WORKING DRAFT

NCITS XXX
T10/1363-D

INFORMATION TECHNOLOGY -
SCSI Multimedia Commands – 3 (MMC-3)

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Draft Revision 4.0	Includes October Mt Fuji5 changes
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NCITS XXX

for Information Technology –

SCSI Multimedia Commands – 3 (MMC-3)

Secretariat

Information Technology Industry Council

Abstract

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

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

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Requests for interpretation, suggestions for improvement and addenda, or defect reports are welcome. They should be sent to the NCITS 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 (NCITS). Committee approval of this standard does not necessarily imply that all committee members voted for approval. At the time it approved this standard, NCITS had the following members:

To be supplied prior to forwarding to NCITS, Chair

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

To be supplied prior to forwarding to NCITS, Secretary

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Multimedia Command Set - 3 (MMC-3)

1 Scope

This standard defines multimedia command set extensions for Device Type 5 devices. The commands specified within this standard define standard access and control to those Features of the device that are used in multimedia applications.

The SPC and these extensions are 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 Fibre Channel, SCSI Parallel Interface, High Performance Serial Bus (IEEE 1394), Serial Storage Architecture, and ATA/ATAPI.

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 SCSI devices employed in multimedia applications.

- System software/firmware independence across device classes and physical interfaces. Thus, different tape drives, optical media drives, and other devices can be added to the system without requiring modifications to generic system hardware and software. Provision is made for the addition of special Features and functions through the use of vendor-specific options. Reserved Op-codes are provided for future standardization.

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

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

ANSI Standard NCITS.336:2000	SCSI Parallel Interface 3 (SPI-3)
ANSI Standard X3.301:1997	SCSI-3 Primary Commands (SPC)
ANSI Standard X3.304:1997	SCSI-3 MultiMedia Command Set (MMC-1)
ANSI Standard NCITS.33:2000	SCSI-3 MultiMedia Command Set (MMC-2)
ANSI Standard NCITS.306:1998	SCSI-3 Block Command Set (SBC)
ANSI Standard NCITS.314:1998	SCSI-3 Medium Changer Commands (SMC)
ANSI Standard NCITS.325:1998	Serial Bus Protocol - 2 (SBP-2)
ANSI Standard NCITS.317:1998	AT Attachment with Packet Interface 4 (ATA/ATAPI-4)
ISO/IEC 3901	International Standard Recording Code (ISRC)
ISO/IEC 10149	Information Technology-Data Interchange on Read-only 120 mm Optical Data Discs (CD-ROM).
ISO/IEC 16448	120mm DVD Read-Only-Media (DVD-ROM)
ISO/IEC 16449	80mm DVD Read-Only-Media (DVD-ROM)
ISO/IEC 16824	120 mm DVD ReWritable Disc (DVD-RAM)
IEC 908:1987	Compact Disc Digital Audio System.
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.

NCITS T10/1383-D	SCSI-3 Medium Changer Commands 2 (SMC-2)
NCITS T10/1236D	SCSI Primary Command Set - 2 (SPC-2)
NCITS T13/1321D	AT Attachment with Packet Interface 5 (ATA/ATAPI-5)

For more information on the current status of the above documents, contact NCITS 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 NCITS 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

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

Multimedia Command Set Modifications for the MRW Format, revision 1.0, Mount Rainier Promoters Group, January 2001, published by Philips Electronics NV

Mt. Fuji4 Commands for Multi-Media devices T10/99-121R1

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, DVD+RW Promoters Group, revision 1.0, March 2001, published by NV Philips

Multimedia Command Set Modifications for DVD+RW Formats, DVD+RW Promoters Group, revision 1.0, March 2001, published by NV Philips

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 media.

3.1.2   AGID (Authentication Grant ID)

A value used for resource control during key management. Individual key management threads are identified through the use of AGID.

3.1.3   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.

3.1.7   ATAPI (AT Attachment Packet Interface)

A device that complies with NCITS.317:1998, the AT Attachment Packet Interface. In this document such devices are referred to as devices implementing the Packet command Feature set.

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.

3.1.9   BCA (Burst Cutting Area)

Provides a unique physical identification mark for individual DVD medium. This area is not directly addressable by the user.

3.1.10   BCD (Binary Coded Decimal)

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

3.1.11   Bootable CD

A CD that has boot records recorded is bootable.

3.1.12   Bordered Area

A recorded area of DVD-R media. See 4.5.3.2.

3.1.13   CD/DVD Media

Term that is used when referring to media that conforms to the CD, DDCD or DVD specifications.

3.1.14   CDB (Command Descriptor Block)

The structure used to communicate commands from an Initiator to CD/DVD Logical Units.

3.1.15 CD (Compact Disc)

A family of related optical storage media.

3.1.16 CD-DA (Compact Disc-Digital Audio)

The standard for storing digital audio information. See IEC 908:1987.

3.1.17 CD-R (CD Recordable)

A CD that can be written only once.

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

A standard for storing digitized audio and digital data. CD-ROM is used to describe media with digital data rather than discs that encode audio only.

3.1.19 CD R/RW (either a CD-R, or a CD-RW, or both)

3.1.20 CD-RW (CD ReWritable)

A CD that can be re-written.

3.1.21 CD-Text

A method for storing text information on CD-DA disc

3.1.22 Challenge key

Data used during an authentication key exchange process.

3.1.23 Command Packet

"Command Packet" is a structure used to communicate commands from an Initiator to a CD/DVD device. See Command Descriptor Block.

3.1.24 complete session

A session that contains a completed (written) Lead-in and Lead-out area. In DVD-R a complete session contains a completed Border-In, and a Border-out.

3.1.25 control field

A 4-bit field in the Q Sub-channel data indicating the type of information encoded on the current track. Indicates audio versus data and the type of audio encoding, etc. The control field is also found in the Table of Contents entries.

3.1.26 CPPM (Content Protection for Prerecorded Media)

A system for protecting DVD-Audio content on DVD-ROM media

3.1.27 CPRM (Content Protection for Recordable Media)

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 a CD. The CIRC bytes are present in all CD modes. The error correction procedure that uses the CIRC bytes is referred to as the CIRC based algorithm.

3.1.29 CSS (Content Scrambling System)

An encryption system for content protection of DVD-video.

3.1.30 DA (Data Area)

On a MRW disc these are the 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

A byte in the header of CD data sectors. This indicates if data is present and if layered error correction information is present. This is also applicable to DDCD data sectors.

3.1.32   DDCD (Double Density Compact Disc)

A family of related optical storage media with density double that of CD media.

3.1.33   DDCD-R (DDCD Recordable)

A DDCD that can be written only once.

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

A standard for storing digital data.

3.1.35   DDCD R/RW (either a DDCD-R, or a DDCD-RW, or both)

3.1.36   DDCD-RW (DDCD ReWritable)

A DDCD that can be re-written.

3.1.37   Defect Management

A method for providing apparent error free media.

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. In the case of CD-RW, if there is no closed session, a read-only device cannot find the data groove.

3.1.39   Direct-overwrite

The process, or capability of writing over previously written data without an erase cycle.

3.1.40   Disc Key

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. The primary storage space of the DMA is the collection of DAs while the replacements for defective sectors from the DA comes from the collection of SAs.

3.1.42   Double Sided

A medium with two independently addressed sides.

3.1.43   Dual Layer

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

3.1.44   DVD

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

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

3.1.48   DVD-R (DVD Recordable)

A DVD medium that can be written once.

3.1.49   DVD-RAM (DVD-Random Access Memory)

A DVD that can be re-written.

3.1.50   DVD-ROM (DVD-Read Only Memory)

A standardized medium defined by the DVD specification for recording digital data, including digital video movie data.

3.1.51   DVD+RW (DVD ReWritable)

indicates a DVD that can be re-written.

3.1.52   DVD-RW (DVD Re-recordable)

indicates a DVD that can be re-written.

3.1.53   EAN (European Article Number)

Controlled by the EAN International located at 145 rue Royale B, 1000 Brussels, Belgium. See MCN.

3.1.54   ECC (Error Correction Code)

A code for detecting and correcting errors.

3.1.55   EDC (Error Detection Code)

A code for detecting an error.

3.1.56   EFM (Eight bit to Fourteen bit Modulation code)

EFM is the modulation code used in all CD recording.

3.1.57   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.

3.1.58   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.

3.1.59   Fixed Packet Track

a track that contains a TDB indicating that the track is a fixed track, and has user packets of a fixed size specified in the TDB.

3.1.60   Format

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

3.1.61   Frame

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

3.1.62 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 exists a legacy link to CD-RW formats which have LBA = 0 assigned to 00:02:00.

3.1.63 Hex

Indicates a binary value represented in base 16. This value may extend across multiple bytes.

3.1.64 HMSF address (Hour/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 60. Valid contents of H fields are binary values from 0 through 2.

3.1.65 Hold Track State

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

3.1.66 ID (Identification Data)

A 4-byte field in the header of DVD sectors that contains sector information and a physical sector number.

3.1.67 IED (ID Error Detection)

A code for detecting errors in an ID field.

3.1.68 Incomplete session

A session without Lead-in and Lead-out written.

3.1.69 Index

An index is a subdivision of a track.

3.1.70 Layer

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

3.1.71 Lead-in

On CD media it is the area that contains the TOC data and precedes each program area. The main channel in the Lead-in area contains audio or data null information. This area is coded as track zero. The Q Sub-channel in this area is coded with the Table of Contents information.

The DVD Lead-in area is the area comprising physical sectors 1.2 mm wide or more adjacent to the inside of the Data area. The area contains the Control data and precedes the Data area.

3.1.72 Lead-out

On CD media it is the area that follows each program area. The main channel in the Lead-out area contains audio or data null information. This area is coded as track 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

3.1.73   OTP (Opposite Track Path)

3.1.74   L-EC (Layered Error Correction)

The second level of error correction used on CD data.

3.1.75   Logical Block

An Initiator addressable unit of data.

3.1.76   LBA (Logical Block Address)

The LBA defines a mapping mode to a linear address space.

3.1.77   Logical Unit

This is a physical or virtual peripheral device addressable through a target.

3.1.78   LUN (Logical Unit Number)

The address of a Logical Unit.

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 an area of the disc lead-in called the MTA.

3.1.82   Medium

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

This is the LBA translation method for CD-MRW formatted media. Method 3 is an extension of method 2. See 4.3.1.1.

3.1.86   Middle Area

Area comprising physical sectors 1.0 mm wide or more adjacent to the outside of the Data Area in

3.1.87   OTP (Opposite Track Path)

disc on both layers of DVD media.

3.1.88   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.

3.1.89   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.

3.1.90   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.

3.1.91   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.

3.1.92   MTA (Main Table Area)

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

3.1.93   OPC (Optimum Power Calibration)

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

3.1.94   OTP (Opposite Track Path)

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

3.1.95   output port

A means for connecting to data ports other than the Initiator interface.

3.1.96   PTP (Parallel Track Path)

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

3.1.97   Packet

A packet is a set of recorded link, run-in, data, and run-out blocks. Typical packet is shown in Figure 11.

3.1.98   packet size

the number of Data Blocks in the packet.

3.1.99   packet track

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

3.1.100   Physical Sector Number

A unique address assigned to a physical location and is not modifiable.

3.1.101   post-gap

 A transition area located at the end of a data track.

3.1.102   pre-gap

 A transition area located at the beginning of a data track.

3.1.103 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.

3.1.104 Program Area(s)

a logical address space.

3.1.105 PMA (Program Memory Area)

Contains information about the recordings on a Recordable disc.

3.1.106 Regional Code

A value used to identify one or more regions of the world. Currently there are six regions defined.

3.1.107 Region Playback Control (RPC)

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

3.1.108 relative MSF field

See MSF address definition.

3.1.109 Rzone

An RZone is a logical subdivision of a DVD-R, similar to a Track on CD.

3.1.110 SA (Spare Area)

Each MRW DA is preceded by an associated 8 packet zone which is reserved as the primary spares space for the DA that it precedes. Each of these is a Spares Area.

3.1.111 Scramble Flag

An indication that there is scrambled data on the media.

3.1.112 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.

3.1.113 Sector

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

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

3.1.114 Session

A contiguous area of the Disc that contains a Lead-in, Program Area, and Lead-out.

3.1.115 Single Sided

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

3.1.116 Small Frame

1/98 of a frame.

3.1.117 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.

3.1.118   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.

3.1.119   STA (Secondary Table Area)

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

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

3.1.121   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.

3.1.122   Title Key

A value used during the scrambling process of movie data on DVD media.

3.1.123   Table of Contents (TOC)

The TOC has information on the type of session and the starting address of the tracks. This information is encoded in the Q Sub-channel in the Lead-in area.

3.1.124   Track Descriptor Block (TDB)

Contains information on the attributes of the current track.

3.1.125   Track

A track is logical sub-division of the media.

3.1.126   Track at Once

When a track, including its pre-gap, is written as a single packet.

3.1.127   transition area

Sectors at the beginning or end of tracks e.g. Pause Area, Pre-Gap, Lead-out, Post-Gap.

3.1.128   UPC (Uniform Product Code)

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

3.1.129   user packet

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

3.1.130   writable disc

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

3.1.131   Yellow book

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

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 indicating items that were defined in prior version of this standard are intended to be removed from future version of this standard.

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 with each media type. Finally, 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 and 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 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 CD/DVD 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.

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

4.1.2   Data cache

Some 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 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 ATA/ATAPI, SPI, SBP-2, and FCP see the appropriate Annexes 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.

If any of the conditions in Table 1 occur during the execution of a command, the target shall return CHECK CONDITION status. The appropriate SK/ASC/ASCQ values should be set. The following list illustrates some error conditions and the applicable sense keys. The list does not provide an exhaustive enumeration of all conditions that may cause the CHECK CONDITION status.

Table 1 - Sense key responses for error reporting

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

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

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

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

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

b)   a post-gap area is encountered.

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

When the command is other than an audio playback operation, and the Logical Block Address requested is not within a data track, the command shall be terminated with CHECK CONDITION status and SK/ASC/ASCQ shall be set to ILLEGAL REQUEST/ILLEGAL MODE FOR THIS TRACK. This applies to audio-combined and audio media.

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. Such commands are associated with use of the immediate bit, with some forms of caching. CD/DVD 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 CD/DVD Logical Unit detects a deferred error condition on a Logical Unit, it shall return a deferred error according to the rules described below:

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

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

4.2   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	1 byte of Sub-channel data	12 bytes of main channel data	4 bytes of CIRC code	12 bytes of main channel data	4 bytes of CIRC code
(24 + 3 bits)	(14 + 3 bits)	(12 x (14 + 3) bits)	(4 x (14 + 3) bits)	(12 x (14 + 3) bits)	(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	
•	•	•
•	•	•
•	•	•

Small Frame	P Bit	P Byte
•	•	•
•	•	•
•	•	•
83	7	10
84	6	
85	5	
86	4	
87	3	
88	2	
89	1	
90	0	11
91	7	
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
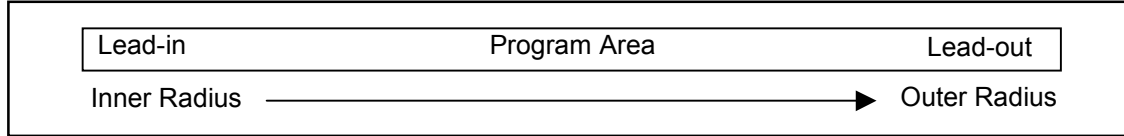
Figure 1 – Single Session disc

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
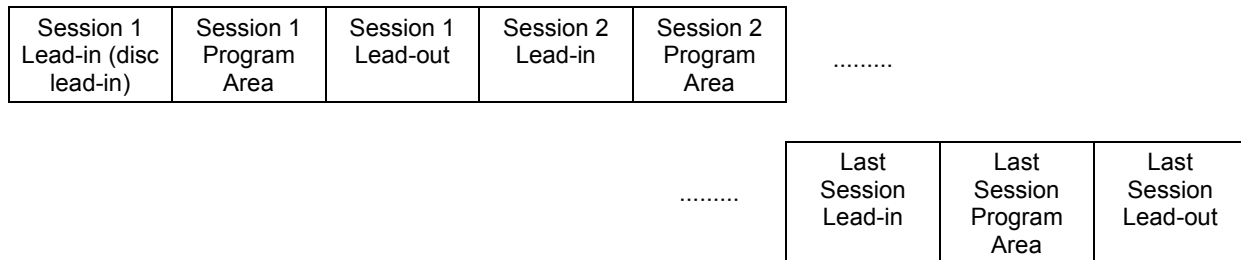
Figure 2 – Multi-Session Recorded Disc

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 1Q 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

1.1.1.1.1   Block Format for Audio

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

4.2.3.7.1   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)

4.2.3.7.2   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 - 2063
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.

4.2.3.7.3   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.

4.2.3.7.3.1   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

4.2.3.7.3.2   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 - 2071
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 form 1 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		

4.2.3.7.3.3   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 - 2347

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) (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.
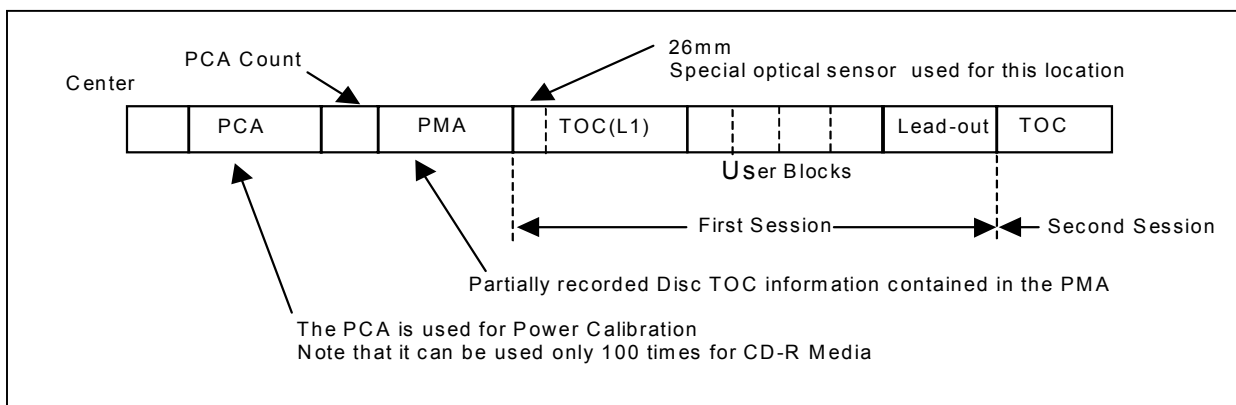
Figure 9 – CD-R and CD-RW medium

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	One or more Track Descriptor Unit(s) (TDU)							
:								
n								

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 CD/DVD 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 CD/DVD Capabilities & Mechanical Status Mode Page (2Ah) or GET PERFORMANCE Command are used to identify the Logical Unit's capability for the mounted media.

Host 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
PLAY CD	BCh	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 5.5). For legacy implementations, if any commands related to audio operations are implemented, then the PLAY AUDIO (10) command (sub-clause 5.11) 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

The Mount Rainier Technical Group is an industry organization that has defined a defect managed format for standard CD-RW media. The format is named CD-MRW (Mount Rainier RW). Details of the disc format are found in *CD-MRW Defect Management & Physical Formatting* (see sub-clause 2.2).

From the perspective of the CD-RW System Description, the entire capacity of a MRW disc consists of a single session containing a single track of 32 sector fixed packets.

Lead-in	Track 1: 32 Sector Fixed packets	Lead-out
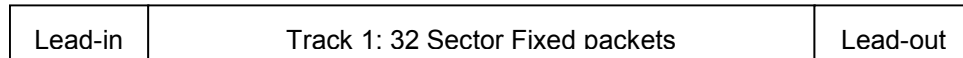
Figure 12 – Track/Session Structure of a CD-MRW Disc

There are differences.

4.2.8.1   Additional Structure

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

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). 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.
Program Area, Part A	Track 1 pre-gap has a fixed size of 150 sectors. The TDB identifies the track as a fixed packet track with packet size = 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 (2 MB of user space).
Program Area, Parts Cx	The Defect Managed Area (DMA) consists of DMA segments, Cx. Each Cx consists of a spares area (SA) followed by a data area (DA). Each SA shall contain 8 packets. Each DA within C1, C2, …, Cn-1, shall 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

Figure 13 – The Additional Structure of CD-MRW

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 $R \leq 8$, 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 pre-MRW disc.

The GAA is available for compatibility with older systems. The GAA LBA space is 0, 1, 2, 3, …, 1023d. Note that LBAs for the GAA exactly match LBAs for a similarly formatted pre-MRW disc.

4.2.8.1.1 Addressing

When method 2 addressing is used, the LBA of the first sector of the DMA is (32 + 8)*32 = 1 280d. Table 20 shows the inequities with method 2 LBA references:

Table 20 – Method 2/Method 3 Addressing Comparison

Method 2 LBA	MRW LBA	Method 2 LBA	MRW LBA	Method 2 LBA	MRW LBA
0	GAA 0	1 280	DMA 0	5 888	DMA 4 352
1	GAA 1	1 281	DMA 1	5 889	DMA 4 353
2	GAA 2	1 282	DMA 2	5 890	DMA 4 354
.	.	.	.	.	.
.	.	.	.	.	.
1 023	GAA 1 023	5 631	DMA 4 351	10 239	DMA 8 703

The GAA addressing is identical to traditional addressing. The new method of addressing sectors in the DMA is named "method 3 addressing" in the CD-MRW Defect Management & Physical Formatting.

There is a small problem: there are two LBA spaces where formerly there was only one. The MRW Mode Page is used a the method of specific address space selection. The host may toggle between address spaces (DMA and GAA) by changing the logical unit's reference in the MRW Mode Page.

4.2.8.1.2 Host Requests/Logical unit Responses

The host may view the MRW disc as a removable magnetic medium with a 2 048 byte sector size. This means that the random read capability of MMC is to be maintained and expanded to include the MRW disc.

Additionally, random write capability shall be added specifically for the MRW disc. Within the logical unit, only the writing of 32 sector fixed packets is allowed. MMC-1 and MMC-2 logical units share this restriction with their hosts. When MRW disc is present, the MRW compliant logical unit does not share this restriction with its host. This is a simple matter of implementing a read/modify/write for packets.

4.2.8.1.3 GAA Contents

Since devices not compliant with this model will be able to present the GAA accurately, it is recommended that the GAA be formatted as a ISO 9660 volume containing no directories and exactly one file named: Read-me.txt with the following contents:

> This document is defined in size and content by the Mt. Rainier technical group, for the support of the CD-MRW format.

> If you have a system manufactured before 2002, you will need to contact your PC system or operating system manufacturer for appropriate software to read this format. Links to supporting software vendors can be found at www.mt-rainier.org.

> If your system's optical drive carries the CD-MRW logo, and you are seeing this content, please contact your PC system or optical drive manufacturer directly.

4.2.8.1.4   Background Formatting

Most of the process for formatting a CD-RW disc into the MRW format is performed in background. During this background formatting process, the disc is available for both read and write access within the LBA Space as it exists after formatting has completed. The MRW capable drive shall perform the necessary tasks to ensure this access.

The user may wish to remove the disc prior to format completion. This is allowed; however, it is required that the medium is written in such a way as to ensure read compatibility with Multi-read capable, read-only devices. This requires that the disc be closed. The format begins again when a host arranges for the format to be restarted.

4.2.8.2   Streamed Writing

The *CD-RW Defect Management & Physical Formatting revision 1.1* defines the method for streamed writing on CD-MRW formatted discs. 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.

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 or read in a streamed way.

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

4.2.8.3   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.

4.2.8.3.1   LBA Spaces

The consequence is that two distinct LBA spaces must be provided and under normal, logical accesses, action on one volume cannot modify data on the other volume. The MRW drive 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.

4.2.8.3.2   Features and Events

The feature sets associated with GAA and DMA are different. Some features are common, but some are also different.

When a MRW formatted (or formatting) disc is mounted, the drive shall always default to the LBA Space of the DMA. If the host chooses to select the GAA, then the drive shall generate a Morph Event and change the set of features that are marked current. Table 21 shows the expected response to a request for current features that are expected to be volatile.

Table 21: Currency of Features for GAA and DMA

Feature	Currency With GAA	Currency with DMA
Restricted Overwrite	Yes	No
Incremental Streaming Writable	Yes	Yes
Random Writable	No	Yes
Defect Management	No	Yes

Some features will be current regardless of the LBA Space selection: Core, Morphing, Removable Medium, Random Read, Multi-read, Formattable, and Real-time Streaming.

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.

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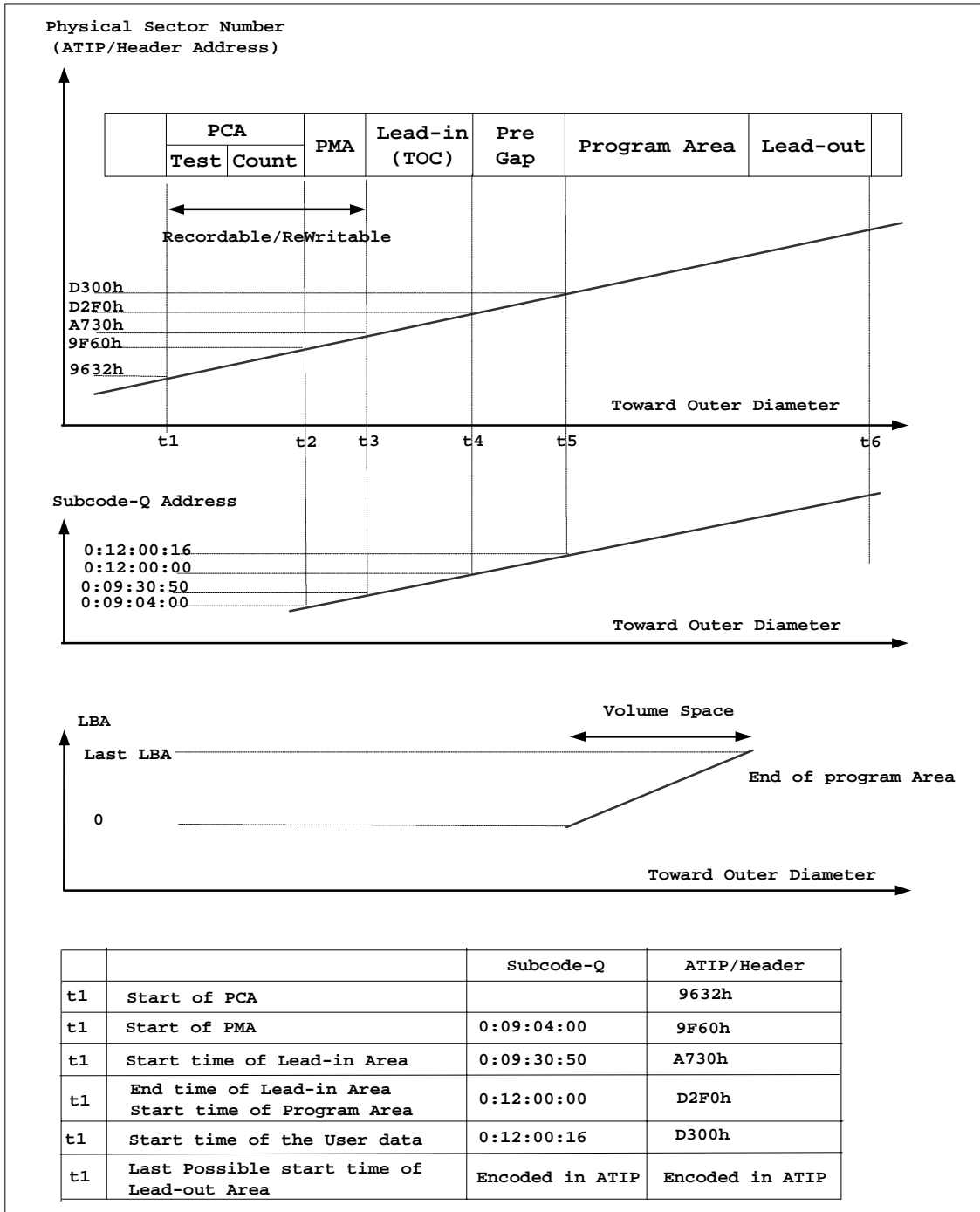
Figure 14– Physical and Logical Layout of DDCD-ROM/R/RW

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.
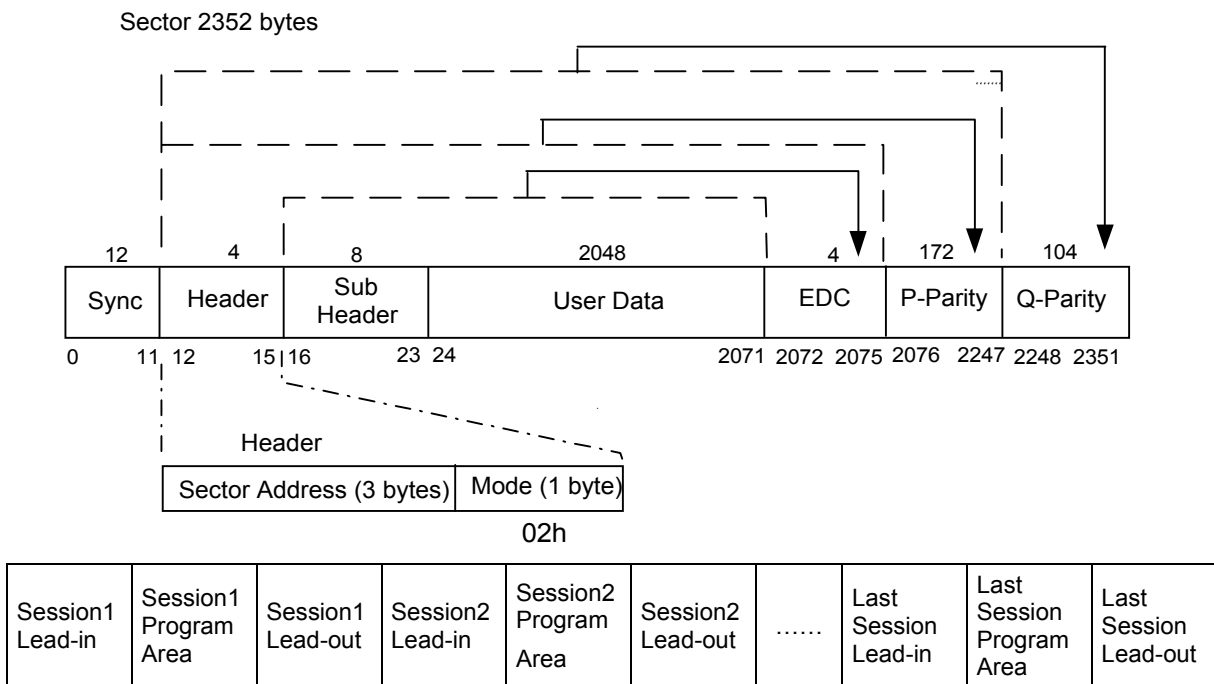
Figure 15 – Multi-Session Recorded Disc

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.
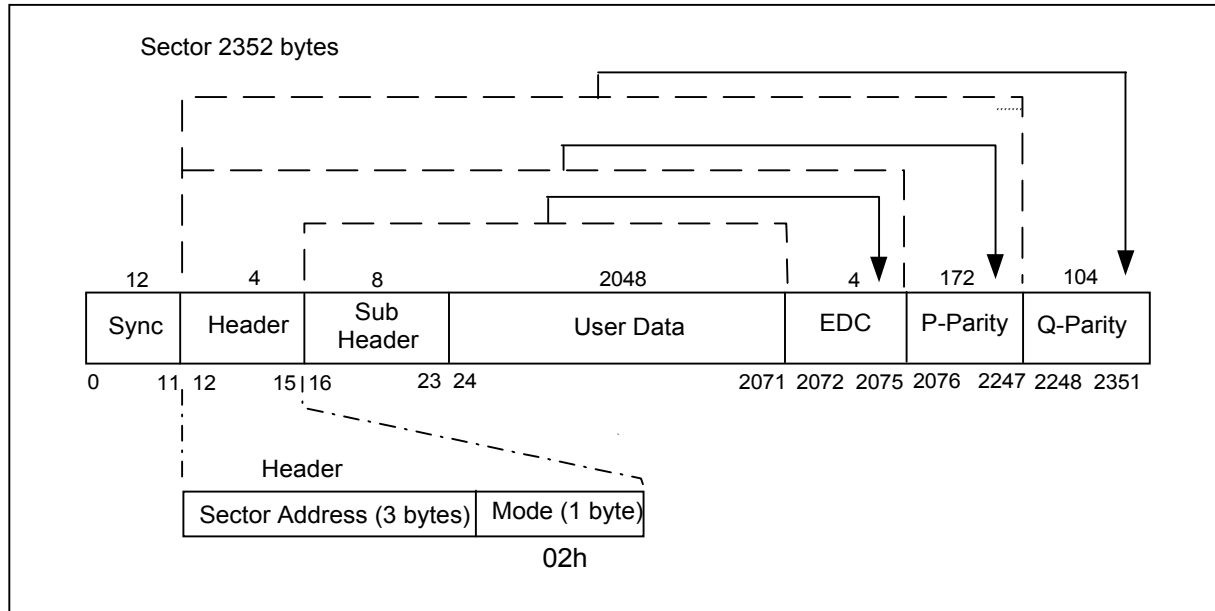
Figure 16 – Sector format Mode 2

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.

Packet

Link	Run-in	Run-in	Run-in	User Data Blocks	Run-out	Run-out	Run-out
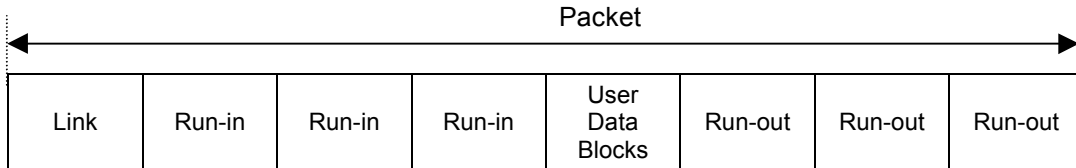
Figure 18 – Packet Layout

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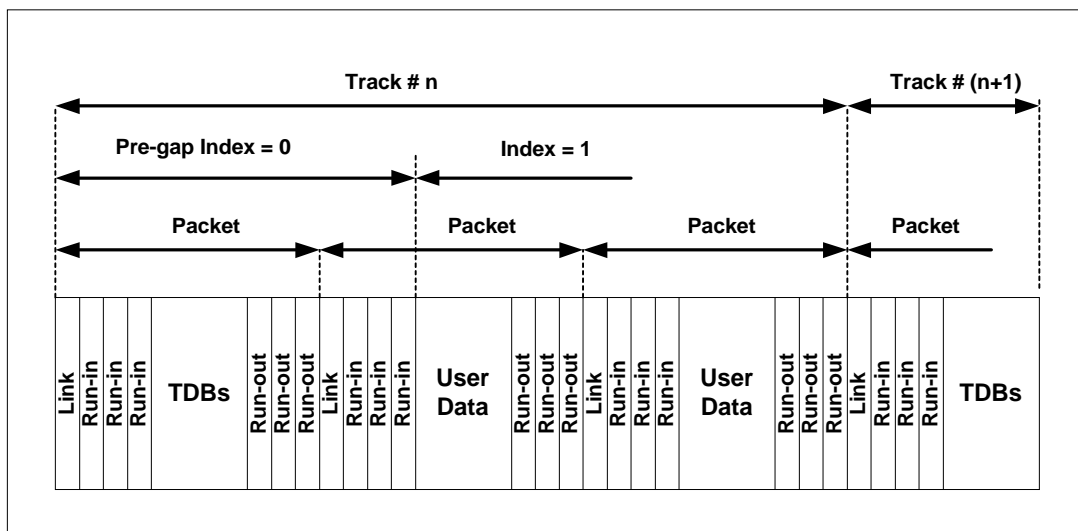
Figure 19 shows an example of the layout of a packet written Track.

Figure 19 – Example of Packet written Track layout

4.4   DVD Model

The DVD Model is the description for the media types DVD-ROM, DVD-R/-RW, DVD-RAM and DVD+RW.

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

Read Only (DVD-ROM)

Recordable (DVD-R)

Re-Writable (DVD-RAM, DVD-RW, DVD+RW).

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

4.4.1   DVD Media Functionality

The DVD media is currently specified by the Physical sections of the DVD Forum Specifications.

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

- DVD-ROM disc has two types of layer structure: single layer and dual layer.

- Each Layer on either side contains a spiral track. This track contains a Lead-in, Data Area, and a Middle Area or a Lead-out.

- Dual Layer discs have two types of track path: Parallel Track Path and Opposite Track Path.

- One ECC BLOCK consisting of 16 sectors, and having 37 856 bytes.

- There is no Sub-channel, only main channel.

- Addressing from the Initiator is LBA (Logical Block Address) only.

- Information concerning error correction that has been performed is not usually returned to the Initiator.

- Some data on DVD Media is used only inside of the DVD Logical Unit and is not transferred to the Initiator.

- The Initiator Read & Write unit (User Data) is 2 Kbytes (2 048 Bytes).

4.4.2   Track Structure

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.

There are two addresses used in the DVD system, the Block address contained in the sector headers (Physical Sector Number), and the address used to reference the blocks from the 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.

Figure 20 through Figure 26 show examples of LBA to Physical Sector Number translations for DVD media.
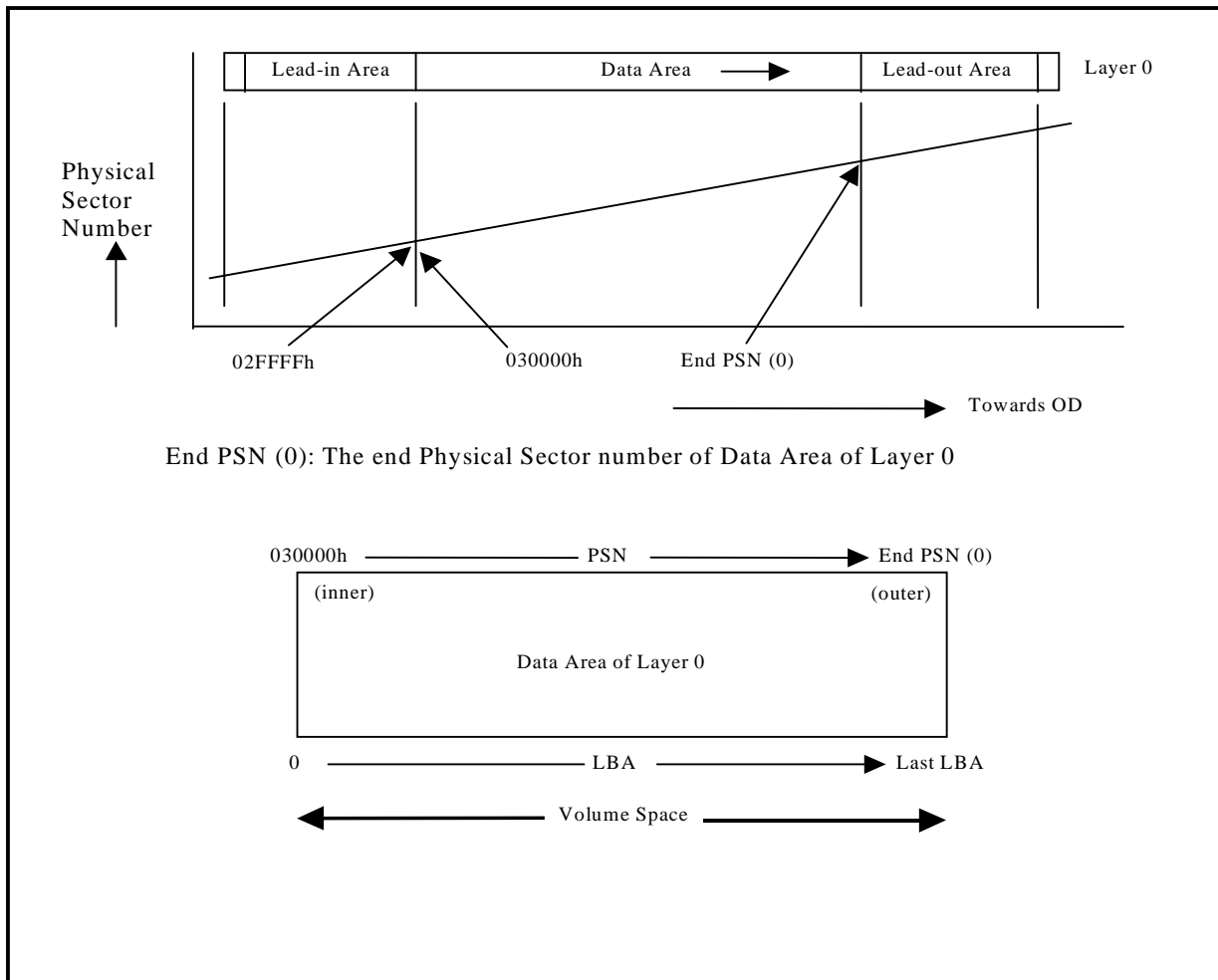
Figure 20 – Physical and Logical Layout of Single Layer DVD-ROM Media
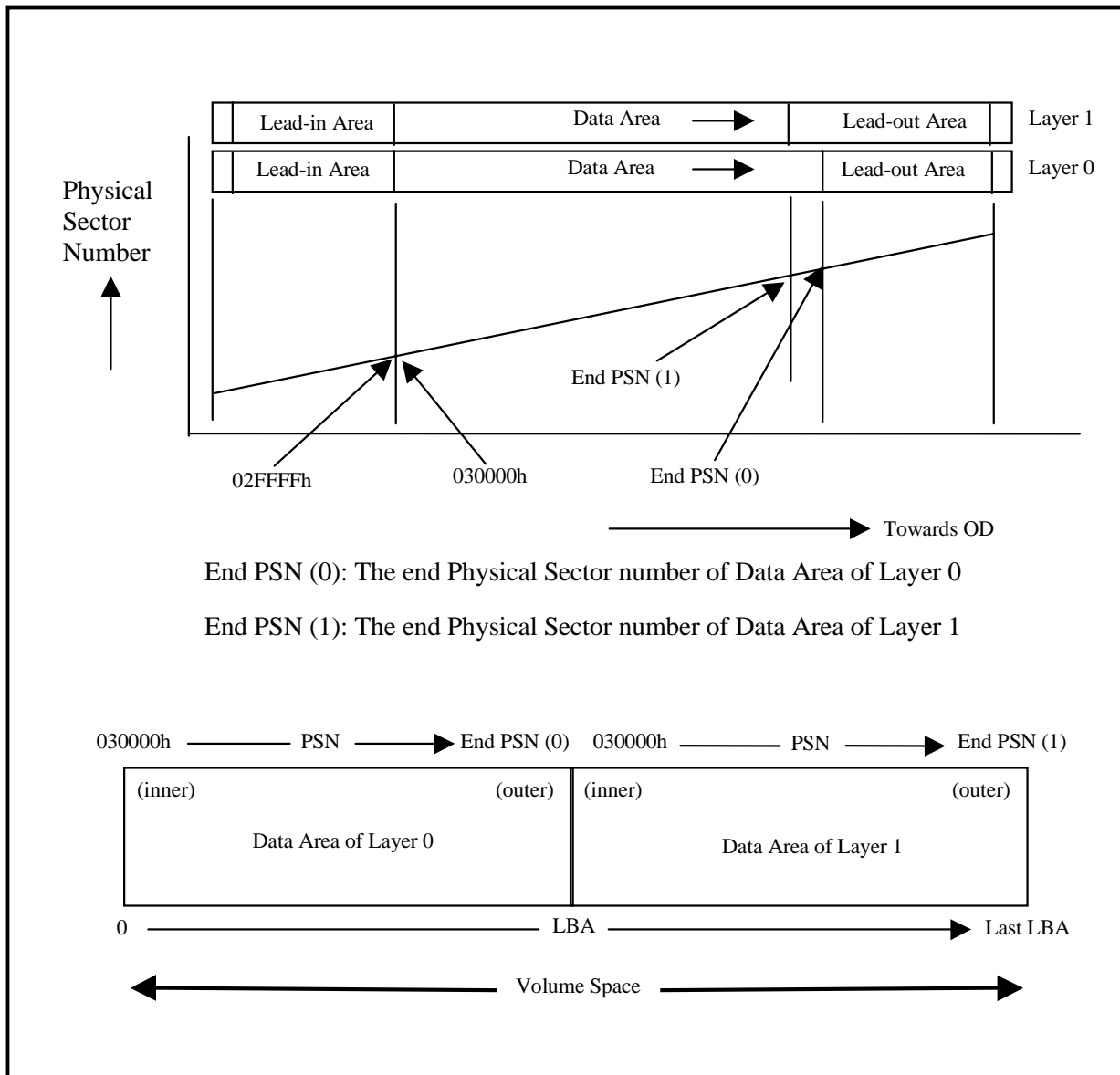
Figure 21 – Physical and Logical Layout of Parallel Track Path DVD-ROM Media

End PSN (1)

Address in Layer 1

$\overline{\text{End PSN (0)}}$

| Lead-out Area | ← Data Area | Middle Area | Layer 1 |

| Lead-in Area | Data Area → | Middle Area | Layer 0 |

Physical
Sector
Number

Address in Layer 0

02FFFFh   030000h   End PSN (0)

Towards OD

End PSN (0): The end Physical Sector number of Data Area of Layer 0

$\overline{\text{End PSN (0)}}$: The number calculated so that each bit of the End PSN (0) is inverted.

End PSN (1): The end Physical sector number of Data Area of Layer 1

030000h ──── PSN ──→ End PSN (0) $\overline{\text{End PSN (0)}}$ ──── PSN ──→ End PSN (1)

| (inner) | (outer) | | (outer) | (inner) |
| | Data Area of Layer 0 | | | Data Area of Layer 1 |

0 ──────── LBA ────────→ Last LBA

←──────── Volume Space ────────→

Figure 22 – Physical and Logical Layout of Opposite Track Path DVD-ROM Media
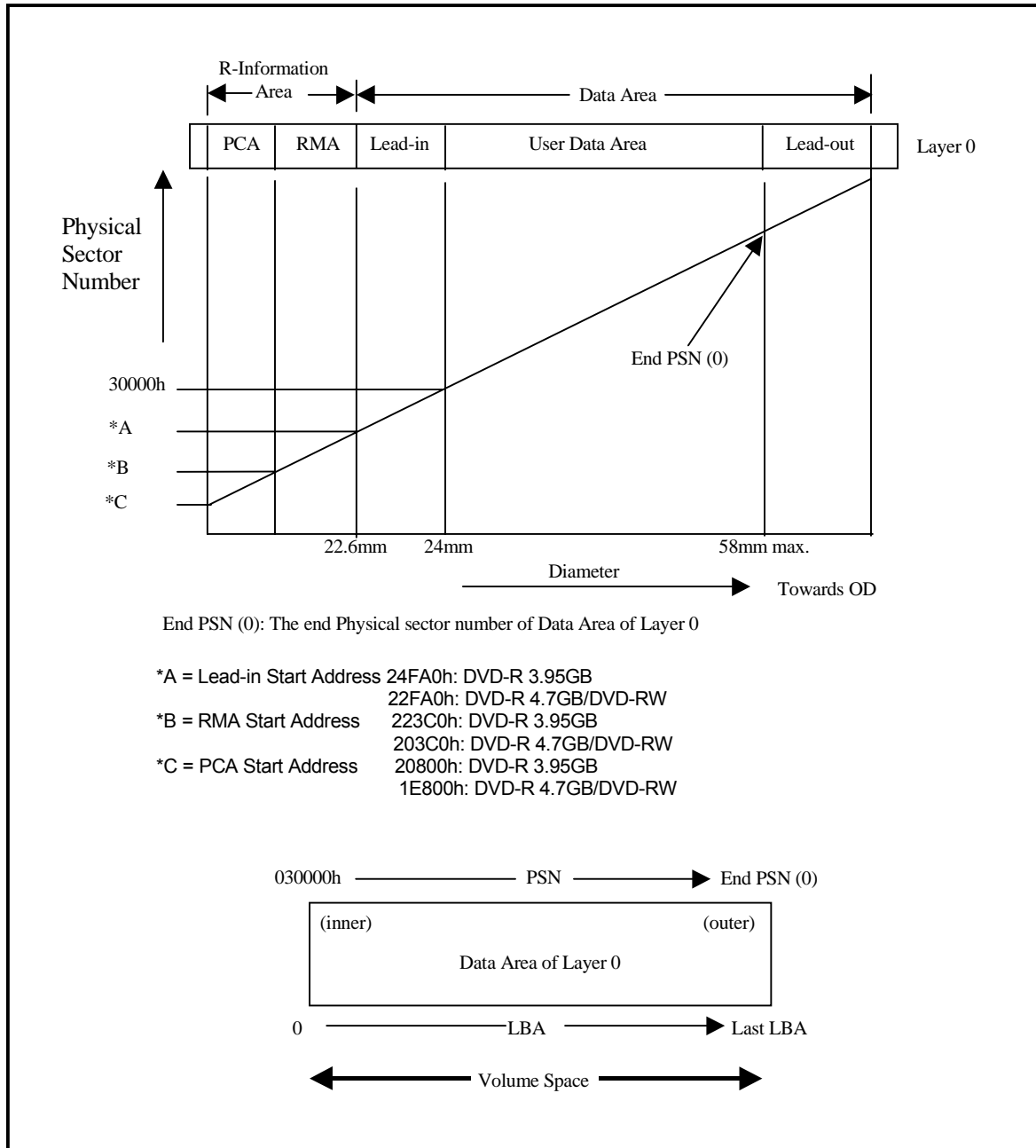
Figure 23 – Physical and Logical Layout of DVD-R/-RW Media
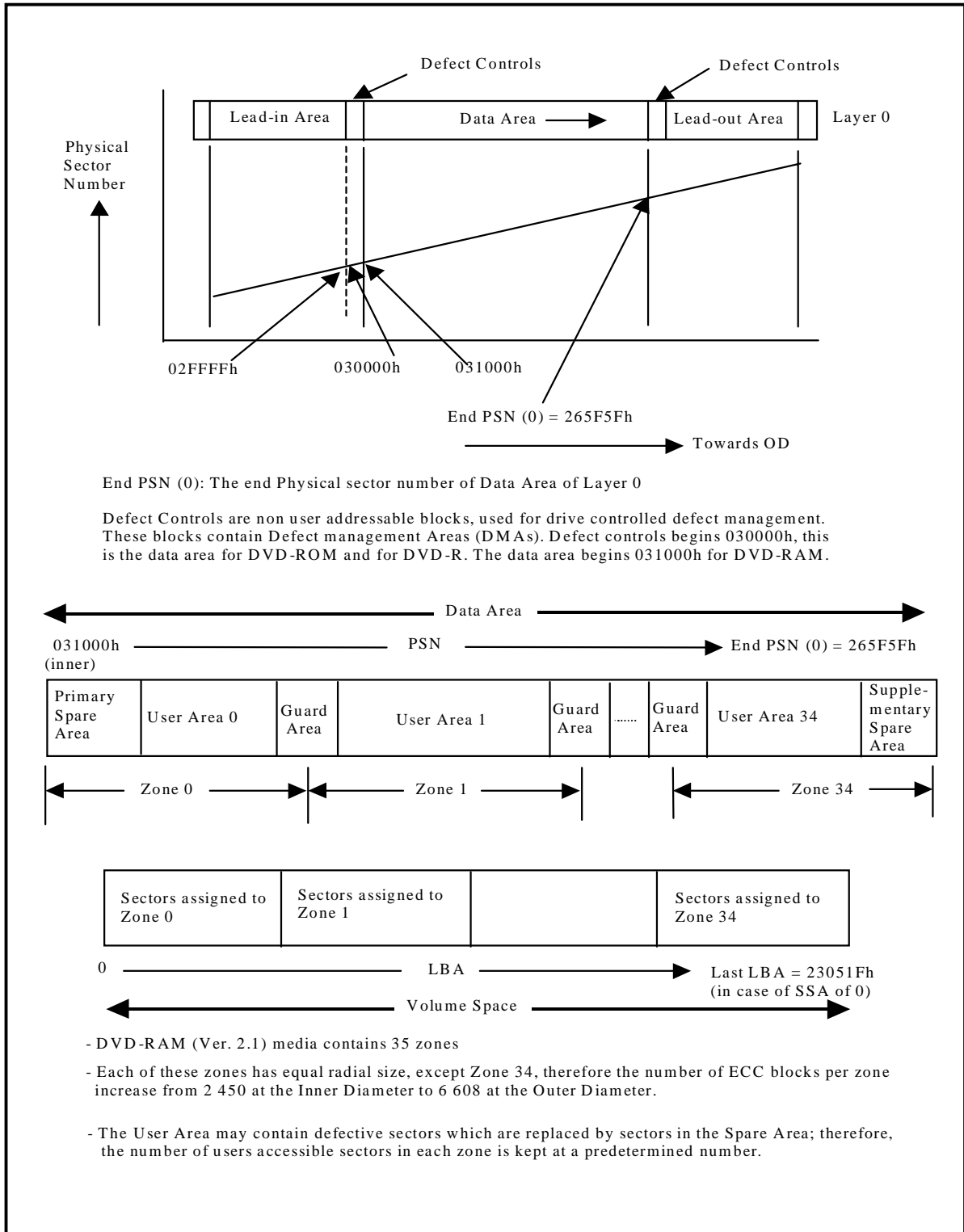
Figure 24 – Physical and Logical Layout of DVD-RAM Ver. 2.1 Media
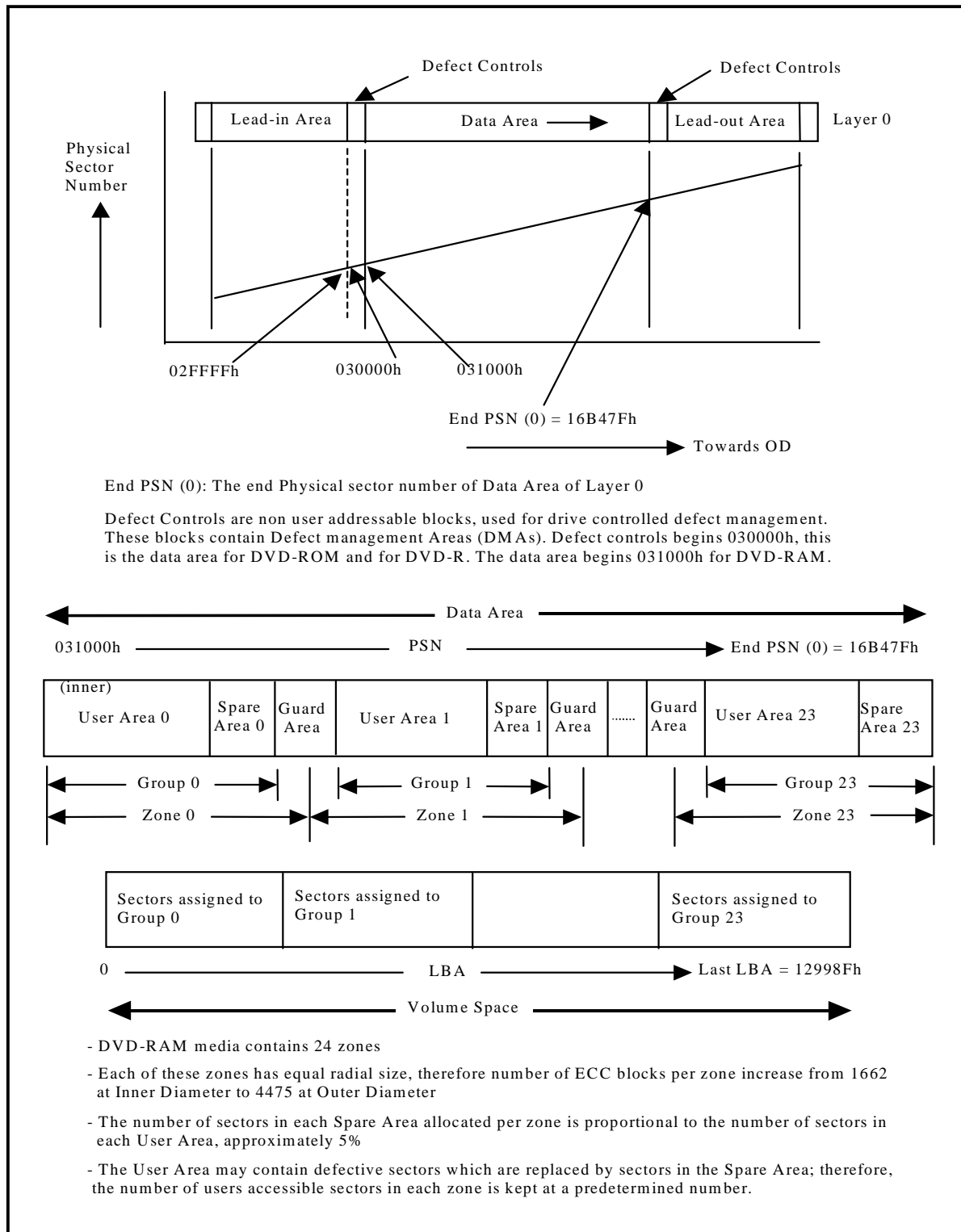
Figure 25 – Physical and Logical Layout of DVD-RAM Ver. 1.0 Media
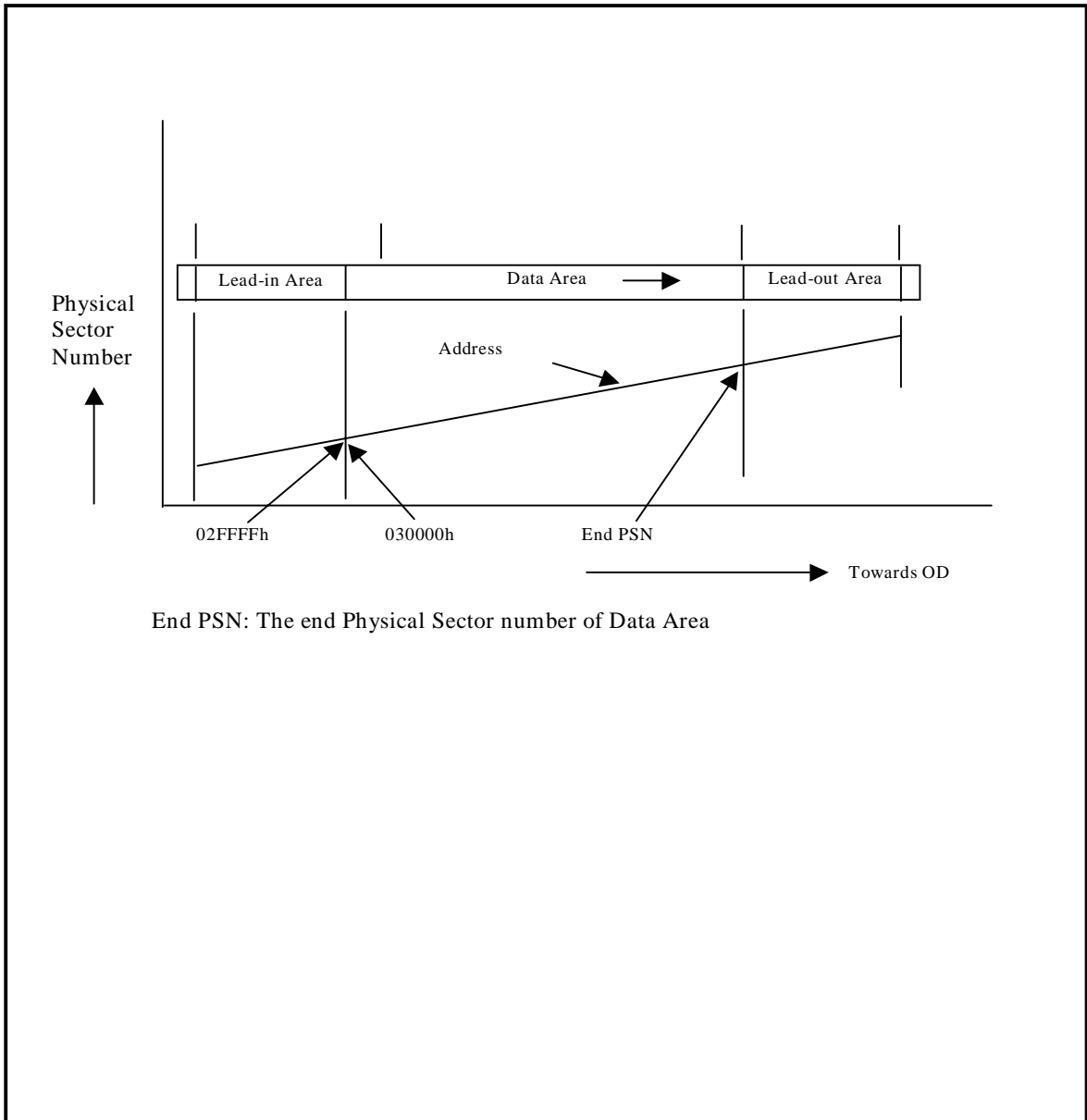
Figure 26 – Physical and Logical Layout of Single Layer DVD+RW Media

4.4.3   Recording for DVD-R

4.4.3.1   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.

4.4.3.2   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.

4.4.3.3   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.

4.4.4   ECC Block

The user data is contained in ECC Blocks. Each ECC Block is made up of 16 sectors and is used to provide error correction. To read any data, the whole ECC Block shall be read and error correction applied. When the ECC Block is written during formatting or normal write operation, the user data and the ECC information is encoded and written to sectors as a whole ECC Block (Figure 27).

Sector Data from 16 Sectors, 2064 bytes each organized as 192 rows of 172 bytes each.	208 rows of Row Parity, 10 bytes each
16 rows of Column Parity 172 bytes per row	
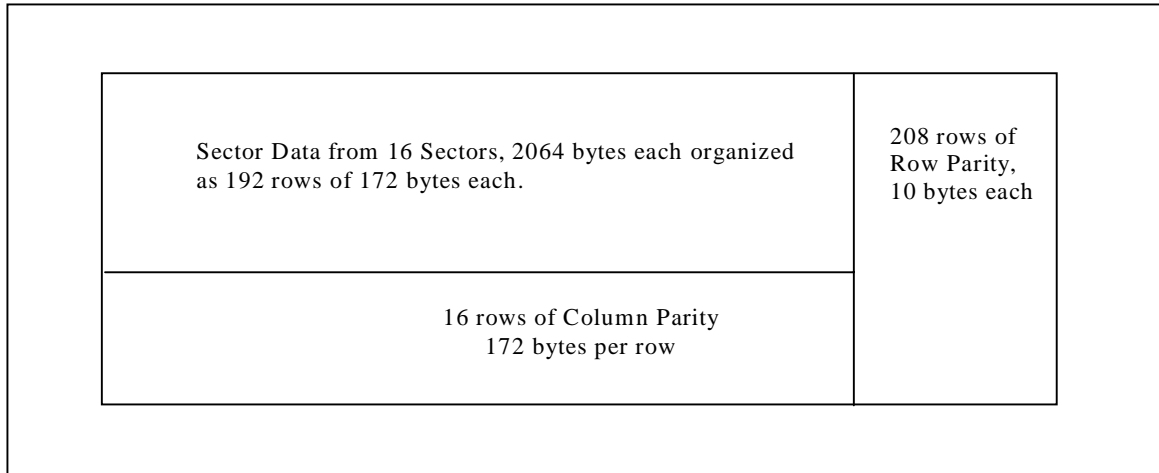
Figure 27 – Data Organization within an ECC Block

4.4.5   Sector Configuration

4.4.5.1   Physical Sector

The data recorded to the DVD media is in a format called "Data Unit 3," which consists of 2 048 bytes of User Data, 12 bytes of Data ID and others, 4 bytes of error detection code (EDC), 302 bytes of ECC and 52 bytes of SYNC. During the formation of the Data Unit 3, there are intermediate products which are called "Data Unit 1" and "Data Unit 2" according to the stage of signal processing as shown in Figure 29. The Data Unit 3 is identical among DVD-ROM, DVD-R/-RW, DVD-RAM, and DVD+RW. In the case of DVD-ROM, DVD-R/-RW, and DVD+RW, only the Data Unit 3 is recorded. DVD-RAM media has other fields in between the Data Unit 3 as shown in Figure 28.

Header field	Mirror field	Gap field	Guard 1 field	VFO3 field	PS field	Data Unit 3	PA3 field	Guard 2 field	Buffer field
128	2	10+J/16	20+K	35	3	2418	1	55 - K	25 – J/16

J is varied randomly from 0 to 15 to shift recording position of Data Unit 3 in a unit of 1 channel bit.
K is varied randomly from 0 to 7 to shift recording position of Data Unit 3 in a unit of 1 byte.

Physical Sector of DVD-RAM media

Figure 28 – Physical sector of DVD media and DVD+RW media
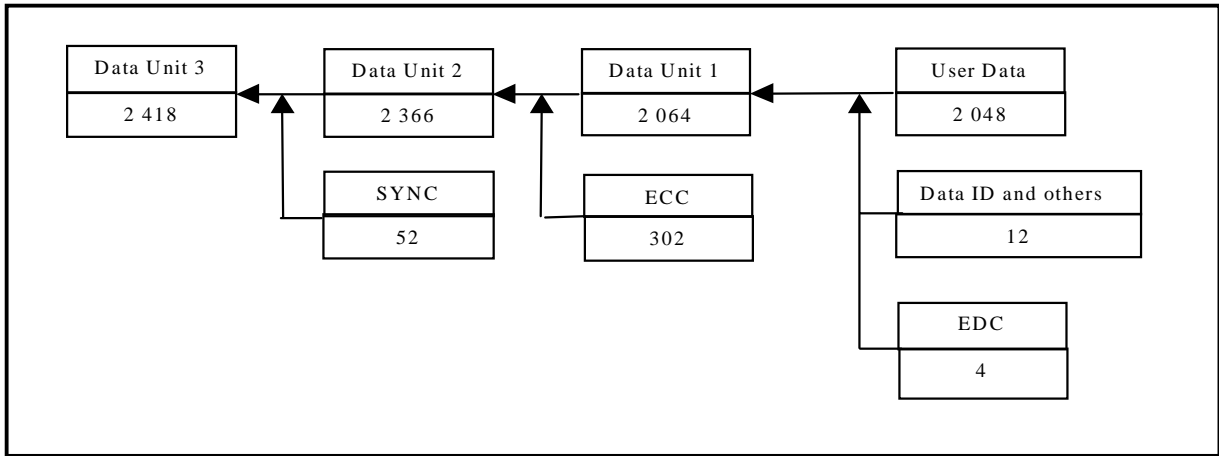
Figure 29 – Formation of Data Unit 3

The physical sector of DVD-RAM consists of Data Unit 3, preceding fields and succeeding fields to it and embossed fields. The Data Unit 3 is identical with that for DVD-ROM. The Header field contains four physical IDs. In the case of DVD-RAM, there are two sets of IDs; one that is contained in the Data Unit 1 and another that is pre-recorded. Addressing of sectors for DVD-RAM only uses the physical (pre-recorded) ID. After formatting, it is possible for the ID in Data Unit 1 to contain an invalid address.

4.4.5.2   Data Unit 1

The make-up of Data Unit 1 is shown in Figure 30.
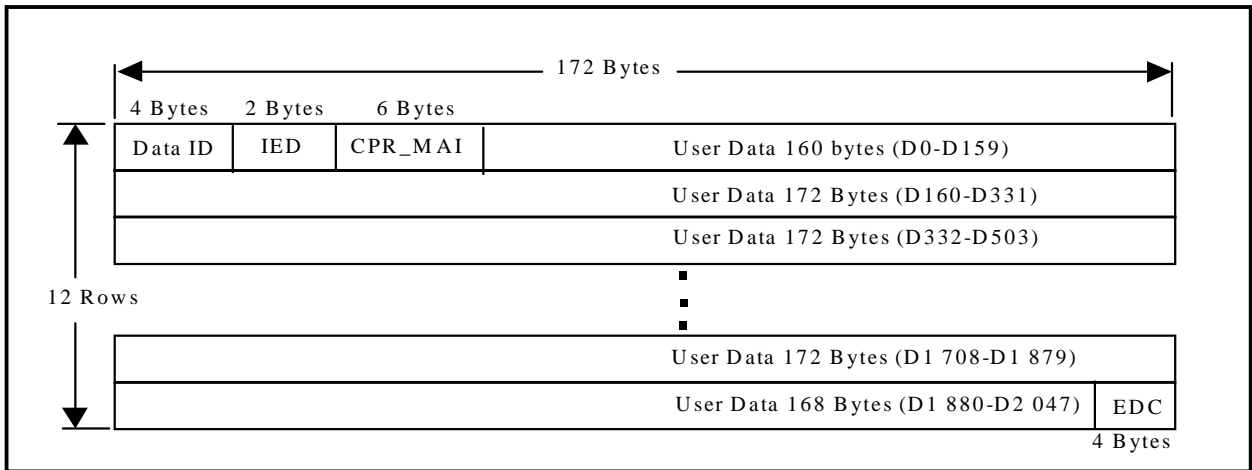
Figure 30 – Data Unit 1

4.4.5.3 Data Configuration of Data ID Field
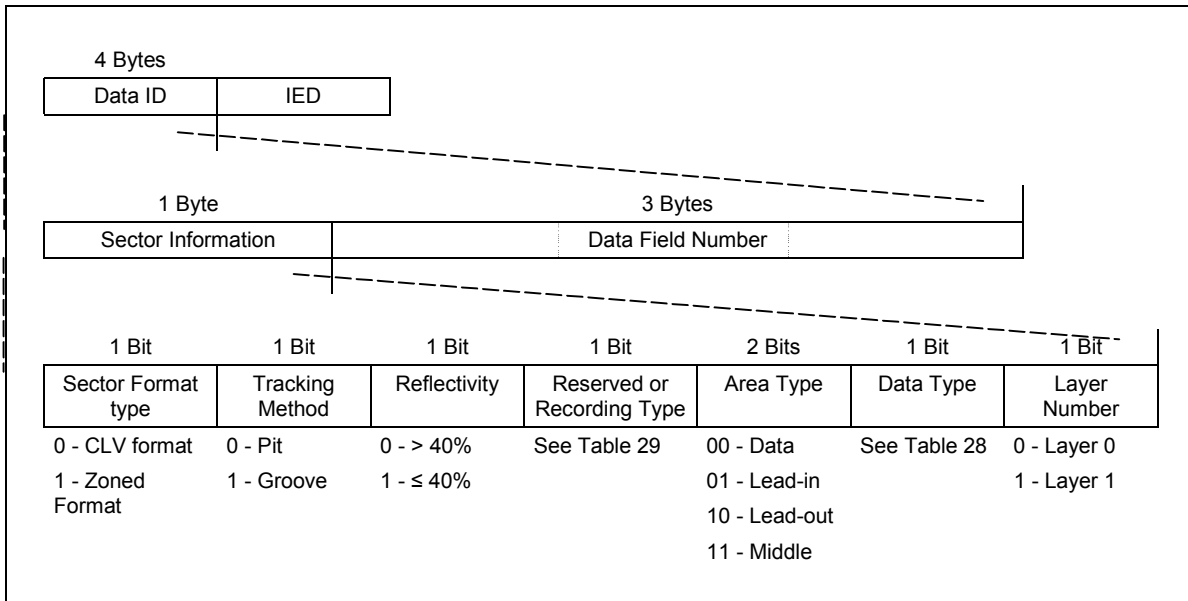
Figure 31 – Data ID Field definition

Data Type bit definition is defined in the following table (Table 28).

Table 28 – Data Type bit definition

Media Type	Data Type bit	
	0	**1**
ROM	Read-only data	N/A
RAM	Embossed data	Rewritable data
R	Read-only data	Next sector is Linking Data
-RW	Re-Recordable data	Next sector is Linking Data
+RW	N/A	Rewritable Data

Table 29 – Recording Type bit definition for DVD-RAM Ver.2.1 Media [1]

Area		Definition
Embossed data zone		Reserved
Rewritable data zone	Lead-in area, Lead-out area	Reserved
	Data area	0b: General data[2] 1b: Real time data[3]
Notes:		

Notes:

1. The definition of the bit for other than DVD-RAM Ver.2.1 Media is Reserved.

2. General data: Linear replacement algorithm is applied to a Block containing the corresponding sector if the Block is defective.

3. Real-Time data: Linear replacement algorithm is not applied to a Block containing the corresponding sector even if the Block is defective.

The Data Field Number consists of the PSN and other data. See Table 30.

Table 30 – Data Field Number for DVD Media

Area	Media Type	Description	Data Field Number
Lead-in and Lead-out	ROM, R, -RW, RAM, +RW	Pre-recorded information, or written for DVD-R/-RW media	PSN
Data Area	ROM, R, -RW, +RW	Pre-recorded information or written for DVD-R/-RW Media	PSN = (LBA + 30000h)
	RAM	ECC Block written by the Initiator	LBA + 31000h
		ECC Block not written by the Initiator after formatting	Any of the following three cases (1) Initialization pattern (2) Unrecorded (3) Old value of LBA + 31000h assigned before previous re-formatting

4.4.6   Data Structure of the Disc Lead-in Area

Figure 32 shows the structure of the lead-in area for each DVD media type.

	DVD-RW, DVD-R for General ver 2.0	**DVD-R ver 1.0, DVD-R for Authoring ver 2.0**	**DVD+RW**	**DVD-ROM**	**DVD-RAM**	
1D830h · · 22FA0h	Initial Zone All 00h	Initial Zone All 00h	Initial Zone All 00h	Initial Zone All 00h*	Initial Zone All 00h*	L
2A480h			Test, Guard, ID Zones			E A
2D600h 2E1FFh	System Reserved Zone					D
2E200h	Buffer Zone 0 All 00h					I N
2E400h	R/RW Physical format information Zone					
2F000h	Reference Code Zone (2 ECC blocks)	Reference Code Zone (2 ECC blocks)	Reference Code Zone	Reference Code Zone*	Reference Code Zone* (1 ECC block)	A R
2F010h					Buffer Zone 1 All 00h*	E A
2F020h	Buffer Zone 1 All 00h	Buffer Zone 1 All ooh	Buffer Zone 1 All 00h	Buffer Zone 1 All 00h*		
2F200h	Control Data Zone* (192 ECC Blocks)	Control Data Zone (192 ECC Blocks)	Control Data Zone (192 ECC Blocks)	Control Data Zone* (192 ECC Blocks)	Control Data Zone* (192 ECC Blocks)	
2FE00h	Extra Border Zone	Buffer Zone 2 All 00h	Buffer Zone 2 All 00h	Buffer Zone 2 All 00h*	Buffer Zone 2* All 00h	
30000h	DATA AREA	DATA AREA	DATA AREA	DATA AREA*	Defect Controls	
31000h					DATA AREA	

NOTE: * = Data in these areas is embossed. For DVD-R for Authoring Ver.2.0 media, Buffer Zone 1 may contain manufacturer specific authoring Information. Otherwise, Buffer Zone 1 contains all 00h data. For DVD-R for General Ver.2.0, Control Data Zone is pre-recorded or embossed Reference Code Zone contains repetition of the Data Symbol "172" with added scrambled data Control Data Zone comprises repetition of 16 sectors (one ECC Block).

Figure 32 – Data Structure of Disc Lead-in Area

4.4.6.1   Control Data Zone

The Control Data Zone contains 192 ECC Blocks. Each of the ECC Blocks (16) Sectors contains one of four distinct types of data. See Table 31 for a generic descriptor.

For DVD-RW media, the Control Data Zone is embossed. Logical Unit may use RW-Physical format information Zone or Extra Border Zone instead of Control Data Zone.

For DVD-R for General Ver.2.0 media, the Control Data Zone is pre-recorded or embossed. And Disc Manufacturing Information field contains all 00h data.

Table 31 – Control Structure of Control Data Block

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

4.4.6.2   Control Zone Sector Descriptions

Table 32 shows the format of the Physical Format Information descriptor.

Table 32 – 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 (1)	Reserved						
17-2047	Medium Unique Data							
Note: For DVD-RW/DVD-R for General Ver.2.0 media, BCA Flag is defined as NBCA Flag.								

The Book Type field is described in Table 33.

Table 33 – Book Type Field

Book Type Value	Definition
0	DVD-ROM
1	DVD-RAM
2	DVD-R
3	DVD-RW
9	DVD+RW
Others	Reserved

Table 34, Table 35, Table 36, Table 37, and Table 38 define the format unique descriptors for each media type.

Table 34 – DVD-ROM Unique Part of Physical Format Information

Bit Byte	7	6	5	4	3	2	1	0
32-2047	Reserved							

Table 35 – 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 36 – 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							

Table 37 – 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 38 – 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							

Table 39 – DVD+RW Unique Part of Physical Format

Bit Byte	7	6	5	4	3	2	1	0
32	Recording Velocity							
33	Maximum read power at reference velocity							
34	P_{IND} at reference velocity							
35	ρ at reference velocity							
36	$\varepsilon 1$ at reference velocity							
37	$\varepsilon 2$ at reference velocity							
38	γ_{target} at reference velocity							
39	Maximum read power at maximum velocity							
40	P_{IND} at maximum velocity							
41	ρ at maximum velocity							
42	$\varepsilon 1$ at maximum velocity							
43	$\varepsilon 2$ at maximum velocity							
44	γ_{target} at maximum velocity							
45	Maximum read power at intermediate velocity							
46	P_{IND} at intermediate velocity							
47	ρ at intermediate velocity							
48	$\varepsilon 1$ at intermediate velocity							
49	$\varepsilon 2$ at intermediate velocity							
50	γ_{target} at intermediate velocity							
51	T_{top} first pulse duration							
52	T_{mp} multi pulse duration							
53	dT_{top} first pulse lead time							
54	dT_{era} erase lead time at reference velocity							
55	dT_{era} erase lead time at intermediate velocity							
56	dT_{era} erase lead time at intermediate velocity							
57-2047	Reserved							

4.4.6.3 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 40.

Table 40 – 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 41.

Table 41 – 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 42. When the Lead-in is recorded in the Disc at once recording mode, this field contains all 00h data.

Table 42 – 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							

4.4.7 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 33.

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.
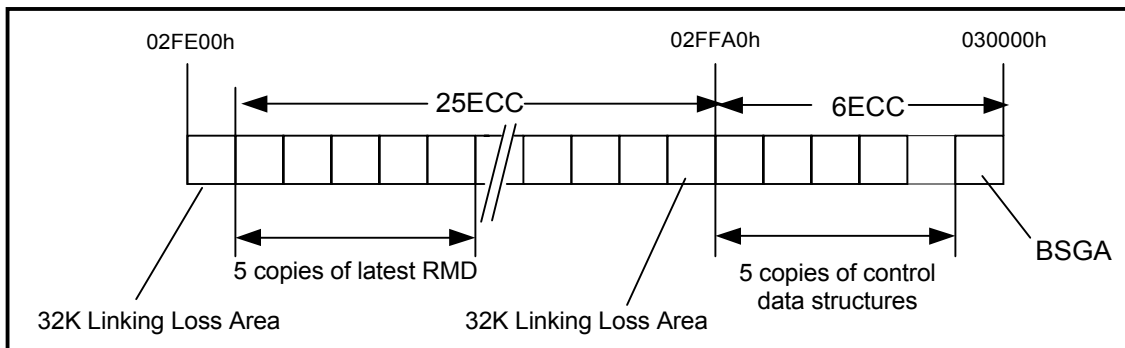
Figure 33 – Structure of Extra Border Zone

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Table 43 describes the contents of the Data Area Allocation field.

Table 43 – Data Area Allocation Definition

Byte	Single Layer/ Parallel Track Path DVD-ROM	Opposite Track Path DVD-ROM	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	DVD-RAM	DVD+RW
4	00h	00h	00h	00h	00h	00h	00
5 6 7	Starting PSN of Data Area (030000h)	Starting PSN of Data Area (030000h)	Starting PSN of Data Area (030000h)	Starting PSN of Data Area (030000h)	Starting PSN of Data Area (030000h)	Starting PSN of Data Area (031000h)	Starting PSN of Data Area (030000h)
8	00h	00h	00h	00h	00h	00h	00h
9 10 11	End PSN of Data Area	End PSN of Data Area	End PSN of Data Area	Last Recorded Sector Number of the last Track in the Session	Last address of Data Recordable area[(1)]	End PSN of Data Area	If CDZ PSN $\leq$ 2F0FFh, then this value shall be the PSN of last recorded sector in DZ. Otherwise, this value may be either the PSN of last recorded sector in DZ, or the last possible PSN in the DZ.
12	00h	00h	00h	00h	00h	00h	00h
13 14 15	000000h	End PSN in Layer 0	000000h	000000h	000000h	000000h	000000h
Note: For DVD-R for General Ver.2.0 media, this field is defined as "Outer limit of Data Recordable area".							

For DVD-RAM, the end PSN is the PSN for the last spare sector of the last zone. It should not be used for counting user capacity.

For DVD+RW, the end PSN should not be used for counting user capacity.

4.4.8   DVD Ready Condition/Not Ready Condition

The Ready Condition occurs after a disc is inserted and the Logical Unit has performed its initialization tasks. These may include reading the Lead-in information from the media. 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 a disc access.

A Not Ready Condition may occur for the following reasons:

a. There is no disc mounted.

b. The Logical Unit is unable to load or unload the disc.

c. The Logical Unit is performing an extended operation as the result of an Immediate Mode command such as FORMAT UNIT or BLANK.

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

Any media access that occurs when the Logical Unit is not spinning shall spin the 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. Any media access that is requested while the Logical Unit is processing an Immediate command, e.g. BLANK or FORMAT UNIT with the Immediate bit set, may result in a Not Ready Condition.

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

4.4.9   DVD Content Protection

The DVD Content Protection is made up of two basic concepts. The first is to scramble the content of the data such that unscrambling is required in order to make the content usable. The capability to unscramble the content is provided only under conditions that require products that follow rules governing the copying, playback, and output of the content. The second basic concept is to use an "Authentication" process to exchange protected information (such as cryptographic Keys) required for the unscramble operation. This process ensures the integrity of such information during transfer from the Logical Unit to the Initiator.

4.4.9.1   Content Protection for Read Only DVD

The DVD-Video Content Scrambling System (CSS) is used to protect DVD-Video content on Read Only Discs. Content Protection for Prerecorded Media (CPPM) is used to protect DVD-Audio content on Read Only Discs. For discs containing CSS or CPPM protected content (or both), the same authentication process is used. Thus, Logical Units that support CSS authentication also support CPPM without modification. Any read by the Host to a disc that contains CSS scrambled content and a sector with a Title Key present, when the Authentication Success Flag (ASF) is set to zero shall be terminated with a CHECK CONDITION status, 5/6F/03 READ OF SCRAMBLED SECTOR WITHOUT AUTHENTICATION. For more information on the Authentication process, see Figure 33. For more information on the Authentication Success Flag, see Figure 34.

Note: Although CSS and CPPM use the same authentication process for transferring the Disc Key or Album ID, CPPM protected sectors do not contain a Title Key. Thus for CPPM, the TITLE KEY Format is not used, and the Authentication Success Flag is not relevant.

For CSS protected content (DVD-Video) only, playback of the content is limited to specific regions of the world, as described in 4.4.9.4.

4.4.9.2   Content Protection for recordable and rewritable DVD

Content Protection for Recordable Media (CPRM) is used to protect audio and video content on recordable and rewritable DVD discs. The interface between the Initiator and Logical Unit for CPRM is similar to that for CPPM, with the following differences:

- CPRM uses a "MEDIA IDENTIFIER" to bind protected content to the disc on which it is recorded. Before encrypting or decrypting such content the Initiator reads the MEDIA IDENTIFIER value using the READ DVD STRUCTURE command with Format code 06h.

- The CPRM "MEDIA KEY BLOCK" is located in the Lead-in area, and is read by the Initiator using the READ DVD STRUCTURE command with Format code 07h.

The CPRM "MEDIA IDENTIFIER" and "MEDIA KEY BLOCK" are protected during transfer to the Initiator using the same Authentication process used for CSS and CPPM, with the addition of a Message Authentication Code (MAC) algorithm described in the CPRM specification. For more information on the authentication process, see Figure 35.

4.4.9.2.1   Authentication Process
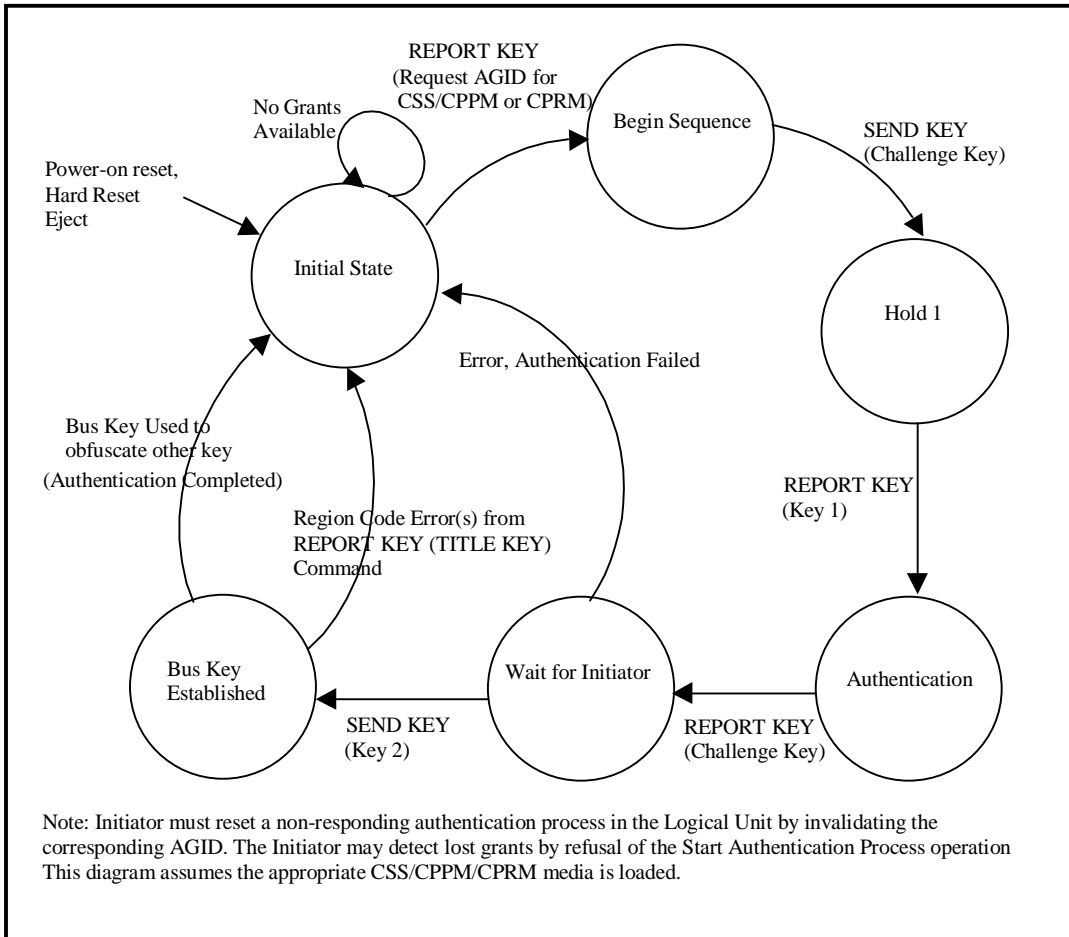
Figure 34 – Device Key Exchange and Authentication State Diagram
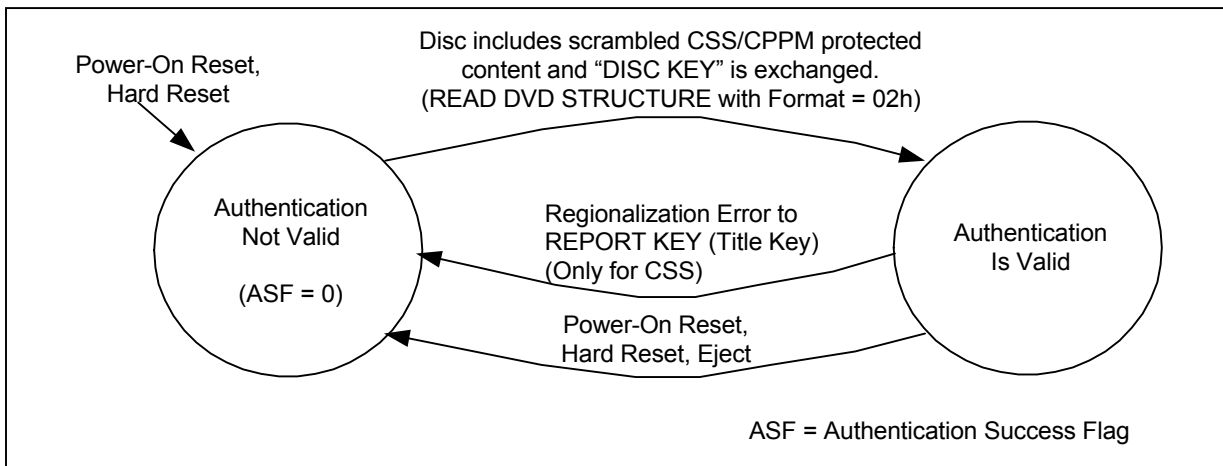
Figure 35 – Authentication Flag Sequence

4.4.9.3   Region Playback Control (RPC)

The copy management capability used for Copy Protected DVD-ROM Media limits the playback of content to specific regions of the world. This capability is called Region Playback Control (RPC) or Regionalization.

4.4.9.4   Playback limitations by World Region

The use of Regionalization is limited to Discs that employ CSS. There are two places that contain region information, one in the Logical Unit and another for each media that contains CSS Scrambled Title(s). When the region in the Logical Unit and that of the CSS Title are different, the system shall prevent the playback of that title (movie).

When a REPORT KEY command is received, by a Logical Unit, in the Bus Key Established state, (see Figure 34), with a Format Code of 04h (Title Key), and the region code of the current media is not playable in the current region set in the Logical Unit, the command shall be terminated with CHECK CONDITION status and SK/ASC/ASCQ shall be set to ILLEGAL REQUEST/MEDIA REGION CODE IS MISMATCHED TO LOGICAL UNIT REGION. A regionalized CSS media shall be deemed not playable if the region of the Logical Unit is not set.

If the Region Code Mismatch error is generated, the Authentication Success Flag (ASF) shall be cleared to zero.

The Logical Unit reports the current RPC State when processing the REPORT KEY command with Format Code 08h.

4.4.9.5   Region Code Setting

Two methods have been defined for setting the region code in the DVD Logical Unit. Each method has the same end result, specifying which region shall be used to determine if it is allowable to play a disc that has a region code included within the information on the disc in this Logical Unit.

The Logical Unit has the following four Region States according to the Logical Unit Region setting (see Figure 36):

1. NONE state - The Logical Unit Region has not been set. The Initiator shall set the initial Logical Unit Region value in the Logical Unit. The region setting counter shall be set to 5. The Logical Unit shall respond to the REPORT KEY command, Key Format 01000b, with successful command completion and a Region Mask value of FFh.

2. SET state - The Logical Unit Region has been set and the change of the Region is acceptable. The region setting counter shall initially be 4, and decrement to 2.

3. LAST CHANCE state - The Logical Unit Region has been set and the change of the Region is acceptable. In order to change the Logical Unit Region using a command method, an inserted disc shall have the same single region with the requested Region. The region setting counter shall be 1.

4. PERMANENT state - The Logical Unit Region has been set and the change of the Region is not acceptable. The region setting counter shall be 0. However, the Logical Unit Region can be re-initialized by the vendor to become the NONE state.

4.4.9.6   Initial Setting

In the NONE state, the Logical Unit Region is not set and the Initiator shall set the initial Logical Unit Region value in the Logical Unit. The region setting counter shall be set to 5. The Logical Unit shall respond to the REPORT KEY command, Key Format 01000b, with successful command completion and a Region Mask value of FFh.

The Initiator shall set a preferable region, the value of which is specified in the Preferred Logical Unit Region Code field of the SEND KEY command with Key Format = 000110b. On execution of this command, the Logical Unit ignores the region code of the inserted medium.

After the successful execution of setting the Logical Unit Region, the Logical Unit shall enter the SET state. The region setting counter shall be decremented to 4.

4.4.9.7 Changing of the Logical Unit Region

In the SET state, the Logical Unit Region has been set and may be changed by one of the two methods specified. After the successful execution of changing the Logical Unit Region, the region setting counter shall be decremented. When the region setting counter is 2 and a successful execution of changing of the Logical Unit Region, the Logical Unit shall enter into the LAST CHANCE state.

In the LAST CHANCE state, the Logical Unit Region may be changed by one of the two methods specified. See 4.4.9.7.1, and 4.4.9.7.2. When using the command method with a disc, the inserted disc shall have the same single Region Code value as the Preferred Logical Unit Region Code specified in the SEND KEY command. After the successful execution of the Logical Unit Region change, the region setting counter shall be zero and the Logical Unit shall enter into the PERMANENT state.

In the PERMANENT state, the user cannot change the Logical Unit Region.

4.4.9.7.1 Changing the Logical Unit Region with a CSS enabled Disc

To set the Logical Unit Region, the procedure shall be executed as follows;

1. Insert a disc having the requested Region,

2. Issue a SEND KEY command with the Key Format = 000110b. The requested Region Code value shall be specified in the Preferred Logical Unit Region Code field.

When the Logical Unit receives the SEND KEY command correctly, the Logical Unit Region is changed to the requested region. If the disc does not have the same region code value as the Preferred Logical Unit Region Code specified in the SEND KEY command, then the command shall be terminated with CHECK CONDITION status and SK/ASC/ASCQ values are set to ILLEGAL REQUEST/MEDIA REGION CODE IS MISMATCHED TO LOGICAL UNIT REGION.

4.4.9.7.2 Setting Disc method for changing the Logical Unit Region

Inserting a special disc that contains a specific region code may set the Logical Unit Region. This special disc does not require any command intervention.

4.4.9.8 Limits on Logical Unit Region Changes

Any of the methods defined in this specification may be used up to five times to change a Logical Unit's region. If the new region is the same as the old region, the region setting process shall be treated as if it had not occurred.

If an attempt by the user is made to change the Logical Unit Region more than five times, the SEND KEY command shall terminate with CHECK CONDITION status, sense key set to ILLEGAL REQUEST and ASC set to LOGICAL UNIT REGION MUST BE PERMANENT/REGION RESET COUNT ERROR.

For more information on the region code setting process, see Figure 36.
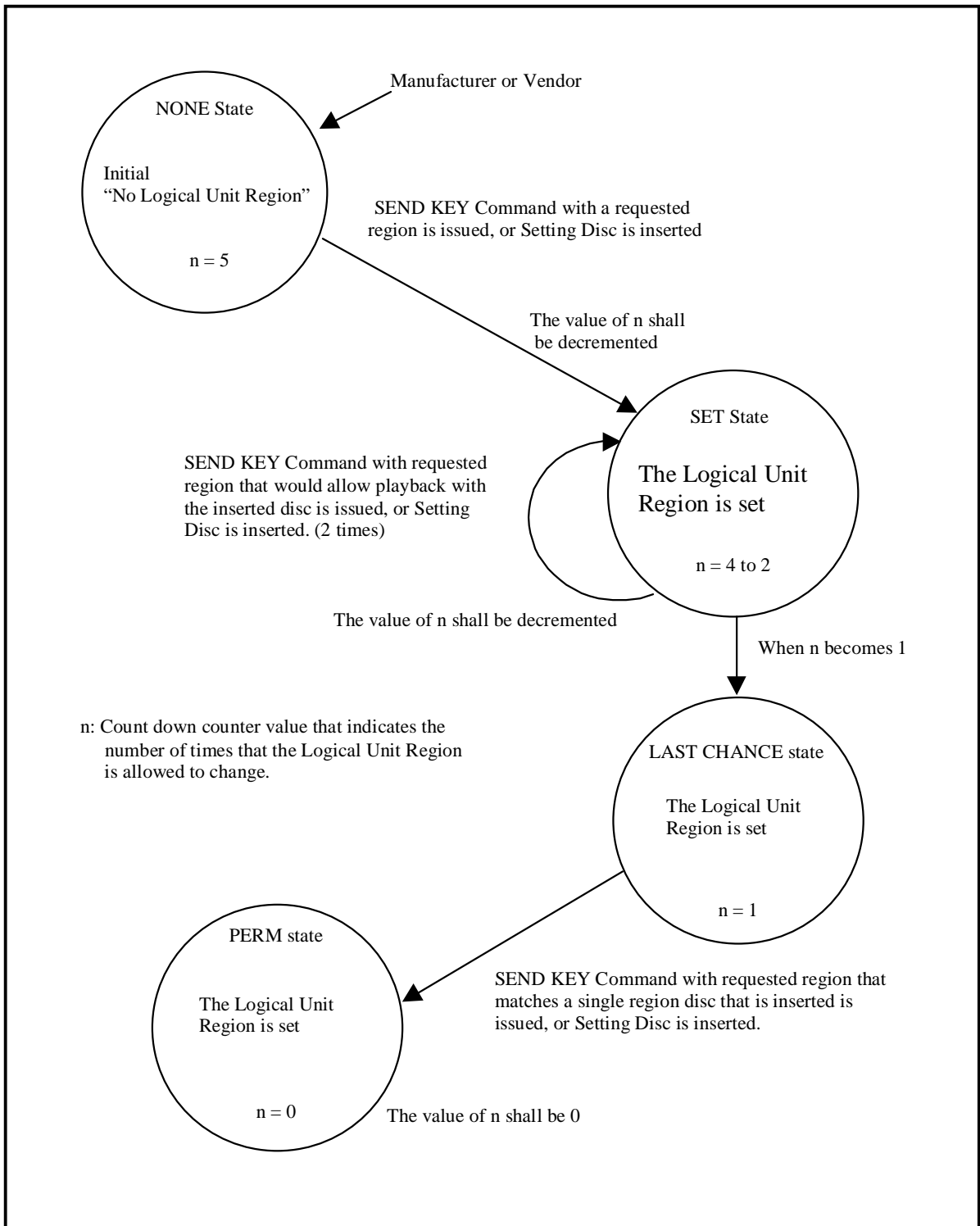
Figure 36 – Region State Diagram

4.5   Changer Model

The changer is a Feature of a CD/DVD device. It shall support two (2) additional commands, MECHANISM STATUS (sub-clause 5.9) and LOAD/UNLOAD MEDIUM (sub-clause 5.8).

A changer device provides a storage area for more than one CD/DVD 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.
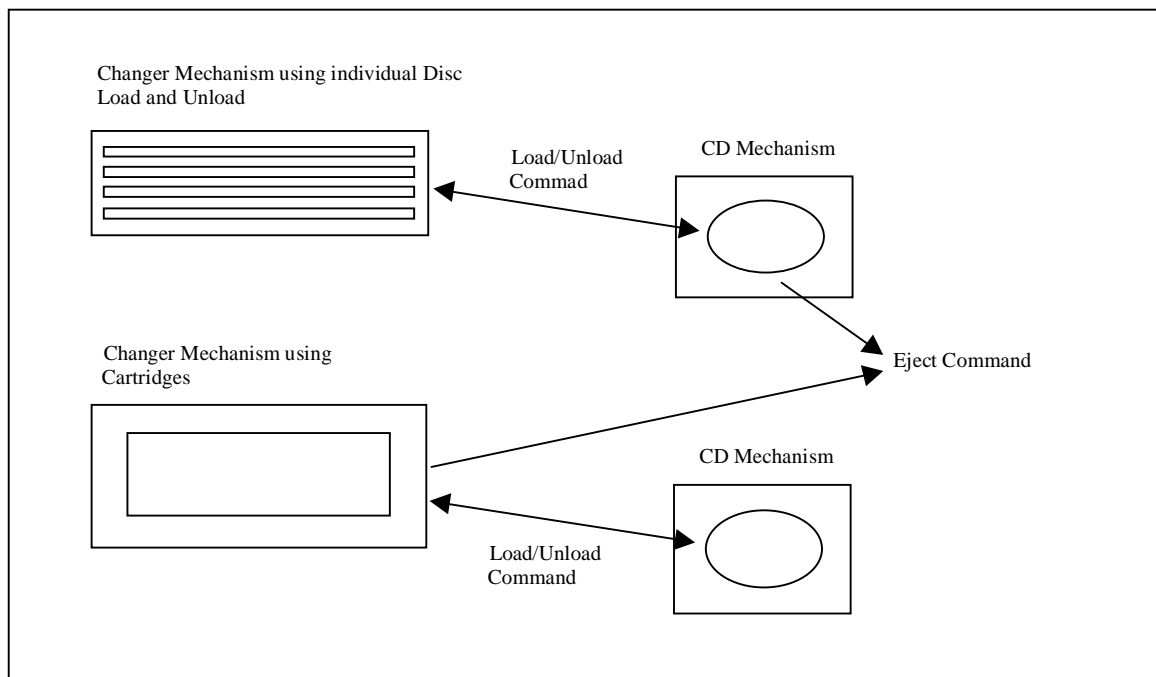
Figure 37 – Media Changer Mechanism Model

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 CD/DVD Devices, there is an optional capability to select each side of the Disc. Although this would not normally be thought of as a changer type of operation, the two sides to the Disc are independent and changer like functions are a good match for selecting sides. When the Logical Unit supports this functionality, each physical slot 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 361), 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).
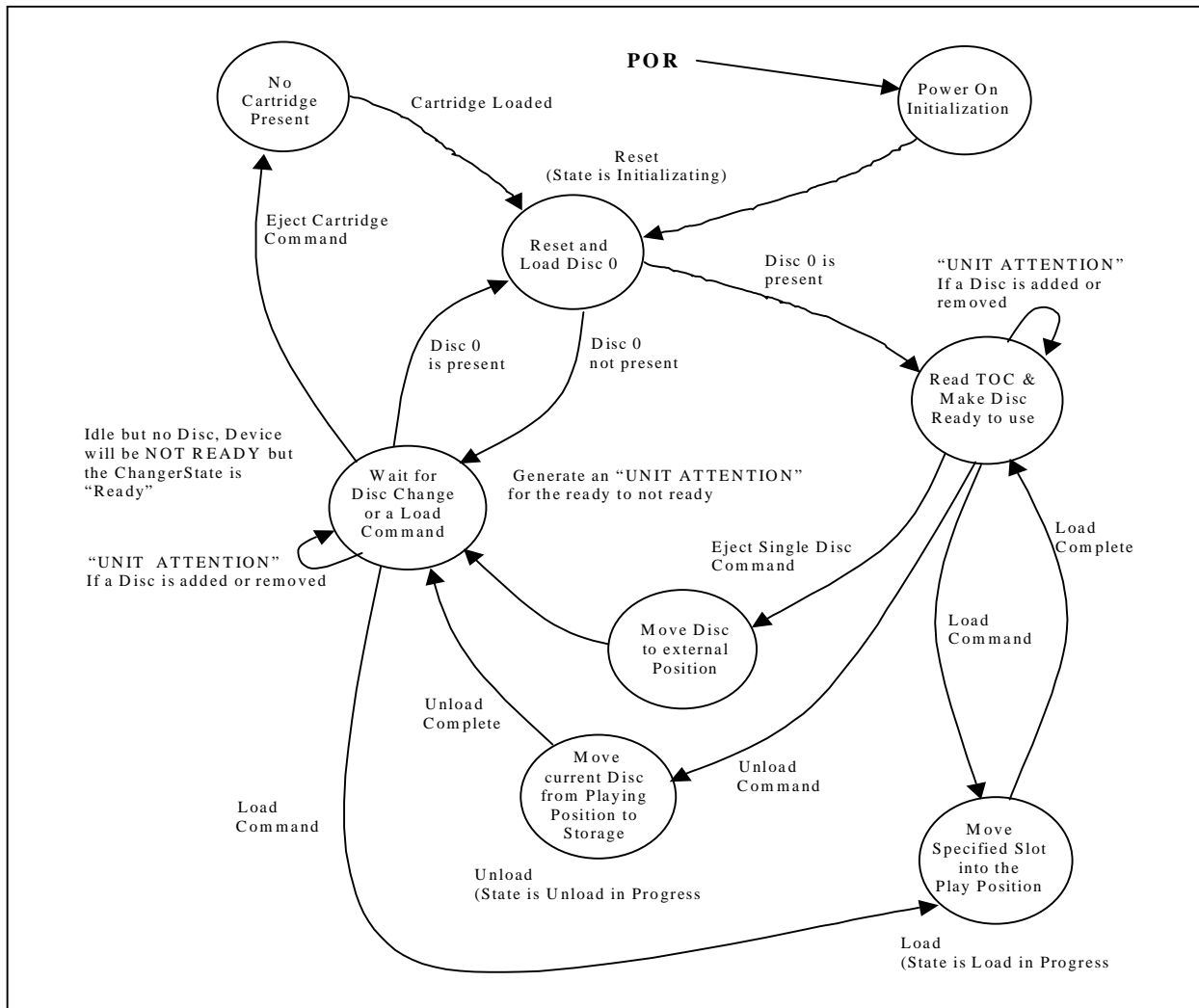
Figure 38 – Changer State Diagram

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 CD/DVD 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 CD/DVD device. This also ensures compatibility with a Bootable CD/DVD. 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

CD/DVD 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 44 shall move the selected disc into the play position when data that has not been cached has been requested by the Initiator.

Table 44 – 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 45).

Table 45 – 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 46)

Table 46 – 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 47 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 47 – 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 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.
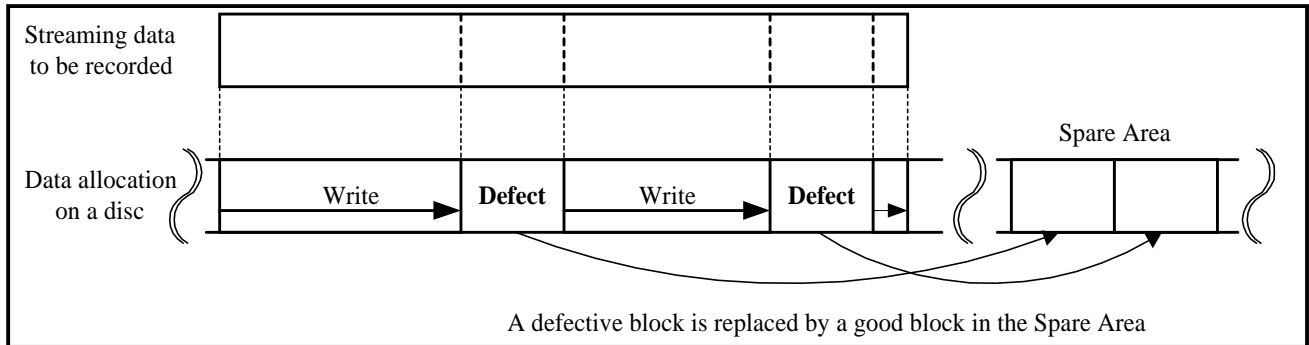
Figure 39 – Example of Data Allocation in case of Linear Replacement

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 40. 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.
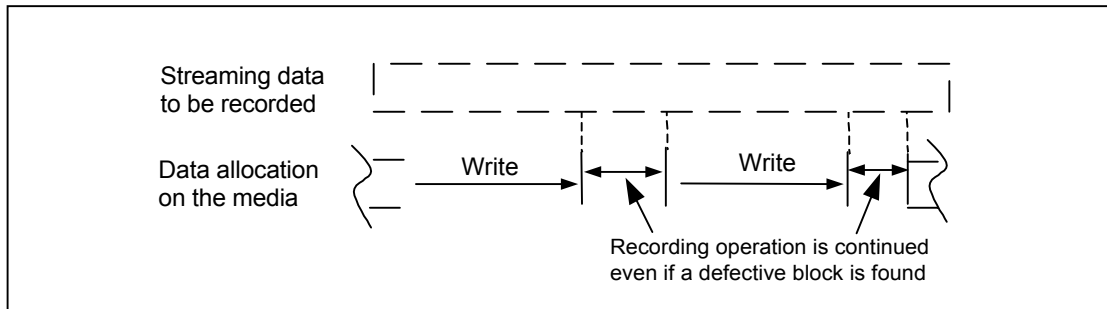
Figure 40 – An example of data allocation on the Stream recording operation

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 48. The defective block may be registered in defect list but the linear replacement algorithm shall not be applied on Stream recording/playback operation.

Table 48 – 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

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 defined uniquely for Multi-Media Logical Units or have a unique behavior when executed by a Multi-Media Logical Unit.

Table 49 – Commands for Multi-Media Logical Units

Command Name	Op Code	Reference
BLANK	A1h	5.2
CLOSE TRACK/SESSION	5Bh	5.3
ERASE (10)	2Ch	SBC
FORMAT UNIT	04h	5.4
GET CONFIGURATION	46h	5.5
GET EVENT/STATUS NOTIFICATION	4Ah	5.6
GET PERFORMANCE	ACh	5.7
INQUIRY	12h	SPC-2
LOAD/UNLOAD MEDIUM	A6h	5.8
MECHANISM STATUS	BDh	5.9
MODE SELECT (10)	55h	SPC-2
MODE SENSE (10)	5Ah	SPC-2
PAUSE/RESUME	4Bh	5.10
PLAY AUDIO (10)	45h	5.11
PLAY AUDIO (12)	A5h	5.12
PLAY AUDIO MSF	47h	5.13
PREVENT ALLOW MEDIUM REMOVAL	1Eh	SPC-2
READ (10)	28h	SBC
READ (12)	A8h	SBC
READ BUFFER	3Ch	SPC-2
READ BUFFER CAPACITY	5Ch	5.15
READ CAPACITY	25h	5.16
READ CD	BEh	5.17
READ CD MSF	B9h	5.18
READ DISC INFORMATION	51h	5.19
READ DVD STRUCTURE	ADh	5.20
READ FORMAT CAPACITIES	23h	5.21
READ SUB-CHANNEL	42h	5.22
READ TOC/PMA/ATIP	43h	5.23
READ TRACK INFORMATION	52h	5.24
REPAIR TRACK	58h	0

Table 49 (continued) – Commands for Multi-Media Logical Units

Command Name	Op Code	Reference
REPORT KEY	A4h	5.26
REQUEST SENSE	03h	SPC-2
RESERVE TRACK	53h	5.27
SCAN	BAh	5.28
SEEK (10)	2Bh	SBC
SEND CUE SHEET	5Dh	5.29
SEND DVD STRUCTURE	ADh	5.30
SEND EVENT	A2h	5.31
SEND KEY	A3h	5.32
SEND OPC INFORMATION	54h	5.33
SET CD SPEED	BBh	5.34
SET READ AHEAD	A7h	5.35
SET STREAMING	B6h	5.36
START STOP UNIT	1Bh	SBC
STOP PLAY/SCAN	4Eh	5.37
SYNCHRONIZE CACHE	35h	5.38
TEST UNIT READY	00h	SPC-2
VERIFY (10)	2Fh	SBC
WRITE (10)	2Ah	5.39
WRITE (12)	AAh	5.40
WRITE AND VERIFY (10)	2Eh	5.41
WRITE BUFFER	3Bh	SPC-2

5.2 BLANK Command

CD/DVD-RW discs have two properties not available with CD/DVD-R: direct-overwrite and the ability to erase. The BLANK command (Table 50) provides the ability to erase any part of a CD/DVD-RW disc.

Table 50 – BLANK Command

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							

Note: The erasing action performed in this command is a Logical Erase, in that the data is overwritten with Mode 0 data on CD media

The IMMED bit allows execution of the Blank command as an immediate operation. 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. The codes for Blanking Type for CD-RW are defined in Table 51.

Start Address/Track Number is the LBA that a range, for erasure, begins:

a) When Blanking Type is Blank a Track Tail, this field indicates the start LBA.

b) When Blanking Type is Blank a Track, this field indicates the track.

When the Logical Unit changes status (NOT READY, READY) a Class 1 Event shall be generated.

Table 51 – Blanking Types CD-RW

Value	Name	Description
000b	Blank the disc	The entire disc is to be erased. 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 area from the start time of Lead-in through the last possible start time of Lead-out plus 6 750 blocks and the entire PMA shall be blank.
001b	Minimally blank the disc	Erases only the PMA, first session TOC and the pre-gap of the first track. The Start Address parameter is ignored. This is used for blanking a disc quickly. After completion of this command the disc is treated as a blank disc. Caution shall be exercised when using this command as the program area still contains user data.
010b	Blank a Track	Erases the track specified in the Start Address/Track Number field. This command erases the track only, it does not erase the TOC or the PMA. The track to be erased shall be in the incomplete session.
011b	Un-reserve a Track	This is valid only when the last recorded track is incomplete, reserved, or is complete and in an incomplete session. If the last track is incomplete the track and PMA entry for incomplete track is erased. If the track is reserved or complete, the track and PMA entry of the track is erased. The Start Address/Track Number parameter is ignored.
100b	Blank a Track Tail	Erase the area between the LBA specified Start Address/Track Number field and the end of the track that includes the LBA specified. The LBA specified shall be the first user data block within a packet. This blank type is valid for only a Packet track. This may be used to prepare for writing a packet track to a CD-RW disc with the same write process as a CD-R. The track to be erased shall be in an incomplete session.
101b	Unclose the last session	Erases the Lead-in and Lead-out of the last session. The last session shall be complete when this command is issued.
110b	Erase Session	If the last session is complete, its Lead-in, program area, and Lead-out shall be erased. If the last session is incomplete, its program area shall be erased. If the last session is empty, the complete session immediately preceding the empty session shall be erased. If the empty session is the only session on the disc, erasing shall not be considered an error.
111b	Reserved	

The Blanking Types for DVD-RW media is defined in Table 52.

Table 52 – Blanking Types for DVD-RW media

Value	Name	Description
000b	Blank the disc	The entire disc is to be erased. 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 erased. The Start Address or Track Number parameter is ignored. If a disc is to be erased 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 erased. 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 erased 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 erased. If the last track is incomplete, the incomplete track is erased. 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 erased shall be in an incomplete session. Erase 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 erased 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 erase 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. Erases 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 erased.
110b	Erase Session	If the last session is complete state, its Lead-in/Border-in through the end of the Lead-out/Border-out shall be erased. If the last session is incomplete state, all track(s) in the incomplete session shall be erased. If the last session is empty state, the complete session immediately preceding the empty session shall be erased. If the disc is blank, erasing shall not be considered an error.
111b	Reserved	

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 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 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. See ANSI X3.301:1997, SPC standard for sense key specific field location.

Recommended error reporting is defined in Table 53.

Table 53 – Recommended errors for BLANK Command

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

5.3 CLOSE TRACK/SESSION Command

The CLOSE TRACK/SESSION command, Table 54, allows closure of either a track or a session. If the Multi Session field in the Write Parameters Page (05h) is set to 11b and there is not sufficient space for the next Session, the Session to be closed shall be closed and next Session shall not be allowed. For CD, the Session is closed without the B0 pointer. For DVD-R/-RW, the Session is closed with Lead-out and the Start PSN of the next Border-in field of Lead-in/Border-in set to 0. In the case of insufficient space for the next Session, legacy CD-R/RW Logical Units may generate an error in the above case. In this case, the Initiator shall change the Multi-Session field in the Write Parameters Page (05h) and retry the Command.

Table 54 – CLOSE TRACK/SESSION Command Descriptor Block

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (5Bh)							
1	Reserved							IMMED
2	Reserved						Session	Track
3	Reserved							
4	(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 Session and Track bits (Table 55) have the following meanings:

Table 55 – **Session and Track Bits Definitions**

Session	Track	Close Actions
0	0	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. If the medium is not DVD+RW or if the optional behavior is not supported, the Logical Unit shall terminate the command with CHECK CONDITION status and set SK/ASC/ASCQ values to ILLEGAL REQUEST/INVALID FIELD IN CDB.
0	1	Close the track associated with the track number in the CDB. For CD, 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 the partially recorded or empty reserved track, the Logical Unit shall pad the track. In the case of an empty track, the Logical Unit shall write the track according to the write parameter page. If the write parameter page is inconsistent with the PMA, CHECK CONDITION 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. For 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. For all other media types, this command shall be terminated with CHECK CONDITION status and SK/ASC/ASCQ values shall be set to ILLEGAL REQUEST/INVALID FIELD IN CDB.
1	0	Close Session. If all Tracks in the last Session are not complete, generate a CHECK CONDITION status and set SK/ASC/ASCQ values to ILLEGAL REQUEST/SESSION FIXATION ERROR – INCOMPLETE TRACK IN SESSION. Or if an empty or partially recorded, reserved Tracks exist in the incomplete Session, generate CHECK CONDITION status and set SK/ASC/ASCQ values to ILLEGAL REQUEST/EMPTY OR PARTIALLY WRITTEN RESERVED TRACK. Behavior of the closing operation is dependent on the Multi-Session field in the Write Parameters Page (05h). Closing an empty Session not produce an error and a write to the media shall not occur. If a MRW background format is in progress, the format operation shall be stopped and the disc shall be structured for removal according to the MRW format. In particular, if a lead-out is required for access by a read-only device, then a lead-out shall be written. If a DVD+RW 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 Formats Specifications* for the specific purpose of providing DVD-ROM read 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. For DVD-RW media, 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.)
1	1	For DVD-RW media, 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.

If a Session or Track is to be closed that is already closed, no error shall be reported.

If Session bit is set to zero and Track bit is set to one, the Track Number field indicates the number of tracks to close. Byte 4 and Byte 5 of the CDB shall be ignored if the Session bit is set to one.

For a CD to close the incomplete track, the following steps are required:

1. If necessary, the track is padded with all zero main data to the minimum length of 4 seconds.

2. The PMA is consulted in order to locate the largest track number recorded, 'N'.

3. The boundaries of the track are determined and a PMA entry is written for track N+1. Closing a Track shall cause cached information for the specified Track to be committed to the medium prior to closing.

For CD Closing a Session shall cause the Lead-in and Lead-out to be written for the incomplete Session. Closing a Session when the last session is closed shall not be considered an error. Closing a session when the last session is empty shall cause no actions to be performed and shall not be considered an error. For DVD-R/-RW, closing an incomplete or intermediate Session shall cause the Lead-in or Border-in and Border-out to be written for the incomplete or intermediate Session. If the Multi-Session field in the Write Parameters Page (05h) is set to 00b, a Lead-out shall be appended to last Border-out. Once the Lead-out has been written for DVD media, data can not be further appended to the medium.

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.

Recommended error reporting is defined in Table 56.

Table 56 – Recommended errors for CLOSE TRACK/SESSION Command

Error	Reference
Deferred Errors	A.1
General Errors	Table A.2
Media Access Errors	Table A.3
Write Errors	Table A.4
Fixation Errors	Table A.5

5.4 FORMAT UNIT Command

The FORMAT UNIT command (Table 57) formats a medium into Initiator addressable logical blocks per the Initiator defined options.

The medium may be certified and control structures created for the management of the medium and defects. There is no guarantee that the medium has not been altered.

Table 57 – Format Unit Command

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							

A FmtData bit of zero indicates that there is no parameter list. A FmtData bit of one indicates that a parameter list is available from the Initiator. For CD-RW, DDCD-RW, DVD-RAM, DVD-RW, and DVD+RW FmtData shall be set to one.

The CmpList bit is used in conjunction with the DCRT (Table 60) bit to determine usage of the existing G1-list, G2-list and SDL to construct new G1-list and G2-list (Table 58) 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 58 – 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

A formatted CD-RW, DDCD-RW, or DVD-RW session shall consist of a single, fixed packet track. The packet size specified in the Write Parameters Page defines the packet size for the format operation.

If the WRITE TYPE field in the Write Parameters Page is not packet (00b), the FORMAT UNIT command shall terminate with a CHECK CONDITION and set SK/ASC/ASCQ values to ILLEGAL REQUEST/COMMAND SEQUENCE ERROR. If the FP bit in the Write Parameters Page is not set to

one (Fixed Packet), the FORMAT UNIT command shall terminate with a CHECK CONDITION and set SK/ASC/ASCQ values to ILLEGAL REQUEST/COMMAND SEQUENCE ERROR.

The Format Code identifies the parameter list format. For DDCD-RW / CD-RW Format Descriptor, the Format Code shall be set to seven (111b), for other Format Descriptor the Format Code shall be set to one (001b).

The Interleave Value field identifies the value to be used when formatting. Interleave Value shall be zero.

During the operation of the FORMAT command that began with the IMMED bit set to one, the Logical Unit shall respond to other 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/FORMAT 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 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.

During the execution of the FORMAT UNIT command, the Logical Unit shall perform a medium defect management algorithm if the Defect Management Feature is current. The FORMAT UNIT command for DVD-RAM media may not provide a method to receive defect location information from the Initiator.

A format data (FmtData) bit of one indicates that the FORMAT UNIT parameter list (see Table 59) shall be transferred to the Logical Unit. The data sent to the Logical Unit consists of a Format List Header, followed by an initialization pattern descriptor (that may have zero length), followed by zero or one Format descriptors. The Format descriptor shall be one of Formattable Capacity Descriptors returned by the READ FORMAT CAPACITIES command.

The FORMAT UNIT command parameter list (Table 59) consists of three descriptors: the Format List Header, the Initialization Pattern Descriptor, and the Format Descriptor.

Table 59 – 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							

The Format List Header (Table 60) 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.

If the Initialization Pattern Descriptor is to be included in parameter data sent to the Initiator, the IP bit shall be set to one, and the data shall begin at a byte offset of 4. If the IP bit is set to zero, the Initialization Pattern Descriptor shall not be included in the Format Unit Parameter data sent to the Logical Unit, and the Format Descriptor shall begin at byte offset 4.

Table 60 – 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)			

A Format Options Valid (FOV) bit of zero indicates that the Logical Unit shall use its default settings for the DPRY, DCRT, STPF, IP, Try-out, IMMED, and VS bits (see below). When the FOV bit is zero, the Host 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.

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 SK/ASC/ASCQ shall be set to ILLEGAL REQUEST/INVALID FIELD IN PARAMETER LIST.

A FOV bit of one indicates that 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:

A Disable Primary (DPRY) bit, when set to zero, indicates that the Logical Unit shall not use portions of the medium identified as defective in the primary defect Plist for Initiator addressed logical blocks. Logical Units that support CD-RW, DDCD-RW, DVD-RAM, DVD-RW, or DVD+RW media do not permit the Initiator to set this bit to one. If 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 PARAMETER LIST.

A Disable Certification (DCRT) bit, when set to zero, indicates that the Logical Unit shall perform a vendor-specific medium certification operation. This may include the generation of a G1-list (C-list) or a Defect Status bitmap (DS #n bits) in the Format 3 RMD on DVD-RW media. A DCRT bit of one indicates that the Logical Unit shall perform no vendor-specific medium certification process or format verification operation while executing the FORMAT UNIT command.

For CD-RW media, use of the DCRT bit is specific to the format type selected.

The STPF bit shall be reserved.

An Initialization Pattern (IP) bit of zero indicates that an initialization pattern descriptor is not included and that the Logical Unit shall use its default initialization pattern. An IP bit of one indicates that an initialization pattern descriptor is sent to the Logical Unit as part of the FORMAT UNIT parameter list (See sub-clause 5.4.1).

For CD-RW media, the IP bit is reserved.

A Try-out bit of one indicates that the Logical Unit `shall` not alter the media format, but `shall` examine whether the specified FORMAT command can be performed without error, based on available information before starting the formatting.

For CD-RW media, the Try-out bit is reserved.

An immediate (IMMED) bit of zero indicates that status `shall` be returned after the format operation has completed. An IMMED bit value of one indicates that the Logical Unit shall return status as soon as the command descriptor block has been validated, and the entire Format Descriptor has been transferred.

If the IMMED bit is set to one, and a REQUEST SENSE command is issued during the formatting operation, the Logical Unit `shall` return a sense key of NOT READY and an ASC of LOGICAL UNIT NOT READY, FORMAT IN PROGRESS, unless an error has occurred. The sense key specific bytes shall be set to the percentage of the operation that has completed. The sense key specific field contains a value from 0 to FFFFh, where FFFFh indicates the formatting is completed.

The Vendor Specific (VS) bit is vendor-specific.

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. Any other value in this field shall cause CHECK CONDITION status to be returned and SK/ASC/ASCQ values shall be set to ILLEGAL REQUEST/INVALID FIELD IN PARAMETER LIST.

5.4.1 Initialization Pattern

The initialization pattern option specifies that the logical blocks contain the specified initialization pattern. The initialization pattern descriptor (Table 61) is sent to the Logical Unit as part of the FORMAT UNIT parameter list.

Table 61 – 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 : n	Initialization Pattern							

The IP Modifier field specifies the type and location of a header that modifies the initialization pattern (see Table 62).

Table 62 – IP Modifier Field

IP Modifier	Descriptor
00b	No header. The device server shall not modify the initialization pattern.
01b	The device server 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 device server 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 Initialization Pattern Type field (Table 63) indicates the type of pattern the device server shall use to initialize each logical block within the application client 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 63 – Initialization Pattern Type

Initialization Pattern Type	Description
00h	Use default pattern[1]
01h	Repeat the initialization pattern as required to fill the logical block.[2]
02h – 7Fh	Reserved
80h - FFh	Vendor Specific
Notes: 1. If the initialization pattern length is not zero the device server shall terminate the command with CHECK CONDITION status and SK/ASC/ASCQ shall be set to ILLEGAL REQUEST/INVALID FIELD IN PARAMETER LIST. 2. If the initialization pattern length is zero the device server shall terminate the command with CHECK CONDITION status and SK/ASC/ASCQ shall be set to ILLEGAL REQUEST/INVALID FIELD IN PARAMETER LIST.	

A Security Initialize (SI) bit of one indicates that the device server shall attempt to write the initialization pattern to all areas of the media including those that may have been reassigned. A SI bit of one shall take precedence over any other FORMAT UNIT field. The initialization pattern shall be written using a security erasure write technique. Application clients 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.

An SI bit of zero indicates that the device server shall initialize the application client accessible area of the media. The device server is not required to initialize other areas of the media. However, the device server shall format the medium as defined in the FORMAT UNIT command.

When the SI bit is one, the device server need not rewrite (format) header and other information not previously accessible to the application client. If any area of the medium that previously was accessible to the application client cannot be written, the device server 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 device server 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 IP Modifier field modifies the pattern.

The Format descriptor specifies an eight-byte entry.

5.4.2   CD-RW Format Descriptor, Format Code 111b

If the Format Code, in the CDB, is 111b the CD-RW Format Descriptor defined in Table 64 shall be sent.

Table 64 – 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 complete when this command is issued, a CHECK CONDITION status shall be generated.

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

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

5.4.3   Format Code 001b

If the Format Code, in the CDB, is 001b the Format Code 1 Format Descriptor defined in Table 65 shall be sent.

Table 65 – 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 descriptor specifies an eight-byte entry.

The Format Type field specifies the type of formatting. Contents of the Number of Blocks field and the Type Dependent Parameter field depend on the type of formatting.

5.4.3.1   Format Type = 00h (Full Format)

Formatting for the entire media is specified. 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.

On CD-RW media, the whole 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 58. 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. In other cases, 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.

5.4.3.2   Format Type = 01h (Spare Area Expansion)

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 in sub-clause 5.21.

5.4.3.3   Format Type = 04h (Zone Reformat)

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 Table 58. 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.

5.4.3.4   Format Type = 05h (Zone Format)

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 in sub-clause 5.21.

5.4.3.5   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, sub-clause 5.21. 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.

5.4.3.6   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.

5.4.3.7   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, 5.21.

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.

5.4.3.8   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.

5.4.3.9   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.

5.4.3.10   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.

5.4.3.11   Format Type = 20h (Full Format, DVD+RW 3.0 GB) (OBSOLETE)

Formatting for the whole media is specified. The Number of Blocks field specifies the maximum number of addressable blocks for the whole disc and the Type Dependent Parameter field specifies the sparing parameters SL and SI. The Logical Unit shall verify that SL and SI are usable values (i.e. values that do not cause overflow of the SDL).

If the Multi-Session Field (Table 349) in the Write Parameter Page is 11b, the Logical Unit shall erase the remaining area of the disc.

5.4.3.12 Format Types = 24h, (MRW Full Format)

The CD-RW disc shall be formatted according to the *CD-MRW Defect Management & Physical Formatting Specification* (sub-clause 2.2).

The Number of Blocks parameter shall have the value 0xFFFFFFFF. If the field contains any other value, the Logical Unit shall terminate the command with CHECK CONDITION status and set SK/ASC/ASCQ values to ILLEGAL REQUEST/INVALID FIELD IN PARAMETER BLOCK. The number of blocks formatted shall be exactly the number of blocks reported by the READ FORMAT CAPACITIES command for type 24h.

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.

For a New Format operation, the medium format shall be performed to create a single track, single session of fixed packets of size = 32, mode 2 form 1 data. Defect management tables are initialized as a part of the formatting process.

Much of the formatting is performed in background. The initiator may suspend a background format process by issuing the CLOSE TRACK/SESSION command with Session = 1 and Track = 0.

For a Restart Format operation, the Logical Unit shall continue formatting a suspended background format process. If there is no suspended background format to continue, the Logical Unit shall terminate the command with CHECK CONDITION status and set SK/ASC/ASCQ values to ILLEGAL REQUEST/ COMMAND SEQUENCE ERROR.

Certification of the format is based upon current medium status as shown in Table 66.

Table 66 – 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. The CD-MRW DM&PF Specification requires certification of the user area.	
MRW formatted	Reinitialize MRW structures, verify MRW structures and user areas. The CD-MRW DM&PF Specification requires 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.

5.4.3.12.1 Background Formatting: New Format

If the IMMED bit is cleared to zero, formatting begins with the MTA initialization. Once that has completed, the FORMAT UNIT command terminates with GOOD status and continues the format in background. Once MTA initialization has been completed, the disc is MRW available.

If the IMMED bit is set to one, the FORMAT UNIT command terminates with GOOD status and proceeds with all format-writing functions performed in the background. If any media accessing command is issued prior to the disc being MRW available, the Logical Unit shall terminate the command with CHECK

CONDITION status and set SK/ASC/ASCQ values to NOT READY/LOGICAL UNIT NOT READY/FORMAT IN PROGRESS .

Once the formatting process has achieved MRW available, format progress may be tracked. If no error has occurred, then in response to a TEST UNIT READY command, the Logical Unit shall terminate the command with GOOD status and SK/ASC/ASCQ values shall be set to NO SENSE/LOGICAL UNIT NOT READY/FORMAT IN PROGRESS. The sense key specific bytes shall be set as a progress indicator (Table 67).

Table 67 – Sense Key Specific Bytes in Sense Data

Bit Byte	7	6	5	4	3	2	1	0
15	SKSV	Reserved						
16	(MSB)	Progress Indication						
17								(LSB)

The progress indication field is a percent complete indication in which the returned value is the numerator that has 65536 (10000h) as its denominator. The progress indication shall be based upon the total operation.

Once the background format operation has completed, the CD-RW Logical Unit shall post a Background Format Completed Media Event. The response to a TEST UNIT READY command shall then be: the command shall be terminated with GOOD status and SK/ASC/ASCQ values shall be set to NO SENSE/NO ADDITIONAL SENSE INFORMATION, and SKSV shall be cleared to zero.

5.4.3.12.2 Stopping and Restarting a Background Format

If a format is executing in background:

- Only issuing the CLOSE TRACK/SESSION command may stop the formatting process.

- The inactivity timer (CD-ROM Mode Page) is disabled. This ensures that lack of initiator activity does not allow a spin down during background formatting.

- If the initiator sends a SCSI command which requires that the medium spin down, the CD-RW Logical Unit shall terminate the command with CHECK CONDITION status and set SK/ASC/ASCQ values to NOT READY/LOGICAL UNIT NOT READY/FORMAT IN PROGRESS. Example: START STOP UNIT command is issued with Start = 0.

- If the initiator/Logical Unit physical interface provides a command layer with commands that can cause the medium to spin down, then those commands shall 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 CD-RW Logical Unit, it shall be executed normally.

Whenever a CD-RW disc is mounted, the CD-RW Logical Unit shall examine the disc structures. The state of formatting is reported in the Disc Information Block (Table 162).

The initiator may restart a suspended background format at any time. If the format has already completed, this shall not be considered an error.

The initiator may choose to write to the disc while an incomplete format is NOT in progress. If the initiator writes to any LBA which is beyond the start of the current, temporary lead-out, the Logical Unit shall restart the format automatically. If the Logical Unit performs an automatic restart, the initiator shall be informed with the BGformatRestarted event.

5.4.3.12.3 Recovering an Incomplete Format

The background format can be stopped in a controlled way as described in 5.4.3.12.2, above. A Hard Reset or loss of power can also stop a background format operation, but not in a controlled way. This can produce a disc which is partially formatted, however, it may also contain recoverable data.

An initiator operated recovery application can be produced in order to recover data from the disc. Since the defect management system may be corrupted, it is recommended that the READ CD MSF be used for data recovery.

The *CD-MRW Defect Management & Physical Formatting* specification describes a method for check-pointing the background format progress. If the MTA is not corrupted, then a format restart restarts the formatting operation from the last checkpoint. If the MTA is corrupted and either the MIP or the MDT is unrecoverable, then a new format is required.

5.4.3.13 Format Type = 26h (Full Format, DVD+RW)

DVD+RW Basic Format, Mandatory when the Write bit in the DVD+RW Feature Descriptor is set to one. 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 host, then the drive shall terminate the command with CHECK CONDITION status and set sense bytes (Sense Key/ASC/ASCQ) to ILLEGAL REQUEST/ILLEGAL VALUE IN PARAMETER BLOCK. Implementation of background format is mandatory.

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.

Much of the formatting is performed in background. The initiator may suspend a background format process by issuing the CLOSE TRACK/SESSION command. See sub-clause 5.3.

For a Restart Format operation, the Logical Unit shall continue a suspended background format. If there is no suspended background format to continue, the Logical Unit shall terminate the command with CHECK CONDITION status and set SK/ASC/ASCQ values to ILLEGAL REQUEST, COMMAND SEQUENCE ERROR.

DCRT has no meaning when formatting type 26h. The device ignores DCRT.

5.4.3.13.1 Background Formatting for Format Type 26h

The background formatting process is best illustrated in Figure 41.
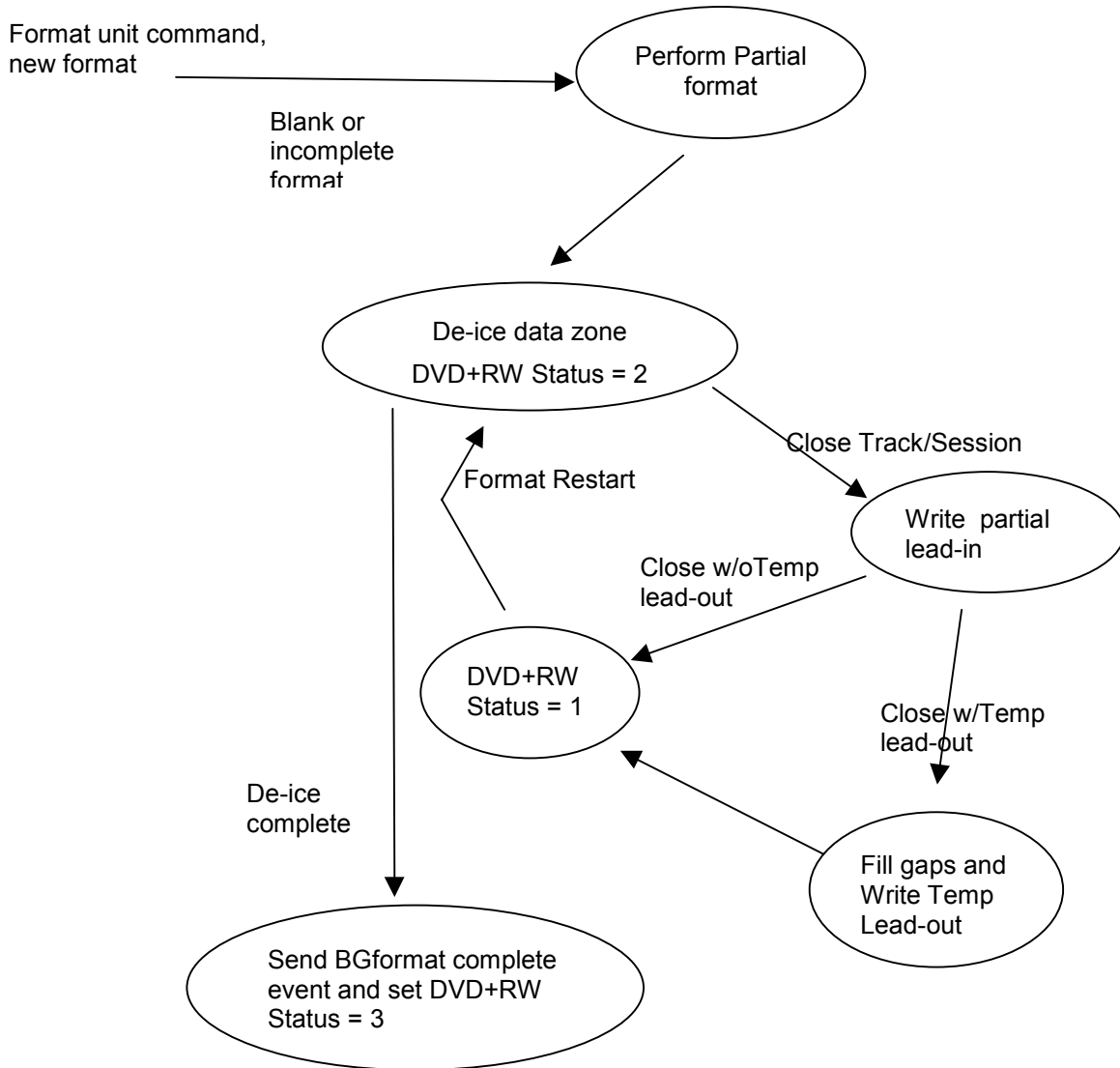
Figure 41 – Background Process Flow

5.4.3.13.2 Background Formatting: Getting Started

According to the *DVD+RW 4.7 Gbytes Basic Format Specifications*: "The disc shall be considered partially formatted if the lead-in has been recorded from the Inner Disc Test Zone up to the Data Zone."

Once the disc has completed the partial formatted state, the format operation may continue in background. That is, the FORMAT UNIT command shall terminate.

All format write functions shall write only complete DVD+RW ECC blocks.

5.4.3.13.3 Background Formatting: Stopping the Format

If a format is executing in background:

- The formatting process may be stopped by issuing the CLOSE TRACK/SESSION command.

- 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 SK/ASC/ASCQ values to NOT READY, LOGICAL UNIT NOT READY, FORMAT IN PROGRESS. Example: START STOP UNIT command is issued with Start = 0.

- If the initiator/Logical Unit physical interface provides a command layer with commands that can cause the medium to spin down, then those commands shall 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.

Whenever a DVD+RW disc is mounted, the Logical Unit shall examine the disc structures. The state of formatting is reported in the Disc Information Block as returned by the READ DISC INFORMATION command.

5.4.3.13.4 Background Formatting: Restarting

If an incompletely formatted disc is mounted in a write-capable DVD+RW Logical Unit, formatting shall not continue automatically at that time.

The initiator may explicitly restart the format by sending the format command again with restart specified in the type dependent parameter of the format descriptor.

The initiator may implicitly restart the format by sending a write command requesting that some LBA beyond the currently formatted region be written. In this case, the Logical Unit shall post the BGformatRestarted media event.

The FDCB (See *DVD+RW 4.7 Gbytes Basic Format Specifications)* should be consulted in order to correctly restart the background format.

5.4.3.13.5 Background Formatting: Progress Reporting

If the IMMED bit is set to one, then the FORMAT UNIT command terminates with GOOD status and proceeds with all format writing functions performed in the background. If any media accessing command is issued while the initial areas are being formatted, the DVD+RW Logical Unit shall terminate the command with CHECK CONDITION status and set SK/ASC/ASCQ values to NOT READY, LOGICAL UNIT NOT READY, FORMAT IN PROGRESS.

Regardless of the setting of IMMED, once the partial formatting has completed, background formatting begins. The initiator may monitor format progress. The response to a TEST UNIT READY command shall be: the command shall be terminated with GOOD status and SK/ASC/ASCQ values shall be set to NO SENSE/LOGICAL UNIT NOT READY/ FORMAT IN PROGRESS, unless an error has occurred. The sense key specific bytes (Table 68) shall be set as a progress indicator.

Table 68 – 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)

The progress indication field is a percent complete indication in which the returned value is the numerator that has 65 536 (10000h) as its denominator. The progress indication shall be based upon the total operation.

Once the background format operation has completed, the DVD+RW Logical Unit shall post a Background Format Completed Media Event. The response to a TEST UNIT READY command shall then be: the command shall be terminated with GOOD status and SK/ASC/ASCQ values shall be set to NO SENSE, NO ADDITIONAL SENSE, NO ADDITIONAL SENSE QUALIFIER, and SKSV shall be cleared to zero.

5.4.3.13.6 Background Formatting: Formatting Concurrently with Writing

Once the partial format has completed, the initiator may issue a write to any address that exists after formatting has completed. It is possible for the Logical Unit to locate and write the data as requested.

Suppose some write request is made to a DVD+RW ECC block that is completely blank. When this occurs, the data shall be placed into the correct ECC block buffer positions and un-addressed sector positions within the buffer shall be zero filled. For example, suppose a write command requests to write only the fifth and sixth sectors within a DVD+RW ECC block. The Logical Unit shall load a 16-sector buffer as shown in Table 69.

Table 69 – Writing User Data During Format Operation

ECC Block Sector	Data Content	ECC Block Sector	Data Content
ECC Block Sector 0	Zero fill	ECC Block Sector 8	Zero fill
ECC Block Sector 1	Zero fill	ECC Block Sector 9	Zero fill
ECC Block Sector 2	Zero fill	ECC Block Sector 10	Zero fill
ECC Block Sector 3	Zero fill	ECC Block Sector 11	Zero fill
ECC Block Sector 4	User Data	ECC Block Sector 12	Zero fill
ECC Block Sector 5	User Data	ECC Block Sector 13	Zero fill
ECC Block Sector 6	Zero fill	ECC Block Sector 14	Zero fill
ECC Block Sector 7	Zero fill	ECC Block Sector 15	Zero fill

The difficulty is simply that this allows the blank area to become fragmented.

Note: All blank areas shall be written either with initiator data or format patterns. The Logical Unit shall fill all blank fragments.

5.4.3.13.7 Background Formatting: Formatting Concurrently with Reading

If the initiator attempts to read the media, the result shall be identical to the case where format has completed. Thus, written sectors shall return the data written in the sector. If the sector has not yet been de-iced, then the Logical Unit shall return all zeros in the place of sector data.

5.4.3.13.8 Background Formatting: Early Eject

When the initiator wishes to stop the background format, it shall first notify the Logical Unit with the CLOSE TRACK/SESSION command.

When track = 0 and session = 0, the Logical Unit shall stop the format at an ECC block boundary and record the formatting state in the FDCB. At that point, background formatting shall be stopped.

When track = 0 and session = 1, the Logical Unit shall first perform all ECC block format writes necessary to bring the disc to a state where exactly 2 zones exist: the inner zone is entirely written and the outer zone is entirely blank. A temporary lead-out is appended to ensure that the disc is readable in DVD read-only devices. The Logical Unit shall record the formatting state in the FDCB. Finally, the lead-in is updated to mark the restart point for the format continuation.

5.4.3.14 Format Type = 28h (DDCD-RW quick format).

When the Intermediate bit is set to 1, the new formatting operation, which realizes quasi fast formatting, shall be performed. At the first formatting operation, a specified small area is formatted quickly. Additional formatting operations are performed when necessary. The new format operation creates a single track of fixed packets of size = 32, mode2form1 data, with the following actions:

1. A PMA entry is updated for the single track.

2. The Lead-in area is not recorded.

3. The Pre Gap of the track is recorded.

When ejecting, the last formatted address is recorded in the medium.

As long as a Session on a DDCD-RW(ReWritable) disc is not finalized, the Recording Management Area (RMA) is used for intermediate storage. The RMA contains information about the Packet recording state on the DDCD-RW, this information is encoded as main data in the Lead-in Area.

In the Format UNIT command, 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 shall be adjusted to a value greater than the existing Track size and less than or equal to the value 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 Length.

Recommended error reporting is defined in Table 70.

Table 70 – Recommended errors for FORMAT UNIT Command

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

5.5   GET CONFIGURATION Command

This command is intended to provide information to the initiator about the overall capabilities of the device and, specifically, the current capabilities of the device.

The GET CONFIGURATION command, Table 71, requests that the device respond with the configuration of the device and medium.

The configuration of the device, is described by the Logical Unit supported Features. The currently defined Features are listed in Table 370. The maximum number of Features is 65 536; and the maximum number of bytes that a device may return, to describe its set of supported Features, is 65 534. Feature lists longer than 65 534 bytes require multiple commands.

Persistent Prevent may be used to control when changes occur. If a Persistent Prevent is in place, the configuration should not change except under initiator control.

Table 71 – GET CONFIGURATION Command Descriptor Block

Bit Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (46h)							
1	Reserved			Reserved			RT	
2	(MSB) Starting Feature Number							
3								(LSB)
4	Reserved							
5	Reserved							
6	Reserved							
7	(MSB) Allocation Length							
8								(LSB)
9	Control							

The RT (Requested Type) (Table 72) field indicates the set of Feature Descriptors desired from the Logical Unit.

Table 72 – RT Field definition

RT Field	Description	Starting Feature Number (SFN) Usage
00b	Indicates that the Logical Unit `shall` return the Feature Header and all Feature Descriptors supported by the Logical Unit whether or not they are currently active.	The first Feature Descriptor returned shall have a Feature number greater than or equal to the SFN.
01b	Indicates that the Feature Header and only those Feature Descriptors that have their Current bit set shall be returned.	
10b	Indicates that exactly one Feature Header and zero or one Feature Descriptors be returned. If the Logical Unit does not support the indicated Feature, no Feature Descriptor is returned. Note: this may be used to request Feature 0, which is a list of Profiles.	The SFN specifies the Feature Descriptor that 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.

5.5.1 GET CONFIGURATION response data

The GET CONFIGURATION response Data (Table 74) consists of a header field and zero or more variable length feature descriptors.

Table 73 – 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 74.

Table 74 – 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 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 372) with their CurrentP bit set. If there are no Profiles currently active, this field shall contain zero.

The Feature Descriptor(s) generic format returned is defined in Table 75. Each individual Feature description is defined in the appropriate sub-clause.

Table 75 – Feature Descriptor generic format

Bit Byte	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 contains the code number assigned to the Feature.

Version field, see sub-clause 6.4.2.1.

Persistent bit, see sub-clause 6.4.2.2.

Current bit, see sub-clause 6.4.2.3.

5.5.2 Features

Features are the smallest set of commands, pages, and behavior that may be implemented. A list of features is shown in Table 370 .

A Feature Descriptor shall describe features supported by a Logical Unit. All feature descriptors shall be a multiple of four bytes long. The format of a Feature Descriptor is shown in Table 369.

The Feature Code field shall identify a Feature supported by the Logical Unit.

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 are to be included in a different Feature.

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.

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.

The Additional Length field indicates the number of Feature specific bytes that follow this header. This field shall be an integral multiple of 4.

5.5.3 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. See Table 371, Table 372 and

Table 373 for definitions and description of the Profile List.

The Profile Descriptors are shown in Table 372. 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. The Profile Number identifies a Profile to which the Logical Unit conforms. See

Table 373 .

The Current 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 368.

Recommended error reporting is defined in Table 76.

Table 76 – Recommended Errors for GET CONFIGURATION Command.

Error	Reference
Deferred Errors	A.1
General Errors	Table A.2
Media Access Errors	Table A.3

5.6 GET EVENT/STATUS NOTIFICATION Command

The GET EVENT/STATUS NOTIFICATION command, Table 77, requests the Logical Unit to report events and statuses as specified in the Notification Class Request field and provides asynchronous notification. Two modes of operation are defined here. They are polling and asynchronous modes.

In polling mode, the Initiator should issue GET EVENT/STATUS NOTIFICATION commands at periodic intervals with an IMMED (Immediate) bit set to one. The target shall complete this command with the most recently available event status requested. The Logical Unit shall support polling mode.

In asynchronous mode, the Initiator should issue a single GET EVENT/STATUS NOTIFICATION command with an IMMED (immediate) bit of 0 requested. If the Logical Unit does not support Asynchronous Mode, the command shall fail as an illegal request. If the Initiator requests Asynchronous Mode using a request that is not queued or overlapped, the command shall fail as an illegal request.

When Asynchronous Event Status reporting is supported, the target shall not complete a GET EVENT/STATUS NOTIFICATION command with an IMMED bit of 0 until a change in event status of the requested class occurs. The target shall complete the GET EVENT/STATUS NOTIFICATION command as soon as possible after the event occurs. The event is reported as outlined below.

Only one class of event per GET EVENT/STATUS NOTIFICATION command shall be reported. The priority of event reporting shall be by Event Class number. The lower the Class Number the higher the priority.

This command shall not return 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.

Table 77 – GET EVENT/STATUS NOTIFICATION Command

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

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 the event. An event shall be considered reported even if the result data was truncated due to an insufficient Allocation Length if Event Descriptor is transferred at least one byte. 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.

Notification Class Request field specifies that the Logical Unit report event(s) from the event classes requested in this field. Table 78 defines the codes listed in this field.

Table 78 – Notification Class Request field definition

Bit	Definition
0	Reserved
1	Operational Change Request/Notification
2	Power Management
3	External Request
4	Media
5	Multi-Initiator
6	Device Busy
7	Reserved

If a Logical Unit does not support any of the requested event classes, the Logical Unit shall terminate the command successfully, returning only the Event Status Notification Response (see Table 79), and indicating a returned Class of 0.

Initiators that manage media event status may or may not be linked to other entities that manage power states. This notification field provides a way that power and media event status notifications can be independently managed by the responsible entities. If a driver manages media, power management and Device Busy events, the driver can issue this command with Notification Class Request field set to 01010100b to request the Logical Unit to report power management, media, and device busy events.

Table 79 – Event Status Notification Response

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

The Event Header returns the data defined in Table 80.

Table 80 – Event Header Return Data

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

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

The No Event Available (NEA) bit, when set to one, shall indicate none of the requested notification classes are supported. When set to zero, it shall indicate that at least one of the requested notification classes is supported.

The Notification Class field specifies the class of notification by number. See Table 81.

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

Table 81 – Notification Class Field

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

The data returned, with a class code 001b, is defined in Table 82.

Table 82 – Operational Change/Notification Returned Data

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

Persistent Prevented bit reports the current state of the persistent prevent for the Logical Unit. See sub-clause 6.4.3.4.

Operational Status field (Table 84) reports the device's ability to respond to the Initiator.

Table 83 – Operational Event format

Code	Status	Description
0h	NoChg	No changes in the Logical Unit Operational state performed or requested
1h	Operational Change Request	The Logical Unit The unit requests to change operational state (morph request)
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.

Table 84 – Operational Status Format

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	Busy/Reserved	The Logical Unit is performing operations that are likely take an indefinite amount of time to terminate or the Logical Unit is reserved by another Initiator.
3h - Fh	Reserved	Reserved

Operational Event field reports Logical Unit requests to change state and notifications of changes in device state. If a persistent prevent is in place, any action request that can be reported before performing the action shall not be performed by the Logical Unit, and the device shall notify the Initiator of the requested action. In all other cases, the Logical Unit shall notify the Initiator of actions that change Device State. An example of an action that shall be reported after the action is taken is termination of a format operation due to completion of formatting. Upon reporting operational change notification to the Initiator, this field is reported as 0h on subsequent GET EVENT/STATUS NOTIFICATION commands until a new change in operational state occurs.

Operation Request/Report field (Table 85) reports the operation requested or operation that has been performed. The request usually originates from another Initiator.

Table 85 – Operational Request/Report Format

Code	Event	Description
0h	NoChg	No changes in operational state performed or requested
1h	Change	An unspecified event has changed the Feature list
2h	Add Change	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	

Event 0h requires no Initiator action. The Initiator should respond to Events 1h through 5h with a GET CONFIGURATION command to determine the Logical Unit configuration.

The data returned, with a class code 010b, is defined in Table 86.

Table 86 – Power Management Status Returned Data

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

Power Event field (Table 87) reports the current change in the power status. This field is set to a new power event if a change in the Power State occurs. Upon reporting the current power status change to

the Initiator, this field is reported as 0h on subsequent GET EVENT/STATUS NOTIFICATION commands until a new change in the power state occurs.

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.

Table 87 – 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	

The Power Status field (Table 88) indicates the 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 88 – 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	

The data with a class code 011b is defined in Table 89.

Table 89 – External Request Descriptor

Bit / Byte	7	6	5	4	3	2	1	0
0	Reserved				External Request Event			
1	Persistent Prevented	Reserved			External Request Status			
2	(MSB)				External Request			
3				(LSB)				

The External Request Event field reports external requests to change state and notifications of changes in Logical Unit state. 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. Upon reporting operational change notification to the Initiator, this field is reported as 0h on subsequent GET EVENT/STATUS NOTIFICATION commands until a new External Request occurs. The External Request Events are listed in Table 90.

Table 90 – External Request Event Format

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. 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 reports the Logical Unit's ability to respond to the Initiator.

Table 91 – 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 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 92 – 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 Host. 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	

The data returned, with a class code 100b, is defined in Table 93.

Table 93 – Media Event Descriptor

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

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The Media Event field is defined in Table 94.

Table 94 – 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.
4h	MediaChanged	The user has requested that the media in the specified slot be loaded.
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 95.

Table 95 – Media Status Byte Definition

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

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

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

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 5.9.

The data returned, with a class code 110b, is defined in Table 100.

Multi-Initiator Class Events notify the Initiator of requests for control by other Initiators.

Table 96 – Multiple Initiator Descriptor

Bit / Byte	7	6	5	4	3	2	1	0
0	Reserved				Multiple Initiator Event			
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. Upon reporting Multi- Initiator Events to the Initiator, this field is reported as 0h on subsequent GET EVENT/STATUS NOTIFICATION commands until a new Multi-Initiator Event occurs. The Multi-Initiator Events are listed in Table 99.

Table 97 – 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 98) filed reports the Logical Unit ability to respond to the Initiator.

Table 98 – 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 99) reports the other initiator's relative priority.

Table 99 – 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	

Device Busy Events are used to notify the Initiator of commands that are executing but that require an abnormally long time to complete. Response data is defined in Table 100.

Table 100 – Device Busy Event Descriptor

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

The Device Busy Event field code is defined in Table 101.

Table 101 – Device Busy Event Format

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 102.

Table 102 – Device Busy Status Format

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.

This type of event is usable in two environments. The first is 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. The second environment is where immediate commands and deferred writing are performed; this command may be issued in the immediate mode to obtain status. If a normal command is issued while the device is busy, this command cannot be issued until the normal command completes. Therefore, if queuing is not used, the 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 time-out section 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.

If Report Status Notification is not supported or not enabled, the Logical Unit shall return CHECK CONDITION status and set SK/ASC/ASCQ values to ILLEGAL REQUEST/INVALID FIELD IN CDB.

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

If the IMMED bit is set to zero (and the Logical Unit supports tagged command queuing) and there is NO event to report, the GET EVENT/STATUS NOTIFICATION command shall be queued by the target until there is an Event to report.

If the IMMED bit is set to zero and the target does not support tagged command queuing, the target shall return CHECK CONDITION and set SK/ASC/ASCQ values to ILLEGAL REQUEST/INVALID FIELD IN CDB.

Recommended error reporting is defined in Table 103.

Table 103 – Recommended Errors for GET EVENT/STATUS NOTIFICATION Command.

Error	Reference
Deferred Errors	A.2
General Errors	Table A.2
Media Access Errors	Table A.3

5.7   GET PERFORMANCE Command

The GET PERFORMANCE command, Table 104, 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 104 – GET PERFORMANCE Command Descriptor Block

Bit Byte	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 are dependent upon the Type field value, see Table 105.

The Type field specifies which type of data (see Table 105) shall be transferred. When the Type field is set to 00b, it indicates the Performance data shall be transferred. When the Type field is set to 01b, it indicates the Unusable Area data shall be transferred. When the Type field is set to 02h, it indicates the Defect Status data shall be transferred. When the Type field is set to 03h, it indicates the Write Speed Descriptor shall be transferred. The other values are reserved.

Table 105 – Type field values description

Type field value (Byte10)	Definition	Data Type field				Reference
		bit 4-3	bit 2	bit 1	bit 0	
00h	Performance	Tolerance	Write	Except		5.7.1
01h	Unusable Area	Reserved	Unusable Area Type			5.7.2
02h	Defect Status Data	Reserved	Reserved			5.7.3
03h	Write Speed	Reserved	Reserved			5.7.4
04h - FFh	Reserved					

5.7.1 Performance (Type field = 00h)

The command reports its characteristics of reading/writing performance.

The command can report two forms: the nominal performance and exception locations that may cause seek delays to occur. These performance parameters are reported separately for read and write.

The corresponding parameter field allocation is specified in Table 105.

The Tolerance field, when set to 10b, shall indicate that the descriptors returned shall have a 10% tolerance for the nominal performance and 20% for the exception list. All other values are reserved for future standardization.

The Write bit, when set to zero, shall indicate that the performance parameters for reading shall be returned. When set to one, the performance parameters for writing shall be returned.

The Except field, when set to 00b, shall indicate that the nominal performance parameters be returned. When set to 01b, the entire performance exception list, qualified by the Starting LBA, shall be returned. When set to 10b, only performance exceptions that cause the performance to fall outside the nominal shall be reported. For example, slipped sectors not included in the 10b list shall be included in the 01b list. An Except field of 11b is reserved.

The Starting LBA field 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 equal to this field or greater.

The Maximum Number of Descriptors shall indicate the maximum number of descriptors that the Logical Unit returns.

The performance response (Table 106) shall contain a Performance header and Performance descriptors.

Table 106 – 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 107.

Table 107 – 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 Write bit, 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, when set to zero, `shall` indicate that the result data is for nominal performance (see Table 108). When set to one, shall indicate that the result data is for exception conditions (Table 109). 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 108) 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 108 – 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 109 – 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.

5.7.2 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 105.

The Unusable Area Type field specifies the type of the unusable area to be transferred. See Table 110.

Table 110 – Unusable Area Type values

Unusable Area Type value	Description
000b	Zone boundary information
001b	PDL information
010b	SDL information
Others	Reserved

The Starting LBA field in Table 104 shall indicate the starting point for returning Unusable Area data. All Unusable Area data shall be for logical block addresses equal to this field or greater.

The Maximum Number of Descriptors field shall indicate the maximum number of descriptors that the Logical Unit returns.

The Unusable Area data shall be formatted as listed in Table 111. The Unusable Area data contains a header (Table 112), followed by zero or more Descriptors. Each Descriptor contains information about an Unusable Area such as an entry of defect list and Zone boundary.

Table 111 – Unusable Area Data

Bit Byte	7	6	5	4	3	2	1	0
0 - 7	Unusable Area Header							
8 - n	Unusable Area Descriptor(s)							

Each Unusable Area Descriptor shall be transferred to the Initiator in ascending order of the Starting Logical Block Address.

Table 112 – Unusable Area Header

Bit Byte	7	6	5	4	3	2	1	0
0	(MSB)							
1				Unusable Area Data Length				
2								
3								(LSB)
4	Reserved							
5	Reserved							
6	Reserved							
7	Reserved							

The Unusable Area Data Length field shall specify the amount of result data not including the Unusable Area 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.

Table 113 – 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.

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5.7.3   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.

The Starting LBA field in CDB shall indicate the starting point for returning Defect Status data. All Defect Status data shall be for logical block addresses equal to this field or greater.

The Maximum Number of Descriptors field shall indicate the maximum number of descriptors that the Logical Unit returns.

The Defect Status data shall be formatted as listed in Table 114. The Defect Status data contains a header, followed by zero or more Descriptors. Each Descriptor contains information about an Defect Status such as a Defect Status bitmap on DVD-RW media. A Defect Status Descriptor size shall be 2 048 bytes.

Table 114 – Defect Status Data

Bit Byte	7	6	5	4	3	2	1	0
0 - 7	Defect Status Header							
8 - n	Defect Status Descriptor(s)							

Each Defect Status Descriptor(s) shall be transferred to the Initiator in ascending order of the Starting LBA. If the certified areas are non-contiguous and scattered, separate descriptors, to exclude the void areas shall return the Defect Status Descriptor(s).

Table 115 – Defect Status Header

Bit Byte	7	6	5	4	3	2	1	0
0	(MSB)							
1	Defect Status Data Length							
2								
3								(LSB)
4	Reserved							
5	Reserved							
6	Reserved							
7	Reserved							

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 116 – 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.

5.7.4 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, Logical Unit shall report the most appropriate list of speeds such as the list for CD-R media or just maximum recording speed. Logical Unit shall report Write Speed descriptors 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. Initiator should detect a possible Write Speed descriptor by this command, then set the Write Speed via SET STREAMING command. To apply this descriptor to 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 117 – Write Speed Descriptor

Bit Byte	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 118.

Table 118 – Write Rotation Control values

WRC value	Description
00b	Media default rotation control
01b	CAV
Others	Reserved

Media default rotation control is the rotation control defined by the media specification originally. Media default rotation control is as follows:

• CD-R/RW   CLV

• DVD-R/-RW   CLV

• DVD-RAM   ZCLV

• DVD+RW   CAV

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.

Recommended error reporting is defined in Table 119.

Table 119 – Recommended errors for GET PERFORMANCE Command

Error	Reference
Deferred Errors	A.2
General Errors	Table A.2
Media Access Errors	Table A.3

5.8 LOAD/UNLOAD MEDIUM Command

The LOAD/UNLOAD MEDIUM command (Table 120) requests the Logical Unit Changer to load or unload a Disc. A new LOAD/UNLOAD MEDIUM command issued before the changer enters the READY STATE (00b), see Table 126, shall cause the changer to stop any LOAD/UNLOAD MEDIUM command in progress and begin processing the new LOAD/UNLOAD MEDIUM command.

Table 120 – LOAD/UNLOAD MEDIUM Command

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

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

The Load/Unload (LoUnlo) bit and the Start bit encoding is shown in Table 121

Table 121 – Load/Unload Operations

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

The SLOT field indicated the Slot to be loaded or unloaded. Changer should always initialize (Load) Slot 0 on power-on reset or Hard reset.

Any attempt to Load or Unload a Disc when the Device does not support that capability shall result in a CHECK CONDITION status returned and SK/ASC/ASCQ values shall be set to ILLEGAL REQUEST/INVALID FIELD IN CDB.

A load request, when the slot does not contain a Disc or the Play Position does not contain a Disc shall be terminated with CHECK CONDITION statue, and SK/ASC/ASCQ values shall be set to ILLEGAL REQUEST/INVALID FIELD IN CDB. An unload request, when the Play Position does not contain a Disc shall be terminated with CHECK CONDITION status and SK/ASC/ASCQ values shall be set to ILLEGAL REQUEST/INVALID FIELD IN CDB.

A load request, when the slot does not contain a Disc shall be terminated with CHECK CONDITION status and SK/ASC/ASCQ values shall be set to NOT READY/MEDIUM NOT PRESENT. When this error is returned there are two possible actions by the CD Changer Device. If the Logical Unit reports Software Slot Selection (SSS) = 1, (see Table 361), then the slot specified shall be selected for use. If the Logical Unit reports SSS = 0 then the previously used slot shall continue to be selected for use.

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

A unit attention condition shall not be generated when discs are loaded or unloaded from the playing position.

Recommended error reporting is defined in Table 122.

Table 122 – Recommended errors for LOAD/UNLOAD MEDIUM operation

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

5.9 MECHANISM STATUS Command

The Mechanism Status command (Table 123) 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 operation may be due to external controls or Initiator commands. This command provides a method that allows the Initiator to know what has transpired with the changer mechanism.

Table 123 – MECHANISM STATUS Command Descriptor Block

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

The Allocation Length field specifies the maximum length, in bytes, of the Mechanical Status Parameter list, see Table 124, that shall be transferred from the Logical Unit to the Initiator. An Allocation Length field of zero indicates that no data shall be transferred. This condition shall not be considered an error.

The Mechanism Status Parameter list returned contains a header (Table 125) followed by zero or more fixed-length Slot Tables (Table 128). If the Logical Unit does not support the changer commands, then the number of slot tables returned to the Initiator shall be zero.

Table 124 – Mechanism Status Parameter List

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

Table 125 – 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 Table(s)				
7								(LSB)

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

The Changer State field (Table 126) indicates the current state of the changer.

Table 126 – 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 127) encodes the current operation of mechanism.

Table 127 – 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, PLAY CD, SCAN during PLAY CD)
4h-6h	Reserved
7h	No State Information Available

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The Slot Table response data format is defined in Table 128. 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 256.

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).

Table 128 – Slot Table Response Format

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

The Disc Present bit, bit 7, indicates that there is a Disc in this slot. The reporting of this information is optional after a reset or Disc change. If this Feature is not supported, this bit shall be set to one after a reset condition or when a medium has been changed. When the Logical Unit is given a load command for a slot that contains no Disc, the bit corresponding to that slot shall then contain a 0 for any following response. If this bit is valid after a reset or medium change, then this capability shall be reported in the CD Capabilities and Mechanical Status Page (see Table 361).

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

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 0, 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 0.

Recommended error reporting is defined in Table 129.

Table 129 – Recommended errors for Mechanism Status Command

Error	Reference
Deferred Errors	A.2
General Errors	Table A.2

5.10 PAUSE/RESUME Command

The PAUSE/RESUME command (Table 130) requests that the Logical Unit stop or start a playback operation. This command is used with PLAY AUDIO commands that are executing in immediate mode.

Table 130 – PAUSE/RESUME Command Descriptor Block

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

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

If an audio play operation cannot be resumed and the Resume bit is one, the command is terminated with CHECK CONDITION status and SK/ASC/ASCQ values shall be set to ILLEGAL REQUEST/COMMAND SEQUENCE ERROR. If the Resume bit is zero and an audio play operation cannot be paused, (no audio play operation has been requested, or the requested audio play operation has been completed), the command is terminated with CHECK CONDITION status and SK/ASC/ASCQ values is 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, or to request a Resume when a play operation is in progress.

Table 131 – Recommended errors for PAUSE/RESUME Command

Error	Reference
Deferred Errors	A.2
General Errors	Table A.2
COMMAND SEQUENCE ERROR	Table A.1

5.11 PLAY AUDIO (10) Command

The PLAY AUDIO (10) command (Table 132) 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 mode parameters.

If any command related to audio operations is implemented then the PLAY AUDIO (10) command shall be implemented.

Table 132 – PLAY AUDIO (10) Command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (45h)							
1	Reserved			Reserved				RelADR
2	(MSB)							
3	Starting Logical Block Address							
4								
5	(LSB)							
6	Reserved							
7	(MSB)				Play Length			
8	(LSB)							
9	Control							

The RelAdr bit shall be set to zero.

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

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 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 .

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.

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.

Table 133 – Recommended errors for PLAY AUDIO (10) Command

Error	Reference
Deferred Errors	A.2
General Errors	Table A.2
Media Access Errors	Table A.3

5.12 PLAY AUDIO (12) Command

The PLAY AUDIO (12) command (Table 134) 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 mode parameters, including the SOTC bit.

Table 134 – 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 is defined in Table 135.

Table 135 – Recommended errors for PLAY AUDIO(12) Command

Error	Reference
Deferred Errors	A.2
General Errors	Table A.2
Media Access Errors	Table A.3

5.13 PLAY AUDIO MSF Command

The PLAY AUDIO MSF command (Table 136) 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 mode parameters including the SOTC bit described on page 120.

Table 136 – 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 is defined in Table 137.

Table 137 – Recommended errors for PLAY AUDIO MSF Command

Error	Reference
Deferred Errors	A.2
General Errors	Table A.2
Media Access Errors	Table A.3

5.14 READ (12) Command

The READ (12) command (Table 216) requests that the Logical Unit transfer data to the Initiator. The most recent data value written in the addressed logical block shall be returned. 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.

Table 138 – 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 Logical Units and shall be set to zero. A DPO bit of zero indicates the retention priority field in the Cache Page shall determine the priority, if supported. All other aspects of the algorithm implementing the cache memory replacement strategy are vender specific.

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 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.

Recommended error reporting is defined in Table 217 .

Table 139 – Recommended errors for READ (12) Command

Error	Reference
Deferred Errors	A.2
General Errors	Table A.2
Media Access Errors	Table A.3

5.15 READ BUFFER CAPACITY Command

The READ BUFFER CAPACITY command (Table 140) checks the total length of buffer and the length of blank area.

Table 140 – 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							

The Logical Unit reports the length of the buffer during Session at Once Recording or Track at Once Recording or Disc at once recording.

The BLOCK bit, if set to one, indicates that the Initiator is requesting buffer data returned in blocks.

An Allocation Length of zero is not an error.

The READ BUFFER CAPACITY data (Table 141) is sent in response to this command.

Table 141 – READ BUFFER CAPACITY data when BLOCK bit of CDB = 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				Blank 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 Blank Length of Buffer indicates the length of unused area of the buffer in bytes.

If the READ BUFFER CAPACITY command is issued in a condition except Session at Once recording or Track at Once recording, or Disc at Once recording, the Blank Length of Buffer field may be invalid.

Table 142 – READ BUFFER CAPACITY data when BLOCK bit of CDB = 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 indicates 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 Block bit, if set to one, indicates the current number of blocks is being returned. If set to zero, the Initiator shall assume legacy behavior of number of bytes being returned.

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.

Table 143 – Recommended errors for READ BUFFER CAPACITY Command

Error	Reference
Deferred Errors	A.2
General Errors	Table A.2

5.16 READ CAPACITY Command

The READ CAPACITY command (Table 144) provides a means for the Initiator to request information regarding the capacity of the Logical Unit. This command shall not report the correct capacity of the recorded data for CD-R, CD-RW and DVD-R/-RW media that does not have a Lead-out in the last Session or last Border-out. For CD-ROM, the returned logical block address is modified to allow returning a possibly inexact value (but one with a known error bound) based on the Table of Contents data.

Table 144 – READ CAPACITY Command Descriptor Block

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

The RelAdr, PMI bits, and Logical Block Address field shall be set to zero for multimedia Logical Units.

Eight bytes of READ CAPACITY response data (Table 145) shall be returned in response to the command.

Table 145 – READ CAPACITY Response Data format

Bit Byte	7	6	5	4	3	2	1	0
0	(MSB)							
...	Logical Block Address							
3								(LSB)
4	(MSB)							
...	Block Length in Bytes = 2 048d							
7								(LSB)

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

The Block Length shall be reported, in bytes, as 2 048d. A block length of 512 is obsolete.

For CD media other than MRW format, the last logical block shall be determined by converting the last recorded Lead-out to an LBA and subtracting one. If the resulting address points to a run out block (because the session was recorded with packets or track at once in data mode), the Logical Unit shall subtract 2 from the LBA to point to the actual last user data block. If no complete session exists on the medium, this field shall be set to zero.

If the mounted medium is a DVD+RW disc, then the value returned is the LBA that represents the last block of the user space. If a background format is in progress, then the LBA shall be reported as if the format had completed.

If the mounted medium has the MRW format, then the LBA value returned is the LBA that represents the last block of the LBA space selected in the MRW Mode Page. If a background format is in progress, then the LBA shall be reported as if the format had completed.

Recommended error reporting is defined in Table 146.

Table 146 – Recommended errors for READ CAPACITY Command

Error	Reference
Deferred Errors	A.2
General Errors	Table A.2
Media Access Errors	Table A.3

5.17 READ CD Command

The READ CD command (Table 147) provides a single standard, universal way of accessing CD data. This command is generic to all types of CD data formats.

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

Table 147 – READ CD Command Descriptor Block

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

The Expected Sector Type field (Table 148) is used as a filter or mask to select the types of data format information returned to the Initiator. A transfer operation is terminated as soon as data is encountered that does not match one of those specified in the sector type field of the command. If the requested data is not of the type/types requested, the command shall be terminated with a CHECK CONDITION status and SK/ASC/ASCQ values shall be set to ILLEGAL REQUEST/ILLEGAL MODE FOR THIS TRACK. The sector/sectors that do not match shall not be transferred to the Initiator.

Table 148 – Expected Sector type field bit definitions

Sector Type	Definition	Description
000b	All types (mandatory)	No checking of the data type is performed. The Logical Unit shall always terminate a command at the sector where a transition between CD-ROM and CD-DA data occurs.
001b	CD-DA (optional)	Only IEC 908:1987 (CD-DA) sectors shall be returned. If any other format is encountered, the command shall be terminated with CHECK CONDITION status.
010b	Mode 1 (mandatory)	Only Yellow Book (see Table 350) sectors with a user data field of 2 048 bytes shall be returned. All other data formats encountered return an error.
011b	Mode 2 formless (mandatory)	Only Yellow Book (see Table 350) sectors with the expanded user data field (2 336 bytes) shall be returned. If any other format is encountered, the command shall be terminated with CHECK CONDITION status.
100b	Mode 2 form 1 (mandatory)	Only sectors (see Table 350) that have a user data field of 2 048 bytes shall be returned. If any other format is encountered, the command shall be terminated with CHECK CONDITION status.
101b	Mode 2 form 2 (mandatory)	Only sectors (see Table 350) that have a user data field of 2 324 shall be returned. If any other format is encountered, the command shall be terminated with CHECK CONDITION status. NOTE: 4 spare bytes are included making the total data length returned 2 328 bytes/sector.
110b-111b	Reserved	

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

The Header Code field (Table 149) is encoded to select Header/Sub-header information that should be included in the returned data stream.

Table 149 – Header Code field definition

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

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

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

The Error field (see Table 150) is an encoded field that indicates that if any of the C2 and/or Block error data is included in the data stream.

If the Logical Unit does not support the C2 pointers, and the Error field is not zero, the C2 data field shall be zero filled.

Table 150 – READ CD, Error field definition

Error Field	Definition	Description
00b	none	No error information is returned.
01b	C2 error block data	The C2 error, Pointer bits (2 352 bits or 294 bytes) is included in the data stream. There is one bit for each byte in error in the sector (2 352 total). The bit ordering is from the most significant bit to the least significant bit in each byte. The first bytes in the sector are the first bits/bytes in the data stream.
10b	C2 and Block Error Bits	Both the C2 error bits (2 352 bits/294 bytes) and the Block Error Byte are included in the data stream. The Block Error Byte is the logical or of all the C2 Error bit bytes. The Error Byte shall be padded with a byte (undefined) to ensure an even number of bytes in the data stream. The Block error byte shall be first in the data stream followed by the pad byte.
11b	Reserved	Reserved for future enhancement.

The Sub-channel data selection field (see Table 151) indicates that CD Sub-channel information is to be included in the data stream. This may be the Q information and/or the "Raw" Sub-channel information. If the field is set to a nonzero value, then that Sub-channel data shall be included in the data stream to the Initiator.

Table 151 – READ CD, Sub-channel Data Selection Field definition

Sub-channel data selection value	Definition	Description	Type
000b	No Sub-channel data	No Sub-channel data shall be returned.	Mandatory
001b	RAW	RAW P-W Sub-channel data shall be returned.	Optional
010b	Q	Q data shall be transferred.	Optional
011b	Reserved		
100b	P-W	R-W data shall be transferred.	Optional
101b-111b	Reserved		

In the case of R-W the Logical Unit may return the data de-interleaved and error corrected, RAW or padded with zeroes depending on the R-W supported and R-W de-interleaved and error corrected bits in the CD capabilities and Mechanism status page. In the case of RAW the Logical Unit returns the P-W Sub-channel data that is not de-interleaved. See Table 155 and for P-W data formats.

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

If Q (010b) is selected, then sub-channel data for each sector shall be transferred in a 16-byte structure as shown in Table 152.

Table 152 – Formatted Q Sub-channel response data

Byte	Description
0	Control (4 MS bits), ADR (4 LS bits)
1	Track number
2	Index number
3	Min
4	Sec
5	Frame
6	ZERO
7	AMIN
8	ASEC
9	AFRAME
10	CRC or 00h (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.

The lengths of the data returned from a READ CD command vary, based on the type of sector that is being read and the requested fields to be returned to the Initiator. Many combinations are possible, but most are not very useful. Table 153 specifies how the Logical Unit responds to many of the requests. Requests for transfers not specified in the Table 153 shall not be supported and treated as illegal. Illegal values cause the command to be terminated with a CHECK CONDITION status and SK/ASC/ASCQ shall be set to ILLEGAL REQUEST/INVALID FIELD IN CDB. The definition of sector formats is shown in Table 148.

Table 153 – Number of Bytes Returned Based on Data Selection Field

Data to be transferred	Byte[2] 9	CD-DA	Mode 1	Mode 2	Mode 2 Form 1	Mode 2 Form 2
User Data	10h	2 352	2 048[1]	2 336[1]	2 048	2 328[1]
User Data + EDC/ECC	18h	(10h)[1]	2 336	(10h)[1]	2 328	(10h)[1]
Header	20h	(10h)[1]	4	4	4	4
Header Only + EDC/ECC	28h	(10h)[1]	Illegal	Illegal	Illegal	Illegal
Header & user data	30h	(10h)[1]	2 052[1]	2 340[1]	Illegal	Illegal
Header & User Data + EDC/ECC	38h	(10h)[1]	2 340	(30h)[1]	Illegal	Illegal
Sub Header Only	40h	(10h)[1]	0	0	8	8
Sub Header Only + EDC/ECC	48h	(10h)[1]	Illegal	Illegal	Illegal	Illegal
Sub Header & user data	50h	(10h)[1]	(10h)[1]	(10h)[1]	2 056[1]	2 336[1]
Sub Header & user data + EDC/ECC	58h	(10h)[1]	(18h)[1]	(10h)[1]	2 336	(50h)[1]
All Headers Only	60h	(10h)[1]	4	4	12	12
All Headers Only + EDC/ECC	68h	(10h)[1]	Illegal	Illegal	Illegal	Illegal
All Headers & user data	70h	(10h)[1]	(30h)[1]	(30h)[1]	2 060[1]	2 340[1]
All Headers & user data + EDC/ECC	78h	(10h)[1]	(38h)[1]	(30h)[1]	2 340	2 340
Sync & User Data	90h	(10h)[1]	Illegal	Illegal	Illegal	Illegal
Sync & User Data + EDC/ECC	98h	(10h)[1]	Illegal	Illegal	Illegal	Illegal
Sync & Header Only	A0h	(10h)[1]	16	16	16	16
Sync & Header Only + EDC/ECC	A8h	(10h)[1]	Illegal	Illegal	Illegal	Illegal
Sync & Header User Data	B0h	(10h)[1]	2 064	2 352	Illegal	Illegal
Sync & Header User Data + EDC/ECC	B8h	(10h)[1]	2 352	(B0h)	Illegal	Illegal
Sync & Sub Header Only	C0h	(10h)[1]	Illegal	Illegal	Illegal	Illegal
Sync & Sub Header Only + EDC/ECC	C8h	(10h)[1]	Illegal	Illegal	Illegal	Illegal
Sync & Sub Header & User Data	D0h	(10h)[1]	Illegal	Illegal	Illegal	Illegal
Sync & Sub Header & User Data + EDC/ECC	D8h	(10h)[1]	Illegal	Illegal	Illegal	Illegal
Sync & All Headers Only	E0h	(10h)[1]	16	16	24	24
Sync & All Headers Only + EDC/ECC	E8h	(10h)[1]	Illegal	Illegal	Illegal	Illegal
Sync & All Headers & user data	F0h	(10h)[1]	2 064	2 352[1]	2 072	2 352[1]
Sync & All Headers & user data + EDC/ECC	F8h	(10h)[1]	2 352[1]	(F0h)[1]	2 352[1]	(F0h)[1]
Repeat 10h - F8h and Add Error Bits	02h	+294[3]	+294	+294	+294	+294
Repeat 10h - F8h and Add Block & Error Bits	04h	+296	+296	+296	+296	+296
Notes: 1. Data should be returned as if Byte 9 contained this value. 2. Value of Byte 9 in the READ CD command Descriptor Block, in hexadecimal. 3. "+" indicates the addition of the specified number of bytes to the stream of the data.						

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

The CD-DA audio data includes 16 bits of information for each channel, and shall be formatted as follows when an audio track is read. See Table 154.

Table 154 – CD-DA (Digital Audio) Data Block Format

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

If the CD Logical Unit does not support the CD-DA Stream-Is-Accurate capability (See Table 361), then the digital audio data shall be read as a continuous stream. If the Logical Unit stops while streaming, a non-recoverable error shall be generated. The next read command shall be terminated with CHECK CONDITION status and SK/ASC/ASCQ values shall be set to ABORTED COMMAND/READ ERROR - LOSS OF STREAMING. This is due to the 1-second uncertainty of the address. (i.e. there is no header in CD-DA data). Reissuing the command may not return exactly the same data as the previous try. When the Logical Unit supports the stream accurate capability, no error shall be generated, only some time delay for rotational latency.

The format for P-W raw data is described in Table 155.

Table 155 – P-W RAW data format

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

R-W raw data (bits 0-5, Table 156) is returned in the format and order found on the media. It is the responsibility of the initiator to de-interleave and perform error detection and correction on the RAW data to make it usable to higher level applications.

Table 156 – P-W Data de-interleaved and error corrected

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

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

The basic RAW format is shown in Figure 42 below. The data is synchronized with the Sub-channel sync patterns S0 and S1. Each group of 6 bits (R-W) is called a "symbol." The symbol following the Sub-channel patterns S0 and S1, is the first symbol of the first pack in a packet.

5.17.1 Description of Sub-channels R-W
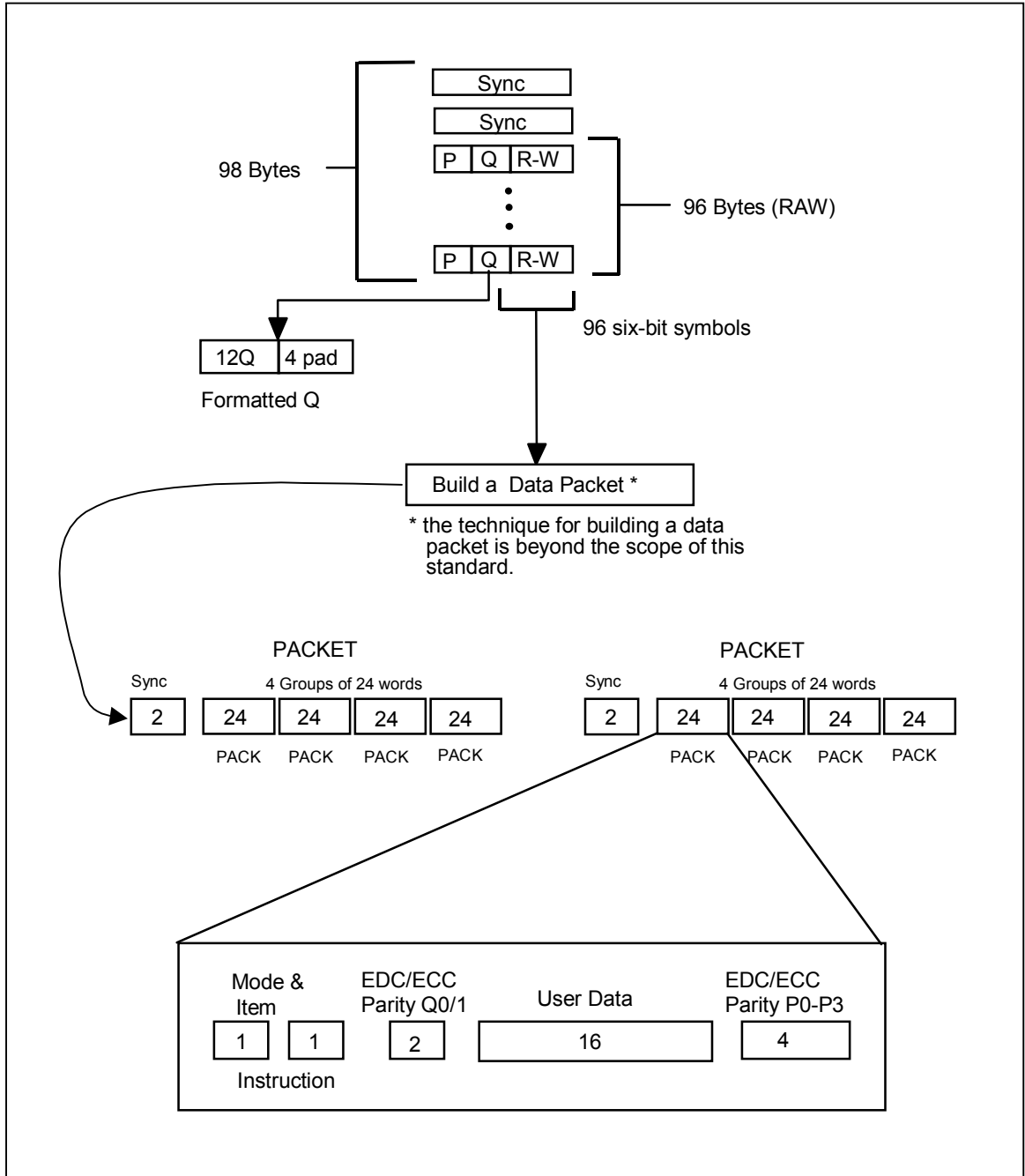
Figure 42 – Read CD Sub-channel, R-W (100b)

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

The first two symbols in a pack have additional protection with a (4, 2) Reed Solomon Error Correction Code. The first symbol of a pack contains a mode-switch of 3 bits and a 3 bit subdivision of mode, called "item." The defined mode-item combinations are listed in Table 157.

Table 157 – Sub-channel R-W: Allowed mode/item combinations

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

The R-W information is returned as part of the "raw" Sub-channel data. The lower 6 bits of each of the bytes contain the R-W data. This data follows the format shown in Figure 42. If the Q information needs to be taken from the raw data then it shall not be interleaved.

5.17.2 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.

Recommended error reporting is defined in Table 158.

Table 158 – Recommended errors for READ CD Command

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

5.18 READ CD MSF Command

The READ CD MSF command described in Table 159 provides a single standard command format for accessing CD data via MSF addressing. This command is generic to all types of CD data formats.

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

Table 159 – READ CD MSF Command Descriptor Block

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

The Starting M field, the Starting S field, and the Starting F field specify the absolute MSF address where the Read operation shall begin. The 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 maximum 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 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.

A starting MSF address equal to an ending MSF address prevents a read operation. This shall not be considered an error. If the starting MSF address is greater than the ending MSF address, the command shall be terminated with CHECK CONDITION status and set the values of SK/ASC/ASCQ to ILLEGAL REQUEST/ INVALID FIELD IN CDB.

For descriptions of Sector Type field see Table 148.

For a description of all fields in byte 9, and Sub-channel Selection Bits (byte 10), see sub-clause 5.17

Recommended error reporting is defined in Table 160.

Table 160 – Recommended errors for READ CD MSF Command

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

5.19 READ DISC INFORMATION Command

The READ DISC INFORMATION command (Table 161) provides information about all discs. The parameters returned by the Logical Unit are specific to the media that is currently installed in the Logical Unit. In the case of a DVD-ROM Logical Unit, the disc information returned may be for the last closed Session. In the case of media that does not have logical Tracks, the number of Tracks and Sessions is considered one. If this command is required by an implemented Feature, the command shall always function, even if that Feature's Current bit becomes zero.

Table 161 – READ DISC INFORMATION Command

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 Command Packet. An Allocation Length of zero shall not be considered an error. If the Allocation Length is greater than the amount of available Disc Information Data (Table 162), only the available data is transferred.

If a field or bit is not applicable to the installed medium, the default parameters in the Write Parameters Page shall be returned in the corresponding field.

Table 162 – Disc Information Block

Bit Byte	7	6	5	4	3	2	1	0
0	(MSB)			Disc Information Length				
1								(LSB)
2	Reserved			Erasable	State of last Session		Disc Status	
3	Number of First Track on Disc							
4	Number of Sessions (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 Time				
18				HMSF				
19								(LSB)
20	(MSB)							
21				Last Possible Start Time for Start of Lead-out				
22				HMSF				
23								(LSB)
24	(MSB)							
...				Disc Bar Code				
31								(LSB)
32	Reserved							
33	Number of OPC Table Entries							
34 - n	OPC Table Entries							

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

Disc Status field indicates the status of the disc and is shown in Table 163. A Logical Unit that does not have the ability to write the inserted medium (ex. CD/DD/DVD-ROM) returns COMPLETE (10b) status. For DVD-RW media, if State of Last Session field value is 10b, the returned value of the Disc Status field value shall be 01b.

Table 163 – 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 (non-write protected Random Writable media)
(1) When a disc is in DVD-RW restricted overwrite mode and the last session is Intermediate state, this status code is returned.	

The State of Last Session field is defined in Table 164. For media that does not use Sessions this field shall be 11h.

Table 164 – 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 Intermediate State, this status code is returned.

The Erasable bit, when set to one, indicates that CD/DVD-RW, DVD-RAM or DVD+RW medium is present. Otherwise, such a medium is not present

The Number of First Track identifies the first track number:

For non-CD media, this field shall be set to 1. For CD/DD media,

a) If Disc Status is set to 00 (Empty Disc), the Number of First Track field shall be 1.

b) If there are no entries in the PMA and the first track is an Incomplete Track, the Number of First Track field shall be equal to 1.

c) If the only session on the disc is an Incomplete Session, the Number of First Track field is from the PMA.

d) Otherwise, the Number of First Track field contains the track number for the first TOC entry in the first Session. The Number of Sessions (bytes 4 & 9) on the disc refers to all complete sessions plus any incomplete or empty sessions. A Blank Disc shall always have a session count equal to one.

First Track Number in Last Session (bytes 5 & 10) is the track number of the first track in the last session. In order for Tracks in the last Session, that may be open, to be scanned by the READ TRACK

INFORMATION command, the First Track Number in Last Session is identified. This is inclusive of the invisible track.

Last Track Number in Last Session (bytes 6 & 11) is the track number of the last track in the last session. In order for Tracks in the last Session, that may be open, to be scanned by READ TRACK INFORMATION command, the Last Track Number in Last Session is identified. This is inclusive of the invisible track.

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

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

The URU (Unrestricted Use Disc) bit, when set to one, indicates that the mounted DVD-R, CD-R/RW disc is defined for unrestricted use. For DDCD, the Unrestricted Use Disc bit shall be set to one. When the Unrestricted Use Disc bit is set to zero, the mounted DVD-R, CD-R/RW disc is defined for restricted use. To record data to the mounted disc, the appropriate Initiator Application code shall be set through the Write Parameters Page. For DDCD, Initiator Application code is not treated. Initiator Application code of the Write Parameters Page is ignored by the DDCD Logical Unit.

An Initiator Application Code of zero may be used to indicate a restricted use disc - general purpose. Logical Units that cannot determine the state of the URU bit from the medium shall set this bit to one.

The BG format status is represented by bits 0 and 1 of byte 7. The value gives the background format status of the mounted disc (See Table 165).

Table 165 – 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 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.

In addition, when the BG format status indicates that a format is in progress the following values are specified as if the format had completed:

> Byte 2 shall indicate that the last session is closed and no new sessions may be added.
>
> Byte 3, Number of First Track on Disc shall be set to 1.
>
> Byte 4, Number of Sessions shall be set to 1.
>
> Byte 5, First Track Number in Last Session shall be set to 1.
>
> Byte 6, Last Track Number in Last Session shall be set to 1.
>
> Bytes 9, 10, and 11 shall be cleared to zero.
>
> Bytes 16 through 19 shall be the disc lead-in start address as found in lead-in ATIP.

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

In the case of a session that contains no data track (only audio), A0/PSEC field in the TOC of the session is always 00h regardless of actual Disc Type. For DDCD, the Disc Type shall be set to 20h. For CD discs, the Disc Type shall be determined from the following sequences:

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

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

3) From the first Session of a Complete Disc;

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

Table 166 – Disc Type Field - PMA

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

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

The Last Session Lead-in Start Time field is valid only for CD/DD-R/RW media. Otherwise, this field shall be set to 0. This field is an address given in TIME format as defined in sub-clause 4.2.1. This field shall specify the location of the next Lead-in to be recorded. If the disc is empty as specified in the Disc Status field or has no Complete Session, then the Lead-in Start Time is returned as specified by ATIP. If the last Session, is second or greater, Empty or Incomplete, this field shall specify the Lead-in Start Time of the Last Session. If the Disc Status is Complete, the Last Session Lead-in Start Time shall be FFh/FFh/FFh/FFh TIME format as specified in sub-clause 4.2.1.

The Last Possible Start Time for Start of Lead-out field is valid only for CD/DD-R/RW media. Otherwise this field shall be set to 0. This field is returned as the address, encoded in the ATIP and is returned in TIME format as specified in sub-clause 4.2.1.   If the disc is a Complete Disc, the Last Possible Start Time for Start of Lead-out shall be FFh/FFh/FFh/FFh HMSF.

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. See Table 361.

For DDCD, the Disc Bar Code is not exist. The Disc Bar Code field shall be set to 0.

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

Table 167 – 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								

Speed is in kbytes per second. See SEND OPC command sub-clause 5.33

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

Recommended error reporting is defined in Table 168.

Table 168 – Recommended errors for READ DISC INFORMATION Command

Error	Reference
Deferred Errors	A.2
General Errors	Table A.2
Media Access Errors	Table A.3

5.20 READ DVD STRUCTURE Command

The READ DVD STRUCTURE command, Table 169, requests that the DVD Logical Unit transfer data from areas on the DVD Media to the Initiator. There are several control structures on the DVD media, including the Lead-in and Burst Cutting Area (BCA). The Lead-in area for DVD media contains information about the media as well as information used by the Logical Unit to allow it to recover information from the media. The BCA for DVD media is optional, contents are specified by the media manufacture.

Table 169 – READ DVD STRUCTURE Command

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 (Table 170).

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 number of data bytes returned in response to a READ DVD STRUCTURE command is limited by the Allocation Length field of the CDB. 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 170 – Format Code definitions for READ DVD STRUCTURE Command

Format Code	Returned Data	Layer Byte Usage	Address Field Explanation	Description
00h	Physical	Layer Number	Reserved	Returns information in the DVD Lead-in area. Multi-session DVD-R/-RW returns information in the last Border-in.
01h	Copyright	Layer Number	Reserved	Returns the Copyright information from the DVD Lead-in area
02h	Disc Key	Reserved	Reserved	Returns the Disc Key obfuscated by using a Bus Key
03h	BCA	Reserved	Reserved	Returns the BCA information on DVD media
04h	Manufacturer'	Layer Number	Reserved	Returns the Disc Manufacturing information from the DVD Lead-in area
05h	Copyright Management	Reserved	LBA	Returns Copyright management information from specified sector
06h	Media Identifier	Reserved	Reserved	Returns the Media Identifier protected by using a Bus Key
07h	Media KEY BLOCK	Reserved	Pack Number	Returns the Media KEY BLOCK protected by using a Bus Key
08h	DDS	Reserved	Reserved	Returns the DDS information on DVD-RAM Media
09h	DVD-RAM Medium Status	Reserved	Reserved	Returns the medium status information on DVD-RAM media
0Ah	Spare Are Information	Reserved	Reserved	Returns the Spare Area information for the media
0Bh		Reserved		
0Ch	RMD in the last Border-out	Reserved	Start Field number of RMD Blocks	Returns the Field of RMD in the last Border-out
0Dh	RMD	Reserved	Start RMA Sector Number	Returns RMD sectors that are recorded in RMA
0Eh	Pre-recorded information in Lead-in	Reserved	Reserved	Returns pre-recorded information in the Lead-in area
0Fh	Unique Disc Identifier	Reserved	Reserved	Returns Unique Disc Identifier of the disc
10h	Physical in the Lead-in	Layer number	Reserved	Returns physical format information of Control Data Zone in the Lead-in
11h – 2Fh	Reserved	Reserved	Reserved	
30h	Disc Control Blocks	Reserved	Content Descriptor	Returns Disc Control Block identified by the Content Descriptor
31h - BFh	Reserved	Reserved	Reserved	
C0h	Write Protection	Reserved	Reserved	Returns Write Protection Status and MSWI Status
C1h-FEh	Reserved			
FFh	Structure List	Layer Number	Reserved	Returns a list of DVD Structures present in the specified Layer

5.20.1 Physical Format Information

For DVD-R/-RW media, this Format code returns the last updated Physical format information. Therefore, for example, if a medium is recorded with multi-bordered area, this information is retrieved from the last Border-in. Format 10h shall be used for retrieving Control Data Zone information in the Lead-in.

Physical Format Information is shown in Table 171.

Table 171 – READ DVD STRUCTURE Data Format (Format field = 00h)

Bit Byte	7	6	5	4	3	2	1	0
0	(MSB)			DVD STRUCTURE Data Length				
1								(LSB)
2	Reserved							
3	Reserved							
DVD Lead-in Structure								
0 – 2047	Layer Descriptor							

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

Layer Descriptor is defined in Table 172.

Table 172 – Layer Descriptor

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	00h							
5	(MSB)							
6	Starting Physical Sector Number of Data Area							
7								(LSB)
8	00h							
9	(MSB)							
10	End Physical Sector Number of Data Area							
11								(LSB)
12	00h							
13	(MSB)							
14	End Physical Sector Number in Layer 0							
15								(LSB)
16	BCA	Reserved						
17 - 2047	Media Specific							

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

The Book Type field (Table 173) specifies the DVD Book this media complies with.

Table 173 – Book Type Field

Book Type	Book Name
0000b	DVD-ROM
0001b	DVD-RAM
0010b	DVD-R
0011b	DVD-RW
1001b	DVD+RW
Others	Reserved

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

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

The Maximum Rate field (Table 174) is used to specify to the Logical Unit the read rate to use for this media.

Table 174 – Maximum Rate Field

Maximum Rate	Read Rate
0000b	2.52 Mbps
0001b	5.04 Mbps
0010b	10.08 Mbps
1111b	Not Specified
Others	Reserved

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

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

The Layer Type field (Table 175) indicates the read/write ability of the layer.

Table 175 – Layer Type Field

Bit	Layer Type
0	Layer contains embossed data
1	Layer contains recordable area
2	Layer contains rewritable area
3	Reserved

The Linear Density field (Table 176) indicates the minimum/maximum pit length used for this layer.

Table 176 – Linear Density Field

Linear Density Code	Linear Density
0000b	0.267 um/bit
0001b	0.293 um/bit
0010b	0.409 to 0.435 um/bit
0100b	0.280 to 0.291 um/bit
1000b	0.353 um/bit
Others	Reserved

The Track Density field (Table 177) indicates the track width used for this media. Currently = 0000b 0.74 µm/track

Table 177 – Track Density Field

Track Density Code	Track Density
0000b	0.74 um/track
0001b	0.80 um/track
0010b	0.615 um/track
Others	Reserved

The Starting Sector Number of Data Area field (Table 178) specifies the first block that contains user data.

Table 178 – Starting Physical Sector Number of Data Area field

Starting Sector Number	Media Type
30000h	DVD-ROM, DVD-R/-RW, DVD+RW
31000h	DVD-RAM
Others	Reserved

The End Physical Sector Number of Data Area field specifies the last sector of the user data in the last layer of the media. For DVD-RAM, the End Physical Sector Number of Data Area is the PSN for the last spare sector of the last zone.

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

The Burst Cutting Area (BCA) flag indicates the presence of data in the Burst Cutting Area. If set to zero, it indicates BCA data does not exist. If set to one, it indicates BCA data exist.

In case of DVD-R/-RW, the Logical Unit may have cache memory for the Lead-in Control data. If the disc has no Lead-in, and there is no DVD Control Data in the cache, the Logical Unit shall generate CHECK CONDITION status and set SK/ASC/ASCQ values to ILLEGAL REQUEST/INVALID FIELD IN CDB. If the Lead-in is already written or there are DVD structures in the cache, the Logical Unit shall return the requested structures.

The Media Specific field may be filled with all zero data or information as specified in the associated DVD specification.

Most of the data in the layer descriptor for DVD+RW media is from the ADIP information block (see *DVD+RW 4.7 Gbytes Basic Format Specifications*). The DVD+RW layer descriptor is shown in Table 179.

Table 179 – DVD+RW Layer Descriptor

Bit / Byte	7	6	5	4	3	2	1	0
0 - 8	Copy of bytes 0 through 8 from ADIP information block							
9	If CDZ PSN ≤ 2F0FFh, then this value shall be the PSN of last recorded sector in DZ.							
10	Otherwise, this value may be either the PSN of last recorded sector in DZ, or the last possible							
11	PSN in the DZ.							
12 - 18	00h							
19 - 255	Copy of bytes 19 - 255 from ADIP information block							
256 - 2048	Reserved							

5.20.2 DVD Copyright Information

The Read DVD Structure data format 01h (Table 180) includes the DVD Copyright information response.

Table 180 – READ DVD STRUCTURE Data Format (Format field = 01h)

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

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

The Copyright Protection System Type field indicates the presence of data structures specific to a copyright protection system. Three values are defined, 00h indicates there is no such data and 01h indicates a specific data structure for CSS/CPPM exists, and 02h indicates a specific data structure for CPRM exists. All other values are reserved.

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

5.20.3 Disc Key

The Disc Key data recorded on the media is identified with a data format defined in Table 181.

Table 181 – READ DVD STRUCTURE Data Format (Format field = 02h)

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

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

DISC KEY Data field returns the DISC KEY data for CSS and/or the Album Identifier for CPPM that are obfuscated by a Bus Key. The length of DISC KEY Data field is currently 2 048 bytes.

When neither the DISC KEY data nor the Album Identifier exist on DVD media, this command with Format = 02h shall be terminated with CHECK CONDITION status and SK/ASC/ASCQ values shall be set to ILLEGAL REQUEST/COPY PROTECTION KEY EXCHANGE FAILURE - KEY NOT PRESENT.

When the DVD Logical Unit is not in the Bus Key Established state for CSS/CPPM, this command with Format = 02h shall be terminated with CHECK CONDITION status and SK/ASC/ASCQ values shall be set to ILLEGAL REQUEST/COPY PROTECTION KEY EXCHANGE FAILURE - KEY NOT ESTABLISHED.

5.20.4 BCA Information

The BCA information is defined in data format 03h shown in Table 182.

Table 182 – READ DVD STRUCTURE Data Format (Format field =03h)

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

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

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

When a READ DVD STRUCTURE command with a Format field value of 03h is presented for a DVD media without BCA, the command shall be terminated with CHECK CONDITION status and SK/ASC/ASCQ values shall be set to ILLEGAL REQUEST/INVALID FIELD IN CDB.

5.20.5 DVD Disc Manufacturing Information

Table 183 defines the data format for the Disc Manufacturing information.

Table 183 – READ DVD STRUCTURE Data Format (Format field = 04h)

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

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

The Disc Manufacturing Information is taken from the DVD media Lead-in. In the case of DVD-R/-RW multi session disc, this information is taken from the last Border-in.

5.20.6 Copyright Management Information

The Copyright Management Information returned is shown in Table 184.

Table 184 – READ DVD STRUCTURE Data Format (Format field = 05h)

Bit Byte	7	6	5	4	3	2	1	0
0	(MSB)			DVD STRUCTURE Data Length				
1								(LSB)
2	Reserved							
3	Reserved							
	Copyright Management Information							
0	CPR_MAI							
1	Reserved							
2	Reserved							
3	Reserved							

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

The definition of the CPR_MAI field depends on the mounted media. The CPR_MAI field definition is shown in Table 305.

Table 185 – CPR_MAI Field Definition

Bit Media	7	6	5	4	3	2	1	0
DVD-ROM	CPM	CP_SEC	CGMS		CP_MOD			
DVD-R, ver 1.0 DVD-RW, ver 1.0	CPM	Resvd	CGMS		Reserved			
DVD-RAM Ver.1.0/2.1 DVD-R for Authoring Ver .2.0	Reserved							
DVD-R for General, ver 2.0, DVD-RW, ver 1.1, and DVD+RW	Reserved				ADP_TY		Reserved	

The CPM bit, if set to 0, indicates that this sector contains no copyrighted material. If the CPM bit is set to 1, this sector contains copyrighted material.

When the CPM bit is set to 0, the CP_SEC bit is set to 0. When the CPM bit is set to 1, the CP_SEC bit indicates whether this sector has a specific data structure for prerecorded media copyright protection system. A value of 0 indicates that no such data structure exists in this sector. A value of 1 indicates a specific data structure for CSS or CPPM exists in this sector.

When the CPM bit is set to 0, the CGMS field is set to 00b. When the CPM bit is set to 1, and if the CGMS field is set to 00b, it indicates that copying is permitted without restriction. If the CGMS field is set to 01b, it indicates that the CGMS field is reserved, and if the CGMS field is set to 10b, indicates that one generation of copies may be made, and if the CGMS field is set to 11b, indicates that no copying is permitted.

When the CP_SEC bit is set to 0, the CP_MOD field is set to 0h. When the CP_SEC bit is set to 1, the CP_MOD field indicates the copyright protection mode of the specified sector. A value of 0h indicates the sector is scrambled by CSS. A value of 1h indicates the sector is encrypted by CPPM. Other values are reserved.

The ADP_TY field is defined only for DVD-RW Ver.1.1 and DVD-R for General Ver.2.0 media. The ADP_TY field, if set to 01b, indicates that this sector contains materials defined in DVD Specifications for Read-Only Disc Part 3 VIDEO SPECIFICATIONS. A value of 00b indicates that no such data exists in this sector. All other values of ADP_TY are reserved.

> Note: For DVD-R/-RW media, a value of each field may not be correct at the first and last 16 sectors of each recording extent due to the nature of recording method for DVD-R/-RW media.

5.20.7 Media Identifier

The Media Identifier data recorded on the media is identified with a data format defined in Table 186.

Table 186 – READ DVD STRUCTURE Data Format (Format Field = 06h)

Byte \ Bit	7	6	5	4	3	2	1	0
0	(MSB)			DVD STRUCTURE Data Length				
1								(LSB)
2				Reserved				
3				Reserved				
Media Identifier Structures								
0	(MSB)							
:				Media Identifier Data				
n								(LSB)

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

The Media Identifier Data field returns the Media Identifier, which is protected by a Bus Key.

When the DVD Logical Unit is not in the Bus Key Established state for CPRM, this command with Format = 06h shall be terminated with CHECK CONDITION status and SK/ASC/ASCQ values shall be set to ILLEGAL REQUEST/COPY PROTECTION KEY EXCHANGE FAILURE - KEY NOT ESTABLISHED.

5.20.8 Media Key Block

The Media Key Block pack data recorded on the media is identified with a data format defined in Table 187.

Table 187 – READ DVD STRUCTURE Data Format (Format Field = 07h)

Bit Byte	7	6	5	4	3	2	1	0
0	(MSB)	DVD STRUCTURE Data Length						
1								(LSB)
2	Reserved							
3	Total Packs							
	Media Key Block Structures							
0	(MSB)							
:		Media Key Block Pack Data						
n								(LSB)

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

The Total Packs field reports the total number of Media Key Block Packs that are available for transfer to the Initiator.

The Media Key Block Pack Data field returns the requested Media Key Block Pack, which is protected by a Bus Key only when the Address field set to 00000000h.

The Address field in the command specifies which of the available Media Key Block Packs shall be read. A valid AGID field value shall be supplied only when the Address field is set to 00000000h.

If the Address field value is 00000000h, the DVD Logical Unit is not in the Bus Key Established state for CPRM, and Format = 07h, this command shall be terminated with CHECK CONDITION status and SK/ASC/ASCQ values shall be set to ILLEGAL REQUEST/COPY PROTECTION KEY EXCHANGE FAILURE - KEY NOT ESTABLISHED.

5.20.9 DVD-RAM Disc Definition Structure (DDS)

The DVD-RAM Disc definition is identified with the data format defined in Table 188.

Table 188 – READ DVD STRUCTURE Data Format (Format field = 08h)

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)	DVD STRUCTURE Data Length						
1								(LSB)
2	Reserved							
3	Reserved							
DVD-RAM Disc Definition Structure (DDS)								
0 ... 2047	DDS Information							

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

The DDS Information is taken from the Defect Controls of the DVD-RAM media lead-in. The length of the DDS Information is currently 2 048 bytes only.

When a READ DVD STRUCTURE command with a format field value of 08h is presented for other than DVD-RAM media, the command shall be terminated with CHECK CONDITION status and SK/ASC/ASCQ values shall be set to ILLEGAL REQUEST/INVALID FIELD IN CDB.

5.20.10   DVD-RAM Medium Status

The DVD-RAM Medium Status data returned is defined in Table 189.

Table 189 – READ DVD STRUCTURE Data Format (Format = 09h)

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			DVD STRUCTURE Data Length				
1								(LSB)
2	Reserved							
3	Reserved							
DVD-RAM Medium Status Data								
0	Cartridge	OUT	Reserved		MSWI	CWP	PWP	Reserved
1	Disc Type Identification							
2	Reserved							
3	RAM – SWI Information							

When a READ DVD STRUCTURE command with the Format field value of 09h is issued for other than DVD-RAM media, 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 DVD STRUCTURE Data Length indicates the length in bytes of the following DVD Structure data that is available to be transferred to the Initiator. The DVD Structure Data Length value does not include the DVD STRUCTURE Data Length field itself.

The Cartridge bit of one indicates that a medium is in a cartridge. The Cartridge bit of zero indicates that a medium is not in a cartridge.

The Out bit of one indicates that a medium has been taken out from a cartridge or a medium is put into a cartridge. The Out bit of zero indicates that a medium has not been taken out from a cartridge. This field is valid only when the Cartridge bit is set to one. If the Cartridge bit is set to zero, the Out bit shall be set to zero.

The Media Specific Write Inhibition (MSWI) bit of one indicates that the writing is inhibited by the specific reason. The reason is indicated in the RAM-SWI Information field. The MSWI bit of zero indicates that the writing is not inhibited by the specific reason.

The Persistent Write Protection (PWP) bit of one indicates that the media surface is set to write protected status. The PWP bit of zero indicates that the media surface is set to write permitted status.

The Media Cartridge Write Protection (CWP) bit of one indicates that the write protect switch/tabs on a cartridge is set to write protected state. The CWP bit of zero indicates that the write protect switch/tabs on a cartridge is set to write permitted state. This field is valid only when the Cartridge bit is set to one. If the Cartridge bit is set to zero, the CWP bit shall be set to zero.

The Disc Type Identification field indicates the Disc Type:

  00h: A Disc shall not be written without a cartridge.

  10h: A Disc may be written without a cartridge.

  Others: Reserved

The DVD-RAM Specific Write Inhibition Information (RAM-SWI Information) field indicates the reason of DVD-RAM specific write inhibition status. This field is valid only when the MSWI bit is set to one.

If MSWI bit is set to one, RAM-SWI Information field shall be set according to Table 190.

Table 190 – RAM-SWI Information field definition

Value	Description
00h	Reserved
01h	Bare Disc Write Inhibition (Disc Type Identification field of 00h and no cartridge)
02h-FEh	Reserved
FFh	Unspecified reason

5.20.11　　DVD-RAM Spare Area Information

The DVD-RAM Spare Area Information data returned is defined in Table 191.

Table 191 – READ DVD STRUCTURE Data Format (Format = 0Ah)

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			DVD STRUCTURE Data Length				
1								(LSB)
2				Reserved				
3				Reserved				
DVD-RAM Spare Area Information								
0	(MSB)							
1				Number of unused Primary Spare blocks				
2								
3								(LSB)
4	(MSB)							
5				Number of unused Supplementary Spare blocks				
6								
7								(LSB)
8	(MSB)							
9				Number of allocated Supplementary Spare blocks				
10								
11								(LSB)

When a READ DVD STRUCTURE command with the Format field value of 0Ah is issued for other than DVD media which is capable of allocation of the Supplementary Spare area, 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 Initiator can recognize whether the media is capable of allocation of the Supplementary Spare area or not, indicated in the Defect Management Feature Descriptor reported by the GET CONFIGURATION command.

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

The Number of unused Primary Spare blocks field indicates the number of unused spare blocks in the Primary Spare area.

The number of unused Supplementary Spare blocks field indicates the number of unused spare blocks in the Supplementary Spare area.

The number of allocated Supplementary Spare blocks field indicates the number of allocated spare blocks in the Supplementary Spare area.

5.20.12 RMD in the last Border-out

The RMD field recorded in the Border-out is defined in Table 192.

Table 192 – READ DVD STRUCTURE Data Format (Format field = 0Ch)

Bit Byte	7	6	5	4	3	2	1	0
0	(MSB)			DVD STRUCTURE Data Length				
1								(LSB)
2	Reserved							
3	Reserved							
RMD in last Border-out								
0								
...				RMD				
n								

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

The RMD Bytes field returns the RMD that is written in the last recorded Border-out.

The Address field in the command specifies the starting RMD Field number where the read operation shall begin. The Allocation Length field in the command specifies the maximum number of RMD bytes that shall be returned. The largest RMD available is 30 720 bytes (15 sectors).

5.20.13   Recording Management Area Data

The DVD-R/-RW Recording Management Data Structure sectors recorded in the RMA, on the media, is identified with the data format defined in Table 193. This format is available only for DVD-R/-RW media. For other media, this format is reserved.

Table 193 – READ DVD STRUCTURE Data Format (Format field = 0Dh)

Bit \ Byte	7	6	5	4	3	2	1	0
0	(MSB)			DVD STRUCTURE Data Length				
1								(LSB)
2	Reserved							
3	Reserved							
	DVD-R/-RW Recording Management Data Structure							
0	(MSB)							
1				Last Recorded RMA Sector Number/				
2				Start Sector Number of Valid Format 3 RMD Set				
3								(LSB)
4								
…				RMD Bytes				
n								

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

Last Recorded RMA Sector Number / Start Sector Number of Valid Format 3 RMD Set field indicates the RMA sector number where the last RMD is recorded. On DVD-RW restricted overwritten media, this field indicates the start sector number of valid Format 3 RMD Set.

The RMD Bytes field returns RMD that is written in RMA. The Address field in the command specifies the starting address of the RMA sector where the read operation shall begin. The Allocation Length field in the command specifies the maximum length of the descriptor returned to the Initiator. The returned RMD data shall end at the next ECC boundary.

The maximum number of RMD bytes that can be returned is 32768.

5.20.14 Pre-recorded Information in Lead-in

The Pre-recorded Information in Lead-in area recorded on the media is identified with a data format defined in Table 194. This format is available only for DVD-R/-RW media. For other media, this format is reserved.

Table 194 – READ DVD STRUCTURE Data Format (Format field = 0Eh)

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			DVD STRUCTURE Data Length				
1								(LSB)
2				Reserved				
3				Reserved				
			DVD-R Pre-recorded Information Structure					
0				Field ID (= 1)				
1				Disc Application code				
2				Disc Physical code				
3	(MSB)							
4				Last address of Data Recordable Area				
5								(LSB)
6				Reserved (DVD-R/-RW Ver.1.0)				
	Part Version (R for General Ver.2.0/R for Authoring Ver.2.0				Extension code (R for General Ver.2.0/R for Authoring Ver.2.0)			
7				Reserved				
8				Field ID (= 2)				
9				OPC Suggested Code				
10				Wavelength Code (all R media) / OPC suggested code (RW Ver.1.0)				
11 - 14				Write Strategy Code				
15				Reserved				
16				Field ID (= 3)				
17 - 22				Manufacturer ID				
23				Reserved				
24				Field ID (= 4)				
25 - 30				Manufacturer ID				
31				Reserved				
32				Field ID (= 5)				
33 - 38				Manufacturer ID (R Ver.1.0) / Write Strategy code (RW Ver.1.0 /R for General Ver.2.0/R for Authoring Ver.2.0)				
39				Reserved				
40 - 63				Reserved				

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

The contents of Pre-recorded information are specified by the DVD Specifications for Recordable Disc, Part 1 or DVD Specifications for Re-recordable Disc Part 1.

5.20.15　　　　Unique Disc Identifier

The Unique Disc Identifier data recorded on the media is identified with a data format defined in Table 195. This format is available only for DVD-R/-RW media. For other media, this format is invalid and reserved.

Table 195 – READ DVD STRUCTURE Data Format (Format field = 0Fh)

Bit Byte	7	6	5	4	3	2	1	0
0	(MSB)			DVD STRUCTURE Data Length				
1								(LSB)
2				Reserved				
3				Reserved				
				DVD-R/-RW Unique Disc Identifier				
0				Reserved				
1				Reserved				
2	(MSB)			Random Number				
3								(LSB)
4	(MSB)							
5				Year				
6								
7								(LSB)
8	(MSB)			Month				
9								(LSB)
10	(MSB)			Day				
11								(LSB)
12	(MSB)			Hour				
13								(LSB)
14	(MSB)			Minute				
15								(LSB)
16	(MSB)			Second				
17								(LSB)

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

This format returns the Unique Disc Identifier that is recorded in RMD Field 0.

5.20.16 Format Information of Control Data Zone in the Lead-in (Format 10h)

This format is available only for DVD-R/-RW media. For other media, this format is invalid and reserved.

This Format code returns Physical format information of Control Data Zone in the Lead-in area even if the disc is recorded with multi-bordered area.

Table 196 – READ DVD STRUCTURE Data Format (With Format field = 10h)

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	00h							
5	(MSB)							
6	Starting Physical Sector Number of Data Area							
7								(LSB)
8	00h							
9	(MSB)							
10	End Physical Sector Number of Data Area							
11								(LSB)
12	00h							
13	(MSB)							
14	End Physical Sector Number in Layer 0							
15								(LSB)
16	BCA	Reserved						
17 - 2047	Media Specific							

The Media Specific field shall return information as specified in the associated DVD specification.

The other field definitions are same as the definitions of Format code 00h.

5.20.17 Disc Control Blocks

The Address field of the READ DVD STRUCTURE command shall contain a Content Descriptor to identify the Disc Control Blocks (DCB) requested. Valid values are as shown in Table 197.

Table 197 – Content Descriptor

Content Descriptor	Definition
00000000h	Reserved
00000001h - FFFFFFFDh	The DCB with a matching Content Descriptor is returned
FFFFFFFEh	Reserved
FFFFFFFFh	Return a list of readable and writable DCB Content Descriptors

Disc Control Block data returned is formatted as shown in Table 198.

Table 198 – READ DVD STRUCTURE Data Format (Format field = 30h)

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			DVD STRUCTURE Data Length				
1								(LSB)
2				Reserved				
3				Reserved				
				Specific Disc Control Block Information				
0 … 32767				DCB Data				

Each Disc Control Block is up to 16 sectors in length. The first 40 bytes of the block have a common definition, and the remaining bytes depend on the value of the Content Descriptor field. The Disc Control Block is defined in the *DVD+RW 4.7 Gbytes Basic Formats Specifications*. If a Disc Control Block, with fewer than 32 768 bytes is read, the Logical Unit shall pad the Disc Control Block with 00h bytes.

Table 199 – Generic Disc Control Block

Bit Byte	7	6	5	4	3	2	1	0
0	(MSB)							
1				Content Descriptor				
2								
3								(LSB)
4	(MSB)							
5				Unknown Content Descriptor Actions				
6								
7								(LSB)
8 - 39				Vendor ID				
40 - 32 767				DCB Data				

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

The Content Descriptor field identifies the contents of bytes 40 - 32 767.

The Unknown Content Descriptor Actions field contains a bit mask. This mask shall describe actions the Logical Unit is allowed to perform if the Logical Unit does not know the Content Descriptor. Each bit, when set to one, shall prohibit the corresponding action. When set to zero, the corresponding action is allowed.

Table 200 – Unknown Content Descriptor Actions

Bit	Actions
0	Recording within the user data area
1	Reading DCBs
2	Formatting of the medium
3	Modification of this DCB
4 -31	Reserved

The Vendor ID field contains 24 arbitrary bytes.

When Content Descriptor FFFFFFFFh (Table 201) is requested, the Logical Unit shall generate a list of DCBs that may be read from and/or recorded on the current medium by the Initiator. If the Logical Unit records DCBs that are generated internally, and those DCBs cannot be sent from the Initiator, the Logical Unit shall not report those DCBs as recordable.

Table 201 – Disc Control Block (FFFFFFFFh)

Bit Byte	7	6	5	4	3	2	1	0
0	(MSB)							
1			Content Descriptor = FFFFFFFFh					
2								
3								(LSB)
4				Reserved				
5				Reserved				
6				Reserved				
7				Reserved				
8 – 39				Vendor ID				
40				Reserved				
41			Number of Readable DCBs (= M)					
42				Reserved				
43			Number of Recordable DCBs (= N)					
44	(MSB)							
45				Readable DCB 0				
46								
47								(LSB)

M * 4 + 40	(MSB)							
M * 4 + 41				Readable DCB M-1				
M * 4 + 42								
M * 4 + 43								(LSB)

Table 201 – Disc Control Block (FFFFFFFFh) cont.

Bit Byte	7	6	5	4	3	2	1	0
M * 4 + 44	(MSB)							
M * 4 + 45				Recordable DCB 0				
M * 4 + 46								
M * 4 + 47								(LSB)

(M + N) * 4 + 40	(MSB)							
				Recordable DCB N – 1				
(M + N) * 4 + 43								(LSB)

The Content Descriptor field shall contain FFFFFFFFh.

The Unknown Content Descriptor Actions field shall be set to 0.

The Vendor ID field shall be set to the value the Logical Unit uses for its own DCBs.

The Number of Readable DCBs field shall identify the number of entries in the Readable DCB list.

The Number of Recordable DCBs field shall identify the number of entries in the Recordable DCB list.

Each Readable DCB field shall contain a Content Descriptor of a DCB that may be read from the medium.

Each Recordable DCB field shall contain a Content Descriptor of a DCB that may be sent from the Initiator. If a DCB is both readable and recordable, the DCB shall appear in both lists. The Logical Unit shall not record any DCB that it does not recognize.

5.20.18 Write Protection Status

The Write protection status is returned in the format as shown in Table 202.

Table 202 – READ DVD STRUCTURE Data Format (Format field = C0h)

Byte \ Bit	7	6	5	4	3	2	1	0
0	(MSB)			DVD STRUCTURE Data Length				
1								(LSB)
2	Reserved							
3	Reserved							
Write Protection Status								
0	Reserved				MSWI	CWP	PWP	SWPP
1	Reserved							
2	Reserved							
3	Reserved							

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

The Software Write Protection until Power down (SWPP) bit of one indicates that the software write protection is active. The SWPP bit of zero indicates that the software write protection is inactive. If the Logical Unit does not support SWPP, this bit shall be set to zero.

The Persistent Write Protection (PWP) bit of one indicates that the media surface is set to write protected status. The PWP bit of zero indicates that the media surface is set to write permitted status. If the mounted medium and Logical Unit do not support PWP, this bit shall be set to zero.

The Media Cartridge Write Protection (CWP) bit of one indicates that the write protect switch/tabs on a cartridge is set to write protected state. The CWP bit of zero indicates that the write protect switch/tabs on a cartridge is set to write permitted state. If the cartridge does not have CWP function or medium is mounted without cartridge, this bit shall be set to zero. Otherwise, CWP bit shall indicate its actual status.

The Media Specific Write Inhibition (MSWI) bit of one indicates that any writing is inhibited by the media specific reason. The MSWI bit of zero indicates that writing is not inhibited by the media specific reason.

5.20.18.1 DVD Structure List

The DVD Structure List is returned in the format as shown in Table 203.

Table 203 – READ DVD STRUCTURE Data Format (Format field = FFh)

Bit Byte	7	6	5	4	3	2	1	0
0	(MSB)			DVD STRUCTURE Data Length				
1								(LSB)
2	Reserved							
3	Reserved							
DVD Structure List								
0 - n	Structure List							

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

The Structure List is returned as a sequence of Structure List Entries as shown in Table 204.

Note: This DVD Structure is generated by the Logical Unit rather than read from the medium.

Table 204 – Structure List Entry

Bit Byte	7	6	5	4	3	2	1	0
0	Format Code							
1	SDS	RDS	Reserved					
2	(MSB)			Structure Length				
3								(LSB)

The Format Code field shall identify a DVD Structure that is readable via the READ DVD STRUCTURE command.

The SDS bit, when set to zero, shall indicate that the DVD structure is not writable via the SEND DVD STRUCTURE command. When set to one, shall indicate that the DVD structure is writable via the SEND DVD STRUCTURE command.

The RDS bit, when set to zero, shall indicate that the DVD structure is not readable via the READ DVD STRUCTURE command. When set to one, shall indicate that the DVD structure is readable via the READ DVD STRUCTURE command.

The Structure Length field shall specify the length of the DVD Structure that is identified by the Format Code.

Table 205 describes errors that may occur during the operation of the command or which may cause a CHECK CONDITION status to be reported.

Table 205 – Recommended errors for READ DVD STRUCTURE Command

Error	Reference
Deferred Errors	A.2
General Errors	Table A.2
Media Access Errors	Table A.3

5.21 READ FORMAT CAPACITIES Command

The READ FORMAT CAPACITIES command (Table 206) allows the Initiator to request a list of the possible format capacities for an installed random-Writable media. This command also has the capability to report the capacity for a media when it is installed. If the command is required, by an implemented Feature it shall function independently of the state of that Feature's Current bit.

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.

Table 206 – READ FORMAT CAPACITIES Command

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code (23h)							
1	Reserved			Reserved				
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	(MSB)	Allocation Length						
8								(LSB)
9	Control							

Table 207 – READ FORMAT CAPACITIES Data Format

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 .. 7	Formattable Capacity Descriptor 0							
….								
0 .. 7	Formattable Capacity Descriptor n							

Table 208 – 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 209 – 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)

The Number of Blocks indicates the number of addressable blocks for the capacity defined by each Descriptor Type.

The Descriptor Type field（Table 210） indicates the type of information the descriptor contains.

Table 210 – 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 211 – Formattable Capacity Descriptor(s)

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, Table 212, indicates the type of information required for formatting.

Table 212 – 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 213 – 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 212. In the case of Format Type 20h (Obsolete), M specifies SL where $SL = 2^M$, $4 \leq M \leq 15$ or $SL = 0$ if $M = 0$ and N identifies SI where $SI = 2^N$, $4 \leq N \leq 24$.

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.

Table 214 indicates the values returned if the Logical Unit implements the command.

Table 214 – Returned Current/Maximum Descriptor for Combination of Logical Unit and Media

Logical Unit Type	No Media	ROM Media	Sequential Writable Media	Random Writable Media
ROM	`Descriptor Type = 11b`	`Descriptor Type = 10b`	`Descriptor Type = 10b or 11b`	`Descriptor Type = 10b`
Sequential Writable			`Descriptor Type = 10b`	`Descriptor Type = 10b`
Random Writable			`Descriptor Type = 10b or 11b`	`Descriptor Type = 01b or 10b plus Formattable Capacity Descriptor(s)`

This command is not mandatory for all Logical Unit types shown in Table 214; the table indicates the values returned if the command is implemented.

Table 215 describes errors that may occur during the operation of the command or which may cause a CHECK CONDITION status to be reported.

Table 215 – Recommended errors for READ FORMAT CAPACITIES Command

Error	Reference
Deferred Errors	A.2
General Errors	Table A.2
Media Access Errors	Table A.3

5.22 READ SUB-CHANNEL Command

The READ SUB-CHANNEL command (Table 216) requests that the Logical Unit return the requested Sub-channel data plus the state of audio play operations.

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

Table 216 – READ SUB-CHANNEL Command

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							

The TIME bit allows selection of address reporting format. If TIME is cleared to zero, the reported address format is Logical Block Address, represented as a 32-bit integer with ms-byte first. If TIME is set to one, the reported address format is Time, as shown in Table 2.

When the sub Q bit is set to one, the Logical Unit shall return the Q Sub-channel data. When the sub Q 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 217) field specifies the returned sub channel data.

Table 217 – Sub-channel parameter list codes

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

The Track Number field specifies the track number from that 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. This field may contain 00h when the Format code is not 03h.

5.22.1 Sub-channel Data Header

The Sub-channel data header format (Table 218) is four bytes. If the Sub Q bit is zero, in the command, the Logical Unit shall return only the Sub-channel data header. In this case, the Sub-channel data length is 0.

Table 218 – Sub-Q Channel Data Header Format

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

The audio status field indicates the status of audio play operations. The audio status values are defined in Table 219. 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 6.3.7) is set to one, the Logical Unit shall report 14h in this audio status byte and shall report no deferred error.

Table 219 – 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.

5.22.2 Sub-channel Data Format (01h), CD current position

Table 220 defines the response data format for the CD current position data format.

Table 220 – CD current position data format

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

The ADR field gives the type of information encoded in the Q Sub-channel of this block, as shown in Table 221.

Table 221 – 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 222.

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 222 – 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 223 – 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 TIME bit, (Table 216) is zero, this field is an LBA. If the TIME bit is one, the address is TIME. See Table 2 for a definition of the TIME field.

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

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

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

b) In other cases, for instance after a READ command, the Logical Unit may either report position data for the last sector processed for that operation or may report position data from the sector at the current read head position.

Note: When the type of information encoded in the Q Sub-channel of the current sector is the media catalog number or ISRC, the track, index, and address fields should be extrapolated from the previous sector.

5.22.3 Sub-channel Data Format (02h), Media Catalog Number

With a Sub-channel format code of 02h the data returned is the Media Catalog Number. The Media Catalog field contains the identifying number of this media is expressed in ASCII. A value in this field of all ASCII zeros indicates that the media catalog number is not supplied. Table 224 defines the media catalog number data format.

Table 224 – 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 19	Media Catalog Number (MCN)							

If media catalog number data is found, the MCVAL bit is set to one. If MCN data is not detected, the MCVAL bit is set to zero to indicate the media catalog number field is invalid.

Media Catalog Number (see Table 225) data returned in bytes 4 through 19 by this command with Sub-channel data format field code 02h may be from any block that has MCN Q Sub-channel data. See sub-clause 4.2.3.4.2.

Table 225 – MCN Format of Data Returned

Byte	Char	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0		MCVAL	Reserved						
1	N1	N1 (Most significant)							
2	N2	N2							
3	N3	N3							
...	...	...							
12	N12	N12							
13	N13	N13 (Least significant)							
14		Zero							
15		AFRAME							

The Media Catalog Number, N1 through N13, when sent to the Initiator, is formatted as ASCII characters.

The MCVAL bit when set to one, indicates the Media Catalog Number field is valid.

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.

5.22.4 Sub-channel Data Format (03h), International Standard Recording Code

The track ISRC field contains the identifying number of this media according to the ISRC standards (DIN-31-621) expressed in ASCII. Table 226 defines the Track International Standard Recording Code data format. A unique ISRC may exist for each track.

Table 226 – Track International Standard Recording Code data format

Bit / Byte	7	6	5	4	3	2	1	0
0	Sub-channel Data Format Code (03h)							
1	ADR				CONTROL			
2	Track Number							
3	Reserved							
4	(MSB)							
…	Track International Standard Recording Code (ISRC)							
19								(LSB)

If ISRC data is detected, the TCVAL bit (see Table 227) is set to one. If ISRC data is not detected, the TCVAL bit is set to zero to indicate the ISRC field is invalid.

The ADR and control fields shall be returned from the ADR and Control fields on the media.

The Track Number shall indicate the track for that the ISRC was requested.

Track ISRC data (see Table 227) may be from any block in the specified track that has ISRC data. When ADR field is 3 (0011b), it is used to assign a unique number to an audio track. This is done by means of the ISRC that is 12 characters long (represented by I1 to I12, see Table 227.) The ISRC shall only change immediately after the TNO has been changed.

ISRC data returned is encoded as ASCII characters. The format of the data is defined in Table 227.

Table 227 – ISRC Format of Data Returned

Byte	Char	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0		TCVAL	Reserved						
1	I1	I1 (Country Code)							
2	I2	I2							
3	I3	I3 (Owner Code)							
4	I4	I4							
5	I5	I5							
6	I6	I6 (Year of Recording)							
7	I7	I7							
8	I8	I8 (Serial Number)							
9	I9	I9							
10	I10	I10							
11	I11	I11							
12	I12	I12							
13		Zero							
14		AFRAME							
15		Reserved							

All bytes are specified in ASCII. The following translation (Table 228) is specified for multimedia Logical Units:

Table 228 – ISRC Translation

ASCII	Hex	MEDIA
'0' - '9'	30h - 39h	00 - 09h
'@' - 'o'	40h - 6Fh	10h - 3Fh

The following codes shall be valid for the above fields (Table 227):

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)

e) The Zero field shall return 00h.

f) 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.

Table 229 describes errors that may occur during the operation of the command or which may cause a CHECK CONDITION status to be reported.

Table 229 – Recommended errors for READ SUB-CHANNEL Command

Error or ASCQ	Reference
Deferred Errors	A.2
General Errors	Table A.2
Media Access Errors	Table A.3
AUDIO PLAY OPERATION IN PROGRESS	Table A.1
AUDIO PLAY OPERATION PAUSED	Table A.1
AUDIO PLAY OPERATION SUCCESSFULLY COMPLETED	Table A.1
AUDIO PLAY OPERATION STOPPED DUE TO ERROR	Table A.1
NO CURRENT AUDIO STATUS TO RETURN	Table A.1

5.23 READ TOC/PMA/ATIP Command

The READ TOC/PMA/ATIP command (Table 230) requests that the Logical Unit transfer data from the Table of Contents, the Program Memory Area (PMA), and the Absolute Time in Pre-Grove (ATIP) from CD media. For media that does not support a TOC, fabricated information is returned that is similar to that of CD media for some formats. This fabrication is required for some legacy Initiator environments.

Table 230 – READ TOC/PMA/ATIP Command

Bit / Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (43h)							
1	Reserved			Reserved			TIME	Reserved
2	Reserved				Format			
3	Reserved							
4	Reserved							
5	Reserved							
6	Track/Session Number							
7	(MSB)	Allocation Length						
8								(LSB)
9	Control							

The TIME bit requests the address form of all reported addresses. If TIME is cleared to zero, then all address reporting shall be in Logical Block Addresses. If TIME is set to one, then all address reporting shall be in the TIME format as shown in Table 2.

The Format field specifies the form of returned data. Valid Format field values and their meanings are shown in Table 231.

Table 231 – Format Field

Format field	Return Data	Optional/ Mandatory	Description	Track/ Session field Usage
0000b	TOC	M	The Track/Session Number field specifies starting track number for which the data is returned. For multi-session discs, this command returns the TOC data for all sessions and for Track number AAh only the Lead-out area of the last complete session. See Table 233.	Track Number
0001b	Session Info	M	This format returns the first complete session number, last complete session number and last complete session starting address. In this format, the Track/Session Number field is reserved and should be set to 00h. NOTE: This format provides the Initiator access to the last finalized session starting address quickly. See Table 235.	Reserved
0010b	Full TOC	M (for CD)	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.	Session Number
0011b	PMA	O	This format returns all Q sub-code data in the PMA area. In this format, the Track/Session Number field is reserved and shall be set to 00h. See Table 241. There is no defined LBA addressing and TIME bit shall be set to one.	Reserved
0100b	ATIP	O	This format returns ATIP data. In this format, the Track/Session Number field is reserved and shall be set to 00h. See Table 242. There is no defined LBA addressing and TIME bit shall be set to one.	Reserved
0101b	CD-TEXT	O	This format returns CD-TEXT information that is recorded in the Lead-in area as R-W Sub-channel Data	Reserved
All Other Format Codes			Reserved.	Reserved

The Track/Session Number field specifies the starting track number for that the data shall be returned. The data is returned in contiguous ascending track number order. A value of AAh requests that the starting address of the Lead-out area be returned. If this value is zero, the Table of Contents data shall begin with the first track or session on the medium.

If the Track/Session Number field is not valid for the currently installed medium, the command shall be terminated with CHECK CONDITION status and SK/ASC/ASCQ shall be set to ILLEGAL REQUEST/INVALID FIELD IN CDB.

When a Read TOC/PMA/ATIP command is presented for a DDCD/CD-R/RW media, where the first TOC has not been recorded (no complete session) and the Format codes 0000b, 0001b, or 0010b are specified, this command shall be rejected with an INVALID FIELD IN CDB. Devices that are not capable of reading an incomplete session on DDC/CD-R/RW media shall report CANNOT READ MEDIUM – INCOMPATIBLE FORMAT.

5.23.1 READ TOC Response parameter list, general definition

The response parameter list (see Table 232) indicates the general description of the response data to the Read TOC/PMA/ATIP command. Each descriptor field is format specific and is defined in the appropriate format sub-clause.

Table 232 – READ TOC/PMA/ATIP parameter list, general definition

Bit Byte	7	6	5	4	3	2	1	0
0	(MSB)			Data Length				
1								(LSB)
2	First Track/Session/Reserved Field(Hex)							
3	Last Track/Session/Reserved Field(Hex)							
Parameter List Descriptor(s)								
0 : : n	Descriptor data , format specific							

The Data Length indicates the length, in bytes, of the parameter list descriptor data.

The Track/Session/Reserved Field is format specific and indicates the location, if any, of the information in the parameter list descriptors.

Descriptor data fields are format specific. The definitions of the bytes are described in each format sub-clause.

5.23.2 TOC/PMA/ATIP Response Data Format 0000b

The response data consist of four header bytes and zero or more track descriptors. The response data is dependent upon the format specified in the format field of the CDB. The response data returned for Format 0000b is specified in Table 233.

Table 233 – READ TOC/PMA/ATIP response data (Format = 0000b)

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)					TOC Data Length		
1				(LSB)				
2	First Track Number(Hex)							
3	Last Track Number(Hex)							
	TOC Track Descriptor(s)							
0	Reserved							
1	ADR				CONTROL			
2	Track Number(Hex)							
3	Reserved							
4	(MSB)							
…	Track Start Address							
7								(LSB)

The TOC data length indicates the length in bytes of the following TOC data. The TOC data length value does not include the TOC data length field itself. This value is not modified when the allocation length is insufficient to return all of the TOC data available.

5.23.2.1 General Case for CD

The First Track Number field indicates the first track number in the first complete session Table of Contents.

The Last Track Number field indicates the last track number in the last complete session Table of Contents before the Lead-out.

The ADR field (Table 221) gives the type of information encoded in the Q Sub-channel of the block where this TOC entry was found.

The Control Field (Table 222) indicates the attributes of the track.

The Track Start Address contains the address of the first block with user information for that track number as read from the Table of Contents. A TIME bit of zero indicates that the Track Start Address field shall contain a logical block address. A TIME bit of one indicates the Logical Block Address field shall contain a TIME address (see sub-clause 4.1.6).

The Track Number field indicates the track number for that the data in the TOC track descriptor is valid. A track number of AAh indicates that the track descriptor is for the start of the Lead-out area.

5.23.2.2 CD-MRW Deviations

If the disc is MRW formatted or in progress with MRW formatting, form 0 of the TOC shall be reported as follows:

One track, track number = 1, ADR = 0001b, and CONTROL = 0110b. The track start addresses are shown in Table 234.

Table 234 – Track Start Address for MRW Discs

LBA Space	TIME bit	Track 1 Start Address	Lead-out Start Address
GAA	1	00:02:00	Regardless of the state of the MRW formatting process, only the final state is reported. The link separating the last GAA packet and the first DMA packet is reported: 00:18:43.
GAA	0	0	1024
DMA	1	00:18:47	Regardless of the state of the MRW formatting process, only final state is reported. The absolute address of the final state link block separating the last DMA packet and the first STA packet is reported.
DMA	0	0	C+1, where C is the LBA of the last user block of the last packet in the DMA..

5.23.2.3 DDCD Deviations

For DDCD, the control field is always set to 0100b (see table 324).

5.23.2.4 DVD-ROM, DVD-RAM, DVD+RW, and Single Session DVD-R/-RW

DVD has no tracks and no sub-channel. "TOC" data shall be fabricated as follows:

First track =1, Last track = 1

Track 1 descriptor:
    ADR = 1h
    CONTROL = 4h
    Track number = 01h
    Start Address = 0h when TIME = 0, Start Address = 00h, 00h, 02h, 00h. when TIME = 1.

Track 0aah descriptor:
    ADR = 1h
    CONTROL = 4h
    Track number = 0aah
    Start Address = actual start of lead-out LBA, when TIME = 0,
    Start Address = translation with a maximum of 00h, 0ffh, 3bh, 4ah. when TIME = 1.

5.23.2.5 DVD-R/-RW with Multiple Sessions

DVD-R/-RW may have multiple sessions.   Since the number of sessions may be rather large, only two sessions are represented as tracks: the last session is seen as a the last user track. All earlier sessions are concatenated into a single logical track to be referred to as track 1. TOC form 0001b shall be fabricated as follows:

First track =1, Last track = 1

Track 1 descriptor:

ADR = 1h

CONTROL = 4h

Track number = 01h

If TIME = 0, Start Address = 0h, else Start Address = 00h, 00h, 02h, 00h.

Track 2 descriptor:

ADR = 1h

CONTROL = 4h

Track number = 02h

If TIME = 0, Start Address = actual start LBA of last bordered area,

else, Start Address = translation with a maximum of 00h, 0ffh, 3bh, 4ah.

Track 0aah descriptor:

ADR = 1h

CONTROL = 4h

Track number = 01h

If TIME = 0, Start Address = actual start of lead-out LBA,

else, Start Address = translation with a maximum of 00h, 0ffh, 3bh, 4ah.

5.23.3 TOC/PMA/ATIP Response Data Format 0001b

The response data returned for Format 0001b is specified in Table 235.

Table 235 – READ TOC/PMA/ATIP response data (Format = 0001b)

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			TOC Data Length				
1								(LSB)
2	First Complete Session Number (Hex)							
3	Last Complete Session Number (Hex)							
TOC Track Descriptor								
0	Reserved							
1	ADR				CONTROL			
2	First Track Number In Last Complete Session (Hex)							
3	Reserved							
4	(MSB)							
...			Start Address of First Track in Last Session					
7								(LSB)

The TOC Data Length specifies the length in bytes of the available session data. The TOC Data Length value does not include the TOC Data Length field itself. This value is not modified when the allocation length is insufficient to return all of the session data available.

The First Complete Session Number is set to one.

The Last Complete Session Number indicates the number of the last complete session on the disc. The Last Complete Session Number shall be set to one for a single session disc or if the Logical Unit does not support multi-session discs.

The ADR field (Table 221) gives the type of information encoded in the Q Sub-channel of the block where this TOC entry was found.

The Control Field (Table 221) indicates the attributes of the track. First Track Number In Last Complete Session returns the first track number in the last complete session.

The Track Start Address contains the address of the first block with user information for the first track of the last session, as read from the Table of Contents.

5.23.3.1 CD-MRW Deviations

If the disc is MRW formatted or in progress with MRW formatting, form 1 of the TOC shall report one session with one track. The track starting address shall be reported as shown in Table 234.

5.23.3.2 DVD-ROM, DVD-RAM, DVD+RW, and DVD-R/-RW

DVD has no tracks and no sub-channel. "TOC" data shall be fabricated as follows:

First Complete Session Number =1, Last Complete Session number = 1

TOC track descriptor:

      ADR = 1h

      CONTROL = 4h

      First Track Number In Last Complete Session = 01h

      If TIME = 0, Start Address of First Track in Last Session = 0h,

      else, Start Address of First Track in Last Session = 00h, 00h, 02h, 00h.

5.23.4 TOC/PMA/ATIP Response Data Format 0010b

None of the fields in the response data of Format 0010b are affected by the TIME bit in the CDB. The response data returned for Format 0010b is specified in Table 236.

Table 236 – READ TOC/PMA/ATIP response data (Format = 0010b)

Bit Byte	7	6	5	4	3	2	1	0
0	(MSB)			TOC Data Length				
1								(LSB)
2	First Complete Session Number (Hex)							
3	Last Complete Session Number (Hex)							
	TOC Track Descriptor(s)							
0	Session Number (Hex)							
1	ADR				CONTROL			
2	TNO							
3	POINT							
4	Min							
5	Sec							
6	Frame							
7	Zero							
	HOUR				PHOUR			
8	PMIN							
9	PSEC							
10	PFRAME							

Multiple TOC Track Descriptors may be returned, but only one of each entry is reported.

For Format field of 0010b, the Logical Unit shall return TOC data for Q Sub-channel modes 1 and 5 (except mode 5, point 1 through 40) in the Lead-in area.

The TOC Data Length specifies the length in bytes of the available TOC data. The TOC Data Length value does not include the TOC Data Length field itself. This value is not modified when the allocation length is insufficient to return all TOC data available.

The First Complete Session Number shall be set to one.

The Last Complete Session Number indicates the number of the last complete session on the disc. The Last Complete Session Number is set to one for a single session disc or if the Logical Unit does not support multi-session discs.

The ADR field (Table 221) gives the type of information encoded in the Q Sub-channel of the block where this TOC entry was found.

The Control Field (Table 222) indicates the attributes of the track.

The ZERO field shall contain a value of zero for CD media other than DDCD media. For DDCD media this field shall contain the value HOUR in bits 7-4 and PHOUR in bits 3-0.

Entries in bytes 2 through 7 of the descriptors (TNO, POINT, MIN, SEC, FRAME, ZERO) shall be converted to hex by the Logical Unit if the media contains a value between 0 and 99bcd. For DDCD

bytes 7 through 10 (PHOUR, PMIN, PSEC, and PFRAME) shall be converted to hex by the Logical Unit if the media contains a value between 0 and 99bcd. Otherwise, the value is returned with no modification.

The returned TOC data of a multi-session disc is arranged in ascending order of the session number with duplicates removed. The TOC data within a session is arranged in the order of Q Sub-channel POINT field value of A0h – AFh, Track Numbers, B0h, BFh. Only recorded Points shall be returned.

The TOC Track Descriptor format in the Lead-in area of the TOC is described in Table 237.

Table 237 – TOC Track Descriptor Format, Q Sub-channel

CTRL	ADR	TNO	POINT	MIN	SEC	FRAME	ZERO	PMIN	PSEC	PFRAME
4 or 6	1	00h	01h-63h	ATIME (Absolute time)			00h	Start position of track		
4 or 6	1	00h	A0h	ATIME (Absolute time)			00h	First Track Number	Disc Type	00h
4 or 6	1	00h	A1h	ATIME (Absolute time)			00h	Last Track Number	00h	00h
4 or 6	1	00h	A2h	ATIME (Absolute time)			00h	Start position of Lead-out		
4 or 6	5	00h	B0h	Start time of next possible program in the Recordable Area of the disc			# of pointers in Mode 5	Maximum start time of outer-most Lead-out area in the Recordable Area of the disc		
4 or 6	5	00h	B1h	00h	00h	00h	00h	# of skip interval Pointers (N<=40)	# of skip Track Pointers (N<=21)	00h
4 or 6	5	00h	B2h-B4h	Skip #	Skip #	Skip #	Skip #	Skip #	Skip #	Skip #
4 or 6	5	00h	01h-40h	Ending time for the interval that should be skipped			Reserved	Start time for interval that should be skipped on playback		
4 or 6	5	00h	C0h	optimum recording power	Reserved	Reserved	Reserved	Start time of the first Lead-in Area of the disc		
4 or 6	5	00h	C1h	Copy of information from A1 point in ATIP.						

If the disc is MRW formatted or in progress with MRW formatting, form 2 of the TOC shall be constructed to contain the values expected when formatting has completed.

The DDCD TOC Track Descriptor format in the Lead-in area of the TOC is described in Table 238.

All of the TOC Track Descriptors, in Table 237, are further define in sub-clause found. The POINT Field (Table 239) defines various types of information within the TOC Lead-in area.

Table 238 – DDCD TOC Track Descriptor Format, Q Sub-channel

CTRL	ADR	TNO	POINT	MIN	SEC	FRAME	HOUR	PHOUR	PMIN	PSEC	PFRAME
4	1	00h	01h-63h	ATIME (Absolute time)				Start position of track			
4	1	00h	A0h	ATIME (Absolute time)				0000b	First Track Number	Disc Type 20h	00h
4	1	00h	A1h	ATIME (Absolute time)				0000b	Last Track Number	00h	00h
4	1	00h	A2h	ATIME (Absolute time)				Start position of Lead-out			
4	1	00h	F0h	ATIME (Absolute time)				0000b	Book type Book ver.	Material type	Moment of inertia
4	5	00h	B0h	Start time of next possible program in the Recordable / ReWritable Area of the disc				Maximum start time of outer-most Lead-out area in the Recordable / ReWritable Area of the disc			
4	5	00h	C0h	Copy of Special Information1 in ATIP (ROM: reserved and set to zero)			# of Mode 5 ptrs	Start time of the first Lead-in Area of the disc			
4	5	00h	C1h	Copy of Additional Information1 in ATIP.			0000b	Set to zero			
4	5	00h	CFh	Stop position of Inner part Lead-out Area				Start position of outer part Lead-in Area			

Table 239 – POINT Field

ADR	POINT Field	Description
1	01-63h	Track number references
1	A0h	First Track number in the program area
1	A1h	Last Track number in the program area
1	A2h	Start location of the Lead-out area
5	01-40h	Skip Interval Pointers
5	B0h	Used to Identify a Multi-session Disc (Photo CD) Contains start time of next possible program area
5	B1h	Number of skip interval pointers & Skip track assignments
5	01-40h	Skip Interval Pointers
5	B2-B4h	Skip Track Assignment Pointers
5	C0h	Start time of first Lead-in area of disc (This only exists in the first Lead-in area)
5	C1h	Copy of information from additional area 1 in ATIP.

The Disc Type field (see Table 240) indicates the type of disc inserted.

Table 240 – Disc Type Byte Format

Value	Description
00h	CD-DA or CD Data with first track in Mode 1
10h	CD-I disc
20h	CD data XA disc with first track in Mode 2, DDCD disc

5.23.4.1 CD-MRW Deviations

If the disc is MRW formatted or in progress with MRW formatting form 2 of the TOC, PMA, shall be constructed to contain the values expected when formatting has completed.

5.23.4.2 DVD-ROM, DVD-RAM, DVD+RW, and DVD-R/-RW

No fabrication for DVD media is defined for form 0010b.

5.23.5 TOC/PMA/ATIP Response Data Format 0011b

None of the fields in the response data of Format 0011b are affected by the TIME bit in the CDB. The response data returned for Format 0011b is specified in Table 241.

Table 241 – READ TOC/PMA/ATIP response data (Format = 0011b)

Byte \ Bit	7	6	5	4	3	2	1	0
0	(MSB)			PMA Data Length				
1								(LSB)
2	Reserved							
3	Reserved							
PMA Descriptor(s)								
0	Reserved							
1	ADR				CONTROL			
2	TNO							
3	POINT							
4	Min							
5	Sec							
6	Frame							
7	Zero							
	HOUR				PHOUR			
8	PMIN							
9	PSEC							
10	PFRAME							

Multiple PMA Descriptors may be returned.

The returned PMA descriptors are arranged in the order found in the PMA, with duplicates removed.

The PMA Data Length indicates the length in bytes of the available PMA data. The PMA Data Length value does not include the PMA Data Length field itself. This value is not modified when the allocation length is insufficient to return all PMA data available. This value is set to 2 plus eleven times the number of descriptors read.

The ZERO field shall contain a value of zero for CD media other than DDCD media. For DDCD media this field shall contain the value HOUR in bits 7-4 and PHOUR in bits 3-0.

Entries in bytes 2 through 10 of the descriptors, (TNO, POINT, MIN, SEC, FRAME, Zero), shall be converted to binary by the Logical Unit if the media contains a value between 0 and 99bcd. (See 4.2.3.8.2)

5.23.5.1 CD-MRW Deviations

If the disc is MRW formatted or in progress with MRW formatting form 3 of the TOC, PMA, shall be constructed to contain the values expected when formatting has completed.

5.23.5.2 DVD-ROM, DVD-RAM, DVD+RW, and DVD-R/-RW

No fabrication for DVD media is defined for form 0011b.

5.23.6 TOC/PMA/ATIP Response Data Format 0100b

None of the fields in the response data of Format 0100b are affected by the TIME bit in the CDB. The response data returned for Format 0100b is specified in Table 242.

Table 242 – READ TOC/PMA/ATIP response data (Format = 0100b)

Byte \ Bit	7	6	5	4	3	2	1	0
0	(MSB)			ATIP Data Length				
1								(LSB)
2	Reserved							
3	Reserved							
ATIP Descriptor								
0	Indicative Target Writing Power				(DDCD)	Reference Speed		
1	0	URU	Reserved					
2	1	Disc Type	Disc Sub-Type			A1 Valid	A2 Valid	A3 Valid
3	Reserved							
4	ATIP Start Time of Lead-in (Min)							
5	ATIP Start Time of Lead-in (Sec)							
6	ATIP Start Time of Lead-in (Frame)							
7	Reserved							
8	ATIP Last Possible Start Time of Lead-out (Min)							
9	ATIP Last Possible Start Time of Lead-out (Sec)							
10	ATIP Last Possible Start Time of Lead-out (Frame)							
11	Reserved							
12 – 14	A1 Values							
15	Reserved							
16-18	A2 Values							
19	Reserved							
20-22	A3 Values							
23	RESERVED							
24-26	S4 Values							
27	Reserved							

ATIP Data Length specifies the number of bytes to be transferred in response to the command. The ATIP Data Length value does not include the data length field itself. This value is not modified when the Allocation Length is insufficient to return all of the ATIP data available.

ATIP Descriptor field definition is dependent upon the setting of the DDCD bit. When the DDCD bit is cleared to zero, the fields are defined for CD-R/RW media. When the DDCD bit is set to one, the fields are defined for DDCD-R/RW media.

5.23.6.1 ATIP Descriptor for CD-R/RW Media

Indicative Device Writing Power - encoded information indicating the media's recommended initial laser power setting. The field is contained within the low order 3 bits of the field. The high order bit shall be set to one. The meaning of the field varies between CD-R and CD-RW media (see the Orange Books).

Reference Speed - is encoded information indicating the recommended write speed for the media:

> 00h = reserved and 01h = 2X recording.   This is valid only for CD-RW media.

The Unrestricted Use Disc (URU) flag, when set to one, indicates that the mounted CD-R/RW disc is defined for unrestricted use. When the URU flag is set to zero, the mounted CD-R/RW disc is defined for restricted use. To record data to the mounted disc the appropriate Host Application code shall be set through the Write Parameters Mode Page.

A Host Application Code of zero may be used to indicate a restricted use disc - general purpose.

Disc Type - zero indicates CD-R media; one indicates CD-RW media.

Disc Sub-Type - reports the following value according to the Orange Book Part 2 or Part 3 (B1,B2,B3).

A1 - when set to one, indicates that the A1 Values field is valid. Otherwise, the A1 Values field is invalid.

A2 - when set to one, indicates that the A2 Values field is valid. Otherwise, the A2 Values field is invalid.

A3 - when set to one, indicates that the A3 Values field is valid. Otherwise, the A3 Values field is invalid.

ATIP Start time of Lead-in - the start time of the lead-in. The value is read from ATIP and returned in hex format. Legal values for the M field are 50h through 63h.

ATIP Last Possible Start Time of Lead-out - the last possible start time of lead-out. The value is read from ATIP and returned in hex format. Valid values for the M field are 0 through 4Fh.

Table 243 – Disc Type and Disc Sub Type field definition

Media	Disc Type	Disc Sub-Type	Field Definition
CD-R	0	See Orange Book	Media Type (Physical Characteristic)
CD-RW	1	000	Standard Speed CD-RW
		001	High Speed CD-RW

For description of A1, A2, and A3 (Additional-Info1,2, and 3) fields, please refer to the applicable Orange Book. For the recording speed, refer to mode page 2Ah or Set Stream command.

5.23.6.2 ATIP Descriptor for DDCD-R/RW Media

Indicative Device Writing Power - encoded information indicating the media's recommended initial laser power setting. Unlike the CD version, the field is contained within the entire field.

Reference Speed - is encoded information indicating the recommended write speed for the media:

> 000b-001b = reserved, 010b = 4x recording, 011b = 8x recording, and 100b-111b is reserved.

The Unrestricted Use Disc (URU) bit is unchanged when used with DDCD media.

A Host Application Code

Disc Type - zero indicates DDCD-R media; one indicates DDCD-RW media.

Disc Sub-Type - has no meaning for DDCD and is reserved

A1, A2, and A3 are unchanged when used with DDCD media.

ATIP Start time of Lead-in - the start time of the lead-in. The value is binary and not in the HMSF format.

ATIP Last Possible Start Time of Lead-out - the last possible start time of lead-out. The value is binary and not in the HMSF format.

The special information 4(S4) fields are available for both DDCD-R and DDCD-RW.

5.23.6.3 TOC/PMA/ATIP Format 0100b for DVD Media

TOC/PMA/ATIP format 0100b has no definition for data fabrication for DVD media. If the Initiator requests a TOC/PMA/ATIP of this form. the Logical Unit shall terminate the command with CHECK CONDITION status and set sense bytes SK/ASC/ASCQ to ILLEGAL REQUEST/INVALID FIELD IN CDB.

5.23.7 TOC/PMA/ATIP Response Data Format 0101b

None of the fields in the response data of Format 0101b (Table 244) are affected by the TIME bit in the CDB.

When a Read TOC/PMA/ATIP command with the Format code 0101b is presented for a DDCD-R/RW media, this command shall be rejected with an INVALID FIELD IN CDB.

Table 244 – READ TOC/PMA/ATIP response data (With Format Field = 0101b)

Bit Byte	7	6	5	4	3	2	1	0
0	(MSB)				CD-TEXT Data Length			
1	(LSB)							
2	First Track/Session/Reserved Field(Hex)							
3	Last Track/Session/Reserved Field(Hex)							
CD-TEXT Descriptor(s)								
0 : : N	Descriptor data , format specific							

CD-TEXT Data Length specifies the number of bytes to be transferred in response to the command. The ATIP Data Length value does not include the data length field itself. This value is not modified when the allocation length is insufficient to return all of the CD-TEXT data available. This length is variable depends on the number of recording Pack Data.

CD-TEXT Information Descriptor(s) provides Pack Data available in the lead-in area of the disc. Each Pack Data consists of 18 bytes of CD-TEXT information. If a Pack Data is recorded repeatedly on the disc, the device should return it only once.

The detail of Pack Data and CD-TEXT information is described in .

TOC/PMA/ATIP format 0101b has no definition for data fabrication for DVD media. If the Initiator requests a TOC/PMA/ATIP of this form. the Logical Unit shall terminate the command with CHECK CONDITION status and set sense bytes SK/ASC/ASCQ to ILLEGAL REQUEST/INVALID FIELD IN CDB.

Table 245 describes errors that may occur during the operation of the command or which may cause a CHECK CONDITION status to be reported.

Table 245 – Recommended errors for READ TOC/PMA/ATIP Command

Error or ASCQ	Reference
Deferred Errors	A.2
General Errors	Table A.2
Media Access Errors	Table A.3
AUDIO PLAY OPERATION IN PROGRESS	Table A.1

5.24 READ TRACK INFORMATION Command

The READ TRACK INFORMATION command (Table 246) provides information about a track, regardless of its status. In case of media that does not support logical tracks, the number of tracks and sessions is considered one. If an implemented Feature requires this command,, the command shall function if any media is present.

For CD/DD, if the PMA/TOC is unreadable, the command shall be terminated with CHECK CONDITION status and SK/ASC/ASCQ values shall be set to MEDIUM ERROR/UNABLE TO RECOVER TABLE-OF-CONTENTS. For DVD-R/-RW, if the RMA/RMD in Border-out is unreadable, the command shall be terminated with CHECK CONDITION status and SK/ASC/ASCQ values shall be set to MEDIUM ERROR/L-EC UNCORRECTABLE ERROR.

If this command is issued during a long immediate operation, the Logical Unit shall return CHECK CONDITION status. For specific values of SK/ASC/ASCQ, refer to the specific command description.

Table 246 – 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							

The Address/Number Type field in byte 1 is used to specify the contents of bytes 2 through 5 of the CDB.

The Logical Block Address/Track/Session Number field, Bytes 2 through 5 are defined in Table 247.

Table 247 – LBA/Track/Session Number Field definition

Address/ Number Type field	Logical Block Address/Track/Session Number	Description
00b	Logical Block Address	T_{LBA}, where T_{LBA} is the number of the track that contains the block associated with Logical Block Address.
01b	00h	T_{toc}, where T_{toc} is the Lead-in area of the disc
01b	T_{CDB}, a valid track number	T_{CDB}
01b	FFh	T_{INV}, where T_{INV} is the Track number of the invisible or incomplete Track
10b	Session Number	$T_{session}$, where $T_{session}$ is the number of the first Track that is in the Session Number.
11b	Reserved	

The number of Track Information Block bytes returned is limited by the Allocation Length parameter of the CDB. An Allocation Length of zero is not an error. Fields not used with the installed media shall return 0.

The format and content of the Track Information Block is shown in Table 248.

Table 248 – Track Information Block

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			Data Length				
1								(LSB)
2	Track Number (Least Significant Byte)							
3	Session Number (Least Significant Byte)							
4	Reserved							
5	Reserved		Damage	Copy	Track Mode			
6	RT	Blank	Packet/Inc	FP	Data Mode			
7	Reserved						LRA_V	NWA_V
8	(MSB)							
9				Track Start				
10				Address				
11								(LSB)
12	(MSB)							
13				Next Writable				
14				Address				
15								(LSB)
16	(MSB)							
17				Free				
18				Blocks				
19								(LSB)
20	(MSB)							
21				Fixed Packet Size/				
22				Blocking Factor				
23								(LSB)
24	(MSB)							
25				Track Size				
26								
27								(LSB)
28	(MSB)							
29				Last Recorded Address				
30								
31								(LSB)
32	Track Number (Most Significant Byte)							
33	Session Number (Most Significant Byte)							
34	Reserved							
35	Reserved							

Data length field specifies the length, in bytes, of the requested data to be transferred in response to the command. The data length value does not include the data length field itself. If the Allocation length specified is less than the data length, the response shall be truncated at the allocation length specified. This truncation shall not cause a CHECK CONDITION status to be presented. The Data Length is not modified when the allocation length is insufficient to return all of the response data available.

Track Number is the track number for all of the information in this structure or a value of 1 for media not containing logical tracks. If the Track number is set to zero, and the P through W bit is set (see Table 350), the contents of Track Information Block shall be returned for the lead-in area. In this case, the Track Start Address field is the start address of the lead-in area.

Session Number is the number of the session containing this track, or a value of 1 for media not containing sessions that contain this track.

The Copy bit indicates that this track is a second or higher generation copy. For media that does not support CGMS, this bit shall beset to zero.

The Damage bit, when set to one, and the NWA_V is set to zero, the track shall be considered "not closed due to an incomplete write". The Logical Unit may attempt an automatic repair when the CLOSE TRACK/SESSION command is issued. Further incremental writing in this track is not possible. The Damage bit, when set to one, and the NWA_V is set to one, indicates a Track that may be recorded further in an incremental manner. The Logical Unit shall attempt an automatic repair when the next command that requires writing to the Track is issued. If the repair is successful, the Damage bit shall be set to zero. Prior to the start of the repair, the NWA field shall contain the address of the Next Writable Sector assuming a successful repair.

Track Mode is the control nibble as defined for mode 1 Q Sub-channel for this track. For non-CD media, this field shall be set to 4. See Table 347 and Table 222. For DDCD, this field shall be set to 4.

For CD/DD, if the RT bit is zero, then the track is not reserved, otherwise the track is reserved. The RT bit indicates that a PMA entry indicating the tracks start and end addresses exists. For DVD, the RT bit of zero indicates that the Track is Complete, Invisible, or Incomplete status. A RT bit of one indicates that the Track is Empty Reserved or Partially Recorded Reserved status.

If the Logical Unit is not capable of reading the PMA or RMA, this field shall be set to zero.

The Blank bit, when set to one, indicates that the track contains no written data and Last Recorded Address field is invalid. For CD/DD, Tracks with the Track Descriptor Block recorded shall not be considered blank. For other media, this bit shall be set to zero.

For CD/DD, the Packet/Inc bit is valid only when the RT bit is set to one or the track indicated is the incomplete track. The Packet/Inc bit, when set to one, indicates that this track is to be written only with packets (CD) or incremental recording (DVD).

The FP (Fixed Packet) bit is valid only when the Packet/Inc bit is set to one. When the Packet/Inc bit is set to one and the FP bit is also set to one, then the track is to be written only with fixed packets on CD/DD media, or the track is to be written with restricted overwrite method on DVD-RW media. When the Packet/Inc bit is set to one and the FP bit is set to zero, then the track is to be written only with variable packets on CD/DD media, or the track is to be written with incremental recording on DVD-R/-RW media. Except for C/DD/DVD-R/-RW, this field should be set to zero.

When writing, certain parameters may be set via the Write Parameters Page. The state of the track determines what parameters shall be set and that parameters in the mode page shall match. Required Write Parameters are defined in Table 249.

Table 249 – Write Parameter Restrictions due to Track State

RT	Blank	Packet	CD Write Parameter Restrictions	DVD Write Parameter Restrictions
0	0	0	Can't write to stamped disc, or during track at once on invisible track, or writing session at once mode	Can't write to stamped disc, or writing disc-at-once, can not write to complete disc.
0	0	1	Write type is set to packet; all parameters common to READ TRACK INFOMATION and the Write Parameters Page shall match.	Write type is set to incremental; all parameters common to READ TRACK INFOMATION and the Write Parameters Page shall match
0	1	0	Write type may be set to packet or TAO. All other parameters shall be changeable. If this track is the first track of a Session, then Session at Once is allowed.	Write type is set to disc-at-once: Invisible Track of disc-at-once, empty. Can't start disc-at-once recording in this state. A Track shall be reserved prior to start of disc-at-once recording. All parameters common to READ TRACK INFOMATION and the Write Parameters Page shall match
0	1	1	Invalid State	Write type is set to incremental; Invisible track for incremental recording, the Track is writable. All parameters common to READ TRACK INFOMATION and the Write Parameters Page shall match
1	0	0	Can't write to recorded track or during track at once on reserved Track.	Can't write to disc during disc at once on reserved Track.
1	0	1	Write type is set to packet; all parameters common to READ TRACK INFO and the Write Parameters Page shall match.	Write type is set to incremental; Partially recorded reserved Track, the Track is writable. All parameters common to READ TRACK INFOMATION and the Write Parameters Page shall match
1	1	0	Write type is set to TAO. Track mode set to same as READ TRACK INFO. Copy bit may be set only if copyright bit in track mode is clear. All other common parameters shall match.	Write type is set to disc-at-once; Empty reserved Track for disc-at-once. All parameters common to READ TRACK INFOMATION and the Write Parameters Page shall match
1	1	1	Write type is set to Packet. Track mode set to same as READ TRACK INFO. Copy bit may be set only if copyright bit in track mode is clear. FP and packet size are changeable. All other common parameters shall match.	Write type is set to incremental; Empty reserved Track, the Track is writable. All parameters common to READ TRACK INFOMATION and the Write Parameters Page shall match

For CD, when the RT, Blank and Packet bits are set to one, FP bit of the READ TRACK INFORMATION response data is set to zero.

Data Mode field defines the track content. Data Mode is defined in Table 251.

Table 250 – Track Status Indications

RT	Blank	Packet/ Inc	FP	DVD Write Method	DVD Track Status	CD Write Method	CD Track Status
0	0	0	-	- DAO	Complete	Uninterrupted/ TAO/SAO	Complete/During TAO/SAO
0	0	1	0	Incremental	Incomplete or Complete (1)	Variable	Incomplete
0	0	1	1	- Restricted Overwrite	Complete or Incomplete (2)	Fixed	Incomplete
0	1	0	-	DAO	Invisible	TAO/Variable/ Fixed(*3)	Invisible
0	1	1	0	Incremental	Invisible	-	(invalid)
0	1	1	1	- Restricted Overwrite	Invisible	-	(invalid)
1	0	0	-	DAO	during DAO	TAO	Complete/During TAO
1	0	1	0	Incremental	Partially Recorded Reserved	Variable	Complete/ Partially Recorded Reserve
1	0	1	1	-	(invalid)	Fixed	Complete/ Partially Recorded Reserve
1	1	0	-	DAO	Empty Reserved Before starting writing	TAO	Empty Reserved
1	1	1	0	Incremental	Empty Reserved	Variable/Fixed	Empty Reserved
1	1	1	1	-	(invalid)	-	(invalid)

(1) If Free Blocks field is 0, the track is in the Complete state. Otherwise, the track is Incomplete state.
(2) In the case of a track that is in the intermediate state session, the track is considered as in the Incomplete state.
(3) In case last Session is empty, SAO is also valid.

Table 251 – Data Mode

Value	Definition
1	Mode 1 (ISO/IEC 10149)
2	Mode 2 (ISO/IEC 10149 or CD-ROM XA) DDCD
Fh	Data Block Type unknown (no track descriptor block)
0, 3 - Eh	Reserved

If NWA_V is zero, then the next writable address field is not valid. Otherwise the next writable address field is valid. NWA_V shall be set to zero if the Track is not writable for any reason. If the disc is MRW formatted or in progress with MRW formatting, then NWA_V shall be set to zero.

If LRA_V is zero, then the Last Recorded Address field is not valid. Otherwise, the Last Recorded Address field is valid. The LRA_V bit shall be set to zero if the Track has damage for any reason and is repaired automatically.

Track Start Address contains the address of the first block with user information for that track.

The Next Writable Address, if valid, is the LBA of the next writable user block in the Track specified by the LBA/Track Number field in the CDB. For CD media, Next Writable Address shall be associated with the RT, Blank, Packet and FP bits as defined in Table 252. If the write type is Raw, the Next Writable Address may be a negative number as required to point to the start of the first Lead-in. When streaming in any write type, the Next Writable Address shall be the next user data block the Logical Unit expects to receive if no under-run occurs.

Table 252 – Next Writable Address Definition

RT	Blank	Packet	FP	NWA_V	Definition
0	0	0	-	0^4	LBA that shall be specified by next write command *2
0	0	1	0	1^1	LBA that shall be specified by next write command *2
0	0	1	1	1^1	LBA that shall be specified by next write command *2, *3
0	1	0	0	1	LBA of the first data block after pre-gap *5
0	1	1	0	-	-
0	1	1	1	-	-
1	0	0	-	0^4	LBA that shall be specified by next write command *2
1	0	1	0	1^1	LBA that shall be specified by next write command *2
1	0	1	1	1^1	LBA that shall be specified by next write command *2, *3
1	1	0	-	1	LBA of the first data block after pre-gap
1	1	1	0	1	LBA of the first data block after pre-gap
1	1	1	1	-	-

Notes:
1 – When "Free Blocks" is 0 (data full), NWA_V is 0.
2 - NWA shall be taken account of data blocks in buffer that has not yet been written to media. If the Logical Unit can write the data of next write command without interrupting of current data streaming(no underrun condition), NWA shall be contiguous to last address data in buffer. If WCE in Mode Cache Page is zero, NWA shall be taken account of Link Blocks (2 Run-out blocks, 1 Link block and 4 Run-out blocks) in case of Addressing Method-1.
3 - NWA shall follow the Addressing Method-2 if Method-2 bit in Mode CD Capabilities and Mechanical Status Page is set to one.
4 – During TAO (SAO), NWA_V is 1.
5 - In the case of SAO NWA shall be the first block after Lead-in for the first track of session.

The Free Blocks field represents the maximum number of user data blocks available for recording in the track. If the medium is MRW formatted or in progress with MRW formatting, Free Blocks shall be cleared to zero.   For CD media, this field shall be computed as follows: First, the Available Track Space (ATS) shall be computed.

For the invisible track, *ATS = (StartTimeofLastPossibleLead-out) – NWA + 5.*

For a reserved track, *ATS = (PMAStopTime) – NWA + 5.*

For DDCD media, this field shall be computed as follows: First, the Available Track Space (ATS) shall be computed.

For the invisible/incomplete track, *ATS = (StartTimeofLastPossibleLead-out) – NWA + 4.*

For a reserved track, *ATS = (PMAStopTime) – NWA + 4.*

If the track is reserved for fixed packets, or written with fixed packets, or is the invisible track and the Write Parameters Page specifies fixed packets,

$$FreeBlocks \; = \; IP \left\lfloor \frac{ATS}{PacketSize \, + \, 7} \right\rfloor \bullet PacketSize.$$

Otherwise, *FreeBlocks = ATS –7.*

Note: The StartTimeofLastPossibleLead-out is the last possible location of the link block at the start of the Lead-out. If a disc is fully recorded, the PMA entry for the last track is equal to the StartTimeofLastPossibleLead-out.

The Logical Unit for reading and writing translates addressing within fixed packet written tracks. The NWA shall also reflect this translation:

$$NWA_{Method2} = NWA_{Method1} - 7 \cdot IP \left\lfloor \frac{NWA_{Method1} - TrackStartAddress}{PacketSize + 7} \right\rfloor$$

Method 1 is the physical address.

 Method 2 is used on fixed packet written tracks to hide the link areas from the Initiator. The TrackStartAddress is always a physical address, even if prior tracks are recorded with Method 2. IP( ) is the integer part of the value.

For CD, the Fixed Packet Size is valid only when the Packet and the FP bits are both set to one. For DVD-R, if the FP bit is set to zero, the Fixed Packet Size field specifies the number of sectors that are actual disc access unit. In the case of DVD, this field has a value of 16. FP bit set to one is undefined.

If the disc is stamped, then DAMAGE = 0, BLANK = 0, RT = 0, and NWA_V = 0.

Track Size is the number of user data blocks in the track. For CD the track size shall be computed as follows:

First, compute the Complete Track Size (CTS).

For an incomplete track: *CTS = (StartTimeofLastPossibleLead-out) – PMATrackStart + 5.*

For a reserved track: *CTS = (PMAStopTime) – PMAStartTime + 5.*

For DDCD, the track size shall be computed as follows:

For an incomplete DDCD track:

      CTS = (StartTimeofLastPossibleLead-out) – PMATrackStart + 4.

For a reserved DDCD track:

      CTS = (PMAStopTime) – PMAStartTime + 4.

If the track is reserved for, or written with, fixed packets: $TrackSize = IP\left\lceil \dfrac{CTS}{PacketSize + 7} \right\rceil \bullet PacketSize.$

Otherwise, $TrackSize = CTS - 7$.

READ TRACK INFORMATION shall provide certain valid fields for a disc with the Unrecordable status: Track Number, Session Number, Track Mode, Data Mode, Track Start Address.

For CD media, the Track Size number may not be exact for the tracks that do not have a PMA entry. The track size, of tracks that do not have PMA entries, is calculated as follows:

TrackSize of track *n = (start of track n+1) - (start of track n)*, n+1 is the Lead Out if n is the last track recorded in the TOC.

The Track Size from this calculation may include blocks from the following track and these blocks may not be readable.

If the disc is MRW formatted or in progress with MRW formatting, Track Size shall be reported according to the LBA Space selected in the MRW Mode Page. The Track Size of a MRW disc is simply the sum of all the DA sizes given in user sectors.

Table 253 describes errors that may occur during the operation of the command or which may cause a CHECK CONDITION status to be reported.

Table 253 – Recommended Errors for the Read Track Information Command

Error	Reference
Deferred Errors	A.2
General Errors	Table A.2
Media Access Errors	Table A.3

5.25 REPAIR TRACK Command

A track that has been defined for incremental writing 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 packet write. The REPAIR TRACK (Table 254) command shall fill multiple ECC block lengths with data from beginning of damaged sector of the ECC block and ended with link field. The recovery indicated here only allows the track to become writable again.

Table 254 – 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							

The Immed bit allows execution of the REPAIR TRACK command function as an immediate operation. If Immed is set to 0, then the requested repair operation is executed to completion prior to returning status. If Immed is set to 1, then status is returned once the Command Packet has been validated.

The Track Number field specifies the track that requires repair.

Behavior of this command is the same as automatic repair. This command causes a repair action without an explicit write of data.

Table 255 describes errors that may occur during the operation of the command or which may cause a CHECK CONDITION status to be reported.

Table 255 – Recommended errors for REPAIR TRACK Command

Error	Reference
Deferred Errors	A.2
General Errors	Table A.2
Media Access Errors	Table A.3
Write Errors	Table A.4

5.26 REPORT KEY Command

The REPORT KEY command (Table 256) requests the start of the authentication process and provides data necessary for authentication and for generating a Bus Key for the DVD Logical Unit. This command, in conjunction with the SEND KEY command, is intended to perform authentication for Logical Units that conform to DVD Content Protection schemes, and generates a Bus Key as the result of that authentication.

The REPORT KEY command also requests the DVD Logical Unit to transfer TITLE KEY data, obfuscated by a Bus Key, to the Initiator.

Table 256 – REPORT KEY Command Descriptor Block

Bit Byte	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							

The KEY Format field (Table 258) indicates the types of information that is to be sent to the Initiator.

The REPORT KEY command with KEY Format field of 000000b or 010001b, initiates the authentication process. The Logical Unit, when ready to begin the authentication process, shall grant the request by returning an Authentication Grant ID (AGID). If there is no available Authentication Grant ID, the command shall be terminated with CHECK CONDITION status and SK/ASC/ASCQ shall be set to ILLEGAL REQUEST/SYSTEM RESOURCE FAILURE.

The Key Class field shall identify the type of authentication conversation according to Table 257.

Table 257 – KEY Class Definition

Key Class	Authentication Type
00h	DVD CSS/CPPM or CPRM
01h	ReWritable Security Service – A
02h - FFh	Reserved

Note: DVD CSS/CPPM and CPRM authentication use the same Key Class field value since they have the same Challenge KEY, KEY1, and KEY2 sizes, and since they are licensed through the same entity.

The Allocation Length field specifies the maximum length in bytes of the REPORT KEY response data that shall be transferred from the Logical Unit to the Host. An Allocation Length of zero indicates that no data shall be transferred. This condition shall not be considered as an error.

The AGID field is used to control simultaneous key exchange sequences. The AGID specified in subsequent Key Exchange commands shall match a currently active AGID. An AGID becomes active by

requesting one with KEY Format 000000b or 010001b. The AGID remains active until the authentication sequence completes or is invalidated. The AGID field shall be reserved when the KEY Format Field contains 0h, 5h or 11h.

Note: Logical Units that support more than one KEY Format for requesting an AGID do not necessarily support simultaneous key exchange sequences.

In case of KEY Format = 000100b, the Logical Block Address field specifies the logical block address that contains the TITLE KEY to be sent to the Initiator obfuscated by a Bus Key. In all other cases, this field shall be reserved.

Table 258 – KEY Format Code definitions for REPORT KEY Command (KEY Class 0)

Key Format	Returned Data	Description	AGID Use
000000b	AGID for CSS/CPPM	Returns an AUTHENTICATION GRANT ID for Authentication for CSS/CPPM	Reserved & N/A
000001b	Challenge Key	Returns a Challenge KEY	Valid AGID Required
000010b	KEY1	Returns a KEY1	
000100b	TITLE KEY	Returns a TITLE KEY obfuscated by a Bus Key	
000101b	ASF	Returns the current state of the Authentication Success Flag for CSS/CPPM	Reserved & Ignored
001000b	RPC State	Report Logical Unit region settings	
010001b	AGID for CPRM	Returns an AUTHENTICATION GRANT ID for Authentication for CPRM	Reserved & N/A
111111b	None	Invalidate Specified AGID. Invalidating an invalid AGID shall not be considered an error. An AGID that has not been granted shall be considered invalid	Valid AGID required
All other values	Reserved		

The data returned to the Initiator for this command is shown in the following tables. The response for each format is defined. It should be noted that with a Key Format Code of 3Fh, no data shall be returned to the Initiator. Table 259 defines the response data for Key Format 000000b.

Table 259 – REPORT KEY Data Format (With KEY Format = 000000b, Key Class = 0)

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			REPORT KEY Data Length (06h)				
1								(LSB)
2	Reserved							
3	Reserved							
	AUTHENTICATION GRANT ID FOR CSS/CPRM							
0	Reserved							
1	Reserved							
2	Reserved							
3	AGID			Reserved				

This KEY Format requests the Logical Unit to return an Authentication Grant ID for CSS/CPPM. If the authentication process is started by the REPORT KEY command with a KEY Format of 000000b, the authentication shall be processed to exchange Key data only for CSS/CPPM protected contents.

Note: If the command with this KEY Format is required by an implemented Feature, the command should function, even when the current bit for that Feature is zero.

Table 260 defines the response data for Key Format 000001b

Table 260 – REPORT KEY Data Format (With KEY Format = 000001b, Key Class = 0)

Bit Byte	7	6	5	4	3	2	1	0
0	(MSB)			REPORT KEY Data Length (0Eh)				
1								(LSB)
2	Reserved							
3	Reserved							
Challenge Key								
0	(MSB)							
:				Challenge Key Value				
9								(LSB)
10	Reserved							
11	Reserved							

Challenge Key Value field returns a value to be used to interrogate an external device to determine conformance with the DVD Content Protection scheme. The external device then generates the corresponding KEY2.

Table 261 defines the response data for Key Format 000010b

Table 261 – REPORT KEY Data Format (With KEY Format = 000010b, Key Class = 0)

Bit Byte	7	6	5	4	3	2	1	0
0	(MSB)			REPORT KEY Data Length (0Ah)				
1								(LSB)
2	Reserved							
3	Reserved							
KEY1								
0	(MSB)							
:				KEY1 Value				
4								(LSB)
5	Reserved							
6	Reserved							
7	Reserved							

KEY1 Value field returns a value used to determine the Logical Unit's conformity with DVD Content Protection scheme by an external device. The KEY1 value is also used as a parameter to generate a Bus Key in the Logical Unit.

When the Logical Unit is unable to produce a KEY1 value, this command with KEY Format = 000010b shall be terminated with CHECK CONDITION status and SK/ASC/ASCQ shall be set to ILLEGAL REQUEST/COPY PROTECTION KEY EXCHANGE FAILURE - KEY NOT PRESENT.

Table 262 defines the response data for Key Format 000100b

Table 262 – REPORT KEY Data Format (With KEY Format = 000100b, Key Class = 0)

Bit Byte	7	6	5	4	3	2	1	0
0	(MSB)		REPORT KEY Data Length (0Ah)					
1								(LSB)
2	Reserved							
3	Reserved							
	COPYRIGHT MANAGEMENT/TITLE KEY Information							
0	CPM	CP_SEC	CGMS		CP_MOD			
1	(MSB)							
2								
3			TITLE KEY Value					
4								
5								(LSB)
6	Reserved							
7	Reserved							

The CPM bit identifies the presence of copyrighted material in this sector. If set to zero the material is not copyrighted, if set to one the material is copyrighted.

When the CPM bit is one, the CP_SEC field indicates that the specified sector has a specific data structure for copyright protection system. If set to zero no such data structure exists in this sector .If set to one, a specific data structure for CSS or CPPM exists in this sector.

When the CPM bit is 1, the CGMS field indicates the restrictions on copying:

00b   Copying is permitted without restriction
01b   Reserved
10b   One generation of copies may be made
11b   No copying is allowed

When the CP_SEC bit is 1, the CP_MOD field indicates the copyright protection mode of the specified sector. A value of 0h indicates the sector is scrambled by CSS. A value of 1h indicates the sector is encrypted by CPPM. Other values are reserved.

TITLE KEY Value field returns the TITLE KEY that is obfuscated by a Bus Key. The length of Title Key Value is currently 5 bytes only. Note that CPPM protected sectors do not contain a TITLE KEY.

When the TITLE KEY does not exist on the specified sector of DVD media, this command with KEY Format = 000100b shall be terminated with CHECK CONDITION status and SK/ASC/ASCQ shall be set to ILLEGAL REQUEST/COPY PROTECTION KEY EXCHANGE FAILURE/KEY NOT PRESENT.

When the Logical Unit is not in the Bus Key Established state for CSS/CPPM, this command with KEY Format = 000100b shall be terminated with CHECK CONDITION status and SK/ASC/ASCQ shall be set to ILLEGAL REQUEST/COPY PROTECTION KEY EXCHANGE FAILURE - KEY NOT ESTABLISHED.

Table 263 defines the response data for Key Format 000101b

Table 263 – REPORT KEY Data Format (With KEY Format = 000101b, Key Class = 0)

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)	REPORT KEY Data Length (06h)						
1								(LSB)
2	Reserved							
3	Reserved							
AUTHENTICATION SUCCESS FLAG								
0	Reserved							
1	Reserved							
2	Reserved							
3	Reserved							ASF

ASF bit of one indicates that the authentication process for CSS/CPPM has completed successfully.

Note, however, that the ASF value is not relevant to CPPM, since CPPM protected sectors do not contain a Title Key.

Table 264 defines the response data for Key Format 001000b

Table 264 – REPORT KEY Data Format (With KEY Format = 001000b, Key Class = 0)

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)	REPORT KEY Data Length (06h)						
1								(LSB)
2	Reserved							
3	Reserved							
RPC State								
0	Type Code		# of Vendor Resets Available		# of User Controlled Changes Available			
1	Region Mask							
2	RPC Scheme							
3	Reserved							

The Logical Unit shall not report an error concerning media to this KEY Format code.

The Type Code field (Table 265) specifies the current state of the Regionalization process.

Table 265 – Type Code Field Definitions

Type Code	Name	Definition
00b	NONE	No Logical Unit region setting
01b	SET	Logical Unit region is set
10b	LAST CHANCE	Logical Unit Region is set. Additional restrictions required to make a change
11b	PERM	Logical Unit Region has been set permanently, but may be reset by the vendor if necessary.

# of Vendor Resets Available is a count down counter that indicates the number of times that the vendor can reset the region. The manufacturer of the Logical Unit sets this value to 4 and the value is decremented each time the vendor clears the Logical Unit's region. When this value is zero, the vendor can no longer clear the Logical Unit's region.

# of User Controlled Changes Available is a count down counter that indicates the number of times that the user can set the region. This value is initially 5.

The Region Mask returns a value that specifies the Logical Unit Region in which the Logical Unit is located. Once the Logical Unit Region has been set, the Logical Unit shall be located in only one region. Each bit represents one of eight regions. If a bit is cleared in this field, the disc can be played in the corresponding region. If a bit is set in this field, the disc cannot be played in the corresponding region.

RPC Scheme specifies the type of Region Playback Controls being used by the Logical Unit. See Table 266.

Table 266 – RPC Scheme field Definition

RPC Scheme	RPC Name	Definition
00h	Unknown	Logical Unit does not enforce Region Playback Controls (RPC)
01h	RPC Phase II	Logical Unit region shall adhere to this standard and all requirements of the CSS license agreement concerning RPC.
02h - FFh	Reserved	

Table 267 defines the response data for Key Format 010000b

Table 267 – REPORT KEY Data Format (With Key Format = 010001b, Key Class = 0)

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)							
1				REPORT KEY Data Length (06h)				(LSB)
2	Reserved							
3	Reserved							
	AUTHENTICATION GRANT ID FOR CPRM							
0	Reserved							
1	Reserved							
2	Reserved							
3	AGID			Reserved				

This KEY Format requests the Logical Unit to return an Authentication Grant ID for CPRM. If the authentication process is started by the REPORT KEY command with a KEY Format of 010001b, the authentication shall be processed to exchange Key data only for CPRM protected contents.

Note: If the command with this KEY Format is required by an implemented Feature, the command should function, even when the current bit for that Feature is zero.

Table 268 describes errors that may occur during the operation of the command or which may cause a CHECK CONDITION status to be reported.

Table 268 – Recommended errors for REPORT KEY Command

Error	Reference
Deferred Errors	A.2
General Errors	Table A.2
Media Access Errors	Table A.3

5.27 RESERVE TRACK Command

The RESERVE TRACK command (Table 269) allows reservation of disc space for a `track`. A PMA entry for the `track` shall be either written or cached for writing prior to disc removal.

Table 269 – 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 shall be according to the Write Parameters Page. For DVD-R/-RW, track reservation size shall be determined by the settings of the Write Parameters Page. See Table 270. For CD, the PMA start time shall reflect the appropriate pre-gap, as determined by the previous track's mode and the settings of the Write Parameters Page. Table 270 specifies the PMA stop time, and specifies the Track sizing.

Table 270 – Track reservation sizing (CD)

Write Parameters Mode Page Write Type Value	PMA Stop Time
Session-at-once	CHECK CONDITION status is returned and SK/ASC/ASCQ is set to ILLEGAL REQUEST/COMMAND SEQUENCE ERROR
Track-at-once	Reserves the number of user blocks specified. The PMA stop time shall be $PMAStart + \mathrm{Re}\,servationSize + 2$
Variable Packet	Reserve behaves as in track-at-once.
Fixed Packet	Set $p = \dfrac{\mathrm{Re}\,servationSize}{PacketSize}$ packets, where packet size is taken from the Write Parameters Page. If p is an integer, then the reservation is performed and the PMA stop time shall be $PMAStart + (PacketSize + 7) \bullet p - 5$. Otherwise, the reservation is not performed, CHECK CONDITION status is returned and SK/ASC/ASCQ is set to ILLEGAL REQUEST/INVALID FIELD IN CDB. Enough space for reservation size user data packets shall be reserved.

Table 271 – TRACK reservation sizing (DVD-R/-RW)

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 $ReservedTrackSize = ReservationSize$ where *ReservationSize* is a value that is specified in the CDB
Incremental	Reserves the number of user blocks specified. The Reserved Track Size shall be $$ReservedTrack = 16 \bullet Cell \left\lceil \frac{ReservationSize + (NWA \wedge 0Fh)}{16} \right\rceil -(NWA \wedge 0Fh) + 16$$ 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

Note: Cell (x) returns the least integral value greater than or equal to x.

If the last track, defined in the PMA/RMA, is N, then the invisible track is assigned track number N+1. A track shall only be reserved from the beginning of the invisible track. After the reservation is done, the track number given to the new track is the current track number of the invisible track. The number of the invisible track is increased by one following a reservation.

For CD, if the Reservation Size is smaller than four seconds, excluding pre-gap length, the Logical Unit shall return CHECK CONDITION status.

For DVD-R/-RW, the actual reserved size shall be raised to ECC block unit by the device. If Reservation Size field is set to 0, no reservation is done by device and shall not be considered an error.

Reserving shall be allowed when the last track is invisible. When the last track is not invisible, shall generate a CHECK CONDITION status and set SK/ASC/ASCQ to ILLEGAL REQUEST/COMMAND SEQUENCE ERROR.

For DVD-R/-RW, maximum reserved Tracks that can be reserved are limited to two at the same time. Attempting to reserve Track when two Empty/Partially recorded reserved tracks are already reserved, the command `shall` be terminated with CHECK CONDITION status and SK/ASC/ASCQ values are set to ILLEGAL REQUEST/NO MORE TRACK RESERVATIONS ALLOWED.

Attempting to reserve Track when there are less than 3 ECC blocks in the RMA, the command shall be terminated with CHECK CONDITION status and SK/ASC/ASCQ values are set to MEDIUM ERROR/RMA/PMA IS FULL.

For CD, Reserving a track when the Write Type is set to packet (See Table 348) shall cause the TDB (Track Descriptor Block) to be written.

Table 272 describes errors that may occur during the operation of the command or which may cause a CHECK CONDITION status to be reported.

Table 272 – Recommended errors for RESERVE TRACK Command

Error	Reference
Deferred Errors	A.2
General Errors	Table A.2
Media Access Errors	Table A.3
Write Errors	Table A.4

5.28 SCAN Command

The SCAN command requests a fast-forward or fast-reverse scan operation starting from the Scan Starting Address. The Logical Unit shall respond to this command by scanning all the way to the end of the last audio track on the media.

Like the PLAY AUDIO command, the SCAN command shall terminate the scan at the last audio track or upon receipt of a STOP PLAY/SCAN command. Upon receipt of the STOP PLAY/SCAN command the Logical Unit shall set the current address to the last address of data read from the media by the scan operation. Subsequent Audio Play commands shall cause the Logical Unit to begin playing at the location last output by the SCAN command. If the 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.

Table 273 – SCAN Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (BAh)							
1	Reserved			Direct	Reserved			RELADR
2	(MSB)							
3	Scan Starting Address Field							
4								
5								(LSB)
6	Reserved							
7	Reserved							
8	Reserved							
9	Type		Reserved					
10	Reserved							
11	Control							

If the DIRECT bit is set to zero, the Logical Unit shall perform a fast-forward scan operation. A DIRECT bit of one causes a fast-reversed scan operation.

The RELADR bit shall be set to zero.

The Scan Starting Address specifies the address at that the audio fast scan operation shall begin. The The Type field (Table 274) specifies the format of the address contained in the Scan Starting Address Field.

Table 274 – Type field bit definitions

Bits 7 - 6	Address Type
0 0	Logical block address format
0 1	MIN, SEC, and FRAME format (MSF)
1 0	Track Number (TNO) format
1 1	Reserved

With a Type field of 00h the Scan Starting address field specified in command bytes 2-5 are defined in Table 275.

Table 275 – Scan starting address field format-logical blocks

Bit Byte	7	6	5	4	3	2	1	0
2	(MSB)							
3				Scan Starting Logical Block Address Field				
4								
5								(LSB)

With a Type field of 01h, bytes 2-5 specify the MSF address of the starting sector. See Table 276 below.

Table 276 – Scan Starting Address format - MIN, SEC, FRAME format

Bit Byte	7	6	5	4	3	2	1	0
2	Reserved							
3	CD-Absolute Time (MIN)							
4	CD-Absolute Time (SEC)							
5	CD-Absolute Time (FRAME)							

The MIN, SEC and FRAME fields specify the relative running time from the beginning of the disc. The MIN field has a range of 00d to 99d (00h to 63h). The SEC field ranges from 00d to 59d (00h to 3Bh). The FRAME field has a range of 00h to 74d (00h to 4Ah). All MSF fields shall be binary

With a Type field of 10h, bytes 2 - 5 specify a starting address of a specific Track Number (TNO). See Table 277 below

Table 277 – 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.

Table 278 describes errors that may occur during the operation of the command or which may cause a CHECK CONDITION status to be reported.

Table 278 – Recommended errors for SCAN operation

Error	Reference
Deferred Errors	A.2
General Errors	Table A.2
Media Access Errors	Table A.3

5.29 SEND CUE SHEET Command

A Session-at-once recording is written beginning with the Lead-in and continuing through the Lead-out. Only user data is sent with the write commands, so a guide structure is required by the Logical Unit in order to control the recording process. This guide structure is called the cue sheet. The cue sheet is constructed in the Initiator and sent to the Logical Unit.

Table 279 – SEND CUE SHEET Command Descriptor Block

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (5Dh)							
1	Reserved							
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	(MSB)							
7	Cue Sheet Size							
8								(LSB)
9	Control Byte							

The Cue Sheet Size parameter is the number of bytes in the cue sheet to be sent to the Logical Unit. Prior to beginning the write process, the entire Cue Sheet shall be received by the Logical Unit. If the Logical Unit cannot accept and buffer the entire cue sheet, then CHECK CONDITION is returned and SK/ASC/ASCQ values are set to ILLEGAL REQUEST/INVALID FIELD IN CDB.

If the Write Parameters Page does not have Write Type set to Session-at-once, then CHECK CONDITION status is returned and SK/ASC/ASCQ values are set to ILLEGAL REQUEST/COMMAND SEQUENCE ERROR.

If the Write Mode in the Write Parameter Mode Page, is changed from session at once, the Q sheet may not be available.

5.29.1 CUE SHEET FORMAT

The Cue Sheet contains information required to specify the layout of a disc to be written, and shall be sent to the Logical Unit via the SEND CUE SHEET command before writing data to the disc.

The Cue Sheet format is shown in Table 280.

Table 280 – Cue Sheet format

Byte Number	Cue Sheet Data
0	Mixture of
...	Information of absolute disc location, catalog Code,
(m-1)* 8	and ISRC (total m lines)

If the Catalog Code is to be recorded, it shall be described at the beginning of the Cue sheet.

If the ISRC is to be recorded, it shall be described immediately preceding each Track's information in the Cue Sheet.

For the Cue sheet, the Lead-out start time shall be the last entry.

5.29.2 Information of the absolute disc location

The Logical Unit writes a disc according to this information. This information defines the following parameters:

1. Generation of Sub-channel P and Q channel.
2. Format and block size of the data transferred by the WRITE command

Table 281 – Sample CUE SHEET

Byte Number	CTL/ ADR	TNO	INDEX	DATA FORM	SCMS	ABSOLUTE TIME		
						MIN	SEC	FRAME
00 (Lead-in)	01h[5]	00h	00h[1]	01h[5]	00h	00h[1]	00h[1]	00h[1]
08 (TNO:01)	01h	01h	00h	01h	00h	00h	00h	00h
10 (TNO:01) [2]	01h	01h	01h	00h	00h	00h	02h	00h
18 (TNO:02)	01h	02h	00h	C0h	00h	07h	29h	71h
20 (TNO:02)	01h	02h	01h	C0h	00h	07h	31h	71h
28 (TNO:03)	01h	03h	01h	C0h	00h	14h	18h	03h
30 (TNO:04)[4]	41h	04h	00h	10h	00h	19h	06h	62h
38 (TNO:04)	41h	04h	01h	10h	00h	19h	09h	62h
40 (TNO:05)[4]	41h	05h	00h	11h	00h	27h	37h	10h
48 (TNO:05)	41h	05h	01h	10h	00h	27h	40h	10h
50 (TNO:06)	01h	06h	00h	01h	80h[6]	38h	53h	23h
58 (TNO:06)	01h	06h	01h	00h	80h[6]	38h	55h	23h
60 (Lead-out)	01h[5]	AAh	01h[3]	01h[5]	00h	56h	37h	46h

NOTES:

1. Always zero for Lead-in except when DATA FORM is set to 41h.

2. The first information track on a disc is preceded by a pause encoding of 2-3 seconds. (If the first track is a Data track, this track does not contain pause encoding, but always contains a "pause" of 2 seconds of pre-gap).

3. Always 01h for Lead-out

4. Pre-gap

5. For the Lead-out area the DATA FORM shall be one. For Lead-in, DATA FORM shall be either 01h or 41h. The control mode of the first track is specified. All data for both Lead-in and Lead-out shall be generated by the Logical Unit except if DATA FORM 41h is selected for the Lead-in.

6. Copy

This information is composed of data units of 8 bytes (1 line). The information consists of three parts:
1) The Lead-in area, and contains only one data unit.
2) The Program area, that contains data units.
3) The Lead-out area, and contains one or more data units.

The data units in Program Area and Lead-out area are in Absolute Time order from the start time of index = 0 of the first track of the session.

Each data unit of Program area and Lead-out area indicates that the value of each field (CONTROL, TNO, X, DATA FORM or ZERO) changes at the time shown in ABSOLUTE TIME field.

Table 282 – Cue Sheet Data

CTL/ADR	TNO	INDEX	DATA FORM	SCMS	ABSOLUTE TIME		
					Min	Sec	Frame
01h	02h	01h	C0h	00h	07h	31h	71h
01h	03h	01h	C0h	00h	14h	18h	03h

The above data unit indicates that the value of TNO changes from 02 to 03 when ABSOLUTE TIME is 14:18:03 MSF.

5.29.2.1 Control/Address Field

The CTL/ADR byte contains the Control field in the upper 4 bits and the ADR in the lower 4 bits. Refer to Table 283.

Table 283 – CTL/ADR byte

7	6	5	4	3	2	1	0
CTL Field				ADR Field			

5.29.2.2 CTL Field (upper 4 bits)

The CTL (Control) field contains 4 bits that define the kind of information in a track. The definition is shown in Table 284.

Table 284 – Control Field

Bit 7	Bit 6	Bit 5	Bit 4	Definition
0	0	x	0	2 audio channels without pre-emphasis
1	0	x	0	4 audio channels without pre-emphasis
0	0	x	1	2 audio channels with pre-emphasis of 50/15 µs.
1	0	x	1	4 audio channels with pre-emphasis of 50/15 µs.
0	1	x	0	Data track
x	x	0	x	digital copy prohibited
x	x	1	x	digital copy permitted

The bits of the Control field (except for the copy bit) shall only be changed during an actual pause (Index = 00) of at least 2 seconds and during Lead-in area.

5.29.2.3 ADR Field (lower 4 bits)

Table 285 defines the codes found in the ADR Field

Table 285 – ADR Field

Bit 3	Bit 2	Bit 1	Bit 0	Definition
0	0	0	1	start time at TNO/IDX
0	0	1	0	CATALOG CODE
0	0	1	1	ISRC CODE

All other codes are reserved for future use.

Control shall be the same for each entry associated with a particular track except for first part of pre-gap.

5.29.2.4 TNO

The TNO field indicates track number expressed in hexadecimal. Each track has a minimum length of 4 seconds, not including the pause length preceding the track.

5.29.2.5 INDEX Field

The index number expressed in hexadecimal. The Logical Unit supports only 00h to 63h.

5.29.2.6 DATA FORM

Table 286 defines the data form byte.

Table 286 – Data Form Byte

7	6	5	4	3	2	1	0
Data Form of Sub-channel		Data Form of Main Data					

5.29.2.7 SCMS (Serial Copy Management System)

Bit 7 of data form of 1 indicates that Copy bit of CONTROL field alternates for Serial Copy Management System (see Table 287). The other 7 bits (Reserved) are zero This bit is effective if Copy bit of the Control Code is zero.

Table 287 – SCMS Byte

7	6	5	4	3	2	1	0
Alternate Copy bit	Reserved						

5.29.2.8 DATA FORM OF MAIN DATA

The DATA FORM OF MAIN DATA field specifies the format of the main data to be sent by a WRITE command to write on the disc. Currently available data formats are 1.) CD-DA, 2.) CD-ROM mode 1, 3.) CD-ROM XA, and CD-I. For Lead-in and Lead-out area data are generated automatically except if DATA FORM is set to 41h

5.29.2.9 CD-DA Data Form

Table 288 defines a CD-DA Data Form for one frame.

Table 288 – CD (CD-DA)

Data Form	Data of One Frame	Data Size
00h	2 352	2 352
01h	2 352	0

The CD-DA data format, Table 289, is as follows;

Table 289 – CD-DA Data format (1 Sample)

Bit Byte	7	6	5	4	3	2	1	0
n*4+0 (L Ch)	L7	L6	L5	L4	L3	L2	L1	L0
n*4+1 (L Ch)	L15	L14	L13	L12	L11	L10	L9	L8
n*4+2 (R Ch)	R7	R6	R5	R4	R3	R2	R1	R0
n*4+3 (R Ch)	R15	R14	R13	R12	R11	R10	R9	R8

n = 0,1, - 587

1 Second = 75 Frames
1 Frame = 588 Samples
1 Sample = 4 bytes (16 bits L, RCh)

5.29.2.10 CD-ROM mode 1 Form

Table 290 defines the form for CD-ROM mode 1.

Table 290 – CD-ROM mode 1

Data Form	Sync/ Header	Data of One Frame	EDC/ECC Area	Data Size
10h	16^2	$2\ 048^1$	288^2	2 048
11h	16^3	$2\ 048^1$	288^3	2 352
12h	16^2	$2\ 048^3$	288^2	2 048
13h	16^3	$2\ 048^3$	288^3	2 352
14h	16^2	$2\ 048^2$	288^2	0

5.29.2.11 CD-ROM XA, CD-I Form

Table 291 defines the form for CD-ROM XA, CD-I.

Table 291 – CD-ROM XA, CD-I

Data Form		Sync/ Header	Sub Header	Data of One Frame	EDC/ECC Area	Data Size
20h	Form 1	16^2	8^1	$2\ 048^1$	280^3	2 336
	Form 2	16^2	8^1	$2\ 324^1$	4^3	2 336
21h	Form 1	16^3	8^1	$2\ 048^1$	280^3	2 352
	Form 2	16^3	8^1	$2\ 324^1$	4^3	2 352
22h	Form 1	16^2	8^1	$2\ 048^3$	280^3	2 336
	Form 2	16^2	8^1	$2\ 324^3$	4^3	2 336
23h	Form 1	16^3	8^1	$2\ 048^3$	280^3	2 352
	Form 2	16^3	8^1	$2\ 324^3$	4^3	2 352
24h	Form 1	NA	NA	NA	NA	NA
	Form 2	16^2	8^2	$2\ 324^2$	4^2	0

Reserved Area: The Reserved Area contains 4 bytes that are reserved for quality control during the disc production process. In case of Generate Zero, the Logical Unit generates zero data of 4 bytes for this area.

5.29.2.12 CD-ROM mode 2

Figure 43 – CD-ROM Mode 2 defines the form for CD-ROM mode 2.

Data Form	Sync/ Header	Data of One Frame	Data Size
30h	16 [2]	2 336 [1]	2 336
31h	16 [3]	2 336 [1]	2 352
32h	16 [2]	2 336 [3]	2 336
33h	16 [3]	2 336 [3]	2 352
34h	16 [2]	2 336 [2]	0

Figure 43 – CD-ROM Mode 2

Notes for all forms:

1. Read Buffer: The data is sent by the Initiator.

2. Generate Data: The Logical Unit generates the data in this area. The Initiator shall not send the data for this area. All sectors in the program area shall have an associated write, even if all data for the sector is to be generated by the Logical Unit. Zero bytes shall be transferred for such sectors.

3. Ignore Buffer: The Logical Unit receives the data for this area from the Initiator with Write command. However, the Logical Unit ignores the data and generates data for this area.

5.29.2.13 Data Form of Sub-channel

The DATA FORM OF SUB-CHANNEL (Table 292) field specifies the format of the Sub-channel data stored in the inner buffer by WRITE command to write on the disc.

Table 292 – Data Form of Sub-channel

Data Form		Data of One Frame				Data Size
Bit 7	Bit 6					
0	0	96 *1				0
0	1	96 *2				96
1	0	Reserved				
1	1	24 Pack [3]	24 Pack [3]	24 Pack [3]	24 Pack [3]	96
Notes:						
1) Generate zero data						
2) RAW Data						
3) PACK DATA, Initiator sends packed data. The Logical Unit writes R-W. The Logical Unit calculates and overwrites ECC, and performs Interleaving for each PACK.						

Note: When this Data Form of Sub-channel is selected, along with 01h Data Form of Main Data, this indicates that there is an attempt to write Raw P-W Sub-channel data in the Lead-in. Absolute Time field should be set with the start address of the Lead-in, that can be read via a READ TRACK INFORMATION command for track 0. In this case, the Data Block Type of the Write Parameters Page should be set to 2, 3, or 4.

The Sub-channel data is placed at the end of each Frame of main data. Figure 44 shows the relationship of Main Data and Sub-channel data.

┌─────────────────────────────────┐
│   Main Data (2 352)   ↑ │
│───────────────────────── 1 Frame │
│   Subcode Data (96)   ↓ │
│─────────────────────────   │
│   Main Data (2 352)   │
│─────────────────────────   │
│   Subcode Data (96)   │
│─────────────────────────   │
│   Data transferred by WRITE Command │
└─────────────────────────────────┘
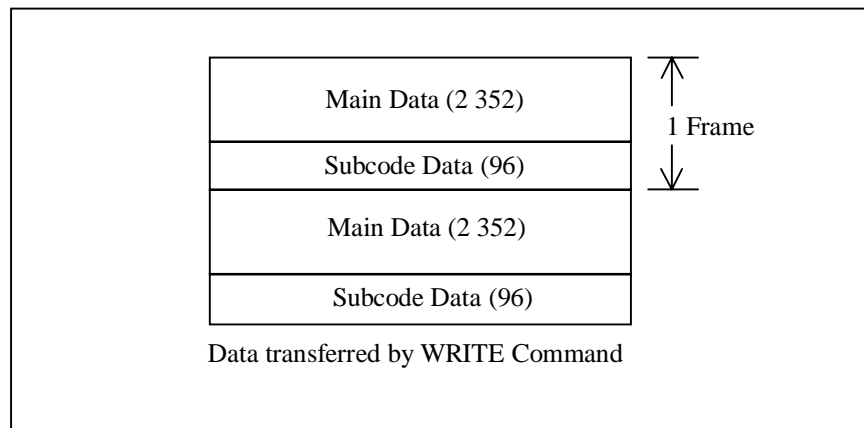
Figure 44 – Location of Sub-channel Data

The P and Q Sub-channel information contained within the Sub-code Data shall be ignored. The P and Q Sub-channel information is generated by the Logical Unit and based on the content of the cue sheet.

5.29.2.14 Absolute Time

The time shown at Min, Sec, and Frame gives the changing point of the CONTROL, TNO, X, DATA FORM or SCMS field. These values are given in absolute time scale.

5.29.2.15 Session Format

The Session Format is used for the identification of the type of disc. Refer to Table 248.

5.29.2.16 Pre-gap

If a Data track is preceded by a different mode of track (such as an audio track) or if the mode number of CD-ROM changes, this Data track starts with an extended pre-gap. A pre-gap is placed at the head of a Data track, also is belonging to the Data track. A pre-gap does not contain actual user data. The pre-gap is encoded as "pause."

An extended pre-gap is divided into two parts. The first part of the extended pre-gap has a minimum 1 second of data, and it is encoded according to the data structure of previous track. The second part has a minimum 2 seconds data, and this data track is encoded according to the same data structure as the other parts.

5.29.2.17 Post-gap

If a Data track is followed by another kind of track (such as an audio track), this Data track ends with a post-gap. A post-gap is placed at the end of a Data track, and is part of the Data Track. A post-gap does not contain actual user data. The minimum length of post-gap is 2 seconds. The Logical Unit does not perform any action for a Post-gap.

5.29.2.18 Media Catalog Number

Table 293, Catalog Number, indicates the catalog number of a disc. The number uses UPC/EAN-code (BAR coding). If no catalog number is used, it shall be omitted. The format is as follows;

Table 293 – Media Catalog Number (N1..N13)

CTL/ ADR	Catalog Number						
Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
02h	N1	N2	N3	N4	N5	N6	N7
02h	N8	N9	N10	N11	N12	N13	00h
Note: The format of the data recorded in the Sub-channel area is not identical to that specified in the Write Parameter Mode Page.							

N1-N13 Catalog Number

CTL: 4 bits are zero.

ADR: 0010b

Catalog Number: ASCII 13 BYTES

5.29.2.19 ISRC

Table 294, ISRC (International Standard Recording Code), is a code that is given to CD-DA tracks. If no ISRC is used, it shall be omitted. If a track has no ISRC, it is not written in the Cue Sheet.

Table 294 – ISRC (I1..I12)

CTL/ ADR	ISRC(International Standard Recording Code)						
byte 0	byte 1	byte 2	byte 3	byte 4	byte 5	byte 6	byte 7
x3h	TNO	I1	I2	I3	I4	I5	I6
x3h	TNO	I7	I8	I9	I10	I11	I12

Note: The format of the data recorded in the Sub-channel area is not identical to that specified in the Write Parameter Mode Page.

CTL: 4 bits of Control code are the same as that of disc location of the specified track

ADR: 0011b

TNO: Track number in HEX.

12 letters ISRC (On the Cue Sheet, I1-I12 shall be described by valid ASCII characters. See Table 294 for valid codes.

I1-I2: Country Code
I3-I5: Owner Code
I6-I7: Year of recording
I8-I12: Serial Number

Table 295 describes errors that may occur during the operation of the command or which may cause a CHECK CONDITION status to be reported. Since this command contains no background activity, deferred errors do not apply.

Table 295 – Recommended Sense Key, ASC and ASCQ SEND CUE SHEET Command

Error	Reference
General Errors	Table A.2

5.30 SEND DVD STRUCTURE Command

The SEND DVD STRUCTURE command (Table 296) provides a means for the Initiator to transfer DVD STRUCTURE data to the Logical Unit.

Table 296 – 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							

The Format field (Table 297) indicates the type of information to be sent to the device. When a SEND DVD STRUCTURE command is issued on non-DVD media for Format codes 00h –BFh, this command shall be terminated with CHECK CONDITION status and SK/ASC/ASCQ values are set to ILLEGAL REQUEST/ CANNOT READ MEDIUM – INCOMPATIBLE FORMAT. When the device/media does not support the specified format code, the command shall be terminated with a CHECK CONDITION status and SK/ASC/ASCQ values are set to ILLEGAL REQUEST/INVALID FIELD IN CDB.

Table 297 – Format Field Definition

Format Code	Data	Description
00h – 03h	Reserved	
04h	User Specific Data	Send User Specific Data to the RMD cache
05h	Copyright Management	Send data to CPR_MAI in data area cache. (CPM, CGMS, ADP_TY)
06h – 0Eh	Reserved	
0Fh	Timestamp	Send Timestamp data to the RMD cache
10h – 2Fh	Reserved	
30h	Disc Control Block	Send a Disc Control Block
31h – BFh	Reserved	
C0h	Write Protection	Send PWP status
C1h – FFh	Reserved	

The DVD-R device shall implement the cache memory for DVD STRUCTURE data.

The cached RMD can be read by using the READ DVD STRUCTURE command.

The Structure Data Length field specifies the length in bytes of the DVD STRUCTURE data to be transferred from the Initiator to the Logical Unit after the CDB is transferred. A Structure Data Length field of zero indicates that no data shall be transferred. This condition shall not be considered an error.

5.30.1 User Specific Data

Table 298 defines the response data format for User Specific Data, Format code 04h

Table 298 – SEND DVD STRUCTURE Data Format (Format Code = 04h)

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			DVD STRUCTURE Data Length				
1								(LSB)
2	Reserved							
3	Reserved							
	DVD-R User Specific Data							
0	(MSB)							
…				User Specific Data				
2047								(LSB)

The DVD STRUCTURE Data Length field specifies the length in bytes of the User Specific Data to follow. A DVD Structure Data Length field of zero indicates that no User Specific Data shall be transferred. This condition shall not be considered an error.

The User Specific Data field contains user specific data. This data shall be used to specify the RMD Field 2, and when writing Lead-in the contents of this field shall also be written in Disc manufacturing information field of Lead-in or Border-in.

5.30.2 Copyright Management Information

Table 299 describes the response data format for Copyright Management Information, format code 05h.

Table 299 – SEND DVD STRUCTURE Data Format (Format Code = 05h)

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			DVD STRUCTURE Data Length				
1								(LSB)
2	Reserved							
3	Reserved							
	Copyright Management Information in data area							
0	CPR_MAI							
1	Reserved							
2	Reserved							
3	Reserved							

The DVD STRUCTURE Data Length field specifies the length in bytes of the Copyright Management data to follow. A DVD Structure Data Length field of zero indicates that no Copyright Management data shall be transferred. This condition shall not be considered an error.

The definition of the CPR_MAI field depends on the mounted media. The CPR_MAI field definition is shown in Table 300.

Table 300 – CPR_MAI Field Definitions

Bit Media	7	6	5	4	3	2	1	0
DVD-R, ver 1.0 DVD-RW, ver 1.0	CPM	Resvd	CGMS		Reserved			
DVD-RAM Ver.1.0/2.1 DVD-R for Authoring Ver .2.0	Reserved							
DVD-R for General, ver 2.0, DVD-RW, ver 1.1 and DVD+RW	Reserved				ADP_TY		Reserved	

If the CPM bit is set to 0, shall indicate that this sector contains no copyrighted material. If the CPM bit is set to 1, shall indicate that this sector contains copyrighted material. If this structure is not sent, the default value of the CPM bit shall be 0.

When the CPM bit is set to 0, the CGMS field shall be set to 00b. When the CPM bit is set to 1, the CGMS field shall be set as shown in Table 301.

Table 301 – CGMS Field Values

CGMS	Definition
00b	Copying is permitted without restriction
01b	Reserved
10b	One generation of copies may be made
11b	No copying is permitted

The identical CGMS value of CPR_MAI in data area shall match with this format following write operation.

The ADP_TY field is defined for DVD-RW Ver.1.1, DVD-R for General Ver. 2.0, and DVD+RW media. If the sector contains materials defined in DVD Specifications for Read-Only Disc Part 3 VIDEO SPECIFICATIONS, the ADP_TY field shall be set to 01b. If the sector contains no such data, ADP_TY field shall be set to 00b. All other values of ADP_TY are reserved.

> Note: A value of each field may not be stable at the first and last 16 sectors of each recording extent due to the nature of recording method for DVD-R/-RW media.

5.30.3 Timestamp

The format of Timestamp field is structured as shown in Table 345. This format code is used to set Unique Disc Identifier field of RMD (Recording Management Data) for DVD-R. This time stamp data may also be used in OPC related field in RMD Field 1 and may help the judgement to do OPC.

The time should be current UTC (Universal Coordinated Time) 24 hour clock.

Table 302 – SEND DVD STRUCTURE Data Format (Format Code = 0Fh)

Bit Byte	7	6	5	4	3	2	1	0
0	(MSB)			DVD STRUCTURE Data Length				
1								(LSB)
2	Reserved							
3	Reserved							
DVD Timestamp Data								
0	Reserved							
1	Reserved							
2	Reserved							
3	Reserved							
4	(MSB)							
5	Year							
6								
7								(LSB)
8	(MSB)			Month				
9								(LSB)
10	(MSB)			Day				
11								(LSB)
12	(MSB)			Hour				
13								(LSB)
14	(MSB)			Minute				
15								(LSB)
16	(MSB)			Second				
17								(LSB)

The DVD STRUCTURE Data Length field specifies the length in bytes of the DVD Timestamp Data to follow. A DVD Structure Data Length field of zero indicates that no DVD Timestamp Data shall be transferred. This condition shall not be considered an error.

The Year field shall specify the year that coded as ASCII in the range "0001" to "9999".

The Month field shall specify the month of the year that coded as ASCII in the range "01" to "12".

The Day field shall specify the day of the month that coded as ASCII in the range "01" to "31".

The Hour field shall specify the hour of the day that coded as ASCII in the range "00" to "23".

The Minute field shall specify the minute of the hour that coded as ASCII in the range "00" to "59".

The Second field shall specify the second of the minute that coded as ASCII in the range "00" to "59".

5.30.4 Disc Control Block

Table 303 defines data format code 30h.

Table 303 – SEND DVD STRUCTURE Data Format (Format Code = 30h)

Bit Byte	7	6	5	4	3	2	1	0
0	(MSB)			DVD STRUCTURE Data Length				
1								(LSB)
2	Reserved							Erase
3	Reserved							
Disc Control Block								
0 … N	Disc Control Block							

The Structure Data Length field shall indicate the number of bytes following this field.

The Erase bit, when set to zero, shall indicate that the Disc Control Block be written to the media. When set to one, it shall indicate that the Disc Control Block on the medium, with a Content Descriptor matching the one sent, shall be erased. When erasing a DCB, at least the first four bytes shall be sent. The Logical Unit shall `not` record any DCB unknown to the Logical Unit.

The Disc Control Block field is defined in the *DVD+RW 4.7 Gbytes Basic Formats Specifications*. If a Disc Control Block, with fewer than 32 768 bytes is sent, the Logical Unit shall pad the Disc Control Block with 00h bytes.

5.30.5 Write Protection

Table 304 defines data format code C0h.

Table 304 – SEND DVD STRUCTURE Data Format (Format Field = C0h)

Bit Byte	7	6	5	4	3	2	1	0
0	(MSB)			Structure Data Length				
1								(LSB)
2	Reserved							
3	Reserved							
Write Protection Data								
4	Reserved						PWP	Reserved
5	Reserved							
6	Reserved							
7	Reserved							

The DVD Structure Data Length field shall indicate the number of bytes following this field.

The Persistent Write Protection (PWP) bit of one indicates that the medium surface shall be set to write protected status. The PWP bit of zero indicates that the medium surface shall be set to write permitted status.

Table 305 describes errors that may occur during the operation of the command or which may cause a CHECK CONDITION status to be reported.

Table 305 – Recommended errors for SEND DVD STRUCTURE Command

Error	Reference
Deferred Errors	A.2
General Errors	Table A.2
Media Access Errors	Table A.3

5.31 SEND EVENT Command

The SEND EVENT command requests the Logical Unit to process an event for the Initiator. The event should be one that the Initiator had received from an earlier GET EVENT/STATUS NOTIFICATION command but not handled by the Initiator. 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. For example if a user pushes an independent play button on the front panel while the Logical Unit is in a persistent prevent state, the play would not be performed and instead the request shall be reported to the Initiator by a GET EVENT/STATUS NOTIFICATION command. Such events may include front panel button presses, etc. 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 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 sent back 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.

Table 306 – 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							
119	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.

The Logical Unit shall terminate the command with CHECK CONDITION status if the Event parameter list length results in the truncation of Event parameter data. SK/ASC/ASCQ values shall be set 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 307 – 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 308 – 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 309 – 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 85 for code descriptions.

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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 – Recommended errors for SEND EVENT Command

Error	Reference
Deferred Errors	A.2
General Errors	Table A.2
Media Access Errors	Table A.3

5.32 SEND KEY Command

The SEND KEY command, Table 311, provides data necessary for authentication and for generating a Bus Key for the DVD Logical Unit.

This command, in conjunction with REPORT KEY command, is intended to perform authentication for Logical Units that conform to DVD Content Protection scheme and to generate a Bus Key as the result of authentication.

Table 311 – SEND KEY Command Descriptor Block

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (A3h)							
1	Reserved				Reserved			
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	Reserved							
8	(MSB)	Parameter List Length						
9								(LSB)
10	AGID		Key Format					
11	Control							

The KEY Format field (Table 312) indicates the type of information that is to be sent to the Initiator.

The AGID field is described in the REPORT KEY command.

Table 312 – Key Format Code definitions for SEND KEY Command

Key Format	Sent Data	Description	AGID Use
000001b	Challenge Key	Accepts a Challenge Key	Valid AGID required
000011b	KEY2	Accepts a KEY2	
000110b	RPC Structure	Set Region	Reserved & Ignored
111111b	None	Invalidate Specified AGID. Invalidating an invalid AGID shall not be considered an error. An AGID that has not been granted shall be considered invalid.	Valid AGID required
All other values		Reserved	

The Key Formats are defined in Table 313, Table 314, and Table 315.

Table 313 – SEND KEY Parameter List (KEY Format field =000001b)

Bit Byte	7	6	5	4	3	2	1	0
0	(MSB)			SEND KEY Parameter List Length (0Eh)				
1								(LSB)
2	Reserved							
3	Reserved							
	Challenge Key Value							
0	(MSB)							
:				Challenge Key Value				
9								(LSB)
10	Reserved							
11	Reserved							

Challenge Key is sent to the DVD Logical Unit to get corresponding KEY1 from the DVD Logical Unit to interrogate conformity with DVD Content Protection scheme.

Table 314 – SEND KEY Parameter List (KEY Format field =000011b)

Bit Byte	7	6	5	4	3	2	1	0
0	(MSB)			SEND KEY Parameter List Length (0Ah)				
1								(LSB)
2	Reserved							
3	Reserved							
	KEY2							
0	(MSB)							
:				KEY2 Value				
4								(LSB)
5	Reserved							
6	Reserved							
7	Reserved							

The KEY2, generated external to the DVD Logical Unit, is sent to the DVD Logical Unit to determine its conformity with DVD Copy Protection scheme. The KEY 2 value shall be used for the second input to generate a Bus Key in the DVD Logical Unit.

When the KEY2 value sent does not conform to the DVD Copy Protection scheme, this command shall be terminated with a CHECK CONDITION status and SK/ASC/ASCQ values are set to ILLEGAL REQUEST/COPY PROTECTION KEY EXCHANGE FAILURE - AUTHENTICATION FAILURE.

When the SEND KEY command with KEY Format = 000011b terminates with CHECK CONDITION status, the retry of authentication shall be performed from the beginning.

Table 315 – SEND KEY Parameter List (KEY Format field =000110b)

Bit Byte	7	6	5	4	3	2	1	0
0	(MSB)		SEND KEY Parameter List Length (06h)					
1								(LSB)
2	Reserved							
3	Reserved							
RPC Structure								
0	Preferred Logical Unit Region Code							
1	Reserved							
2	Reserved							
3	Reserved							

Preferred Logical Unit Regional Code is sent to the DVD Logical Unit to make the Logical Unit regionalized. The Preferred Logical Unit Region Code specifies a single region in which the disc can be played. Each bit represents one of eight regions. If a bit is cleared in this field, the disc can be played in the corresponding region. If a bit is set in this field, the disc cannot be played in the corresponding region. Exactly one bit of the Preferred Logical Unit Region Code shall contain a zero.

If the Logical Unit does not support setting of the Region, or the Region is no longer changeable, then this command shall be terminated with CHECK CONDITION status and SK/ASC/ASCQ values shall be set to DRIVE REGION MUST BE PERMANENT/REGION RESET COUNT ERROR.

Table 316 describes errors that may occur during the operation of the command or which may cause a CHECK CONDITION status to be reported.

Table 316 – Recommended errors for SEND KEY Command

Error	Reference
Deferred Errors	A.2
General Errors	Table A.2
Media Access Errors	Table A.3

5.33 SEND OPC INFORMATION Command

This command is used to restore the Optimum Power Calibration (OPC) (Table 317) values to the Logical Unit for a specific disc. It is used in combination with the READ DISC INFORMATION command (sub-clause 5.19).

Table 317 – SEND OPC INFORMATION Command Descriptor Block

Byte \ Bit	7	6	5	4	3	2	1	0
0	Operation Code (54h)							
1	Reserved			Reserved				DoOpc
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	(MSB)	Parameter List Length						
8								(LSB)
9	Control							

The Parameter List Length shall be set to reflect the number of the parameter bytes to be transferred. The Parameter List Length shall be an integral multiple of eight, (2 byte OPC Speed and 6 bytes of OPC value). This can be extended with a second OPC Speed and Value. In this case the length is 16.

The DoOpc bit, when set to one, indicates the Logical Unit shall perform an OPC operation to set the OPC values for the current speed. These OPC values shall become current. Parameter List length should be set to zero. When the bit is set to zero, the Logical Unit sets OPC values to those sent in the Parameter List.

A Parameter List Length field of zero shall not be considered an error condition.

The Initiator shall transfer zero or more OPC tables.

The transfer length shall be 8X (the number of OPC table entries).

The format of the OPC Data to be transferred is shown in Table 318.

Table 318 – SEND OPC INFORMATION Parameter List

Byte \ Bit	7	6	5	4	3	2	1	0
0	(MSB)	OPC Speed in KBytes per Second						
1								(LSB)
2	(MSB)							
3								
4			OPC Value					
5								
6								
7								(LSB)

Table 319 describes errors that may occur during the operation of the command or which may cause a CHECK CONDITION status to be reported.

Table 319 – Recommended errors for SEND OPC INFORMATION Command

Error	Reference
Deferred Errors	A.2
General Errors	Table A.2
Media Access Errors	Table A.3
Write Errors	Table A.4

5.34 SET CD SPEED Command

The SET CD SPEED (Table 320) command is used to set read speed and write speed and only applicable to CD-R/RW Logical Unit. Note that PLAY AUDIO Commands may not use the speed set by this command.

Table 320 – SET CD SPEED Command

Byte \ Bit	7	6	5	4	3	2	1	0
0	OPERATION CODE (BBh)							
1	Reserved						Rotational Control	
2	(MSB)	Logical Unit Read Speed (Kbytes/sec)						
3								(LSB)
4	(MSB)	Logical Unit Write Speed (Kbytes/sec)						
5								(LSB)
6	Reserved							
7	Reserved							
8	Reserved							
9	Reserved							
10	Reserved							
11	Control							

The Logical Unit Read Speed and Write Speed parameters contain the requested Data rates the Logical Unit should use.

Initiator shall set one of the values of Logical Unit Write Speed Performance Descriptor in CD/DVD Capabilities & Mechanical Status Mode Page (2Ah) to Rotational Control field and Logical Unit Write Speed field.

The Logical Unit is to select the Logical Unit Read Speed specified or any higher rate. A value of FFFFh causes the Logical Unit Read Speed or the Logical Unit Write Speed to be set for optimal performance supported. If the Logical Unit is requested to write at the speed that is not listed in the Logical Unit Write Speed Performance Descriptor, the Logical Unit shall select any slower Logical Unit Write Speed. This condition is not regarded as an error condition. If the Logical Unit is requested to write at the lower speed than the Logical Unit's slowest speed, the Logical Unit may return CHECK CONDITION status and SK/ASC/ASCQ values are set to ILLEGAL REQUEST/INVALID FIELD IN CDB or select an appropriate Logical Unit Write Speed.

Note: Logical Unit should return an error if current write mode is not packet write and buffer under-run free recording is not supported.

The Rotational Control field defines the operations that are defined in Table 321.

Table 321 – Rotational Control field definition

Value	Description
0h	CLV recording
1h	CAV recording
Others	Reserved

In case of CAV recording, Logical Unit Write Speed shall be specified with the speed at most inner program area of the disc. Assume that the outer most radius: 79min 59sec 74frames.

The Logical Unit keeps the actual write speed setting till the current disc is ejected. When the disc is changed to another one and it does not support the write speed that was set for the previous media, the Logical Unit may select an appropriate write speed to the current medium. It is recommended that the Initiator should set the write speed upon the media change.

Table 322 describes errors that may occur during the operation of the command or which may cause a CHECK CONDITION status to be reported.

Table 322 – Recommended errors for SET CD SPEED Command

Error	Reference
Deferred Errors	A.2
General Errors	Table A.2
Media Access Errors	Table A.3

5.35 SET READ AHEAD Command

The SET READ AHEAD command (Table 323) requests that the Logical Unit perform Read Ahead Caching operations from the Read-Ahead Logical Block Address when the Logical Unit encounters the Trigger Logical Block Address during its internal Read Ahead Caching operation.

If this command is received by the DVD Logical Unit when data after the Trigger Logical Block Address and before the Read Ahead Logical Block Address is contained in its cache, that data should be discarded and Read Ahead Caching restarted from the specified Read Ahead Logical Block Address.

Sectors after the Trigger LBA (Not including the Trigger LBA) should be skipped. The Initiator normally reads the data for both the Trigger and Read Ahead LBA. The sectors between these addresses (exclusive) are normally not read by the Initiator.

The Read-Ahead operation shall be performed in background, i.e. the Logical Unit shall accept a command during the Read-Ahead operation.

Table 323 – SET READ AHEAD Command

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							

Table 324 describes errors that may occur during the operation of the command or which may cause a CHECK CONDITION status to be reported.

Table 324 – Recommended errors for SET READ AHEAD Command

Error	Reference
Deferred Errors	A.2
General Errors	Table A.2
Media Access Errors	Table A.3

5.36 SET STREAMING Command

The SET STREAMING command (Table 325) provides a way for the Initiator to indicate to the Logical Unit that the application has specific request or requirements for Logical Unit performance. The Logical Unit may utilize the Initiator supplied information to change mechanical or logical operation. For example, the spindle motor speed may be adjusted downward for lower data rates to help avoid buffer overrun (during reading) or buffer underrun (during writing) followed by a consequent rotational delay. The performance setting is persistent and remains until a new descriptor is sent. The setting only applies to the extent identified by the Start and End LBA field. Only zero or one, performance extents shall be valid at any time.

The SET STREAMING command affects the READ and WRITE Command operation, and may affect other commands, e.g. BLANK and FORMAT UNIT.

If the SET STREAMING command is used to set performance, the Logical Unit may disable read and write reallocation in the specified region in order to meet the performance criteria.

Table 325 – 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							

The Initiator shall send a performance descriptor during the data phase of this command. The Performance Descriptor shall be sent in the format shown in Table 326.

Table 326 – Performance Descriptor

Bit Byte	7	6	5	4	3	2	1	0
0	Reserved			WRC		RDD	Exact	RA
1	Reserved							
2	Reserved							
3	Reserved							
4	(MSB)							
5	Start LBA							
6								
7								(LSB)
8	(MSB)							
9	End LBA							
10								
11								(LSB)
12	(MSB)							
13	Read Size							
14								
15								(LSB)
16	(MSB)							
17	Read Time							
18								
19								(LSB)
20	(MSB)							
21	Write Size							
22								
23								(LSB)
24	(MSB)							
25	Write Time							
26								
27								(LSB)

The Write Rotation Control (WRC) field specifies the type of the medium rotation control to write. See Table 118. If Logical Unit does not support the write rotation control mode specified, the Logical Unit shall generate CHECK CONDITION status and SK/ASC/ASCQ values are set to ILLEGAL REQUEST/INVALID FIELD IN PARAMETER LIST.

The RDD (Restore Logical Unit Defaults) bit, when set to zero, indicates the remaining fields are valid. When set to one, it shall indicate that the Logical Unit is to return to its default performance settings and the remaining fields in this descriptor shall be ignored. Read and Write reallocation ability shall be restored to the operation specified by the Read/Write Error Recovery Mode Page.

The Exact bit, when set to zero, shall indicate that the Logical Unit shall set its internal configuration to match the parameters as best as possible. No errors shall occur. When set to one, the Logical Unit shall set its internal configuration to support the requested parameters. If the Logical Unit cannot perform as

requested, it shall generate CHECK CONDITION status and SK/ASC/ASCQ values are set to ILLEGAL REQUEST/ INVALID FIELD IN PARAMETER LIST.

The RA (Random Access) bit, when set to zero, allows the Logical Unit to independently set the read and write speeds. When set to one, directs the Logical Unit to set its performance settings for the optimized settings for random changes between reading and writing by the Initiator. For example, a CD recorder that can record at 2X and read at 6X may choose to limit reading to 2X if the RA bit was set to one.

The Start LBA field is the first logical block for which the performance request is being made.

The End LBA field is the last logical block for which the performance request is being made.

The data rate to be delivered for reading is (Read Size)/(Read Time).

The Read Size field shall indicate the number of kilobytes the Initiator expects to be delivered per period of Read Time when the Initiator's requests for data occur sufficiently fast.

The Read Time field shall indicate the amount of time, in milliseconds, over that the Read Size is expected to be read. The Initiator may set these two fields by setting Read Size to the size of its application's buffer and the Read Time to the amount of time it takes to empty that buffer.

The Write Size field shall be set to the number of kilobytes to be written per Write Time.

The Write Time field shall indicate the amount of time, in milliseconds, over that the Write Size is expected to be written.

In many cases, the Write Size and Write Time fields should be set to match the corresponding Read fields. If not, the Initiator may set the Write Size to the size of its application buffer and the Write Time to the time it takes to fill that buffer.

Table 327 describes errors that may occur during the operation of the command or which may cause a CHECK CONDITION status to be reported.

Table 327 – Recommended errors for SET STREAMING Command

Error	Reference
Deferred Errors	A.2
General Errors	Table A.2
Media Access Errors	Table A.3
Write Errors	Table A.4

5.37 STOP PLAY/SCAN Command

The STOP PLAY/SCAN (Table 328) command stops playback of CD audio commands.

Table 328 – STOP PLAY/SCAN Command

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

Issuing a Stop Play/Scan command while the Logical Unit is scanning shall result in continuation of the play command. Issuing a Stop Play/Scan command while the Logical Unit is paused shall stop the play command.

Issuing a Stop Play/Scan command when no play operation is in progress shall not be considered an error.

Figure 45 provides an overview of the terminate sequences performed by the Stop Play commands.
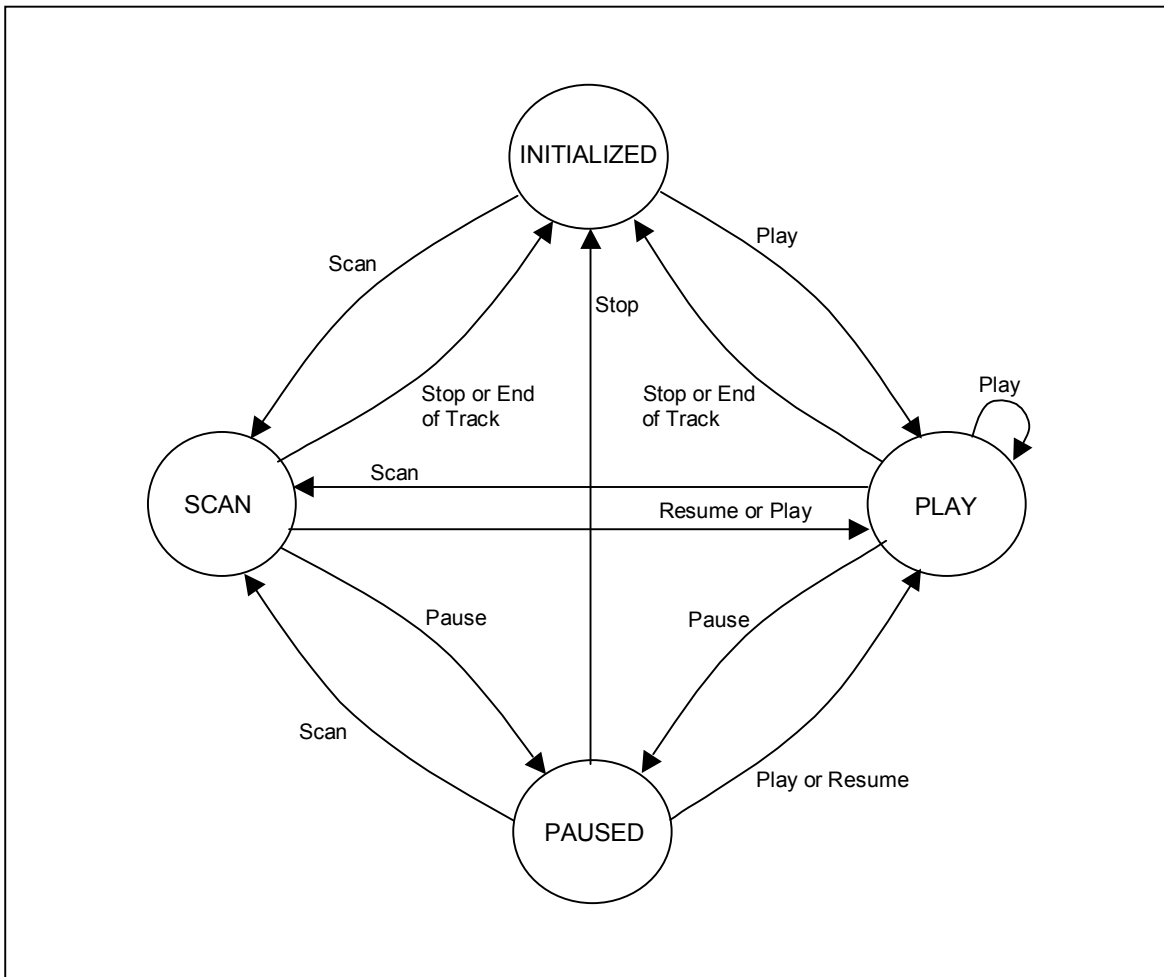
Figure 45 – Stop Play/Play Audio/Audio Scan/Pause/Resume Sequencing

Table 329 describes errors that may occur during the operation of the command or which may cause a CHECK CONDITION status to be reported.

Table 329 – Recommended errors for STOP PLAY/SCAN Command

Error	Reference
Deferred Errors	A.2
General Errors	Table A.2
Media Access Errors	Table A.3

5.38 SYNCHRONIZE CACHE Command

The SYNCHRONIZE CACHE command is shown in Table 330.

This command assures all remaining data in the data buffer has been written to the media. Logical blocks are not necessarily removed from the cache memory as a result of the cache flush operation.

If the data buffer is empty, issuing this command shall result in no data being written to the physical media. This action shall not be considered an error. Normal status shall be presented at the completion of the action.

Table 330 – SYNCHRONIZE CACHE Command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (35h)							
1	Reserved			Reserved			IMMED	RELADR
2	(MSB)							
3	Logical Block Address							
4								
5								(LSB)
6	Reserved							
7	(MSB)			Number of Blocks				
8								(LSB)
9	Control							

RelAdr (Relative Address) is not used by CD/DVD Logical Units and shall be set to zero.

An IMMED (Immediate) bit of one indicates that the Logical Unit shall return status when the command descriptor block has been validated. An Immediate bit of zero indicates that the status shall not be returned until the operation has been completed. If the Immediate bit is one and the Logical Unit does not support immediate operation, then the command shall terminate with CHECK CONDITION status and SK/ASC/ASCQ values shall be set to ILLEGAL REQUEST/INVALID FIELD IN CDB.

The Logical Unit may ignore the Logical Block Address field.

The Number of Blocks field specifies the total number of contiguous logical blocks within the range. A Number of Blocks field, equal to 0, indicates that all remaining logical blocks on the Logical Unit shall be within the range.   The Logical Unit may ignore this field.

A logical block within the specified range that is not in cache memory is not considered an error.

Table 331 describes errors that may occur during the operation of the command or which may cause a CHECK CONDITION status to be reported.

Table 331 – Recommended errors for SYNCHRONIZE CACHE Command

Error	Reference
Deferred Errors	A.2
General Errors	Table A.2
Media Access Errors	Table A.3
Write Errors	Table A.4

5.39 WRITE (10) Command

The Write (10) command (Table 332) requests that the Logical Unit write data transferred from the initiator to the currently mounted medium.   In most cases, the Logical Unit shall use the Write Parameters Page to determine its operating behavior. The description of the behavior, described in this sub-clause, applies only to Multimedia Logical Units or Logical Units. For the write behavior of other Logical Units refer to the WRITE (10) command defined in the SCSI Block Command (SBC) document.

Table 332 – WRITE (10) Command

Bit Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (2Ah)							
1	Reserved			DPO	FUA	Reserved		RELADR
2	(MSB)							
3	Logical Block Address							
4								
5								(LSB)
6	Reserved							
7	(MSB)	Transfer Length						
8								(LSB)
9	Control							

RelAdr (Relative Address) is not used by CD/DVD Logical Units and shall be set to zero.

A FUA (force unit access) bit, set to one, indicates that the Logical Unit shall access the media in performing the command prior to returning GOOD status. In the case where the cache contains a more recent version of a logical block than the media, the logical block shall first be written to the media. WRITE commands shall not return GOOD status until the logical blocks have actually been written on the media, and the Write process is complete. This mode may not work with a sequence of writes intended to produce a continuous stream unless command queuing is implemented

An FUA bit of zero indicates that the Logical Unit may satisfy the command by accessing the cache memory. For WRITE operations, logical blocks may be transferred directly to the cache memory. GOOD status may be returned to the Initiator prior to writing the logical blocks to the medium. Any error that occurs after the GOOD status is returned is a deferred error, and information regarding the error is not reported until the following command.

Disable Page Out (DPO) is not used by CD/DVD Logical Units and shall be set to zero.

The Logical Block Address field specifies the logical block where the write operation shall begin. In case of WCE = 1 (see Write Cache page in SCSI Block Commands) and FUA = 0 with variable packet writing, and if the LBA is equal to the Next Writable Address in the same track as a previous Write, then writing should continue without interruption of streaming. For CD-R/RW media, if, during streaming, a WRITE command is issued for packet writing with an LBA = NWA+7 the Logical Unit shall begin a new packet. If the LBA is equal to the NWA in another track, a SYNCHRONIZE CACHE may be performed before executing the write command. If the LBA is not any next writable address or a writable CD address, the status shall be set to CHECK CONDITION and SK/ASC/ASCQ values are set to ILLEGAL REQUEST/INVALID ADDRESS FOR WRITE.

LBA in the range of -45150 (FFFF4FA2h) to -1 (FFFFFFFFh) shall be encoded as a two's complement negative number. Values in the range 0 through ffff4fa1h shall be considered positive values. Values -45 150 through 404 849 are valid for CD media.

If the medium is MRW formatted or in progress with MRW formatting, then the block size shall be 2 048 bytes. The Logical Block Address shall be valid within the range 0 through MAXLBA where MAXLBA is the address reported by the READ CAPACITY command.

Table 333 shows the LBA to MSF mapping.

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. For CD-R/RW media, the block size shall be determined by the Write Parameters Page (if in track at once, packet, or raw mode) or by the cue sheet (session at once mode).

Table 333 – LBA to MSF translation

Condition	Formulae
$-150 \leq \text{LBA} \leq 404849$	$M = IP\left(\dfrac{LBA + 150}{60 \cdot 75}\right)$ $S = IP\left(\dfrac{LBA + 150 - M \cdot 60 \cdot 75}{75}\right)$ $F = IP(LBA + 150 - M \cdot 60 \cdot 75 - S \cdot 75)$
$-45150 \leq \text{LBA} \leq -151$	$M = IP\left(\dfrac{LBA + 450\,150}{60 \cdot 75}\right)$ $S = IP\left(\dfrac{LBA + 450\,150 - M \cdot 60 \cdot 75}{75}\right)$ $F = IP(LBA + 450\,150 - M \cdot 60 \cdot 75 - S \cdot 75)$
$00/00/00 \leq \text{MSF} \leq 89/59/74$	$LBA = (M \cdot 60 + S) \cdot 75 + F - 150$
$90/00/00 \leq \text{MSF} \leq 99/59/74$	$LBA = (M \cdot 60 + S) \cdot 75 + F - 450150$

For CD-R and DVD-R, once actual writing to the media has started, the data stream shall be uninterrupted until the recording is done. Interruptions of data are called "under-run." The under-run condition may also be forced with the SYNCHRONIZE CACHE command. The Logical Unit shall behave as follows in an under-run condition.

1. Session at Once mode: The Logical Unit shall generate and write a Lead-out (the Lead-in was generated and written before any data). The Logical Unit shall update the PMA (CD) or RMA (DVD).

2. Track at Once mode: The Logical Unit shall pad the track (if reserved or not minimum length) and update the PMA (CD).

3. Variable Packet: For CD, if insufficient space exists for another variable packet within a reserved track, the Logical Unit shall pad the packet such that it fills the track. Otherwise, the Logical Unit shall write run-out and link blocks. For DVD the Logical Unit shall perform linking.

4. Fixed Packet: The Logical Unit shall pad the packet.

5. Raw mode: The Logical Unit shall write run-out and link blocks. The Logical Unit shall read the TOC and track information from the session just written and update the PMA. It is assumed that the Initiator has written the Lead-out.

If the block number specified by the LBA field is already written on CD-R media, the Logical Unit shall return a CHECK CONDITION status and SK/ASC/ASCQ values are set to ILLEGAL REQUEST/INVALID ADDRESS FOR WRITE. This error indicates that an under-run may have occurred, as the run-out and link blocks occupy logical addresses. On CD-RW media, the LBA shall specify an address that is an appendable point (according to CD-R rules) or is the first user data block of an existing packet or track.

While writing is occurring, the Logical Unit may not be able to process all SCSI commands. The following is a list of commands that shall function during writing without causing a SYNCHRONIZE CACHE.

1. TEST UNIT READY

2. REQUEST SENSE

3. INQUIRY

4. READ TRACK INFO (for current track). If the LBA or track number specified is not within the current track, the Logical Unit may return CHECK CONDITION status and SK/ASC/ASCQ values are set to ILLEGAL REQUEST/INVALID FIELD IN CDB.

5. READ BUFFER CAPACITY

6. WRITE with the NWA in the current track.

7. GET CONFIGURATION

8. GET EVENT/STATUS NOTIFICATION

All other commands shall execute normally, but may force a SYNCHRONIZE CACHE before executing. The process of writing from the Logical Unit's cache to the medium shall not cause a not ready condition for any command. When the Logical Unit is padding a reserved track or writing Lead-in and Lead-out, a WRITE command may be terminated with CHECK CONDITION status with SK/ASC/ASCQ values set to LOGICAL UNIT NOT READY, LONG WRITE IN PROGRESS.

If the DVD+RW medium is blank (never formatted), then a write to any address shall be terminated with CHECK CONDITION status and SK/ASC/ASCQ values shall be set to ILLEGAL REQUEST/MEDIUM NOT FORMATTED.

Table 324 describes errors that may occur during the operation of the command or which may cause a CHECK CONDITION status to be reported.

Table 334 – Recommended errors for WRITE (10) Command

Error	Reference
Deferred Errors	A.2
General Errors	Table A.2
Media Access Errors	Table A.3
Write Errors	Table A.4

5.40 WRITE (12) Command

The WRITE (12) command (Table 335) requests that the Logical Unit write the data transferred from the Initiator to the medium. This command is mandatory when the Real-Time Streaming Feature with SW bit is set to one.

Table 335 – 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							

The Streaming bit of one specifies that the Stream recording operation shall be used for the command (see 4.6.1). The Streaming bit of zero specifies that the conventional write 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 are set to one, the Logical Unit shall terminate the command with CHECK CONDITION status with SK/ASC/ASCQ values set to ILLEGAL REQUEST/INVALID FIELD IN CDB.

The Logical Block Address field specifies the logical block where the write operation shall begin.

When the Initiator issue the command with the Streaming bit set to one, the values of the Logical Block Address field and the Transfer Length field shall be the integral multiple of the Blocking factor. The Blocking factor of the media is described in Feature description of each media, see 5.2. If the Logical Block Address field and the Transfer Length field values are not set to the integral multiple of the Blocking factor, the Logical Unit shall terminate the command with CHECK CONDITION status and SK/ASC/ASCQ values set to ILLEGAL REQUEST/INVALID FIELD IN CDB.

For the DVD-RAM Ver.2.1, the Logical Unit shall set all Recording Type bits to one, which are in the Data ID fields of all sectors within the ECC Block to be written, when WRITE (12) command with the Streaming bit set to one is issued by the Initiator. And the Logical Unit shall set all the Recording Type bits to zero when WRITE (12) command with the Streaming bit set to zero is issued by the Initiator.

If the DVD+RW medium is blank (never formatted), then a write to any address shall be terminated with CHECK CONDITION status and SK/ASC/ASCQ values shall be set to ILLEGAL REQUEST/MEDIUM NOT FORMATTED.

Recommended error reporting is defined in Table 336.

Table 336 – Recommended errors for WRITE (12) Command

Error	Reference
Deferred Errors	A.2
General Errors	Table A.2
Media Access Errors	Table A.3
Write Errors	Table A.4

5.41 WRITE AND VERIFY (10) Command

The WRITE AND VERIFY (10) command (Table 337) requests that the Logical Unit write the data transferred from the Initiator to the medium and then verify that the data is correctly written.

Table 337 – WRITE AND VERIFY (10) Command

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

RelAdr (Relative Address) is not used by CD/DVD Logical Units and shall be set to zero.

BytChk (Byte Check) is not used by CD/DVD Logical Units and shall be set to zero.

Disable Page Out (DPO) is not used by CD/DVD Logical Units and shall be set to zero.

Logical Block Address references the block at which the operation shall begin.

Transfer length specifies the number of contiguous logical blocks of data or blanks that shall be written and verified. A transfer length of zero indicates that no logical blocks shall be verified. This condition shall not be considered as an error. Any other value indicates the number of logical blocks that shall be verified.

Verify Error Recovery Mode Page parameters are not supported by Multimedia Logical Units. The read parameters of the Read/Write Error Recovery Mode Page shall be utilized by the Logical Unit as verify parameters. The AWRE and ARRE bits shall control automatic reallocation.

If the currently mounted medium is DVD-RAM, the verify operation of this command shall use stricter criteria for data recoverability than is used by read commands. The criteria are derived from the DVD-RAM Book, with additional vendor specific criteria allowed.

If the currently mounted medium is DVD-RAM Ver.2.1, the Logical Unit shall set the all Recording Type bits to zero, which are in the Data ID fields of all sectors within the ECC Block to be written.

If the currently mounted medium is DVD+RW and the medium is blank (never formatted), then a write to any address shall be terminated with CHECK CONDITION status and SK/ASC/ASCQ values shall be set to ILLEGAL REQUEST/MEDIUM NOT FORMATTED.

Table 338 describes errors that may occur during the operation of the command or which may cause a CHECK CONDITION status to be reported.

Table 338 – Recommended errors for WRITE AND VERIFY (10) Command

Error	Reference
Deferred Errors	A.2
General Errors	Table A.2
Media Access Errors	Table A.3
Write Errors	Table A.4

6   Parameters for Multi-Media Devices

6.1   Overview

This sub-clause defines and lists the specified parameters that an Initiator system or Logical Unit would require performing at a desired level.

Parameters uniquely required to implement a specific Feature set are defined within the sub-clause defining that Feature set. Other parameters that are unique to a specific command are listed in the specific sub-clause defining that command.

6.2   Mode Pages

Mode Pages are used to provide information to or from the Logical Unit. MODE SELECT (used to set parameters) and MODE SENSE (used to interrogate capabilities) commands move the pages (Table 339) to/from the Logical Units. The page definitions are provided in the following sub-clauses.

Each mode page (Table 339) contains a page code, a page length, and a set of mode parameters.

Table 339 – Mode Page Codes for CD/DVD

Page Code	Description	Reference
00h	Vendor-specific (does not require page format)	
01h	Read/Write Error Recovery Mode Page	6.3.4
02h - 04h	Reserved	
05h	Write Parameter page	6.3.5
06h	Reserved	
07h	Verify Error Recovery Mode Page	Shall not be used
08h - 0Ah	Reserved	
0Bh	Medium types supported page	Shall not be used
0Ch	Reserved	
0Dh	CD Device Parameters Page	6.3.6
0Eh	CD Audio Control Page	6.3.7
0Fh - 19h	Reserved	
1Ah	Power Condition Page	6.3.8
1Bh	Reserved	
1Ch	Fault/Failure Reporting Page	6.3.9
1Dh	Time-out & Protect Page	6.3.10
1Eh - 1Fh	Reserved	
20h – 29h	Vendor Specific	
2Ah	CD/DVD Capabilities & Mechanical Status Page	6.3.11
2Bh	Reserved	
2Ch	MRW Mode Page	6.3.12
2Dh – 3Eh	Vendor Specific	
3Fh	Return all pages (valid only for the Mode Sense command	

6.3   Mode Select/Sense Parameters

This section describes the pages used with MODE SELECT and MODE SENSE commands.

The Mode Parameter List (Table 340) contains a header, followed by zero or more variable length mode pages defined in

Table 341.

Table 340 – Mode Parameter List

Bit Byte	7	6	5	4	3	2	1	0
0 - 7	Mode Parameter Header							
8 - n	Page(s)							

Table 341 – Mode Page Format

Bit Byte	7	6	5	4	3	2	1	0
0	PS/ Reserved	Reserved	Page Code					
1	Page Length (n - 1)							
2	Mode Parameter							
n								

6.3.1   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.

6.3.2   Page Code

The Page Code field identifies the format and parameters defined for that mode page.

When using the MODE SENSE command, if Page Code 00h (vendor-specific page) is implemented, the Logical Unit shall return that page last in response to a request to return all pages (page code 3Fh). When using the MODE SELECT command, this page shall be sent last.

6.3.3   Page Length

The Page Length field specifies the length in bytes of the mode parameters that follow. If 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.

The mode parameters header is defined in Table 342.

Table 342 – Mode Parameters Header

Bit Byte	7	6	5	4	3	2	1	0
0	(MSB)			Mode Data Length				
1								(LSB)
2	Obsolete (Medium Type Code)							
3	Reserved							
4	Reserved							
5	Reserved							
6	Block Descriptor Length 0 (8 for legacy SCSI Logical Units)							
7								

When using the MODE SENSE command, the mode data length field specifies the length in bytes of the following data that is available to be transferred. The mode data length is the total byte count of all data following the mode data length field. When using the MODE SELECT command, this field is reserved.

The block descriptor associated with the Mode Select and Mode Sense commands is used for legacy system support. If supported, block sizes (see Table 343.) shall include 2 048 and may include 512, 2056, 2 324, 2 332, 2 336, 2 340, 2 352, 2 368, and 2448 bytes. Table 343 shows the implementation of the various block sizes. These definitions apply for all READ commands. For READ (6), READ (10), READ (12) when Block Descriptors are not supported, block size shall be 2 048. Other block sizes are allowed and the contents of the blocks are not specified by this standard.

Table 343 – Block Descriptor Block Sizes for Read

Bytes	Readable block types
512	Mode 1 or Mode 2 Form 1 sectors divided into four blocks each
2 048	Mode 1, Mode 2 Form1, or DVD
2056	Mode 2 Form 1 with sub-header. Equivalent to READ CD, Flag = 50h.
2 324	Mode 2 Form 2 with no sub-header. Note: There is no mapping to READ CD, as the 4 spare bytes are not returned.
2 332	Mode 2, Form 1 or 2 data. The Logical Unit shall operate as specified for 2 048 byte blocks except that both forms send 2 332 byte blocks. Form 1 blocks return the third layer ECC with the user data. There is no mapping to READ CD, as the 4 spare bytes are not returned.
2 336	Mode 2 data. The Logical Unit shall operate as specified for 2 048 byte block lengths. This mode includes all data: Yellow Book Mode 2 sectors and Form 1 & 3. This is equivalent to READ CD, Flag = 58h.
2 340	All bytes except the synchronization field. Equivalent to READ CD, Flag = 78h.
2 352	Audio or raw blocks. The Logical Unit shall operate as specified for 2 048 byte block lengths. A read of data mode sectors shall return de-scrambled data. Equivalent to READ CD, Flag = F8h.
2448 or 2 368	Audio or raw blocks with raw Sub-channel. The Logical Unit shall not perform the data descrambling operation. Equivalent to READ CD, Flag = F8. Sub-channel data selection = 010b (2 448) or Sub-channel data selection = 001b (2 368).

6.3.4   Read/Write Error Recovery Parameters Mode Page (Page Code 01h)

The Read/Write Error Recovery Parameters Mode Page (Table 344) 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 TOC/PMA/ATIP, WRITE, etc.).

Table 344 – 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	Error Recovery Parameter							
	AWRE	ARRE	TB	RC	Reserved	PER	DTE	DCR
3	Read Retry Count							
4	Reserved (Correction Span in SCSI SBC)							
5	Reserved (Head Offset Count in SCSI SBC)							
6	Reserved (Data Strobe Offset Count in SCSI SBC)							
7	Reserved							
8	Write Retry Count							
9	Reserved							
10	(MSB)	Recovery Time Limit (0)						
11								(LSB)

The Parameters Savable (PS) bit is defined in sub-clause 6.3.1.

NOTE The implementation of error recovery procedures for Logical Units is markedly different from those used for magnetic medium disk drives. At least one level of error correction is required to transfer the data stream. Therefore, the performance of the Logical Unit may differ substantially from what would be expected by sending the same error recovery parameters to a magnetic medium Logical Unit.

An Automatic Write Reallocation Enabled (AWRE) bit of one indicates that the Logical Unit shall enable automatic reallocation to be performed during write operations. An AWRE bit of zero indicates that the Logical Unit shall not perform automatic reallocation of defective data blocks during write operations.

If the media format is MRW, the default value for AWRE is one (1b).

An Automatic Read Reallocation Enabled (ARRE) bit of one indicates that the Logical Unit shall enable automatic reallocation of defective data blocks during read operation. An ARRE bit of zero indicates that the Logical Unit shall not perform automatic reallocation of defective data blocks during read operation. When ARRE is enabled other error recovery modes shall not be used. The Disable Correction and Read Continuous shall not be enabled while ARRE is enabled.

If the media format is MRW, the default value for ARRE is zero (0b).

Since DVD+RW has no defect management system, ARRE and AWRE shall default to zero and cannot be set to one by the initiator.

A Transfer Block (TB) bit of one indicates that a data block that is not recovered within the recovery limits specified, shall be transferred to the Initiator before CHECK CONDITION status is returned. A TB bit of zero indicates that such a data block shall not be transferred to the Initiator. The TB bit does not affect the action taken for recovered data.

A Read Continuous (RC) bit of one indicates that the Logical Unit shall transfer the entire requested length of data without adding delays to perform error recovery procedures. This implies that the Logical Unit may send data that is erroneous or fabricated in order to maintain a continuous flow of data. A RC bit of zero indicates that error recovery operations that cause delays are acceptable during the data transfer.

A Post Error (PER) bit of one indicates that the Logical Unit shall report recovered errors. A PER bit of zero indicates that the Logical Unit shall not report recovered errors. Error recovery procedures shall be performed within the limits established by the error recovery parameters. This capability is different for DVD media. In order to enhance data recovery from DVD media, error correction shall always be used. 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.

An interpretation of the bits 5-0 in the Error Recovery Parameter byte for CD-ROM Logical Units is given in Table 345. An interpretation of the bits 5-0 in the Error Recovery Parameter byte for DVD-ROM Logical Units is given in Table 346.

The Read Retry Count field specifies the number of times that the controller shall attempt its read recovery algorithm.

The Write Retry Count field specifies the number of times that the controller shall attempt its write recovery algorithm. This may not have any effect if the Logical Unit does not support read after write operations.

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.

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.

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.

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 345 – 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 345 – 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 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 345 – 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

Table 346 – 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.

The Read Retry Count field specifies the number of times that the Logical Unit shall attempt its read recovery algorithm.

The Correction Span field should be set to zero.

The Head Offset Count field should be set to zero.

The Data Strobe Offset Count field should be set to zero.

The Write Retry Count field specifies the number of times that the Logical Unit shall attempt its write recovery algorithm. This may not have any effect if the Logical Unit does not support read after write operations.

The Recovery Time Limit field should be set to zero.

A CIRC Recovered Data Error is defined as a block for which the CIRC based error correction algorithm was unsuccessful for a read attempt, but on a subsequent read operation no error was reported. The number of subsequent read operations is limited to the read retry count. Layered error correction was not used.

A CIRC Un-recovered Data Error is defined as a block for which the CIRC based error correction algorithm was unsuccessful on all read attempts up to the read retry count. Layered error correction was not used.

An L-EC Recovered Data Error is defined as a block for which the CIRC based error correction algorithm was unsuccessful, but the layered error correction was able to correct the block within the read retry count.

6.3.5   Write Parameters Page (Page Code 05h)

The Write Parameters Page (Table 347) provides parameters that are often needed in the execution of commands that write to the media.

The values in this page do not necessarily reflect the status on a given medium. They may be used, as applicable, when a write operation occurs. 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.

Fields and bits within the Write Parameters Page not utilized by the installed medium may be ignored.

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.

When a MRW disc 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 Page. If the initiator changes the Write Parameters Page, MRW disc operation shall not be affected.

When a disc is mounted which 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 Page prior to sending the FORMAT UNIT command when specifying format type 24h. Furthermore, the Logical Unit shall not alter current the Write Parameters Page in performing the format.

Table 347 – Write Parameters Page

Bit / Byte	7	6	5	4	3	2	1	0
0	PS	Reserved	Page Code (05h)					
1	Page Length (32h)							
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 Parameter Savable bit is defined in sub-clause 6.3.1.

The BUFE bit, when set to one, indicates that Buffer Under-run Free recording is enabled for sequential recording. The Logical Unit shall perform loss less-linking and continue the writing when the buffer becomes empty. When set to zero, it shall indicate that Logical Unit shall terminate writing and perform linking. In order to minimize compatibility problems, the default value for BUFE should be zero for CD-R/RW Logical Units.

The LS_V (Link Size Valid) bit, when set to one indicates that the value in the Link Size field is valid. When set to zero, indicates compatibility with legacy Logical Units that did not implement the Link Size field; such Logical Units assume a Link Size of 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, device shall ignore 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 348) specifies the stream type to be used during writing. Write Type values are shown in Table 348.

Table 348 – 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 349.

Table 349 – 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 350. 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/WR Logical Units shall be 8.

Table 350 – 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 152): 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 (Table 162) 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 351 – 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 Table 225.

The International Standard Recording Code (ISRC) is formatted as in Table 227.

For the DDCD, this field is ignored.

6.3.6   CD device parameters Page (Page Code 0Dh)

The CD Parameters page (Table 352) specifies parameters that affect all CD-ROM data types.

Table 352 – 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 6.3.1.

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 353).

Table 353 – 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.

6.3.7 CD Audio Control Page (Page Code 0Eh)

The CD Audio Control Page (Table 354) sets the playback modes and output controls for subsequent PLAY AUDIO commands and any current audio playback operation.

Table 354 – 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 = 1	SOTC Default = 0	Reserved
3	Reserved							
4	Reserved							
5	Reserved							
6	Obsolete (75)							
7	Obsolete (75)							
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 6.3.1.

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 always 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 SOTC bit is mandatory.

The CDDA Output Port Channel Selection field (Table 355) 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 355 – CDDA Output Port Channel Selection Codes

Code	Description
0000b	Output port muted
0001	Connect audio channel 0 to this output port
0010b	Connect audio channel 1 to this output port
0011b	Connect audio channel 0 and audio channel 1 to this output port
0100b	Connect audio channel 2 to this output port
1000b	Connect audio channel 3 to this output port

The Output Port Volume Control indicates the relative volume level for this audio output port. The value used is specified as an attenuation of the normal volume level. A value of zero indicates the minimum volume level (Mute), and a value of FFh indicates maximum volume (No attenuation) level. It is recommended that the MUTE and volume functions should be supported on a per channel basis. The attenuation used shall be as specified in Table 356. 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 356 – 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)

6.3.8 Power Condition Page (Page Code 1Ah)

The power condition page (Table 357) 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 357 – 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 6.3.1.

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.

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6.3.9 Fault / Failure Reporting Control Page (Page Code 1Ch)

The Fault / Failure Reporting Control page (Table 358) 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 application client.

Table 358 – 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			DExcept	Test	Reserved	LogErr (0)
3	Reserved				MRIE			
4	(MSB)							
5	Interval Timer							
6								
7								(LSB)
8	(MSB)							
9	Report Count							
10								
11								(LSB)

The Parameter Savable bit is defined in sub-clause 6.3.1.

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 359) 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 359 – 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 application client. 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.

6.3.10 Time-out and Protect Page (Page Code 1Dh)

The Time-out and Protect page (Table 360) specifies parameters that affect Logical Unit operation.

Table 360 – Time-out & Protect Page

Bit Byte	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 Default 0	DISP Default 0	SWPP Default 0
5	Reserved							
6	(MSB)	Group 1 Minimum Time-out (Seconds)						
7								(LSB)
8	(MSB)	Group 2 Minimum Time-out (Seconds)						
9								(LSB)

The Parameter Savable bit is defined in sub-clause 6.3.1.

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 DISP bit when set to 1 shall make the Logical Unit unavailable until power has been removed and then reapplied. The Logical Unit shall report not ready for all media access after this bit has been set to 1.

The SWPP bit provides a Software Write Protect until power 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.

See the Time-out model for more information on the Group 1 & 2 Minimum Time-out fields.

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

The CD/DVD Capabilities and Mechanical Status Page (Table 361) is read only and shall not be set with Mode Select.

Table 361 – 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	Reserved	DVD- RAM Read	DVD-R Read	DVD-ROM Read	Method 2	CD-RW Read	CD-R Read
3	Reserved	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							

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The Parameter Savable bit is defined in sub-clause 6.3.1.

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 6.3.5.

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 5.17).

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 5.17).

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 362.

Table 362 – 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 6.3.7).

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 6.3.7).

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 363).

Table 363 – 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 118.

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 364.

Table 364 – Logical Unit Write Speed Performance Descriptor Table Format

Bit Byte	7	6	5	4	3	2	1	0
0	Reserved							
1	Reserved					Rotation Control		
2	(MSB)	Write Speed Supported (kbytes/sec)						
3								(LSB)

Table 365 – 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.

6.3.12 MRW Mode Page

The MRW Mode Page (Table 366) provides a method by which the initiator can control the special features of a MRW CD-RW Logical Unit.

Table 366 – MRW Mode Page

Bit Byte	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 is known to be implemented as Page Code 2Ch, a vendor unique code. 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 host 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   Features and Profiles for Multi-Media Devices

6.4.1   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.

6.4.2   FEATURES

To determine the Features supported by the Logical Unit, the Initiator shall issue a GET CONFIGURATION command (See sub-clause 5.5). In response to this GET CONFIGURATION command the Logical Unit shall respond with data as shown in Table 367. 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 368.

Table 367 – 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 368 – 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 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 373) 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 369. Each individual Feature description is defined in the appropriate sub-clause.

Table 369 – Feature Descriptor generic format

Bit Byte	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.

6.4.2.1   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.

6.4.2.2   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.

6.4.2.3   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.

6.4.2.4   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.

6.4.2.5 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 370．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 370 – 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	Reserved	-
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 370 – 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 – FEFFh	Reserved	-
FF00h – FFFFh	Vendor Specific	-

6.4.3 Feature Definitions

The following sub-clauses define the Feature sets and the commands supported by each Feature.

6.4.3.1   Profile List Feature (0000h)

This Feature identifies Profiles supported by the Logical Unit. The Profile List descriptor returned is defined in Table 371. 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 371 – 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 372. 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 372 – 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 373.

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 368).

Table 373 – Profile List

Profile Number	Profile Name	Description	Reference
0000h	Reserved		
0001h	Non-removable disk	Re-writable disk, capable of changing behavior	6.4.4.1
0002h	Removable disk	Re-writable; with removable media	6.4.4.2
0003h	MO Erasable	Magneto-Optical disk with sector erase capability	6.4.4.3
0004h	MO Write Once	Magneto-Optical write once	6.4.4.4
0005h	AS-MO	Advance Storage – Magneto-Optical	6.4.4.5
0006h – 0007h	Reserved		
0008h	CD-ROM	Read only Compact Disc capable	6.4.4.6
0009h	CD-R	Write once Compact Disc capable	6.4.4.7
000Ah	CD-RW	Re-writable Compact Disc capable	6.4.4.8
000Bh - 000Fh	Reserved		
0010h	DVD-ROM	Read only DVD	6.4.4.9
0011h	DVD-R Sequential Recording	Write once DVD using Sequential recording	6.4.4.10
0012h	DVD-RAM	Re-writable DVD	6.4.4.11
0013h	DVD-RW Restricted Overwrite	Re-recordable DVD using Restricted Overwrite	6.4.4.12
0014h	DVD-RW Sequential recording	Re-recordable DVD using Sequential recording	6.4.4.13
0015h – 0019h	Reserved		
001Ah	DVD+RW	DVD ReWritable	6.4.4.14
001Bh - 001Fh	Reserved		
0020h	DDCD-ROM	Read only DDCD	0
0021h	DDCD-R	Write only DDCD	6.4.4.16
0022h	DDCD-RW	Re-Write only DDCD	6.4.4.17
0023h-002Fh	Reserved		
0030h-FFFEh	Reserved		
FFFFh	Logical Units Not Conforming to a Standard Profile	The Logical Unit does not conform to any Profile.	6.4.4.18

6.4.3.2   Core Feature (0001h)

This Feature identifies a Logical Unit that supports functionality common to all devices. All Logical Units that conform to this standard shall implement the Core Feature set of commands specified in Table 374.

Table 374 – Core Feature Commands

Op Code	Command Description	Reference
12h	INQUIRY	SPC
46h	GET CONFIGURATION	5.5
4Ah	GET EVENT/STATUS NOTIFICATION	5.6
55h	MODE SELECT (10)	SPC
5Ah	MODE SENSE (10)	SPC
03h	REQUEST SENSE (Note 1)	SPC
00h	TEST UNIT READY	SPC
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 Feature descriptor response data to be returned to the Initiator is defined in Table 375.

Table 375 – Core Feature Descriptor Format

Bit Byte	7	6	5	4	3	2	1	0
0	(MSB)			Feature Code = 0001h				
1								(LSB)
2	Reserved			Version = 0h			Persistent = 1	Current = 1
3	Additional Length = 4							
4	(MSB)							
5	Physical Interface Standard							
6								
7								(LSB)

The Physical Interface Standard field shall be set to a value selected from Table 376.

Note: There could be more than one physical interface between the initiator and logical unit. For example, a Fibre Channel to parallel SCSI bridge. A SCSI target device doesn't know anything but its own physical interface. That is what should be reported here.

Table 376 – 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 NCITS	
00020000h - 0002FFFFh	Defined by SFF	
00030000h - 0003FFFFh	Defined by IEEE	
00040000h – FFFFFFFFh	Reserved	

6.4.3.3 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. Logical Units that support this Feature shall implement the commands specified in Table 377.

Table 377 – Morphing Feature Commands

Op Code	Command Description	Reference
46h	GET CONFIGURATION	5.5
4Ah	GET EVENT/STATUS NOTIFICATION	5.6
1Eh	PREVENT ALLOW MEDIUM REMOVAL (with Persistent bit set to one)	SPC
A2h	SEND EVENT when Class 3 Event (External Request) is implemented.	5.31

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 378.

Table 378 – Morphing Descriptor Format

Bit / Byte	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 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.

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.

6.4.3.4   Removable Medium Feature (0003h)

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. Logical Units that support the Removable Medium Feature shall implement the commands specified in Table 379.

Table 379 – Removable Medium Feature Commands

Op Code	Command Description	Reference
BDh	MECHANISM STATUS	5.9
1Eh	PREVENT ALLOW MEDIUM REMOVAL with the Persistent Prevent bit set to zero.	SPC
1Bh	START STOP UNIT and load eject (LOEJ) bit	SBC

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.

This Feature identifies a Logical Unit that has a medium that is removable. The Feature descriptor response data to be returned is defined in Table 380.

Table 380 – Removable Medium Feature Descriptor Format

Bit Byte	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 381) 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 381 – 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

6.4.3.5 Write Protect Feature (0004h)

This Feature identifies reporting capability and changing capability for Write protection status of the Logical Unit.

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 382 – Write Protect Feature Commands

Op Code	Command Description	Reference
ADh	READ DVD STRUCTURE with Format code C0h, FFh	5.20
BFh	SEND DVD STRUCTURE with Format code C0h, when SPWP bit is one	5.30

The Write Protect Feature descriptor response data to be returned to the Initiator is defined in Table 383.

Table 383 – 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 6.4.2.2.

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.

6.4.3.6 Random Readable Feature (0010h)

This Feature identifies a Logical Unit that can read data from logical blocks specified in a READ command. Logical Units that may be used, as Random Readable block devices shall implement the commands specified in Table 384.

Table 384 – Random Readable Feature Commands

Op Code	Command Description	Reference
25h	READ CAPACITY	5.16
28h	READ(10)	SBC

The Feature descriptor response data to be returned to the Initiator is defined in Table 385.

Table 385 – Random Readable Feature Descriptor Format

Bit / Byte	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							

There is no requirement that the addresses, in sequences of reads, occur in any particular order.

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 6.4.2.2.

The Current bit shall be defined as in sub-clause 6.4.2.3.

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. The Blocking field reported in the Feature Descriptor is for performance optimization only. 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. This Page shall not change due to medium removal or changes. The changeable fields mask shall not change due to medium removal or changes. The Initiator shall be able to change changeable values whether or not media is loaded.

6.4.3.7   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). Reading of CD Audio data via the READ CD command shall be supported. Logical Units that support the Multi-Read Feature shall implement the commands specified in Table 386

Table 386 – Multi-Read Feature Commands

Op Code	Command Description	Reference
28h	READ (10)	SBC
BEh	READ CD	5.16
51h	READ DISC INFOROMATION	5.19
52h	READ TRACK INFORMATION	5.24

The Feature descriptor response data to be returned to the Initiator is defined in Table 387.

Table 387 – Multi-Read Feature Descriptor Format

Bit Byte	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 6.4.2.2.

The Current bit shall be defined as in sub-clause 6.4.2.3.

The Additional Length field shall be set to 00h.

6.4.3.8   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. Logical Units that read CD-ROM media shall support the commands specified in Table 388.

Table 388 – CD READ Feature Commands

Op Code	Command Description	Reference
BEh	READ CD	5.16
B9h	READ CD MSF	5.18
43h	READ TOC/PMA/ATIP Supports Format codes 0h, 1h, 2h and 5h if the CD-TEXT bit is set to one	5.23

The Feature descriptor response data to be returned to the Initiator is defined in Table 389.

Table 389 – CD Read Feature Descriptor Format

Bit / Byte	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 6.4.2.2.

The Current bit shall be defined as in sub-clause 6.4.2.3.

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.

6.4.3.9   DVD Read Feature (001Fh)

This Feature identifies a Logical Unit that can read DVD specific information from the media. Logical Units that read DVD-ROM media shall support the commands specified in Table 390.

Table 390 – DVD READ Feature Commands

Op Code	Command Description	Reference
18h	READ(10)	SBC
A8h	READ(12)	SBC
ADh	READ DVD STRUCTURE	5.20
43h	READ TOC/PMA/ATIP	5.23

The Feature descriptor response data to be returned to the Initiator is defined in Table 391.

Table 391 – 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 6.4.2.2.

The Current bit shall be defined as in sub-clause 6.4.2.3.

The Additional Length field shall be set to 0.

6.4.3.10 Random Writable Feature (0020h)

This Feature identifies a Logical Unit that can write data to logical blocks specified by a Write command. There is no requirement that the addresses in sequences of writes occur in any particular order. Logical Units that may be used as a random writable block device shall implement the commands as specified in Table 392.

Table 392 – Random Writable Feature Commands

Op Code	Command Description	Reference
25h	READ CAPACITY	5.16
2Ah	WRITE (10)	5.39
2Eh	WRITE AND VERIFY (10)	5.41
35h	SYNCHRONIZE CACHE The Immediate bit shall be supported.	5.38

The Feature descriptor response data to be returned to the Initiator is defined in Table 393

Table 393 – 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 6.4.2.2.

The Current bit shall be defined as in sub-clause 6.4.2.3.

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 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. 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.

6.4.3.11 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. Logical Units that support this Feature shall implement the commands shown in Table 394.

Table 394 – Incremental Streaming Writable Feature Commands

Op Code	Command Description	Reference
A1h	BLANK (Note 1)	5.2
5Bh	CLOSE TRACK/SESSION	5.3
51h	READ DISC INFORMATION	5.19
52h	READ TRACK INFORMATION	5.24
53h	RESERVE TRACK	5.27
54h	SEND OPC INFORMATION (Note 2)	5.33
2Ah	WRITE (10)	5.39
35h	SYNCHRONIZE CACHE	5.38
Notes: 1. Shall be supported if the Erasable bit in READ DISC INFORMATION, returned data, is set to one. If supported, Blanking Types 000b, 001b, and 100b shall be supported for CD and Blanking Types 000b and 001b shall be supported for DVD. 2. Shall be supported if the OPC information is ever returned in the READ DISC INFORMATION return data.		

Table 395 – Incremental Streaming Writable Feature Parameters

Page Code	Mode page	Reference
05h	Write Parameters	6.3.5

The Feature descriptor response data is defined in Table 396.

Table 396 – 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 6.4.2.2.

The Current bit shall be defined as in sub-clause 6.4.2.3.

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.

6.4.3.12 Sector Erasable Feature (0022h)

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. Logical Units that support this Feature shall implement the commands listed in Table 397.

Note: This Feature does not apply to DVD-RAM/-RW or DVD+RW, that is a direct overwrite technology.

Table 397 – Sector Erasable Feature Commands

Op Code	Command Description	Reference
2Ch	ERASE(10)	SBC
2Fh	VERIFY(10) (Note 1)	SBC
2Ah	WRITE(10) (Note 2)	5.39
Notes: 1. The BLKVFY bit shall be supported 2. The EBP bit shall be supported		

The Feature descriptor response data to be returned to the Initiator is defined in Table 398.

Table 398 – 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 6.4.2.2.

The Current bit shall be defined as in sub-clause 6.4.2.3.

The Additional Length field shall be set to 00h.

6.4.3.13 Formattable Feature (0023h)

This Feature identifies a Logical Unit that can format media into logical blocks. Logical Units that use media that may be formatted shall implement the commands specified in Table 399.

Table 399 – Formattable Feature Commands

Op Code	Command Description	Reference
04h	FORMAT UNIT with a Format Code of 001b, Format Type 0h	5.2
23h	READ FORMAT CAPACITIES	5.21
03h	REQUEST SENSE	SPC
2Fh	VERIFY(10)	SBC

The Feature descriptor response data to be returned to the Initiator is defined in Table 400.

Table 400 – 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 6.4.2.2.

The Current bit shall be defined as in sub-clause 6.4.2.3.

The Additional Length field shall be set to 0.

6.4.3.14 Defect Management Feature (0024h)

This Feature identifies a Logical Unit that shall have defect management available to provide a defect-free contiguous address space. Logical Units that support this Feature shall implement the parameter listed in Table 401.

Table 401 – Defect Management Feature Parameters

Page Code	Parameter	Reference
01h	CD/DVD Read/Write Error Recovery Mode Page	6.3.4

Note: The AWRE and ARRE shall be supported if medium is Writable.

The Feature descriptor response data to be returned to the Initiator is defined in Table 402.

Table 402 – Defect Management Feature Descriptor Format

Bit / Byte	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 6.4.2.2.

The Current bit shall be defined as in sub-clause 6.4.2.3.

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).

6.4.3.15 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. Logical Units that support this Feature shall implement the commands listed in Table 403.

Table 403 – Write Once Feature Commands

Op Code	Command Description	Reference
25h	READ CAPACITY	5.16
35h	SYNCHRONIZE CACHE	5.38
2Ah	WRITE(10)	5.39
2Eh	WRITE AND VERIFY (10)	5.41

Table 404 – Write Once Feature Parameters

Page Code	Parameter	Reference
01h	CD/DVD Read/Write Error Recovery Mode Page	6.3.4

The Feature descriptor response data to be returned to the Initiator is defined in Table 405.

Table 405 – 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 6.4.2.2.

The Current bit shall be defined as in sub-clause 6.4.2.3.

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. 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.

6.4.3.16 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. Logical Units that write and read CD-RW and DDCD-RW media shall support the commands specified in

Table 406.

Table 406 – Restricted Overwrite Feature Commands

Op Code	Command Description	Reference
25h	READ CAPACITY	5.16
51h	READ DISC INFORMATION	5.19
52h	READ TRACK INFORMATION	5.24
35h	SYNCHRONIZE CACHE	5.38
2Ah	WRITE(10)	5.39

Table 407 – Restricted Overwrite Feature Parameter

Page Code	Parameter	Reference
05h	Write Parameter Page	6.3.5

The Feature descriptor response data to be returned to the Initiator is defined in Table 408.

Table 408 – 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 6.4.2.2. This bit shall be set to zero if the medium is removable.

The Current bit shall be defined as in sub-clause 6.4.2.3. This bit shall be set to zero if Restricted Overwrite medium is not present.

The Additional Length field shall be set to 0.

6.4.3.17 CD-RW CAV Write Feature (0027h)

This Feature identifies a Logical Unit that has the ability to perform writing on CD-RW media in CAV mode. The Logical Unit shall conform to the Orange Book Part 3 Volume 2 specification. This Feature shall not be current if high-speed recordable CD-RW media is not mounted. Logical Unit with write protected media shall not have this Feature current. Logical Units with installed medium that support this Feature shall implement the commands listed in Table 409.

Table 409 – CD-RW CAV Write Feature Commands

Op Code	Command Description	Reference
25h	READ CAPACITY	5.16
51h	READ DISK INFORMATION	5.19
52h	READ TRACK INFORMATION	5.24
35h	SYNCHRONIZE CACHE	5.38
2Ah	WRITE (10)	5.39

Table 410 – CD-RW CAV Write Feature Parameters

Page Code	Parameter	Reference
05h	Write Parameters Page	6.3.5

The CD-RW CAV Write Feature descriptor response data to be returned to the Initiator is defined in Table 411.

Table 411 – CD-RW CAV WRITE 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	Reserved							
6	Reserved							
7	Reserved							

The Feature Code field shall be set to 0027h.

The Version field shall be set to 0.

The Persistent bit shall be defined as in sub-clause 6.4.2.2.

The Current bit shall be defined as in sub-clause 6.4.2.3.

The Additional Length field shall be set to 04h.

6.4.3.18 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 412 – MRW Feature Descriptor

Bit Byte	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 6.4.2.2.

The Current bit shall be defined as in sub-clause 6.4.2.3.

> 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 413.

Table 413 – MRW Feature Commands

Op Code	Command Description	Reference
25h	READ CAPACITY	5.16
4Ah	GET EVENT/STATUS NOTIFICATION	5.6
51h	READ DISK INFORMATION	5.19
28h	READ (10)	SBC

Logical Units that support this feature shall implement the mode pages listed in Table 413.

Table 414 – MRW Feature Parameters

Page Code	Parameter	Reference
2Ch	MRW Mode Page	5.5.11

Logical Units that support this feature and its write capabilities shall implement the commands listed in Table 415 in addition to the commands listed in Table 413.

Table 415 – MRW Write Feature Commands

Op Code	Command Description	Reference
5Bh	CLOSE TRACK/SESSION	5.3
04h	FORMAT UNIT	5.4
28h	WRITE (10)	5.39
2Eh	WRITE AND VERIFY (10)	5.41
2Fh	VERIFY (10)	SBC
23h	READ FORMAT CAPACITIES	5.21

6.4.3.19 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 416.

Table 416 – DVD+RW Feature Descriptor

Bit Byte	7	6	5	4	3	2	1	0
0	Feature Code = 002Ah							
1								
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 6.4.2.2.

The Current bit shall be defined as in sub-clause 6.4.2.3.

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 417.

Table 417 – Command Support Required by the DVD+RW Feature with Write

Op Code	Command Description	Reference
5Bh	Close Track/Session	5.3
04h	Format Unit	5.4
BFh	Send DVD Structure	5.30
2Ah	Write-10	5.39
2Eh	Write and Verify-10	SBC
AAh	Write-12	5.40

The Send DVD Structure Command must support format field values 05h and 30h.

6.4.3.20 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 shall not be current if the Random Writable Feature is current. 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. If this Feature is current, the Random Writable Feature shall not be current.

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 and Features identified in Table 418.

Table 418 – 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)	5.7
51h	READ DISC INFORMATION	5.19
52h	READ TRACK INFORMATION	5.24
25h	READ CAPACITY	5.16
35h	SYNCHRONIZE CACHE	5.38
2Fh	VERIFY (10)	SBC
2Ah	WRITE (10)	5.39
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 419.

Table 419 – 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			Persisten t	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 6.4.2.2.

The Current bit shall be defined as in sub-clause 6.4.2.3.

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 of Table 60 shall be supported. If set to 0, shall indicate that 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 of Table 60 shall be supported. If set to 0, shall indicate that 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 set to 0, shall indicate that 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 set to 0, shall indicate that the Logical Unit does not support BLANK command.

6.4.3.21 CD Track at Once Feature (002Dh)

This Feature identifies a Logical Unit that can write data to a CD track. Logical Units that support this Feature shall implement the commands and Features identified in Table 420.

Table 420 – 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	5.19
52h	READ TRACK INFORMATION	5.24
53h	RESERVE TRACK	5.27
54h	SEND OPC INFORMATION (Note 2)	5.33
35h	SYNCHRONIZE CACHE	5.38
2Ah	WRITE (10)	5.39
Notes: 1. Shall be implemented if the Erasable bit, in the READ DISC INFORMATION returned data, is set to one. If supported, Blanking Type 000b, 001b, and 100b shall be supported. 2. Shall be implemented if OPC Information is returned in the READ DISC INFORMATION returned data.		

Table 421 – CD Track at Once Feature Parameters

Page Code	Parameter	Reference
05h	Write Parameters Page	6.3.5

The Feature descriptor response data to be returned to the Initiator is defined in Table 422.

Table 422 – CD Track at Once Feature Descriptor Format

Bit Byte	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 6.4.2.2.

The Current bit shall be defined as in sub-clause 6.4.2.3.

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 6.3.5. 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 6.4.3.11.

6.4.3.22 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. Logical Units that support Session at Once mastering shall implement the commands listed in Table 423, and parameters listed in Table 424. Logical Units that support mastering in RAW mode shall implement the commands listed in Table 425, and parameters listed in Table 426.

Table 423 – CD Mastering (Session at Once) Feature Commands

Op Code	Command Description	Reference
51h	READ DISC INFORMATION	5.19
52h	READ TRACK INFORMATION	5.24
5Dh	SEND CUE SHEET	5.29
54h	SEND OPC INFORMATION (Note 1)	5.33
2Ah	WRITE (10)	5.39
Notes: 1. Shall be implemented if OPC Information is returned in the READ DISC INFORMATION returned data.		

Table 424 – CD Mastering (Session at Once) Feature Parameter

Page Code	Parameter	Reference
05h	Write Parameters – Session-At-Once Write type shall be supported.	6.3.5

Table 425 – CD Mastering (RAW) Feature Commands

Op-Code	Command	Reference
51h	READ DISC INFORMATION	5.19
52h	READ TRACK INFORMATION	5.24
35h	SYNCHRONIZE CACHE	5.38
2Ah	WRITE (10)	5.39

Table 426 – 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.	6.3.5

The Feature descriptor response data to be returned to the Initiator is defined in Table 427.

Table 427 – CD Mastering Feature Descriptor

Bit Byte	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 6.4.2.2.

The Current bit shall be defined as in sub-clause 6.4.2.3.

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.

6.4.3.23 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. Logical Units that write and read DVD-R/-RW media shall support the commands specified in Table 428 and the parameters identified in Table 429.

Table 428 – 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	5.19
52h	READ TRACK INFORMATION	5.24
53h	RESERVE TRACK	5.27
BFh	SEND DVD STRUCTURE	5.30
2Ah	WRITE (10)	5.39
Note: Shall be implemented if DVD-RW bit = 1.		

Table 429 – DVD-R/-RW Write Feature Parameters

Page Code	Parameter	Sub-Reference
05h	Write Parameter - Session at Once Write Type shall be supported	6.3.5

The DVD-R/-RW Write Feature descriptor response data to be returned to the Initiator is defined in Table 430.

Table 430 – 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 6.4.2.2. This bit shall be set to zero if the medium is removable.

The Current bit shall be defined as in sub-clause 6.4.2.3. 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.

6.4.3.24 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.

A Logical Unit that read DDCD-ROM media shall support the commands specified in Table 431.

Table 431 – DDCD Read Feature Commands

Op Code	Command Description	Reference
BEh	READ CD	5.17
43h	READ TOC/PMA/ATIP Supports Format codes 0h, 1h, 2h and 5h if the CD-TEXT bit is set to one	5.23

The DDCD Read Feature descriptor response data to be returned to the Initiator is defined in Table 432.

Table 432 – DDCD Read Feature Descriptor Format

Bit / Byte	7	6	5	4	3	2	1	0
0	Feature Code = 0030h							
1								
2	Reserved		Version				Persistent	Current
3	Additional Length = 00h							

Version shall be set to 0h.

The Persistent bit shall be defined as in sub-clause 6.4.2.2.

The Current bit shall be defined as in sub-clause 6.4.2.3.

6.4.3.25 Double Density CD-R Write Feature (0031h)

This Feature identifies a Logical Unit that can write data to DDCD-R. A Logical Unit that writes and reads DDCD-R media shall support the commands specified in Table 433.

Table 433 – DDCD-R Write Feature Commands

Op Code	Command Description	Reference
51h	READ DISC INFORMATION	5.19
52h	READ TRACK INFORMATION	5.24
53h	RESERVE TRACK	5.27
2Ah	WRITE (10)	5.39
AAh	WRITE (12)	5.40

Table 434 – 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 6.4.2.2.

The Current bit shall be defined as in sub-clause 6.4.2.3.

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.

6.4.3.26 Double Density CD-RW Write Feature (0032h)

This Feature identifies a Logical Unit that can write data to DDCD-RW. Logical Unit that write and read DDCD-RW media shall support the commands specified in Table 435.

Table 435 – DDCD-RW Write Feature Commands

Op Code	Command Description	Reference
51h	READ DISC INFORMATION	5.19
52h	READ TRACK INFORMATION	5.24
53h	RESERVE TRACK	5.27
2Ah	WRITE (10)	5.39
AAh	WRITE (12)	5.40

Table 436 – DDCD-RW Write Feature Descriptor Format

Bit / Byte	7	6	5	4	3	2	1	0
0	Feature Code = 0032h							
1								
2	Reserved		Version				Persistent	Current
3	Additional Length = 4							
4	Reserved						Intermed-iate	Blank
5	Reserved							
6	Reserved							
7	Reserved							

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 6.4.2.2.

The Current bit shall be defined as in sub-clause 6.4.2.3.

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.

6.4.3.27 Power Management Feature (0100h)

This Feature identifies a Logical Unit that can perform Initiator and Logical Unit directed power management. Logical Units that support this Feature shall implement the commands specified in Table 437 and the mode parameters specified in Table 438.

Table 437 – Power Management Feature Commands

Op Code	Command Description	Reference
4Ah	GET EVENT/STATUS NOTIFICATION (Note 1)	5.6
1Bh	START STOP UNIT (Note 2)	SBC
Note: 1. Power Management Class events shall be supported 2. Power Condition field shall be supported		

Table 438 – Power Management Feature Parameters

Page Code	Page Description	Reference
1Ah	Power Condition Page	6.3.8

The Feature descriptor response data to be returned to the Initiator is defined in Table 439.

Table 439 – Power Management Feature Descriptor Format

Bit Byte	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.

6.4.3.28 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 6.4.2.2.

The Current bit shall be defined as in sub-clause 6.4.2.3.

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.

6.4.3.29 Embedded Changer Feature (0102h)

This Feature identifies a Logical Unit that can move media from a storage area to a mechanism and back. 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 440.

Table 440 – Embedded Changer Feature Command

Op Code	Command Description	Reference
A6h	LOAD/UNLOAD MEDIUM	5.8
BDh	MECHANISM STATUS (Note)	5.9
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.		

The Feature descriptor response data to be returned to the Initiator is defined in Table 441.

Table 441 – Embedded Changer Feature Descriptor Format

Byte \ Bit	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 6.4.2.2.

The Current bit shall be defined as in sub-clause 6.4.2.3.

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.

6.4.3.30 CD Audio External Play Feature (0103h)

This Feature identifies a Logical Unit that can play CD Audio data directly to an external output. Logical Units that have a CD-Audio external output shall support the commands specified by Table 442 and the mode pages specified in Table 443.

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 442 – CD-Audio External Play Feature Commands

OpCode	Command Description	Reference
BDh	MECHANISM STATUS	5.9
4Bh	PAUSE/RESUME	5.10
45h	PLAY AUDIO (10)	5.11
47h	PLAY AUDIO MSF	5.13
43h	READ TOC/PMA/ATIP	5.23
42h	READ SUBCHANNEL	5.22
2Bh	SEEK	SBC
4Eh	STOP PLAY/SCAN	5.37

Table 443 – CD-Audio External Play Feature Parameters

Page Code	Page Description	Reference
0Eh	CD Audio Control Page	6.3.7

The Feature descriptor response data to be returned to the Initiator is defined in Table 444.

Table 444 – CD Audio External Play Feature Descriptor Format

Bit / Byte	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 - n								(LSB)

The Feature Code field shall be set to 0103h.

The Version field shall be set to 0h.

The Persistent bit shall be defined as in sub-clause 6.4.2.2.

The Current bit shall be defined as in sub-clause 6.4.2.3.

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.

6.4.3.31 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 445.

Table 445 – Microcode Upgrade Feature Command

Op Code	Command Description	Reference
3Ch	READ BUFFER with Mode 011b set	SPC
3Bh	WRITE BUFFER with Mode 111b (Download microcode with offset and save)	SPC

The Feature descriptor response data to be returned to the Initiator is defined in Table 446.

Table 446 – Microcode Upgrade Feature Descriptor Format

Bit Byte	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 6.4.2.2.

The Current bit shall be defined as in sub-clause 6.4.2.3.

The Additional Length field shall be set to 0.

6.4.3.32 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. Logical Units that support this Feature shall support the parameter listed in Table 447.

Table 447 – Time-Out Feature Parameter

Page Code	Parameter	Reference
1Dh	Time-out and Protect Page	6.3.10

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 shall be supported if queuing is supported.

The Feature descriptor response data to be returned to the Initiator is defined in Table 448.

Table 448 – Time-Out Feature Descriptor Format

Bit / Byte	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 6.4.2.2.

The Current bit shall be defined as in sub-clause 6.4.2.3.

The Additional Length field shall be set to 00h.

6.4.3.33 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.

Logical Units that support this Feature shall implement the commands specified by Table 449.

Table 449 – DVD CSS Feature Commands

Op Code	Command Description	Reference
A2h	REPORT KEY except KEY Format 010001b (Note)	5.26
A3h	SEND KEY	5.32
ADh	READ DVD STRUCTURE with Format Code 02h	5.20
Note: The KEY Format 000100b (TITLE KEY) does not succeed for CPPM protected sectors, since they do not contain a Title Key.		

The Feature descriptor response data to be returned to the Initiator is defined in Table 450.

Table 450 – 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 6.4.2.2.

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 6.4.2.3.

The Additional Length field shall be set to 4.

The CSS version shall be set to 01h.

6.4.3.34 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 Units supports the Stream playback operation. Logical Units that support this Feature shall implement the commands listed in Table 451.

Table 451 – 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	5.7
A8h	READ (12)	5.14
5Ch	READ BUFFER CAPACITY with Block bit of 1 (Note 1)	5.15
B6h	SET STREAMING (Note 2)	5.36
A7h	SET READ AHEAD	5.35
AAh	WRITE (12) with Streaming bit when SW bit is set to one	5.40
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.		

The Feature descriptor response data to be returned to the Initiator is defined in Table 452.

Table 452 – Real Time Streaming Feature Descriptor Format

Bit Byte	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 6.4.2.3.

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 CD/DVD Capabilities & Mechanical Status Mode Page (2Ah) with the Logical Unit Write Speed Performance Descriptor Blocks are supported. Otherwise,

the CD/DVD 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)

6.4.3.35 Feature 0108h: Logical Unit Serial Number

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 453 – 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.

6.4.3.36 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. Logical Units that support this Feature shall implement the commands listed in Table 454.

Table 454 – Disc Control Blocks Feature Commands

Op Code	Command Description	Reference
ADh	READ DVD STRUCTURE Format Code 30h shall be supported.	5.20
BFh	SEND DVD STRUCTURE If any DCB's are identified as writable, this command shall be supported.	5.30

Table 455 – 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 6.4.2.2.

The Current bit shall be defined as in sub-clause 6.4.2.3.

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.

6.4.3.37 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. Logical Units that support this Feature shall implement the commands listed in Table 456.

Table 456 – DVD CPRM Feature Commands

Op Code	Command Description	Reference
A2h	REPORT KEY	5.26
A3h	SEND KEY	5.32
ADh	READ DVD STRUCTURE	5.20

The Feature descriptor response data to be returned to the Initiator is defined in Table 457.

Table 457 – 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 6.4.2.2.

The Current bit shall be defined as in sub-clause 6.4.2.3.

The Additional Length field shall be set 04h.

The CPRM version field shall be set to 01h.

6.4.4 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 373 shows the list of profiles defined in this document.

6.4.4.1 Profile 1h: Non-Removable Disk

Logical Units identifying Profile 1 as current shall support the Features listed in Table 458.

Table 458 – 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)

6.4.4.2 Profile 2h: Removable Disk

Logical Units identifying Profile 2 as current shall support the Features listed in Table 459.

Table 459 – 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

6.4.4.3   Profile 3h: Magneto-Optical Erasable

Logical Units identifying Profile 3 as current shall support the Features listed in Table 460:

Table 460 – 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

6.4.4.4   Profile 4h: Optical Write Once

Logical Units identifying Profile 4 as current shall support the Features listed in Table 461:

Table 461 – 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

6.4.4.5   Profile 5h: AS-MO

Logical Units identifying Profile 5 shall support the Features listed in Table 462.

Table 462 – 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

6.4.4.6   Profile 8h: CD-ROM

Logical Units identifying Profile 8 as current shall support the Features listed in Table 463 .

Table 463 – 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

6.4.4.7   Profile 9h: CD-R

Logical Units identifying Profile 9 as current shall support the Features listed in Table 464:

Table 464 – 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

6.4.4.8   Profile Ah: CD-RW

Logical Units identifying Profile Ah as current shall support the Features listed in Table 465.

Table 465 – 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

6.4.4.9   Profile 10h: DVD-ROM

Logical Units identifying Profile 10h as current shall support the Features listed in Table 466.

Table 466 – 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

6.4.4.10   Profile 11h: DVD-R Sequential recording

Logical Units identifying Profile 11h as current shall support the Features listed in Table 467:

Table 467 – 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

6.4.4.11 Profile 12h: DVD-RAM

Logical Units identifying Profile 12h as current shall support the Features listed in Table 468.

Table 468 – 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.

6.4.4.12 Profile 13h: DVD-RW Restricted Overwrite

Logical Units identifying Profile 13h as current shall support the Features listed in Table 469.

Table 469 – 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

6.4.4.13 Profile 14h: DVD-RW Sequential recording

Logical Units identifying Profile 14h as current shall support the Features listed in Table 467:

Table 470 – 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

6.4.4.14 Profile 1Ah: DVD+RW

Logical Units identifying Profile 001Ah as current shall support the features listed in Table 471.

Table 471 – 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	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
010Ah	DCBs	The ability to read and optionally write DCBs.

6.4.4.15 Profile 20h: DDCD-ROM

Logical Units identifying Profile 20h as current shall support the Features listed in Table 472.

Table 472 – 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

6.4.4.16 Profile 21h: DDCD-R

Logical Units identifying Profile 20h as current shall support the Features listed in Table 473.

Table 473 – 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

6.4.4.17 Profile 22h: DDCD-RW

Logical Units identifying Profile 20h as current shall support the Features listed in Table 474.

Table 474 – 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

6.4.4.18 Profile FFFFh: Logical Units Not Conforming to a Standard Profile

Logical Units identifying Profile FFFFh as current shall support the Features listed in Table 475 .

Table 475 – 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

(Normative)

SK, ASC and ASCQ Combinations for MMC

A.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.

A.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.

A.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:

Table A.1 – Logical Unit Sense Key, ASC and ASCQ Assignments, lists all errors.

Table A.2 – Logical Unit General Errors, lists errors that may occur at any time, typically in response to a protocol or hardware error or user intervention.

Table A.3 – Media Access Errors, lists errors that may be generated by media access commands of any type (read of control or user data or writing of control or data area).

Table A.4 – Logical Unit Write Errors, describes errors that may be generated by commands that cause user or control data to be written to the medium.

Table A.5 – Logical Unit Fixation Errors, describes errors that may be generated by commands that cause the Logical Unit session to be closed.

Table A.1 – Logical Unit Sense Key, ASC and ASCQ Assignments

Sense Key	ASC	ASCQ	Description
0	00	00	NO ADDITIONAL SENSE INFORMATION
B	00	06	I/O PROCESS TERMINATED
5	00	11	AUDIO PLAY OPERATION IN PROGRESS
5	00	12	AUDIO PLAY OPERATION PAUSED
5	00	13	AUDIO PLAY OPERATION SUCCESSFULLY COMPLETED
5	00	14	AUDIO PLAY OPERATION STOPPED DUE TO ERROR
5	00	15	NO CURRENT AUDIO STATUS TO RETURN
4	00	17	CLEANING REQUESTED
3	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

Notes:

1. All values are in hexadecimal

2. When no value for SK is given, the error is applicable to multiple sense keys.

Table A.1 – Logical Unit Sense Key, ASC and ASCQ Assignments (cont.)

Sense Key	ASC	ASCQ	Description
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

Notes:

1.   All values are in hexadecimal

2.   When no value for SK is given, the error is applicable to multiple sense keys.

Table A.1 – Logical Unit Sense Key, ASC and ASCQ Assignments (cont.)

Sense Key	ASC	ASCQ	Description
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

Notes:

1. All values are in hexadecimal

2. When no value for SK is given, the error is applicable to multiple sense keys.

Table A.1 – Logical Unit Sense Key, ASC and ASCQ Assignments (cont.)

Sense Key	ASC	ASCQ	Description
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
	34	00	ENCLOSURE FAILURE
	35	00	ENCLOSURE SERVICES FAILURE
	35	01	UNSUPPORTED ENCLOSURE FUNCTION
	35	02	ENCLOSURE SERVICES UNAVAILABLE
	35	03	ENCLOSURE SERVICES TRANSFER FAILURE
	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

Notes:

1.   All values are in hexadecimal

2.   When no value for SK is given, the error is applicable to multiple sense keys.

Table A.1 – Logical Unit Sense Key, ASC and ASCQ Assignments (cont.)

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.

Table A.1 – Logical Unit Sense Key, ASC and ASCQ Assignments (cont.)

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.

Table A.2 – Logical Unit General Errors

Sense Key	ASC	ASCQ	Description
0	00	00	NO ADDITIONAL SENSE INFORMATION
B	00	06	I/O PROCESS TERMINATED
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
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
6	0A	00	ERROR LOG OVERFLOW
1	0B	00	WARNING
1	0B	01	WARNING - SPECIFIED TEMPERATURE EXCEEDED
1	0B	02	WARNING - ENCLOSURE DEGRADED
5	1A	00	PARAMETER LIST LENGTH ERROR
4	1B	00	SYNCHRONOUS DATA TRANSFER ERROR
5	20	00	INVALID COMMAND OPERATION CODE
5	24	00	INVALID FIELD IN CDB
5	25	00	LOGICAL UNIT NOT SUPPORTED
5	26	00	INVALID FIELD IN PARAMETER LIST
5	26	01	PARAMETER NOT SUPPORTED
5	26	02	PARAMETER VALUE INVALID
6	28	00	NOT READY TO READY CHANGE, MEDIUM MAY HAVE CHANGED
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	2F	00	COMMANDS CLEARED BY ANOTHER INITIATOR

Notes:

1. All values are in hexadecimal

2. When no value for SK is given, the error is applicable to multiple sense keys.

Table A.2 – Logical Unit General Errors (cont.)

Sense Key	ASC	ASCQ	Description
	34	00	ENCLOSURE FAILURE
	35	00	ENCLOSURE SERVICES FAILURE
	35	01	UNSUPPORTED ENCLOSURE FUNCTION
	35	02	ENCLOSURE SERVICES UNAVAILABLE
	35	03	ENCLOSURE SERVICES TRANSFER FAILURE
	35	04	ENCLOSURE SERVICES TRANSFER REFUSED
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
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
6	5A	00	OPERATOR REQUEST OR STATE CHANGE INPUT
6	5A	01	OPERATOR MEDIUM REMOVAL REQUEST
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
6	5D	00	FAILURE PREDICTION THRESHOLD EXCEEDED
6	5D	FF	FAILURE PREDICTION THRESHOLD EXCEEDED (FALSE)
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.

Table A.3 – Media Access Errors

Sense Key	ASC	ASCQ	Description
4	00	17	CLEANING REQUESTED
3	02	00	NO SEEK COMPLETE
3	06	00	NO REFERENCE POSITION FOUND
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
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
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
5	21	00	LOGICAL BLOCK ADDRESS OUT OF RANGE

Notes:

1. All values are in hexadecimal

2. When no value for SK is given, the error is applicable to multiple sense keys.

Table A.3 – Media Access Errors (cont.)

Sense Key	ASC	ASCQ	Description
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	07	CLEANING FAILURE
3	31	00	MEDIUM FORMAT CORRUPTED
2	3A	00	MEDIUM NOT PRESENT
2	3A	01	MEDIUM NOT PRESENT - TRAY CLOSED
2	3A	02	MEDIUM NOT PRESENT - TRAY OPEN
3	57	00	UNABLE TO RECOVER TABLE-OF-CONTENTS
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	64	00	ILLEGAL MODE FOR THIS TRACK
3	73	00	CD CONTROL ERROR

Notes:

1. All values are in hexadecimal

2. When no value for SK is given, the error is applicable to multiple sense keys.

Table A.4 – Logical Unit Write Errors

Sense Key	ASC	ASCQ	Description
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
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
2	30	04	CANNOT WRITE MEDIUM – UNKNOWN FORMAT
2	30	05	CANNOT WRITE MEDIUM – INCOMPATIBLE FORMAT
5	30	08	CANNOT WRITE – APPLICATION CODE MISMATCH
5	30	09	CURRENT SESSION NOT FIXATED FOR APPEND
5	30	10	MEDIUM NOT FORMATTED
6	5A	02	OPERATOR SELECTED WRITE PROTECT
6	5A	03	OPERATOR SELECTED WRITE PERMIT
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

Notes:

1. All values are in hexadecimal

2. When no value for SK is given, the error is applicable to multiple sense keys.

Table A.5 – Logical Unit Fixation Errors

Sense Key	ASC	ASCQ	Description
5	2C	03	CURRENT PROGRAM AREA IS NOT EMPTY
5	2C	04	CURRENT PROGRAM AREA IS EMPTY
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

Notes:

1. All values are in hexadecimal

2. When no value for SK is given, the error is applicable to multiple sense keys.

Annex B
(normative)
ATAPI Compliance

B.1 Introduction

This section describes the implementation of the MultiMedia Commands in ATAPI devices. The intent is to make the command sets highly compatible. It may be desired that a common device driver exist to control both SCSI and ATAPI devices.

B.2 General

ATAPI devices implement a subset of SCSI behavior. Certain errors and conditions that exist in SCSI 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.

B.2.1 Terms

B.2.1.1 Initiator

the ATAPI equivalent for the SCSI term "Initiator."

B.2.1.2 Device

the ATAPI equivalent for the SCSI term "Target" or "Logical Unit."

B.2.1.3 Command Packet

the ATAPI equivalent for the SCSI term "Command Descriptor Block."

B.2.2 Supported Block Sizes

ATAPI does not use the block size in the mode select block descriptor. Instead, the block size shall be determined by the command. The READ Command shall return 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.

B.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.

B.2.4 Multi-Initiator Environment

A multi-Initiator environment cannot exist in ATAPI. Therefore, conditions that occur only in multi-Initiator environments cannot occur. For example, there is no way in ATAPI to produce a reservation conflict, or for another Initiator to change common mode parameters. The descriptions of these conditions in SCSI shall be ignored in ATAPI implementations.

B.2.5   Command Packet Padding

All ATAPI commands are twelve bytes long. SCSI commands are six, ten, or twelve bytes long. To build the appropriate ATAPI Command Packet, padding bytes shall be added to the six and ten byte SCSI Command Descriptor Blocks. Six byte commands shall have six padding bytes added. Ten byte commands shall have two padding bytes added. These pad bytes shall have a value of zero.

The Control byte shall be reserved and set to zero.

B.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 C

(normative)

Requirements for SBP-2 Compliance

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.

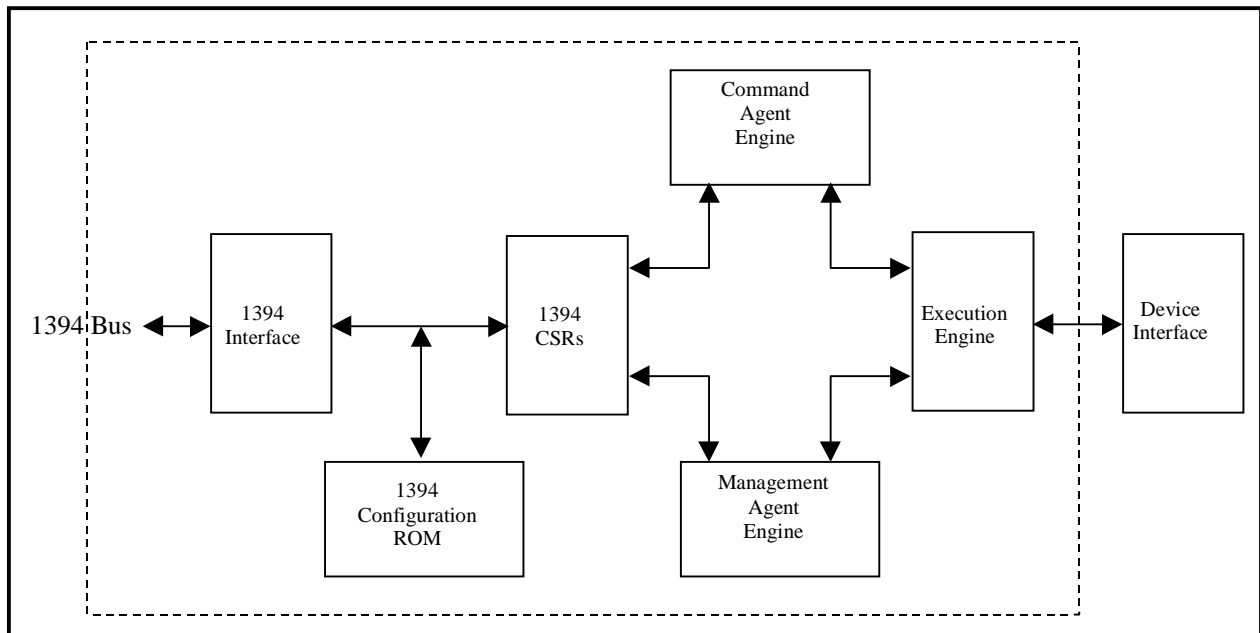- The device does not support isochronous data transfers.

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
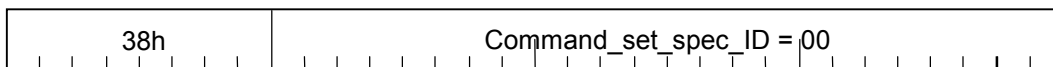
C.3.2 Unit Directory - Command_Set

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
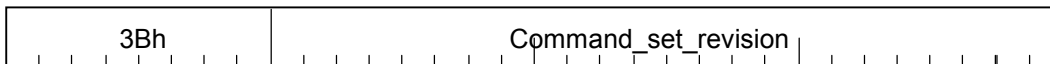
C.3.4 Unit Directory - Logical_Unit_Number

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
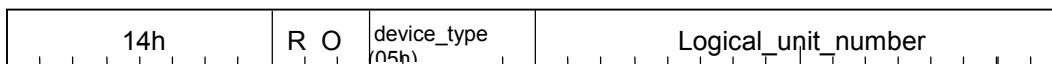
R in the figure above indicates reserved bits.

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						
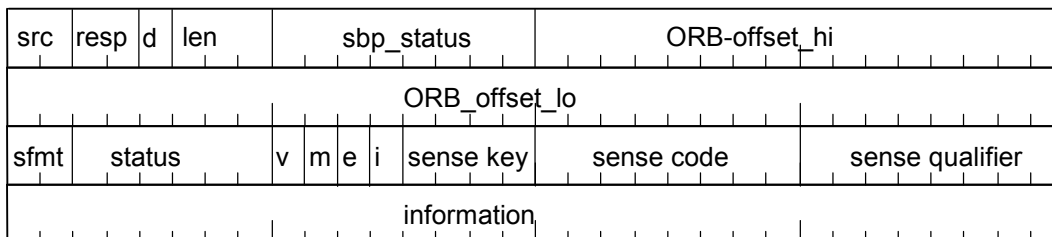
C.7 Unsolicited Status support (normative)

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

(normative)

Requirements for Fibre Channel Protocol for SCSI Compliance

D.1 Introduction

This Annex describes the implementation of the MultiMedia Commands in Fibre Channel devices. The intent is to highlight the concerns of implementation of the command set using the Fibre Channel Protocol (FCP). The Fibre Channel Protocol for SCSI (ANSI Standard *X3.269:1996*) was referenced for the writing of this Annex.

D.2 General

Certain terms are used in FCP in addition to the related SCSI terms. The mechanisms for transporting the commands, data, and status are unique to each transport. FCP differs from other transports such as SBP-2, SCSI, etc. Addressing of units is also unique to each transport. MMC does not directly specify any of these mechanisms; the command and data layer definition may be layered on either transport.

D.2.1 Terms

D.2.1.1 Originator

the FCP equivalent for the SCSI term "Initiator."

D.2.1.2 Responder

the FCP equivalent for the SCSI term "Target" or "Logical Unit."

D.2.1.3 Information Unit (IU)

similar to the SCSI phases. Carried in FCP frames.

D.2.2 Information Units

CDBs are transferred from the initiator to target using FCP_CMND IUs. Responses to these commands are returned in the FCP_RSP IUs. For write operations, a CDB and associated data may be transferred in a single IU possibly followed by subsequent FCP_DATA IUs. For read operations, the final IU may contain both the FCP_DATA and FCP_RSP.

D.2.3 Process login/logout

Before any commands can be issued, the FCP link-level protocol of Process login (PRLI) shall be completed between the initiator and target. This can be accomplished either implicitly via external conventions or explicitly using IUs. The first command that completes after a PRLI shall generate a Unit Attention condition with an ASC of Reset Occurred (ASC=29h, ASCQ=00h).

D.2.4 Sense Information

FCP devices always use auto-sense to report the sense data associated with a CHECK CONDITION status in an FCP_RSP_IU. This replaces the most common but not the only use of the REQUEST SENSE command.

D.2.5 Reset Mapping

FCP initiators use the FCP_CNTL field contained within the FCP_CMND IU to reset the FCP targets. Byte 2, bit 5 of the FCP_CNTL field represents a TARGET RESET that shall be mapped to a Hard Reset for MMC-2 targets. Byte 2, bit 2 of the FCP_CNTL field represents a CLEAR

TASK SET that shall be mapped to a Device Reset for MMC-2 targets. Byte 2, bit 1 of the FCP_CNTL field represents an ABORT TASK SET that shall be mapped to a Device Reset for MMC-2 targets.

Annex E

(normative)

SPI (SCSI Parallel Interface) Implementation Notes

E.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.

E.2   SCSI Signal Utilization

 Logical Unit shall utilize the same signals and timing from the SCSI Standard and Extensions.

E.3   SCSI Compatibility

E.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.

E.4   Reset Functionality

This sub-clause describes the functionality of the various resets implemented in SCSI.

E.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).

E.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.

E.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.

E.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

E.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.

E.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 F

(normative)

Power Management Functions

F.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.

F.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.

F.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.
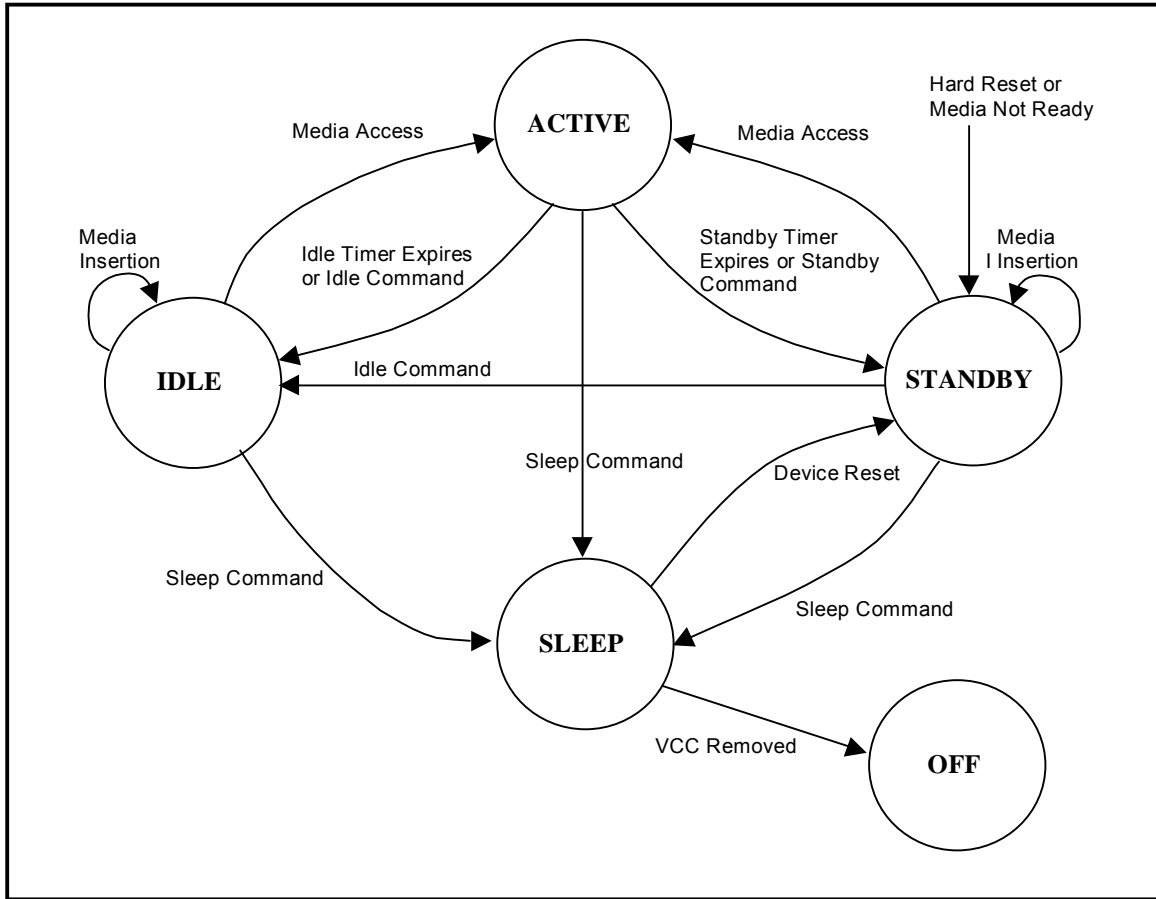
Figure F.1 – Power Management STATE Diagram

F.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.

F.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	

F.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 G

(Informative)

SCSI Command Listings

G.1 Lists of SCSI Commands

Table G.1 lists the commands that may be implemented when claiming compliance with SCSI interface. The listed commands are common to all SCSI devices. When the physical interface is SCSI the requirements listed as mandatory apply.

Table G.1 – Commands Common to all SCSI Devices

Command Name	Operation Code	Requirements	SCSI Ref Std
INQUIRY	12h	M	SPC
LOG SELECT	4Ch	O	SPC
LOG SENSE	4Dh	O	SPC
MODE SELECT (10)	55h	X	SPC
MODE SELECT (6)	15h	X	SPC
MODE SENSE (10)	5Ah	X	SPC
MODE SENSE (6)	1Ah	X	SPC
PREFETCH	34h	X	SBC
PREVENT ALLOW MEDIUM REMOVAL	1Eh	X	SPC
READ (10)	28h	X	SBC
READ (12)	A8h	X	SBC
READ (6)	08h	X	SBC
READ BUFFER	3Ch	O	SPC
READ LONG	3Eh	X	SBC
RECEIVE DIAGNOSTIC RESULTS	1Ch	O	SPC
RELEASE (10)	57h	X	SPC
RELEASE(6)	17h	X	SPC
REQUEST SENSE	03h	X	SPC
RESERVE(10)	56h	X	SPC
RESERVE(6)	16h	X	SPC
Key:			
M = command implementation is mandatory			
O = command implementation is optional			
X = command implementation is device type specific			

Table G.1 – Commands Common to all SCSI Devices (continued)

Command Name	Operation Code	Requirements	SCSI Ref Std
SEEK (10)	2Bh	X	SBC
SEEK (6)	0Bh	X	SCSI-2
SEND DIAGNOSTIC	1Dh	O	SPC
SET LIMITS (10)	33h	X	SBC
SET LIMITS (12)	B3h	X	SBC
START STOP UNIT	1Bh	X	SBC
TEST UNIT READY	00h	M	SPC
VERIFY (10)	2Fh	X	SBC
VERIFY (12)	AFh	X	SBC
WRITE BUFFER	3Bh	X	SPC
Key: M = command implementation is mandatory O = command implementation is optional X = command implementation is device type specific			

The following command codes are vendor-specific:

02h,

05h,

06h,

09h,

0Ch through 11h,

13h,

14h,

19h,

20h through 24h,

26h,

27h,

29h,

and C0h through FFh.

Annex H

(Informative)

Implementation of Features

H.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

H.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.

H.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.

H.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.

H.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 I
(Informative)
MMC Command Listings

Table I.1 – Multimedia Commands - Alphabetically

Command Name	Op Code	Reference
BLANK	A1h	5.2
CLOSE TRACK/SESSION	5Bh	5.3
FORMAT UNIT	04h	5.4
GET CONFIGURATION	46h	5.5
GET EVENT/STATUS NOTIFICATION	4Ah	5.6
GET PERFORMANCE	ACh	5.7
INQUIRY	12h	SPC
LOAD/UNLOAD CD/DVD	A6h	5.8
MECHANISM STATUS	BDh	5.9
MODE SELECT (10)	55h	SPC
MODE SENSE (10)	5Ah	SPC
PAUSE/RESUME	4Bh	5.10
PLAY AUDIO (10)	45h	5.11
PLAY AUDIO (12)	A5h	5.12
PLAY AUDIO MSF	47h	5.13
PREVENT ALLOW MEDIUM REMOVAL	1Eh	SPC
READ (10)	28h	SPC
READ (12)	A8h	5.14
READ BUFFER CAPACITY	5Ch	5.15
READ CAPACITY	25h	5.16
READ CD	BEh	5.17
READ CD MSF	B9h	5.18
READ DISC INFORMATION	51h	5.19
READ DVD STRUCTURE	ADh	5.20
READ FORMAT CAPACITIES	23h	5.21
READ SUB-CHANNEL	42h	5.22
READ TOC/PMA/ATIP	43h	5.23
READ TRACK INFORMATION	52h	5.24
REPAIR TRACK	58h	0
REPORT KEY	A4h	5.26
REQUEST SENSE	03h	SPC
RESERVE TRACK	53h	5.27
SCAN	BAh	5.28
SEEK (10)	2Bh	SBC
SEND CUE SHEET	5Dh	5.29
SEND DVD STRUCTURE	BFh	5.30
SEND EVENT	A2h	5.31
SEND KEY	A3h	5.32
SEND OPC INFORMATION	54h	5.33
SET CD SPEED	BBh	5.34

Table I.1 – Multimedia Commands – Alphabetically (cont.)

Command Name	Op Code	Reference
SET READ AHEAD	A7h	5.35
SET STREAMING	B6h	5.36
START STOP UNIT	1Bh	SBC
STOP PLAY/SCAN	4Eh	5.37
SYNCHRONIZE CACHE	35h	5.38
TEST UNIT READY	00h	SPC
VERIFY (10)	2Fh	SBC
WRITE (10)	2Ah	5.39
WRITE (12)	AAh	5.40
WRITE AND VERIFY (10)	2Eh	5.41

Table I.2 – Multimedia Commands - by OpCode

Command Name	Op Code	Reference
TEST UNIT READY	00h	SPC
REQUEST SENSE	03h	SPC
FORMAT UNIT	04h	5.4
INQUIRY	12h	SPC
START STOP UNIT	1Bh	SBC
PREVENT ALLOW MEDIUM REMOVAL	1Eh	SPC
READ FORMAT CAPACITIES	23h	5.21
READ CAPACITY	25h	5.16
READ (10)	28h	SPC
WRITE (10)	2Ah	5.39
SEEK (10)	2Bh	SBC
WRITE AND VERIFY (10)	2Eh	5.41
VERIFY (10)	2Fh	SBC
SYNCHRONIZE CACHE	35h	5.38
READ SUB-CHANNEL	42h	5.22
READ TOC/PMA/ATIP	43h	5.23
PLAY AUDIO (10)	45h	5.11
GET CONFIGURATION	46h	5.5
PLAY AUDIO MSF	47h	5.13
GET EVENT/STATUS NOTIFICATION	4Ah	5.6
PAUSE/RESUME	4Bh	5.10
STOP PLAY/SCAN	4Eh	5.37
READ DISC INFORMATION	51h	5.19
READ TRACK INFORMATION	52h	5.24
RESERVE TRACK	53h	5.27
SEND OPC INFORMATION	54h	5.33
MODE SELECT (10)	55h	SPC
REPAIR TRACK	58h	0
MODE SENSE (10)	5Ah	SPC
CLOSE TRACK/SESSION	5Bh	5.3

Table I.2 – Multimedia Commands - by OpCode (cont.)

Command Name	Op Code	Reference
READ BUFFER CAPACITY	5Ch	5.15
SEND CUE SHEET	5Dh	5.29
BLANK	A1h	5.2
SEND EVENT	A2h	5.31
SEND KEY	A3h	5.32
REPORT KEY	A4h	5.26
PLAY AUDIO (12)	A5h	5.12
LOAD/UNLOAD CD/DVD	A6h	5.8
SET READ AHEAD	A7h	5.35
READ (12)	A8h	5.14
WRITE (12)	AAh	5.40
GET PERFORMANCE	ACh	5.7
READ DVD STRUCTURE	ADh	5.20
SET STREAMING	B6h	5.36
READ CD MSF	B9h	5.18
SCAN	BAh	5.28
SET CD SPEED	BBh	5.34
MECHANISM STATUS	BDh	5.9
READ CD	BEh	5.17
SEND DVD STRUCTURE	BFh	5.30

Annex J

(informative)

CD-TEXT Format in the Lead-in Area

This annex explains the CD-TEXT information that is stored in the Lead-in Area as raw R-W Sub-channel data. The information here is stored in a memory and can be retrieved to the Initiator immediately.

The CD-TEXT information in the Lead-in area is retrieved from raw R-W Sub-channel data. The data format of RAW Sub-channel is explained in . 6 bits of each byte are R-W Raw data and it is converted from 6 bits to 8 bits from the 1st bytes, it makes 4 chunk of 18 bytes data. Each 18 bytes of data is called CD-TEXT Pack Data as shown in Table J.1 CD-TEXT information is recorded repeatedly in the Lead-in area and this one repeated data is called Text Group. Text Group consists of up to 8 types of language Blocks. Each Block represents one language and consists of maximum 255 Pack Data. Table J.1 defines the contents of one Pack Data.

Table J.1 – CD-TEXT Pack Data format for the Lead-in area

BYTE	CD-TEXT Pack Data Format
0	Header Field ID1: Pack Type Indicator
1	Header Field ID2: Pack Type Indicator
2	Header Field ID3: Pack Type Indicator
3	Header Field ID4: Block Number and Character Position Indicator
4	Text Data Field byte 0
5	Text Data Field byte 1
6	Text Data Field byte 2
7	Text Data Field byte 3
8	Text Data Field byte 4
9	Text Data Field byte 5
10	Text Data Field byte 6
11	Text Data Field byte 7
12	Text Data Field byte 8
13	Text Data Field byte 9
14	Text Data Field byte 10
15	Text Data Field byte 11
16	CRC Field byte 0 or Reserved
17	CRC Field byte 1 or Reserved

Pack is used to indicate the chunk of data in 18 bytes as shown above. Each Pack consists of a Header Field, Text Data Field and CRC Field.

Pack Type Indicator has the value and descriptions defined in

Table J.2 . Packs shall be encoded in the order of the items listed in the Table.

Table J.2 – Pack Type Indicator Definitions

Value	Descriptions
80h	Title of Album name(ID2=00h) or Track Titles (ID2=01h...63h)
81h	Name(s) of the performer(s) (in ASCII)
82h	Name(s) of the songwriter(s) (in ASCII)
83h	Name(s) of the composer(s) (in ASCII)
84h	Name(s) of the arranger(s) (in ASCII)
85h	Message(s) from content provider and/or artist (in ASCII)
86h	Disc Identification information
87h	Genre Identification and Genre information
88h	Table of Content information
89h	Second Table of Content information
8Ah	Reserved
8Bh	Reserved
8Ch	Reserved
8Dh	Reserved for content provider only
8Eh	UPC/EAN code of the album and ISRC code of each track
8Fh	Size information of the Block

The track Number Indicator is accompanied by 2 information fields. The MSB of this byte in the Extension Flag and is normally set to 0b. If it is set to 1b, the Pack is used for an extended application that is beyond the scope of this document. The rest of the byte is used for Track Number or Pack Element Number. Track Number is used when the Text Data field belongs to the track. If the Pack is independent of the Track, this field indicates Pack Element Number that depends on the type of the Pack.

Sequence Number Indicator is the number incrementally increased from the first Pack to the end in each Block. It starts from 00h to FFh.

Block Number and Character Position Indicator contains 3 fields of information defined in Table J.3.

Table J.3 – Block Number Character Position

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
DBCC	Block Number			Character Position			

Bit 7 is the Double Byte Character Code indication, that indicates if Text Data Field contains the Double Byte Character Code or not. If it is set to 0b, the Single Byte Character Code is used.

Bit 4 to 6, 3 bits, indicate the Block Number of the Block to which the Pack belongs. A Block is used to indicate a set of text information representing one particular language. It can be used up to 8 at the same time.

Bit 0 to Bit 3, indicate the Character Position. It is the number of character in the strings that belongs to the Text Data Field in the previous Pack. The Character Position starts from 0 to 15 and 15 indicates that the first character belongs to the one before the previous Pack. When the character code is double byte code, a set of 2 bytes in the Text Data Field is counted at one.

A null code is also counted as a character, that indicates termination of each strings.

Character Position is not used in Packs with ID1=88h, 89h and 8Fh. 00h shall be used in all these Packs.

A Text Data Field consists of 12 bytes. It contains either character strings or binary information depending on the type of Pack. All data in this field shall be transferred as recorded on the disc.

Packs except ID1=88h, 89h and 8Fh shall contains character strings in the Text Data Field. If Packs with ID1=80h to 85h, and 8Eh are used, a character strings for each track shall be provided.

A character string consists of series of characters and a terminator(One null code for single byte, two null code for double byte)`

The size of a character string is recommended to be less than 160 bytes. If a character string does not fit in a Text Data Field of a Pack, it is continued onto the succeeding Packs. The succeeding character string shall be encoded starting at the next byte in the Text Data Field after the terminator of the current string. Unused bytes in the Text Data Field shall be filled with null codes.

In case the same character stings is used for consecutive tracks, the Tab Indicator may be used to indicate the same as previous track. It is a single tab code (09h) for single byte codes, and two tab codes for double bytes character codes. It shall not used for the first track.

Packs with ID1=86h, 87h, 88h, 89h and 8Fh contains binary information in the Text Data Field.

CRC Field consists of 2 bytes. Initiator system may use these bytes to check errors in the Pack. The polynomial is $X^{16} + X^{12} + X^5 + 1$. All bits shall be inverted. This field is not mandatory for supporting CD-TEXT data.

Annex K

(Informative)

Using MRW Formatted Media

K.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.

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Next, examples of the data returned for:

> READ CAPACITY
>
> READ DISC INFORMATION
>
> READ TRACK INFORMATION
>
> READ TOC/PMA/ATIP

K.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.

K.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	xxxxxxxxh	Disc Identification: From PMA. This should be recorded when the MRW format begins.
13		
14		
15		
16	00612614h	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		
18		
19		
20	004B040Ch	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		
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.

K.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	00000000h	Track Start Address: This is given in LBA format. It is always zero for MRW.
9		
10		
11		
12	00000000h	Next Writable Address: Not valid on fixed packet formatted discs. Should be zero filled.
13		
14		
15		
16	00000000h	Free Blocks: Not valid on fixed packet formatted discs. Should be zero filled.
17		
18		
19		
20	00000020h	Fixed Packet Size: This value is 32 for CD MRW
21		
22		
23		
24	GAA: 1 024	Track Size: This is the number of user sectors in the track.
25	DMA: 259 616	
26		
27		
28	xxxxxxxxh	Last Recorded Address: Not required.
29		
30		
31		

K.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

K.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			

K.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			

K.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		MIN, SEC, FRAME
5	mm:ss:ff	Absolute address of current location
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		MIN, SEC, FRAME
5	mm:ss:ff	Absolute address of current location
6		
7	0	ZERO
8		PMIN, PSEC, PFRAME
9	75:05:51	Start time of lead-out
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		PMIN, PSEC, PFRAME
9	97:38:20	Address of first lead-in according to ATIP
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

K.1.4.4   Form 3: PMA

Reporting of the PMA values is not changed due to the MRW format.

K.1.4.5   Form 4: ATIP

Reporting of the ATIP values is not changed due to the MRW format.

K.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.

K.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.

K.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

COMBINATIONS		SOFTWARE	
		Legacy Software System	MRW Aware Software System
H A R D W A R E	Legacy CD-ROM Logical Unit (Multi-read capable)	1A	1B
	MRW Compliant CD-ROM Logical Unit	2A	2B
	Legacy CD-RW Logical Unit (at least MMC1)	3A	3B
	MRW Compliant CD-RW Logical Unit	4A	4B

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

K.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).

K.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.

K.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.

K.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.

K.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.

K.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.

K.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.

K.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.

K.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.

K.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.

K.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).

K.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.

K.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.

6.4.4.18.1 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.

K.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.

K.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.

K.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.

K.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 5.4.3.12.