a record speed in descending order. If the Logical Unit supports both CLV and CAV on the medium, then the Logical Unit shall report all CLV descriptors first.

In the case of no recordable media mounted, the Logical Unit Write Speed Performance Descriptor Table shall report the most appropriate list of the speed such as the list for CD-R disc or just maximum recording speed.

Annex F Error Reporting (Informative)

F.1 Overview

This annex lists error codes that may be generated by MMC defined Logical Units. 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.

F.2 Deferred Errors

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.

F.3 Error Lists

A number of tables are included within this annex for error classification. Each table has columns identifying SK, ASC, and ASCQ values and the associated meaning. Each command description sub-clause contains an error-reporting table with entries that reference the tables included within this annex. There are five classifications:

Error! Reference source not found., lists all errors.

Error! Reference source not found., lists errors that may occur at any time, typically in response to a protocol or hardware error or user intervention.

Error! Reference source not found., 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).

Error! Reference source not found., describes errors that may be generated by commands that cause user or control data to be written to the medium.**Error! Reference source not found.**, describes errors that may be generated by commands that cause the Logical Unit session to be closed.

Table 16 – Logical Unit Sense Key, ASC and ASCQ Assignments

Sense Key(s)	ASC	ASCQ	Description	ATAPI
0	00	00	NO ADDITIONAL SENSE INFORMATION	•
B	00	06	I/O PROCESS TERMINATED	
0, 5	00	11	AUDIO PLAY OPERATION IN PROGRESS	•
0, 5	00	12	AUDIO PLAY OPERATION PAUSED	•
0, 5	00	13	AUDIO PLAY OPERATION SUCCESSFULLY COMPLETED	•
0, 5	00	14	AUDIO PLAY OPERATION STOPPED DUE TO ERROR	•
0, 5	00	15	NO CURRENT AUDIO STATUS TO RETURN	•
3, 4	00	17	CLEANING REQUESTED	•
3, 4	02	00	NO SEEK COMPLETE	•
2	04	00	LOGICAL UNIT NOT READY, CAUSE NOT REPORTABLE	•
2	04	01	LOGICAL UNIT IS IN PROCESS OF BECOMING READY	•
2	04	02	LOGICAL UNIT NOT READY, INITIALIZING CMD. REQUIRED	•
2	04	03	LOGICAL UNIT NOT READY, MANUAL INTERVENTION REQUIRED	•
2	04	04	LOGICAL UNIT NOT READY, FORMAT IN PROGRESS	•
2	04	07	LOGICAL UNIT NOT READY, OPERATION IN PROGRESS	•
2	04	08	LOGICAL UNIT NOT READY, LONG WRITE IN PROGRESS	•
4	05	00	LOGICAL UNIT DOES NOT RESPOND TO SELECTION	
3	06	00	NO REFERENCE POSITION FOUND	•
5	07	00	MULTIPLE PERIPHERAL DEVICES SELECTED	
4	08	00	LOGICAL UNIT COMMUNICATION FAILURE	
4	08	01	LOGICAL UNIT COMMUNICATION TIME-OUT	
4	08	02	LOGICAL UNIT COMMUNICATION PARITY ERROR	
4	08	03	LOGICAL UNIT COMMUNICATION CRC ERROR (ULTRA-DMA/32)	
4	09	00	TRACK FOLLOWING ERROR	•
4	09	01	TRACKING SERVO FAILURE	•
4	09	02	FOCUS SERVO FAILURE	•
4	09	03	SPINDLE SERVO FAILURE	•
4	09	04	HEAD SELECT FAULT	
6	0A	00	ERROR LOG OVERFLOW	•
1	0B	00	WARNING	
1	0B	01	WARNING - SPECIFIED TEMPERATURE EXCEEDED	
1	0B	02	WARNING - ENCLOSURE DEGRADED	
3	0C	00	WRITE ERROR	•
3	0C	07	WRITE ERROR - RECOVERY NEEDED	•
3	0C	08	WRITE ERROR - RECOVERY FAILED	•
3	0C	09	WRITE ERROR - LOSS OF STREAMING	•
3	0C	0A	WRITE ERROR - PADDING BLOCKS ADDED	•

Sense Key(s)	ASC	ASCQ	Description	ATAPI
3	11	00	UNRECOVERED READ ERROR	•
3	11	01	READ RETRIES EXHAUSTED	•
3	11	02	ERROR TOO LONG TO CORRECT	•
3	11	05	L-EC UNCORRECTABLE ERROR	•
3	11	06	CIRC UNRECOVERED ERROR	•
3	11	0F	ERROR READING UPC/EAN NUMBER	•
3	11	10	ERROR READING ISRC NUMBER	•
B	11	11	READ ERROR - LOSS OF STREAMING	•
3	15	00	RANDOM POSITIONING ERROR	•
3	15	01	MECHANICAL POSITIONING ERROR	•
3	15	02	POSITIONING ERROR DETECTED BY READ OF MEDIUM	•
1	17	00	RECOVERED DATA WITH NO ERROR CORRECTION APPLIED	•
1	17	01	RECOVERED DATA WITH RETRIES	•
1	17	02	RECOVERED DATA WITH POSITIVE HEAD OFFSET	•
1	17	03	RECOVERED DATA WITH NEGATIVE HEAD OFFSET	•
1	17	04	RECOVERED DATA WITH RETRIES AND/OR CIRC APPLIED	•
1	17	05	RECOVERED DATA USING PREVIOUS SECTOR ID	•
1	17	07	RECOVERED DATA WITHOUT ECC - RECOMMEND REASSIGNMENT	•
1	17	08	RECOVERED DATA WITHOUT ECC - RECOMMEND REWRITE	•
1	17	09	RECOVERED DATA WITHOUT ECC - DATA REWRITTEN	•
1	18	00	RECOVERED DATA WITH ERROR CORRECTION APPLIED	•
1	18	01	RECOVERED DATA WITH ERROR CORR. & RETRIES APPLIED	•
1	18	02	RECOVERED DATA - DATA AUTO-REALLOCATED	•
1	18	03	RECOVERED DATA WITH CIRC	•
1	18	04	RECOVERED DATA WITH L-EC	•
1	18	05	RECOVERED DATA – RECOMMEND REASSIGNMENT	•
1	18	06	RECOVERED DATA – RECOMMEND REWRITE	•
1	18	08	RECOVERED DATA WITH LINKING	
5	1A	00	PARAMETER LIST LENGTH ERROR	•
4	1B	00	SYNCHRONOUS DATA TRANSFER ERROR	
A	1D	00	MISCOMPARE DURING VERIFY OPERATION	•
5	20	00	INVALID COMMAND OPERATION CODE	•
5	21	00	LOGICAL BLOCK ADDRESS OUT OF RANGE	•
5	21	01	INVALID ELEMENT ADDRESS	•
5	21	02	INVALID ADDRESS FOR WRITE	•
5	24	00	INVALID FIELD IN CDB	•
5	25	00	LOGICAL UNIT NOT SUPPORTED	

Sense Key(s)	ASC	ASCQ	Description	ATAPI, SBP, USB
5	26	00	INVALID FIELD IN PARAMETER LIST	•
5	26	01	PARAMETER NOT SUPPORTED	•
5	26	02	PARAMETER VALUE INVALID	•
5	26	03	THRESHOLD PARAMETERS NOT SUPPORTED	
5	26	04	INVALID RELEASE OF ACTIVE PERSISTENT RESERVATION	
5	27	00	WRITE PROTECTED	•
5	27	01	HARDWARE WRITE PROTECTED	•
5	27	02	LOGICAL UNIT SOFTWARE WRITE PROTECTED	•
5	27	03	ASSOCIATED WRITE PROTECT	•
5	27	04	PERSISTENT WRITE PROTECT	•
5	27	05	PERMANENT WRITE PROTECT	•
7	27	06	CONDITIONAL WRITE PROTECT	•
6	28	00	NOT READY TO READY CHANGE, MEDIUM MAY HAVE CHANGED	•
6	28	01	IMPORT OR EXPORT ELEMENT ACCESSED	
6	29	00	POWER ON, RESET, OR BUS DEVICE RESET OCCURRED	•
6	29	01	POWER ON OCCURRED	•
6	29	02	SCSI BUS RESET OCCURRED	•
6	29	03	BUS DEVICE RESET FUNCTION OCCURRED	•
6	29	04	DEVICE INTERNAL RESET	•
6	2A	00	PARAMETERS CHANGED	•
6	2A	01	MODE PARAMETERS CHANGED	•
6	2A	02	LOG PARAMETERS CHANGED	
6	2A	03	RESERVATIONS PREEMPTED	
5	2B	00	COPY CANNOT EXECUTE SINCE INITIATOR CANNOT DISCONNECT	
5	2C	00	COMMAND SEQUENCE ERROR	•
5	2C	03	CURRENT PROGRAM AREA IS NOT EMPTY	•
5	2C	04	CURRENT PROGRAM AREA IS EMPTY	•
6	2E	00	INSUFFICIENT TIME FOR OPERATION	•
6	2F	00	COMMANDS CLEARED BY ANOTHER INITIATOR	
2	30	00	INCOMPATIBLE MEDIUM INSTALLED	•
2	30	01	CANNOT READ MEDIUM – UNKNOWN FORMAT	•
2	30	02	CANNOT READ MEDIUM – INCOMPATIBLE FORMAT	•
2	30	03	CLEANING CARTRIDGE INSTALLED	•
2	30	04	CANNOT WRITE MEDIUM – UNKNOWN FORMAT	•
2	30	05	CANNOT WRITE MEDIUM – INCOMPATIBLE FORMAT	•
2	30	06	CANNOT FORMAT MEDIUM – INCOMPATIBLE MEDIUM	•
2	30	07	CLEANING FAILURE	•
5	30	08	CANNOT WRITE – APPLICATION CODE MISMATCH	•
5	30	09	CURRENT SESSION NOT FIXATED FOR APPEND	•

Sense Key	ASC	ASCQ	Description	ATAPI, USB, SBP
5	30	10	MEDIUM NOT FORMATTED	•
3	31	00	MEDIUM FORMAT CORRUPTED	•
3	31	01	FORMAT COMMAND FAILED	•
3	31	02	ZONED FORMATTING FAILED DUE TO SPARE LINKING	
4	34	00	ENCLOSURE FAILURE	
4	35	00	ENCLOSURE SERVICES FAILURE	
4	35	01	UNSUPPORTED ENCLOSURE FUNCTION	
5	35	02	ENCLOSURE SERVICES UNAVAILABLE	
4	35	03	ENCLOSURE SERVICES TRANSFER FAILURE	
B	35	04	ENCLOSURE SERVICES TRANSFER REFUSED	
1	37	00	ROUNDED PARAMETER	•
5	39	00	SAVING PARAMETERS NOT SUPPORTED	•
2	3A	00	MEDIUM NOT PRESENT	•
2	3A	01	MEDIUM NOT PRESENT - TRAY CLOSED	•
2	3A	02	MEDIUM NOT PRESENT - TRAY OPEN	•
6	3B	0D	MEDIUM DESTINATION ELEMENT FULL	•
6	3B	0E	MEDIUM SOURCE ELEMENT EMPTY	•
6	3B	0F	END OF MEDIUM REACHED	
6	3B	11	MEDIUM MAGAZINE NOT ACCESSIBLE	•
6	3B	12	MEDIUM MAGAZINE REMOVED	•
6	3B	13	MEDIUM MAGAZINE INSERTED	•
6	3B	14	MEDIUM MAGAZINE LOCKED	•
6	3B	15	MEDIUM MAGAZINE UNLOCKED	•
4	3B	16	MECHANICAL POSITIONING OR CHANGER ERROR	•
5	3D	00	INVALID BITS IN IDENTIFY MESSAGE	
2	3E	00	LOGICAL UNIT HAS NOT SELF-CONFIGURED YET	
4	3E	01	LOGICAL UNIT FAILURE	
4	3E	02	TIMEOUT ON LOGICAL UNIT	
6	3F	00	TARGET OPERATING CONDITIONS HAVE CHANGED	•
6	3F	01	MICROCODE HAS BEEN CHANGED	•
6	3F	02	CHANGED OPERATING DEFINITION	•
6	3F	03	INQUIRY DATA HAS CHANGED	•
4	40	NN	DIAGNOSTIC FAILURE ON COMPONENT NN (80H-FFH)	•
5	43	00	MESSAGE ERROR	
4	44	00	INTERNAL TARGET FAILURE	•
B	45	00	SELECT OR RESELECT FAILURE	
4	46	00	UNSUCCESSFUL SOFT RESET	
4	47	00	SCSI PARITY ERROR	
B	48	00	INITIATOR DETECTED ERROR MESSAGE RECEIVED	
B	49	00	INVALID MESSAGE ERROR	

Sense Key	ASC	ASCQ	Description
4	4A	00	COMMAND PHASE ERROR
4	4B	00	DATA PHASE ERROR
4	4C	00	LOGICAL UNIT FAILED SELF-CONFIGURATION
B	4D	NN	TAGGED OVERLAPPED COMMANDS (NN = QUEUE TAG)
B	4E	00	OVERLAPPED COMMANDS ATTEMPTED
3	51	00	ERASE FAILURE
3	51	01	ERASE FAILURE - INCOMPLETE ERASE OPERATION DETECTED
4	53	00	MEDIA LOAD OR EJECT FAILED
5	53	02	MEDIUM REMOVAL PREVENTED
5	55	00	SYSTEM RESOURCE FAILURE
3	57	00	UNABLE TO RECOVER TABLE-OF-CONTENTS
6	5A	00	OPERATOR REQUEST OR STATE CHANGE INPUT
6	5A	01	OPERATOR MEDIUM REMOVAL REQUEST
6	5A	02	OPERATOR SELECTED WRITE PROTECT
6	5A	03	OPERATOR SELECTED WRITE PERMIT
6	5B	00	LOG EXCEPTION
6	5B	01	THRESHOLD CONDITION MET
6	5B	02	LOG COUNTER AT MAXIMUM
6	5B	03	LOG LIST CODES EXHAUSTED
1	5D	01	FAILURE PREDICTION THRESHOLD EXCEEDED – Predicted Media failure
1	5D	02	LOGICAL UNIT FAILURE PREDICTION THRESHOLD EXCEEDED
1	5D	03	FAILURE PREDICTION THRESHOLD EXCEEDED – Predicted Spare Area Exhaustion
1	5D	FF	FAILURE PREDICTION THRESHOLD EXCEEDED (FALSE)
6	5E	00	LOW POWER CONDITION ON
6	5E	01	IDLE CONDITION ACTIVATED BY TIMER
6	5E	02	STANDBY CONDITION ACTIVATED BY TIMER
6	5E	03	IDLE CONDITION ACTIVATED BY COMMAND
6	5E	04	STANDBY CONDITION ACTIVATED BY COMMAND
5	63	00	END OF USER AREA ENCOUNTERED ON THIS TRACK
5	63	01	PACKET DOES NOT FIT IN AVAILABLE SPACE
5	64	00	ILLEGAL MODE FOR THIS TRACK
5	64	01	INVALID PACKET SIZE
4	65	00	VOLTAGE FAULT

Notes:

1. All values are in hexadecimal
2. When no value for SK is given, the error is applicable to multiple sense keys.

Sense Key	ASC	ASCQ	Description
4	4A	00	COMMAND PHASE ERROR
4	4B	00	DATA PHASE ERROR
4	4C	00	LOGICAL UNIT FAILED SELF-CONFIGURATION
B	4D	NN	TAGGED OVERLAPPED COMMANDS (NN = QUEUE TAG)
B	4E	00	OVERLAPPED COMMANDS ATTEMPTED
3	51	00	ERASE FAILURE
3	51	01	ERASE FAILURE - INCOMPLETE ERASE OPERATION DETECTED
4	53	00	MEDIA LOAD OR EJECT FAILED
5	53	02	MEDIUM REMOVAL PREVENTED
5	55	00	SYSTEM RESOURCE FAILURE
3	57	00	UNABLE TO RECOVER TABLE-OF-CONTENTS
6	5A	00	OPERATOR REQUEST OR STATE CHANGE INPUT
6	5A	01	OPERATOR MEDIUM REMOVAL REQUEST
6	5A	02	OPERATOR SELECTED WRITE PROTECT
6	5A	03	OPERATOR SELECTED WRITE PERMIT
6	5B	00	LOG EXCEPTION
6	5B	01	THRESHOLD CONDITION MET
6	5B	02	LOG COUNTER AT MAXIMUM
6	5B	03	LOG LIST CODES EXHAUSTED
1	5D	01	FAILURE PREDICTION THRESHOLD EXCEEDED – Predicted Media failure
1	5D	02	LOGICAL UNIT FAILURE PREDICTION THRESHOLD EXCEEDED
1	5D	03	FAILURE PREDICTION THRESHOLD EXCEEDED – Predicted Spare Area Exhaustion
1	5D	FF	FAILURE PREDICTION THRESHOLD EXCEEDED (FALSE)
6	5E	00	LOW POWER CONDITION ON
6	5E	01	IDLE CONDITION ACTIVATED BY TIMER
6	5E	02	STANDBY CONDITION ACTIVATED BY TIMER
6	5E	03	IDLE CONDITION ACTIVATED BY COMMAND
6	5E	04	STANDBY CONDITION ACTIVATED BY COMMAND
5	63	00	END OF USER AREA ENCOUNTERED ON THIS TRACK
5	63	01	PACKET DOES NOT FIT IN AVAILABLE SPACE
5	64	00	ILLEGAL MODE FOR THIS TRACK
5	64	01	INVALID PACKET SIZE
4	65	00	VOLTAGE FAULT

Notes:

3. All values are in hexadecimal
4. When no value for SK is given, the error is applicable to multiple sense keys.

Sense Key	ASC	ASCQ	Description
5	6F	00	COPY PROTECTION KEY EXCHANGE FAILURE – AUTHENTICATION FAILURE
5	6F	01	COPY PROTECTION KEY EXCHANGE FAILURE – KEY NOT PRESENT
5	6F	02	COPY PROTECTION KEY EXCHANGE FAILURE –KEY NOT ESTABLISHED
5	6F	03	READ OF SCRAMBLED SECTOR WITHOUT AUTHENTICATION
5	6F	04	MEDIA REGION CODE IS MISMATCHED TO LOGICAL UNIT REGION
5	6F	05	LOGICAL UNIT REGION MUST BE PERMANENT/REGION RESET COUNT ERROR
3	72	00	SESSION FIXATION ERROR
3	72	01	SESSION FIXATION ERROR WRITING LEAD-IN
3	72	02	SESSION FIXATION ERROR WRITING LEAD-OUT
5	72	03	SESSION FIXATION ERROR – INCOMPLETE TRACK IN SESSION
5	72	04	EMPTY OR PARTIALLY WRITTEN RESERVED TRACK
5	72	05	NO MORE TRACK RESERVATIONS ALLOWED
3	73	00	CD CONTROL ERROR
1	73	01	POWER CALIBRATION AREA ALMOST FULL
3	73	02	POWER CALIBRATION AREA IS FULL
3	73	03	POWER CALIBRATION AREA ERROR
3	73	04	PROGRAM MEMORY AREA UPDATE FAILURE
3	73	05	PROGRAM MEMORY AREA IS FULL
3	73	06	RMA/PMA IS ALMOST FULL

Notes:

1. All values are in hexadecimal
2. When no value for SK is given, the error is applicable to multiple sense keys.

Annex G Features and Profiles (Informative)

G.1 What Is a Feature?

A Feature is an atomic unit of functionality.

The descriptions of Features in this document appear complex, however, these descriptions describe almost nothing new; they are simply the descriptions of existing legacy behavior. The only new parts are the descriptors themselves that are either static identification blocks or groups of information that the Logical Unit shall already have to operate, even in a legacy behavior. For example, a Logical Unit shall internally identify whether or not a PLAY AUDIO command may succeed; Features are simply a way to let the Initiator 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, an Initiator can first determine if the “right” driver is available by examining the Profiles. If “the” right driver isn’t available, the Initiator can identify operable subsets when multiple Profiles are reported. Finally, the Initiator can identify basic functions to use the device via the Feature reporting

G.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 Logical Unit 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 Initiator (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 Initiator 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 Logical Unit 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, Initiators 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 Logical Unit 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.

G.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 Initiator 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 Logical Unit (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 Logical Unit 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. It is important for the Initiator to know which operations function with the Logical Unit at any given moment. Preemptive reporting of Feature changes greatly eases Initiator implementations by reducing the number of error conditions that need to 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.

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 Logical Unit 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 shall interact well to provide seamless and solid support. Feature reporting provides a method for clean interaction.

G.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 shall 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 shall not return CHECK CONDITION status to report a unit attention condition. Any pending unit attention condition for which a corresponding event is reported shall not be cleared for the drive.

G.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 Initiator 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 H Event Reporting Using GESN (Informative)

Annex I Power Management (Informative)

I.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 (Table F.1) 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 shall 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 F.1 – 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 Initiator may remove Vcc.

Transitions between these power states may occur at the request of the Initiator 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 Initiator to request the Logical Unit to enter a power state.

- GET EVENT/STATUS NOTIFICATION command. Notifies the Initiator 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.

I.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 Initiator. 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 GET EVENT/STATUS NOTIFICATION 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 Initiator 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 Initiator 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 Initiator may completely remove power from the device by turning off Vcc.

I.3 Power Management State Diagram

The state diagram, Figure F.1, defines 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 F.2 shows transition conditions for this model, and shows the Initial state, the Resultant state, Notification class, and Event class (Media or Power Management). Notification class and Event class (Power Event/Media Event) 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 that 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 Initiator 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 Initiator, when a new event is generated, the Logical Unit may choose only to report the most recent power event.

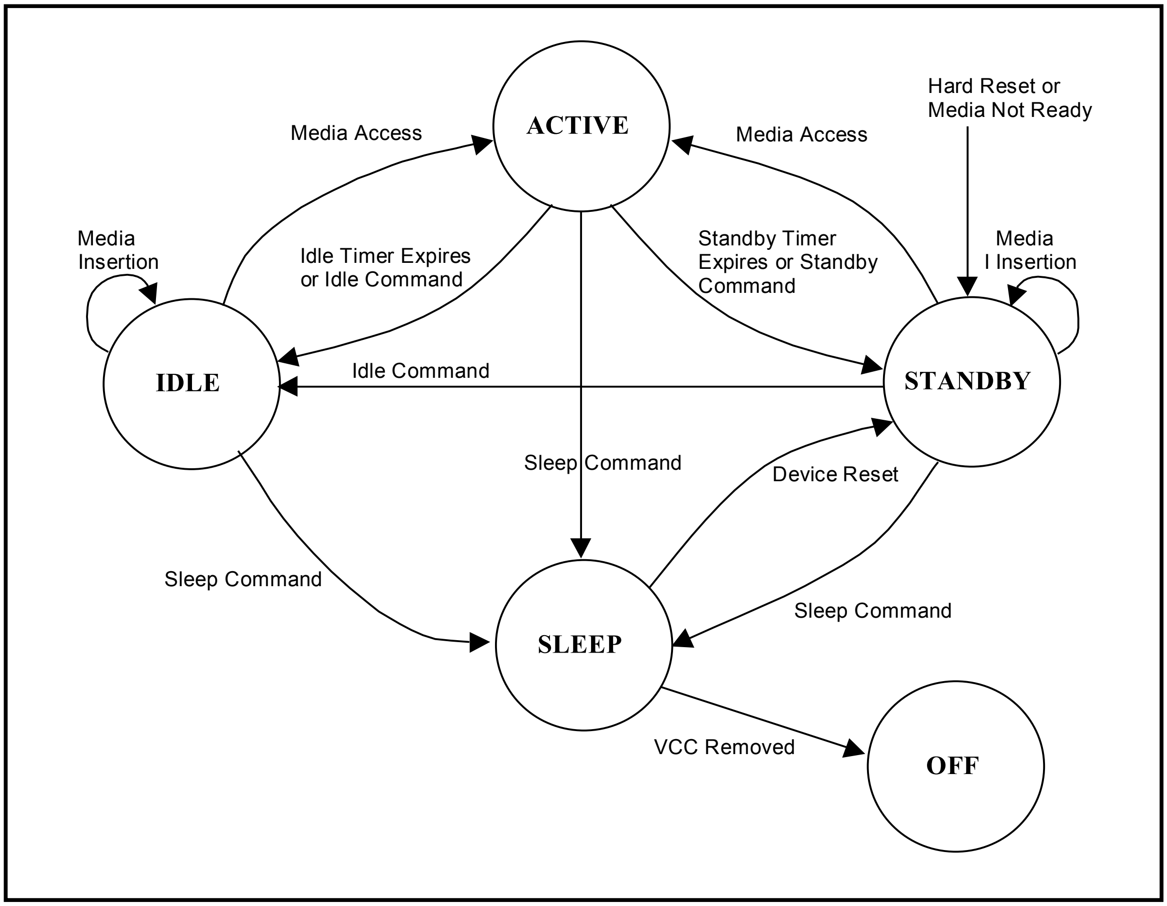


Figure F.1 – Power Management STATE Diagram

I.4 Power Management Timers

The Idle and Standby timers provide a method for the Logical Unit to enter lower power states after an Initiator programmable period of inactivity, without direct Initiator command.

A timer is deactivated (no longer used by the Logical Unit, regardless of Enable / Disable setting provided from the Initiator) 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 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 the default condition 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.

I.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 F.2 – 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 that 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 that 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

Commands issued by the Initiator shall have an effect on the timers implemented by the Logical Unit. The effect is defined in Table F.3.

Table F.3 – Effects of Initiator Commands on Timers

Initiator Command Issued	Timer Effects	Comments
BLANK	Reload Both	Recordable only
CHANGE DEFINITION	None	
CLOSE TRACK	Reload Both	Recordable only
COMPARE	Reload Both	SCSI only
EXCUTE LOGICAL UNIT DIAGNOSTIC	Reload Both	ATA command
SYNCHRONIZE CACHE	Reload Both	
FORMAT UNIT	Reload Both	Recordable only
GET CONFIGURATION	None	
GET EVENT/STATUS NOTIFICATION	None	
INQUIRY	None	
LOAD/UNLOAD MEDIUM	Reload Both	
LOCK/UNLOCK CACHE	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	
PREFETCH	Reload Both	SCSI only
PREVENT ALLOW MEDIUM REMOVAL	Reload Standby	
READ (12)	Reload Both	
READ BUFFER	Reload Standby	
READ CD/DVD CAPACITY	Reload Both	
READ CD	Reload Both	
READ CD MSF	Reload Both	
READ DISC INFORMATION	Reload Both	
READ DVD STRUCTURE	Reload Both	
READ FORMATTABLE CAPACITIES	Reload Standby	
READ LONG	Reload Both	SCSI only
READ TRACK INFORMATION	Reload Both	
READ SUB-CHANNEL	Reload Both	
READ TOC/PMA/ATIP	Reload Both	

Table F.3 – Effects of Initiator Commands on Timers (cont.)

Initiator Command Issued	Timer Effects	Comments
RELEASE	None	SCSI only
REPAIR TRACK	Reload Both	Sequential CD/DVD Recordable
REPORT KEY	Reload Both	
GET PERFORMANCE	Reload Both	May need to access media
REQUEST SENSE	None	
RESERVE	None	SCSI only
RESERVE TRACK	Reload Both	Recordable only
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	DVD Recordable
SEND OPC INFORMATION	Reload Both	Recordable only
SET CD 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 (10)	Reload Both	Recordable only
Device Reset	Reload Both	Reset operation, the Logical Unit shall not return to default timer conditions.
Other commands	Vendor Specific	

I.6 Power Management Status Reporting

The POWER STATUS field of the GET EVENT/STATUS NOTIFICATION (Power Management Class) event data shall always report the current Logical Unit power state. This provides a mechanism for the Initiator to query the current Power State, irrespective of state transitions.

Annex J Using MRW Formatted Media (Informative)

J.1 A CD-MRW EXAMPLE

A CD-RW disc is mounted into a MRW capable CD-RW drive. The lead-in ATIP on this disc indicates that the first lead-in begins at 97:38:20 and the last possible lead-out begins at 75:04:12. Suppose the disc is completely formatted as a CD MRW disc.

The MRW format requires that the program area be formatted as a single track of fixed packets with 32 user sectors each. This yields a maximum of 337 812 sectors within the program area (from 00:00:00 to but not including 75:04:12). The first user sector is found at 00:02:00. This means that the first packet overhead invades the track 1 pre-gap by 5 sectors. So, 337 667 sectors may be dedicated to fixed packets. This yields 8 658 packets with 5 sectors remaining (337 812 - (150 - 5) = 39 * 8 658 + 5). The 5 extra sectors are moved into the lead-out.

The GAA requires 32 packets from the beginning of the program area while the STA requires 33 packets at the end of the program area. This leaves 8 658 - 65 = 8593 packets for the DMA. Each SA/DA pair is 144 packets in length. 8 593 = 59*144 + 97, so we may have 59 SA/DA pairs with 97 packets remaining. Of these 97 packets, 8 are reserved for the final SA, leaving 89 packets for the final DA.

The actual number of user sectors in the DMA is 32*(59*136+89) = 25 916.

There are a few significant disc addresses of interest (Table K.1 – MRW Example: Significant Addresses):

Table K.1 – MRW Example: Significant Addresses

MSF	LBA	Significance
00:00:00	-	Start of program area of the disc.
00:02:00	0	First user sector of GAA
00:18:40	1023	Last user sector of GAA
00:18:43	-	Link block separating GAA from DMA
00:22:60	0	First user sector of DMA: First user sector of first packet of first DA
74:48:34	259615	Last user sector of DMA: Last user sector of last packet of last DA
75:04:07	-	Actual lead-out start address: Link block separating last STA packet and lead-out
75:04:12	-	Last possible start time for start of lead-out according to ATIP

After unit attention conditions have been cleared, the initiator may choose to collect information about this disc.

Next, examples of the data returned for:

READ CAPACITY

READ DISC INFORMATION

READ TRACK INFORMATION

READ TOC/PMA/ATIP

J.1.1 READ CAPACITY Command

The READ CAPACITY command response is the last LBA in the address space and the block size.

Table K.2 – MRW Example: Read Capacity Results

Byte	Field	Value when LBA Space = GAA	Value when LBA Space = DMA
0..3	Last LBA	1 023 (3FFh)	259 615 (3F61Fh)
4..7	Block size	2 048 (800h)	2 048 (800h)

Note that regardless of the current LBA Space, the block size is 2 048 bytes (0800h) bytes per sector.

J.1.2 READ DISC INFORMATION Command

The READ DISC INFORMATION command is sent to the drive in order to determine the general status of the disc. The DISC INFORMATION BLOCK is returned.

We examine byte 2, bit 4 (Erasable) first. If this bit is cleared to zero, then the disc is not CD-RW and consequently cannot be MRW. We shall presume that this bit is set to one, indicating that this is CD-RW disc. Next we should check byte 7, bits 1, 0 (BG format status). If the value is 00b, then this disc is not formatted as MRW and furthermore, a MRW format is not in progress.

Let's suppose that BG format status is not 00b. The following table shows the DISC INFORMATION BLOCK contents according to the information known so far:

Table K.3 – MRW Example: Disc Information

Byte	Value	Meaning
0	20h + # OPC bytes	Disc Information Length: At least 32 bytes, but can be longer if OPC information is supported
1		
2	00011110b	General Disc Status: Erasable, Last session is complete session, complete disc
3	1	Number of first track on disc
4	1	Number of sessions
5	1	First track number of last session
6	1	Last track number of last session
7	1x1000mmb	Information Validity: Disc ID is valid, Disc bar code validity - don't care, Unrestricted Use Disc, MRW format is not dirty, Has MRW format in some state
8	20h	Disc Type: CD-ROM XA
9	0	Reserved in the CD case
10	0	Reserved in the CD case
11	0	Reserved in the CD case
12		
13	xxxxxxxxh	Disc Identification: From PMA. This should be recorded when the MRW format begins.
14		
15		
16		Last Session Lead-in Start time: MSF format. For MRW, this is returned as recorded in lead-in ATIP where each BCD encoded value has been converted to binary (hex).
17	00612614h	
18		
19		
20		Last Possible Start Time for Start of Lead-out: MSF format. For MRW, this is returned as recorded in lead-in ATIP where each BCD encoded value has been converted to binary (hex).
21	004B040Ch	
22		
23		
24	xxxxh	Disc Bar Code: Valid only if indicated so in byte 7. If not valid, this field should be zero filled.
25	xxxxh	
...	xxxxh	
31	xxxxh	

Bytes beyond byte 31 are present only if the SEND OPC command is supported.

J.1.3 READ TRACK INFORMATION Command

Next, our initiator sends the READ TRACK INFORMATION command for track 1. The TRACK INFORMATION BLOCK is returned as follows:

Table K.4 – MRW Example: Track Information

Byte	Value	Meaning
0	20h	Track Information Length: 32 for CD discs
1		
2	1	Track Number
3	1	Session Number
4	0	Reserved
5	0000 0111b	Track Status: Track mode is incrementally recorded data, copying is not prohibited
6	10110010b	Track Status: Reserved, not blank, fixed packet, mode 2 sectors
7	000000x0b	Validities: Last recorded address - don't care, next writable address - not valid
8		
9	00000000h	Track Start Address:
10		This is given in LBA format. It is always zero for MRW.
11		
12		
13	00000000h	Next Writable Address:
14		Not valid on fixed packet formatted discs. Should be zero filled.
15		
16		
17	00000000h	Free Blocks:
18		Not valid on fixed packet formatted discs. Should be zero filled.
19		
20		
21	00000020h	Fixed Packet Size:
22		This value is 32 for CD MRW
23		
24		
25	GAA: 1 024	Track Size: This is the number of user sectors in the track.
26	DMA: 259 616	
27		
28		
29	xxxxxxxxh	Last Recorded Address: Not required.
30		
31		

J.1.4 READ TOC/PMA/ATIP Command

The READ TOC/PMA/ATIP command requires that the initiator select one of 6 forms:

form 0: Legacy TOC (from SCSI2)
form 1: Multi-session information
form 2: Full TOC - all information recorded in the lead-in(s), presented in a non-redundant way
form 3: PMA - all information recorded in the PMA, presented in a non-redundant way
form 4: ATIP - disc specific parameters from the disc lead-in, encoded in the ATIP
form 5: CD-TEXT - valid only for CD audio discs

J.1.4.1 Form 0 TOC: SCSI-2 TOC, List of Track Descriptors

Table K.5 shows the expected data returned for the form 0 TOC request.

Table K.5 – MRW Example: Form 0 TOC (SCSI-2 TOC)

Byte	MSF = 0	MSF = 1	Meaning
0	18	18	Data length
1			
2	1	1	First Track number
3	1	1	Last Track Number
TOC Descriptor: Track 1			
0	0	0	Reserved
1	17h	17h	ADR/CONTROL
2	1	1	Track Number
3	0	0	Reserved
4	GAA: 0	GAA: 00:02:00	Track Start Address
5	DMA: 0	DMA: 00:22:60	
6			
7			
TOC Descriptor: Lead-out			
0	0	0	Reserved
1	16h	16h	ADR/CONTROL
2	AAh	AAh	Track Number
3	0	0	Reserved
4	GAA: 1 024	GAA: 00:18:43	Track Start Address
5	DMA: 259 712	DMA: 74:48:37	
6			
7			

J.1.4.2 Form 1 TOC: Multi-Session Information

Table K.6 shows the expected data returned for the form 0 TOC request.

Table K.6 – MRW Example: Form 1 TOC (Multi-Session)

Byte	MSF = 0	MSF = 1	Meaning
0	10	10	Data length
1			
2	1	1	First Complete Session
3	1	1	Last Complete Session
TOC Descriptor: Multi-Session Descriptor			
0	0	0	Reserved
1	17h	17h	ADR/CONTROL
2	1	1	First Track in Last Complete Session
3	0	0	Reserved
4	GAA: 0	GAA: 00:02:00	Start Address of First Track in Last Complete Session
5	DMA: 0	DMA: 00:22:60	
6			
7			

J.1.4.3 Form 2: Full TOC

When the MRW format has completed, form 2 TOC shall be reported as described for other CD formats (seeTable K.7). When the MRW format is not complete, the final TOC has not been recorded. In this case, the drive shall predict the TOC content. Since some addresses may have no consistent LBA representation, only the MSF form is supported. Note that because these are not logical addresses, there is no reference to the LBA Space.

Table K.7 – MRW Example: Form 2 TOC (Full TOC)

Byte	MSF = 1	Meaning
0	xx	Data length
1		
2	1	First Complete Session number
3	1	Last Complete Session Number
		TOC Descriptor: Track 1
0	1	Session Number
1	16h	ADR/CONTROL
2	0	TNO
3	1	POINT: Track number
4		MIN, SEC, FRAME
5	mm:ss:ff	Absolute address of current location
6		
7	0	ZERO
8		PMIN, PSEC, PFRAME
9	00:02:00	Start address of Track
10		
		TOC Descriptor: Point A0
0	1	Session Number
1	16h	ADR/CONTROL
2	0	TNO
3	A0h	POINT
4		MIN, SEC, FRAME
5	mm:ss:ff	Absolute address of current location
6		
7	0	ZERO
8	1	PMIN: First Track Number
9	0	PSEC
10	0	PFRAME

Table K.7 – MRW Example: Form 2 TOC (Full TOC), continued

TOC Descriptor: Point A1		
0	1	Session Number
1	16h	ADR/CONTROL
2	0	TNO
3	A1h	POINT
4	mm:ss:ff	MIN, SEC, FRAME Absolute address of current location
5		
6		
7	0	ZERO
8	1	PMIN: Last Track Number
9	0	PSEC
10	0	PFRAME
TOC Descriptor: Point A2		
0	1	Session Number
1	16h	ADR/CONTROL
2	0	TNO
3	A0h	POINT
4	mm:ss:ff	MIN, SEC, FRAME Absolute address of current location
5		
6		
7	0	ZERO
8	75:05:51	PMIN, PSEC, PFRAME Start time of lead-out
9		
10		
TOC Descriptor: Point C0		
0	1	Session Number
1	16h	ADR/CONTROL
2	0	TNO
3	C0h	POINT
4	xx	MIN: Optimum recording power
5	0	SEC
6	0	FRAME
7	0	ZERO
8	97:38:20	PMIN, PSEC, PFRAME Address of first lead-in according to ATIP
9		
10		

Table K.7 – MRW Example: Form 2 TOC (Full TOC), continued

TOC Descriptor: Point C1		
0	1	Session Number
1	16h	ADR/CONTROL
2	0	TNO
3	C1h	POINT
4	xx	MIN: ATIP Additional information 001, min byte
5	yy	SEC: ATIP Additional information 001, sec byte
6	zz	FRAME: ATIP Additional information 001, frm byte
7	0	ZERO
8	0	PMIN
9	0	PSEC
10	0	PFRAME

J.1.4.4 Form 3: PMA

Reporting of the PMA values is not changed due to the MRW format.

J.1.4.5 Form 4: ATIP

Reporting of the ATIP values is not changed due to the MRW format.

J.1.4.6 Form 5: CD-TEXT

Reporting CD-TEXT data is valid only for CD-DA discs. This form is not valid when a MRW formatted disc is present. If this form is requested, then the drive shall terminate the READ TOC/PMA/ATIP command with CHECK CONDITION status and SK/ASC/ASCQ values shall be set to ILLEGAL REQUEST/INVALID FIELD IN CDB.

J.1.5 READ(10), READ(12), READ CD, WRITE(10), WRITE and VERIFY(10), SEEK(10), VERIFY(10) COMMANDS

Each of these commands requires that the initiator provide a starting LBA and (except SEEK) a transfer length. The limits of the requested range has always been governed by the maximum LBA value returned by the READ CAPACITY command.

When the MRW Mode Page shows the GAA as current LBA Space, all references to sectors within the range 0 through 1023 are valid. If any of the listed commands references a LBA outside that range, then the command shall be terminated with CHECK CONDITION status and SK/ASC/ASCQ values shall be set to ILLEGAL REQUEST/LOGICAL BLOCK ADDRESS OUT OF RANGE.

When the MRW Mode Page shows the DMA as current LBA Space, all references to sectors within the range 0 through 259615 are valid. If any of the listed commands references a LBA outside that range, then the command shall be terminated with CHECK CONDITION status and SK/ASC/ASCQ values shall be set to ILLEGAL REQUEST/LOGICAL BLOCK ADDRESS OUT OF RANGE.

J.2 LEGACY CONSIDERATIONS

This medium could be mounted in several system combinations of Logical Unit and initiator software. Of course, when all parties are aware of MRW formatted CD-RW media, then there should be no misunderstandings. There is an installed base of Logical Units and software that recognizes this medium differently. Each combination is highlighted here. The greatest attention is given to initiator and Logical Unit interaction when the two components are both Mount Rainier capable.

Table K.8 – MRW: Legacy Combinations

<table>
<tr><th colspan="2" rowspan="2">COMBINATIONS</th><th colspan="2">SOFTWARE</th></tr>
<tr><th>Legacy Software System</th><th>MRW Aware Software System</th></tr>
<tr><td rowspan="4">H
A
R
D
W
A
R
E</td><td>Legacy CD-ROM Logical Unit (Multi-read capable)</td><td>1A</td><td>1B</td></tr>
<tr><td>MRW Compliant CD-ROM Logical Unit</td><td>2A</td><td>2B</td></tr>
<tr><td>Legacy CD-RW Logical Unit (at least MMC1)</td><td>3A</td><td>3B</td></tr>
<tr><td>MRW Compliant CD-RW Logical Unit</td><td>4A</td><td>4B</td></tr>
</table>

The Legacy hardware cannot be “too old”. There are some minimal requirements:

- Logical Units shall be minimally compliant with OSTA Multi-read in order to read CD-RW medium.
- Both CD-ROM and CD-RW Logical Units shall be minimally compliant with MMC1.
- A DVD-ROM Logical Unit, which meets the first 2 requirements when CD-RW medium is mounted, may be viewed as an acceptable legacy CD-ROM Logical Unit.

The Legacy software is presumed to be maximally capable with its companion hardware:

- In the case of reading, the legacy system software is capable of reading information stored in standard file systems (e.g. ISO9660, UDF, Joliet).

Note: It is only for the sake of completeness that we describe what might happen in cases 1A, 1B, 3A, and 3B. Nothing can be done within this document to make the legacy situations operate better. That work has been done in the format definition document: MRW Defect Management & Physical Formatting revision 1.0

J.2.1 Combinations 1A, 1B: Legacy CD-ROM Logical Unit

The legacy CD-ROM Logical Unit sees a MRW disc as having a single, closed session that contains a single fixed packet track with length 32 packets. This Logical Unit sees this disc as having a single LBA space that begins at LBA = 0 (00:02:00). The LBAs continue upward, following method 2 addressing (according to Orange Book).

J.2.1.1 With Legacy Software

If no file system was placed within the GAA, then the initiator shall declare that this disc is not initialized in any recognizable way.

If some file system, recognizable by the system software was placed within the GAA, then it exists entirely within the GAA and makes no references into the DMA. No relocations have been made within the GAA, so there is no loss. The file system within the GAA may contain automatic run software that can provide some special function for the user. Minimally, this shall contain information as described in the CD-MRW DM & PF.

J.2.1.2 With Mount Rainier Aware System Software

Note that software which can recognize and read MRW from a legacy Logical Unit is required to operate differently than software which expects a MRW capable Logical Unit:

In the first case, the system software shall perform address translations and defect insertions

In the second case, the Logical Unit already does all LBA translations and defect replacements.

J.2.2 Combinations 2A, 2B: MRW Compliant CD-ROM Logical Unit

When the Logical Unit is capable of correctly reading a MRW disc, the system software initially sees only the LBA Space defined by the DMA. Both legacy and MRW system software sees only the file system installed in the DMA.

The primary difference with a read-only system is GAA access. The legacy software is unaware of the existence of the GAA and cannot understand how to address it. The MRW compliant system software is able to switch addressing to the GAA.

J.2.3 Combinations 3A, 3B: Legacy (MMC1) CD-RW Logical Unit

The legacy CD-RW Logical Unit is unaware of the MRW format and presents the disc to the initiator as a single session with one fixed packet written track in which the packet size is 32 and the block type is mode 2, form 1.

J.2.3.1 With Legacy System Software

With this combination: this Logical Unit can write and the legacy system software knows how to ask it to write.

J.2.3.2 With Mount Rainier System Software

In this case, the Mount Rainier aware software is aware of the unit’s inability to perform defect management and sector-addressable writes, and shall force read-only access to the medium.

J.2.4 Combinations 4A, 4B: MRW Compliant CD-RW Logical Unit

The most important of these combinations is the case where the system software is Mount Rainier aware.

J.2.4.1 With Legacy System Software

Since the system software is not aware of how to enable writing, the Logical Unit effectively becomes a CD-RW Logical Unit.

J.2.4.2 With MRW Aware System Software

Since this represents the future, a great deal of attention needs to be given to how the Logical Unit should implement the updated MMC and how the system software can use the command set to fully utilize the MRW format. This is described from the initiator perspective.

J.2.4.2.1 Determining the Format State of a New Media

When a new medium is mounted, a media event is generated. This event is typically discovered by polling with the Get Event Status Notification command (GESN).

J.2.4.2.2 Case: Discovering that the Media is Formatted/Formatting as a MRW Disc

The GESN poll reports a NewMedia Media Event.

The GESN poll reports NoEvent (no additional Media Events to report).

The GET CONFIGURATION command is issued, and reports CD-RW Profile and MRW Features as current.

The READ DISC INFORMATION command is issued.

It is discovered that the MRW format status is non-zero.

If formatting was started earlier and needs restarting, then the status is 01b.

If formatting was started earlier and is still running, then the status is 10b.

If formatting has completed, then the status is 11b.

J.2.4.2.3 Case: Discovering Blank Media

The GESN poll reports a NewMedia Media Event.

The GESN poll reports NoEvent (no additional Media Events to report).

The GET CONFIGURATION command is issued, and reports CD-RW Profile as current and MRW Feature as not current or not supported.

The READ DISC INFORMATION command is issued.

It is discovered that the media is RW, BLANK, and the MRW state is 00b.

We may now conclude that a format is required before this medium may be used as a MRW disc.

7.4.19.1.1 Case: Discovering Non-Blank Media which is not a MRW disc

The GESN poll reports a NewMedia Media Event.

The GESN poll reports NoEvent (no additional Media Events to report).

The GET CONFIGURATION command is issued, and reports CD-RW Profile as current and MRW Feature as not current or not supported.

The READ DISC INFORMATION command is issued.

It is discovered that the media is RW, not BLANK, and the MRW state is 00b.

It may now be concluded that a new format is required before this medium may be used as a CD-MRW disc.

When the time arises to access a disc for writing, the initiator must be aware of whether or not this disc should be formatted.

J.2.5 Doing the Format

If it is determined that the currently mounted medium requires formatting before it may be used, and the user desires to format the medium, then:

The parameter list for a FORMAT UNIT command is initialized for Format Type 24h, MRW. We prefer to have the IMMED bit cleared to zero. The FORMAT UNIT command is then issued. The FORMAT UNIT command should not terminate until the track 1 PMA entry, the track 1 pre-gap, the GAA and the first SA have been written. This assures no waiting for additional action before writes are accepted. The total elapsed time for a Logical Unit with 4x write capability is less than 10 seconds.

The initiator writes file system structures for initialization, as required.

If the Format completes, the GESN poll reports a BGformatCompleted Media Event.

If our user wishes to remove the medium, and no BGformatCompleted Media Event has been seen, a CLOSE TRACK/SESSION command is issued to stop the background formatting. For a 4x writing system, the medium is ejected within 1 minute after the user's media removal request was noted.

J.2.5.1 Writing User Data to the Medium During Background Format

Once the FORMAT UNIT command has completed, the initiator may issue WRITE(10) commands for the purpose of initializing the logical volume (e.g. writing initial file system structures). That is, the initiator is not required to perform any special functions or sequences of functions in order to write to the medium. But note: When reading this medium Read(10) and Read(12) commands are guaranteed to be accepted. The initiator should check the CD READ feature to determine if the READ CD and/or READ CD MSF commands are supported.

Note that in order to write the GAA, the initiator is required to first select the GAA address space using the MRW Mode Page.

J.2.5.2 Completing a Format

Suppose that a disc was mounted and our medium identification discovered a disc with incomplete background format. We may issue a new FORMAT UNIT command with the Format Descriptor that indicates that we only wish to continue the background format. There are good reasons to NOT do that.

Suppose a format has begun or a format restart is requested, then sometime after the background part of the format has begun, a CLOSE SESSION is requested in preparation for medium eject. The time required to stop the background format and then close the disc can be up to 30 seconds.

It is possible that a partially formatted disc is mounted only for reading. The initiator knows best when to restart BG format, so the initiator is required to restart the BG format.

J.2.5.3 Early Eject

Above, it was noted that the initiator is in charge of when a BG format is restarted. It follows then, that it is very much the job of the initiator to ensure that the disc is ejected in a usable state. For this reason the Logical Unit must not take independent action to stop the formatting or close the session. However, the Logical Unit is responsible for protecting a BG format, so the Logical Unit is responsible to disallow improper action. The Logical Unit simply disallows media spin-down or ejects when a BG format is in progress. The behavior is described in sub-clause 5.5.2.3.11.