Proposal for:

Revision 1.00
March 9, 1999 4:01 pm

Mt. Fuji Commands for Multimedia Devices

NCITS
T10/99-121R0

This document was developed by a group known as the “Mt. Fuji Group.” This group consisted of DVD drive manufacturers, operating system vendors, independent software developers, and other DVD affiliated companies. This document is intended to be a specification, and thus limits implementation in many cases that the SCSI standards would not restrict.

This document is the basis for changes made to MMC to generate MMC-2. MMC-2 lifts some of the restrictions presented in this specification, allowing more flexibility in implementation.

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1.0 Introduction

This document provides a Command set for a variety of multimedia devices. Previous standards contained descriptions applicable to only one interface, such as ATAPI or SCSI. This specification documents how to Command a Logical Unit regardless of the type of interface used. However, while every attempt was made to make the Command sets common across interfaces, different operating behavior of various transports led to implementation differences. These differences are highlighted in annexes.

DVD is the successor to CD. New CD/DVD (C/DVD) devices are capable of storing extremely large amounts of data, and in some cases will be able to play movies. Logical Units conforming to this specification will be backward compatible with CD Logical Units. This specification combines the capabilities and Command set of the CD with the new capabilities of DVD.

1.1 Abstract

This document defines a standard method for interfacing a storage device to a Host using various transports including ATAPI, SCSI, and IEEE 1394.

1.2 Scope

This document is intended to be used with external standards for the transport of Commands and data. It also lists several peer Command set standards as normative references. In the event of a conflict between one of the base documents and this document, the interpretation of this document ***shall*** prevail ***only if this document acknowledges that a conflict exists between the documents***.

1.3 Audience

This document is intended for use by computer system, Host software, storage peripheral, and interface chip set vendors.

1.4 Normative References

The following standards contain provisions which, when referenced in the text of this standard, constitute provisions of this Specification. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this Specification are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

- American National Standard Institute NCITS T10/1048D Revision 10.0a March 12, 1997, MMC
- DVD Book, DVD Forum
- ISO/IEC 10149:1989, Information technology - Data Interchange on Read-only 120 mm Optical Data Disks.
- IEC 908:1987, Compact Disc Digital Audio System.
- American National Standard Institute NCITS T13/2008D ATA/ATAPI-4.

1.5 Prerequisites and Related Documents

The reader is expected to have a basic understanding of the ATA/SCSI hardware and software interfaces as well as the ATA/SCSI Documents. Specifically, the following documents are required for understanding and implementing an ATA C/DVD because this document is based on them:

- CBEMA, ATA (AT Attachment) ANSI Draft Standard, Revision 9482K, December 2, 1994, Document Number X3T10/948, Computer and Business Equipment Manufacturer's Association. This is referred to as the ATA Document.
- ANSI X3T9.2/375R, Small Computer System Interface
- Red, Yellow, Green, Orange Books and CD-ROM XA Specification.

1.6 Layout of the Document

This document is broken into several sections as shown in Table 1.

Table 1 - Layout of the Document

Section 1.0, "Introduction" on page 25	Introduction, scope, purpose etc.
Section 2.0, "Conventions" on page 29	Describes conventions used in the document, and a definitions of terms and signals.
Section 3.0, "CD Model" on page 41	Description of Command and Media supported by C/DVD devices. This section provides a tutorial on the technology of CD as well as specific requirements for a device that supports the CD media.
Section 4.0, "DVD Model" on page 53	Description of Command and Media supported by C/DVD devices. This section provides a tutorial on the technology of DVD as well as specific requirements for a device that supports the DVD media.
Section 5.0, "AS-MO model" on page 129	Description of the use of AS-MO media.
Section 6.0, "Changer Model" on page 135	Description of the requirements and operation of devices that can select from a number of internally stored media.
Section 7.0, "Power Management Model" on page 141	Description of the requirements for power management for the C/DVD device.
Section 8.0, "Time-out and Reset Models" on page 149	Description of the requirements for time-outs and resets for the C/DVD device.
Section 9.0, "Features" on page 153	Description of Specific functionality that is implemented in groupings.
Section 10.0, "Profiles" on page 161	Description of Groupings of Features that can be supported.
Section 11.0, "Packet Commands" on page 167	Description of packet based Commands for C/DVD devices.
Appendix A - "Error Reporting and Sense Codes (Normative)" on page 437	Descriptions of error behavior and Sense Key, ASC, and ASCQ assignments
Appendix B - "ATAPI Implementation Notes (Normative)" on page 455	Overview of the Packet Interface and how the “Layering” of Packets and ATA occurs.
Appendix C - "SCSI Implementation Notes (Normative)" on page 467	Integration notes for devices that make use of the SCSI interface.
Appendix D - "IEEE 1394 Implementation Notes (Normative)" on page 473	Implemenation notes for using this Command set with IEEE 1394.
Appendix E - "Example Event Implementation Notes (Informative)" on page 477	Notes on using and implementing the GET EVENT/STATUS NOTIFICATION Command.
Appendix F - "Command Implementation Notes (Informative)" on page 479	Notes on using and implementing the READ DISC INFORMATION and READ TRACK/RZONE INFORMATION Commands.
Appendix G - "CD-Text Format in the Lead-In Area (Informative)" on page 487	Description of the CD-Text format.
Appendix H - "Mt. Fuji revision history (Informative)" on page 491	Revision history of the Mt. Fuji documents
Appendix I - "Sample Applications of Events (Informative)" on page 495	Application of Events
Appendix J - "UDF Key Structure (Informative)" on page 501	Notes on how to use this Command set to read UDF written media.

1.7 Document Conventions

This document was written for both the drive firmware designer and host software designers. Media specific information is given when it is helpful to the software designer, as it is assumed that the firmware designers have access to the appropriate media standards. All such information is informative, and where a conflict occurs between this documentation and the media documentation, the media documentation ***shall*** prevail.

A complete set of Commands is documented. However, Logical Units are not required to implement all Commands. The specific requirements for implementing Commands is listed within the Features of the GET CONFIGURATION Command. If a Command is implemented, it ***shall*** be implemented as defined.

Each Command is marked with a set of icons. The icons are informative. If an icon is grey, the Command is not required for that media type. If an icon is black, the Command is required or typically implemented for that media type. Drives that support more than one media type would have the overlapping set of Commands implemented.

1.8 Patents

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

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

1.9 Unresolved Issues

This section identifies issues which are still unresolved. In general the specification has undergone a major number of changes from the last published version. This version should be reviewed completely to understand the new capabilities. There are some major areas that remain unfinished with significant work remaining, including:

- Power State Timers effects from 1394 CSR actions need to be defined.
- Time-out model needs to be changed to allow the “Group 1 & 2” Commands to be specified in a device independent way. This will allow other devices to use this capability (e.g. Diskboys).
- Should an ANSI/ISO/SFF Registration be created for Vendor Unique fields of Features?
- What does Power Management do in a Logical Unit when both ATA and Packet style Commands are used is not defined well enough.

Refer to E-mail on the mtfuji2 Reflector (mtfuji2@dt.wdc.com) for details on each of the issues.

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2.0 Conventions

2.1 Document Conventions

Certain words and terms used in this document have specific meaning beyond the normal English meaning. These words and terms are defined either in this section or in the text where they first appear and are indicated with an initial capital. Names of signals, Commands, status, and sense keys are in all uppercase (e.g. REQUEST SENSE). Lower case is used for words having the normal English meaning.

Fields containing only one bit are usually referred to as the <name> bit instead of the <name> field. Numbers that are not immediately followed by a lower case b or h are decimal. Numbers immediately followed by a lower case b are in binary, and numbers immediately followed by a lower case h are in hexadecimal. The notation "Hex" may appear in the headings of tables, indicating that all numbers in the column are written in hexadecimal. (NNh for Hexadecimal, where NN refers to two hexadecimal digits 0-9, A-F.) All Sense Key information (written as N/NN/NN) is in Hexadecimal.

2.2 Definitions

2.2.1 Absolute M/S/F Field

See "MSF Address."

2.2.2 AGID (Authentication Grant ID)

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

2.2.3 ATA (AT Attachment)

ATA defines the physical, electrical, transport, and Command protocols for the internal attachment of block storage devices.

2.2.4 ATAPI (AT Attachment Packet Interface)

A device which complies with NCITS 317:199x, the AT Attachment Packet Interface. In this document such devices are referred to as devices implementing the Packet Command feature set.

2.2.5 Audio Sector

See "Sector."

2.2.6 BCA (Burst Cutting Area)

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

2.2.7 BCD (Binary Coded Decimal)

The number system used on the physical CD-ROM and CD-DA media. Numbers that use this notation have the "bcd" suffix attached. A byte has two 4-bit values, each of which can have a value from 0 to 9. The maximum value is 99bcd (99 decimal). BCD is only used on the physical CD Media.

2.2.8 Block

The term "Block" refers to data sent to/from the Host. The Block is data addressed by a Logical Block Address (LBA). Generally the amount of data in a Block is controlled by the Command.

2.2.9 Block Sync (SY0)

First frame sync (SY0) of the first sector of an ECC Block.

2.2.10 Book

Term that is used to indicate a book that specifies a CD or DVD standard.

2.2.11 Bordered Area (Border)

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

2.2.12 Border-in

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

2.2.13 Border-out

The area that follows each bordered area and contains the latest RMD copies and Next Border Markers. This area is used to avoid pickup overrunning for DVD Logical Units.

2.2.14 Border Recording

A method that is used for interchange of DVD-R media between DVD-R Logical Unit and DVD Logical Unit with Border Zone during incremental recording mode.

2.2.15 Border Zone

A generic term that is named for border-out and border-in.

2.2.16 BSGLL (Block Sync Guarantee Linking Loss)

An ECC Block that is used to guarantee that the following ECC Block(s) is(are) readable.

2.2.17 CD-DA

Compact Disc-Digital Audio (CD-DA) is a standardized medium for recording digital/audio information. The “Red Book” defines CD-DA media. See IEC 908:1987.

2.2.18 CD-R

Compact Disc-Recordable (CD-R) is a standardized medium defined by the “Orange Book Part 2.” The CD-R system gives the opportunity to write once and read many times CD information. The recorded CD-R disc may be Red Book compatible, so it can be played back on any conventional CD-player. The CD-R format gives the possibility for both Audio and Data recording.

2.2.19 CD-RW

Compact Disc-Rewritable (CD-RW) is a standardized medium defined by the “Orange Book Part 3.” The CD-RW system gives the opportunity to write, erase, overwrite and read CD information. The recorded CD-RW disc has a lower reflectivity than a `Red Book compatible' disc, so it must be played back on CD-RW enabled (MultiRead) CD-players. The CD-RW enabled CD-player can therefore read out CD-RW discs as well as CD-R and conventional CD discs. The CD-RW format gives the possibility for both Audio and Data recording.

2.2.20 CD-R/RW

Either a CD-R or CD-RW Device.

2.2.21 CD-ROM

Compact Disc-Read Only Memory (CD-ROM) is a standardized medium for recording digitized audio and digital data. CD-ROM is used to describe media with digital data rather than discs that encode audio only. The ISO/IEC 10149 standard defines CD-ROM media.

2.2.22 CD Control Field

The CD Control Field is a 4-bit field in the Q sub-channel data indicating the data type. It indicates audio versus data and the type of audio encoding, etc. The control field is also found in the table of contents entries.

2.2.23 CD Data Mode

A byte in the header of CD data sectors. This indicates if data is present and the format of the data.

2.2.24 CD Media

Term that is used when referring to media that conforms to the CD standards.

2.2.25 CD Standard

Comprised of one or more of the following documents available from Sony and Philips:

- Red Book, CD -DA
- Yellow Book, (ISO/IEC 10149) CD-ROM
- Orange book part 2, CD-Recordable and part 3 CD-Rewritable
- White book, CD-Video
- Green Book, CD Interactive, CD-I
- CD-ROM XA
- Enhanced Music CD Extra
- Multisession CD

2.2.26 CD Text

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

2.2.27 CDB (Command Descriptor Block)

The structure used to communicate Commands from a Host to a Logical Unit.

2.2.28 C/DVD Media

Term that is used when referring to media that conform either to the CD or DVD standards.

2.2.29 Challenge key

Data used during an authentication key exchange process.

2.2.30 Changer

“Changer” is a mechanical device which allows a single C/DVD device to load and unload multiple C/DVD media without user intervention.

2.2.31 CIRC (Cross Interleaved Reed-Solomon Code)

CIRC is the error detection and correction technique used within small frames of CD audio or data. The CIRC bytes are present in all CD-ROM data modes. The error correction procedure which uses the CIRC bytes is referred to as the CIRC based algorithm. In most CD-ROM drives, this function is implemented in hardware.

2.2.32 Command Packet

“Command Packet” is a structure used to communicate Commands from a Host to a Logical Unit. See Command Descriptor Block.

2.2.33 CSS (Content Scramble System)

A system for protection of movie content on DVD media.

2.2.34 Data Area

The area between the Lead-in area and the Lead-out area in which user data is recorded. In case of border recording, the Data Area contains Border Zones.

2.2.35 Data Recordable Area

The area on the unrecorded disc that is available to record the Data Area.

2.2.36 Data Sector

See “Sector.”

2.2.37 DVD Control Area

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

2.2.38 DVD Copyright Information

The DVD Copyright Information is recorded in the DVD Control Area and contain information supplied by the content provider.

2.2.39 Defect Management

Methods for handling the defective areas on media.

2.2.40 Disc

Media that adheres to one of the CD or DVD standards.

2.2.41 Disc at once recording

A method in which Lead-in, user data and Lead-out are recorded sequentially without interruption, and no pointer to a next possible session exists.

2.2.42 Disc Key

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

2.2.43 Double Sided

DVD disc structure is two transparent substrates joined together such that the recorded layers are on the inside. A double sided disc has two recorded sides.

2.2.44 Dual Layer

When there are exactly two recording layers accessible from a given side of the media. Layer 0 is closest to the read-out side of the media and layer 1 is further away.

2.2.45 DVD Disc Manufacturing Information

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

2.2.46 DVD Media

Term that is used when referring to media that conforms to the DVD standards.

2.2.47 DVD-R

DVD Recordable (DVD-R) is a standardized medium defined by the “DVD-Book”.

2.2.48 DVD-RAM

DVD-Random Access Memory (DVD-RAM) is a standardized medium defined by the “DVD-Book.” The media is to be written and read many times over the recording surface of the disc using the phase-change rewritable effect.

2.2.49 DVD+RW

DVD+ReWritable (DVD+RW) is a standardized medium defined by ECMA-274. The media may be written and read many times over the recording surface of the disc using the phase-change rewritable effect.

2.2.50 DVD Reference Code

The DVD Reference code is comprised of 2 ECC Blocks (32 sectors) in the Lead-in Area and used for the adjustment of the equalizer system of the drive hardware.

2.2.51 DVD-ROM

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

2.2.52 DVD Standard

Comprised of one or more of the following documents available from the DVD Forum:

- DVD Specification for Read only Disc part one Physical Specifications
- DVD Specification for Read only Disc part two File system specifications
- DVD Specification for Read only Disc part three Video Specifications
- DVD Specification for Read only Disc part ? Audio Specifications
- DVD Specification for Recordable Disc part one Physical Specifications
- DVD Specification for Recordable Disc part two File system specifications
- DVD Specification for Rewritable Disc part one Physical Specifications
- DVD Specification for Rewritable Disc part two File system specifications

2.2.53 EAN (European Article Number)

Controlled by the EAN Council located at Rue des Colonies, 54-BTE8, 1000 Brussels, Belgium.

2.2.54 ECC (Error Correction/Correcting Code)

Code for detecting and correcting errors in a data field.

2.2.55 ECC-Block

An ECC Block is a self-contained block of data and error correction codes. On DVD media, this is a group of 16 DVD sectors.

2.2.56 EDC (Error Detection Code)

Code for detecting an error in a data field.

2.2.57 Field

A Field is a group of one or more contiguous bits.

2.2.58 Format

The arrangement or layout of information on C/DVD media.

2.2.59 Frame

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

2.2.60 Groove

The wobbled guidance track on recordable media. e.g. CD-R and DVD-R, etc.

2.2.61 Hold Track State

When a C/DVD device enters the hold track state the optical pick-up is maintained at an approximately constant radial position on media. This allows a paused operation to be resumed without latency due to seeking. However, rotational latency may be incurred.

2.2.62 ID

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

2.2.63 IED (ID Error Detection code)

Code for detecting errors in an ID field on DVD media.

2.2.64 Incremental Recording

Recording of the disc by several distinct recording actions (for example, at different times using different recording drives). In this recording mode, the specified linking scheme ***shall*** be used.

2.2.65 Index

An index is a subdivision of a logical track. A track can have indices from 0 to 99. Index numbers within a track are sequential.

2.2.66 Invalid

Invalid refers to a reserved or unsupported field or code value.

2.2.67 Layer

The recorded information is in layers as seen from one side of a DVD Disc. There are single and dual layer Discs. In the case of dual layer Discs the data is recorded using either OTP or PTP.

2.2.68 LBA (Logical Block Address)

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

2.2.69 Lead-in Area

The CD Lead-in area is the area on a CD disc preceding the first track. The area 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 but is not directly addressable via the Command set. 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.

2.2.70 Lead-out Area

The CD Lead-out area is the area on a CD disc beyond the last information track. The main channel in the Lead-out area contains audio or data null information. This area is coded as track AAbcd but is not directly addressable via the Command set.

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) discs, or area comprising physical sectors 1.2 mm wide or more adjacent to the inside of the data area in layer 1 of OTP (Opposite Track Path) discs.

2.2.71 L-EC

Layered Error Correction (L-EC) is an error correction technique used with CD-ROM sectors.

2.2.72 Linking Loss Area

Area that is used for linking the new recording data after the previous recording data when incremental recording mode is selected.

2.2.73 Logical Block

See "Block."

2.2.74 Logical Track

A track is a logical sub-division of the CD media. A disc has from one to ninety-nine tracks. The data within a track is always of the same type. A track can be either CD-ROM or CD-Audio. A disc can start at any track number.

2.2.75 Logical Unit

A physical or virtual peripheral device addressable through a device.

2.2.76 LPP (Land Pre-Pit)

Pits embossed on land during the manufacture of a DVD-R disc substrate which contains address information.

2.2.77 LRA (Last Recorded Address)

LRA is the Logical Block Address of the last recorded user data Block.

2.2.78 LUN (Logical Unit Number)

The address of a Logical Unit.

2.2.79 Magazine

A container for multiple discs or cartridges.

2.2.80 Medium

A single Disc.

2.2.81 Middle Area

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

2.2.82 Morph

An Event that occurs whenever the data that would be reported by a GET CONFIGURATION Command changes.

2.2.83 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 bcd values from 0 through 79 in the user data area.

2.2.84 Next Border Marker

The sector that is a flag to indicate whether the next border exists or not.

2.2.85 One

"One" represents a true signal value or a true condition of value.

2.2.86 OPC (Optimum Power Calibration)

A process to determine the optimum recording power for a given disc/Logical Unit system.

2.2.87 OTP (Opposite Track Path)

An OTP disc has a Lead in, two separated user areas, Lead-out, and a Middle area. The physical sector number (PSN) of sectors in layer 0 increases toward the Middle Area. The physical sector number (PSN) of sectors in layer 1 are numbered with the complement of the layer 0 sector below it. The sector numbering in layer 1 increases from the middle area to the lead-out area.The relation between the Logical Block Address and the physical sector number is shown in Figure 7 - *Physical and Logical Layout of Opposite Track Path DVD-ROM Media* on page 57.

2.2.88 Output Port

The Output Port is a means for connecting to data ports other than the Host interface, e.g. Audio.

2.2.89 Page

Several Commands use regular parameter structures that are referred to as pages. These pages are identified with a value known as a page code.

2.2.90 Pause Area

A “Pause Area” is a transition area at the beginning or end of a CD audio track encoded with audio silence. This transition area is required where the CD audio track immediately precedes a CD data track.

2.2.91 PCA (Power Calibration Area)

Area used for Optimum Power Calibration. This area ends at the start of the RMA or PMA.

2.2.92 Phase-change

A physical effect in which a laser beam irradiated area of a recording film is heated so as to reversibly change from an amorphous state to a crystalline state, and vice versa.

2.2.93 Physical Track

A concept of a continuous spiral where the physical track begins at a point in the spiral continuing for 360 degrees along the spiral. A spiral contains multiple physical tracks.

2.2.94 PMA (Program Memory Area)

PMA is the area for temporary storage of Table of Contents entries. This area starts right after the PCA and it ends at the start of the Lead-in.

2.2.95 Post-gap Area

Post-gap Area is a transition area at the end of a data track and is encoded with null information. This transition area is required where the data track immediately precedes an audio track.

2.2.96 Pre-gap Area

Pre-gap Area is a transition area at the beginning of a data track and is encoded with null information. This transition area is required where the data track immediately follows an audio track.

2.2.97 Pre-Groove

The wobbled guidance track on recordable media. e.g. CD-R and DVD-R, etc.

2.2.98 Program Area

Contains the user data on CD media.

2.2.99 PSN (Physical Sector Number)

Each sector on DVD media is addressable by the Logical Unit using an address called the Physical Sector Number or PSN. Not all of these sectors are addressable using an LBA. In the SCSI world this address is normally called the Physical Block Address or PBA.

2.2.100 PTP (Parallel Track Path)

A PTP disc has a Lead in, user area and Lead-out in each layer respectively. The physical sector number (PSN) of both layers increase to the Lead-out in parallel. The relation between the Logical Block Address and the physical sector number is shown in Figure 6 - *Physical and Logical Layout of Parallel Track Path DVD-ROM Media* on page 56.

2.2.101 Read/Modify/Write

Read/Modify/Write operation is a type of write operation and performs the following operation.
- Read data from a medium into a data buffer using the smallest writable unit. e.g. Packet/ECC Block.
- Modify portions of that data with the data from the Host.
- Write these data to the medium using the smallest writable unit.

2.2.102 Reed-Solomon code

An error detection and/or correction code which is particularly suited to the correction of errors which occur in bursts or are strongly correlated.

2.2.103 Region Code

A value used to identify a region of the world for DVD. Currently, there are only six regions defined.

2.2.104 Relative M/S/F Field

See "MSF Address."

2.2.105 RMA (Recording Management Area)

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

2.2.106 RMD (Recording Management Data)

The data to be stored in RMA.

2.2.107 RPC (Regional Playback Control)

The technique used to prevent CSS movie content from being viewed outside the content provider's specified region(s) of the world.

2.2.108 RZone

Contiguous ECC Blocks assigned to user data.

2.2.109 Sector

For CD media, "Sector" refers to the data contained in one frame. In the CD-ROM standard document the term Block is used for this unit. Equivalent to an MSF Frame.

For DVD media, "Sector" is the smallest addressable part of a medium.

2.2.110 Scramble Flag

An indication that there is data on the media that has been scrambled using the CSS encryption technique.

2.2.111 Sequential Recording

A method for recording sectors contiguously onto the media.

2.2.112 Session

A contiguous area of a Disc that contains a lead-in, a Program Area (PA), and a lead-out.

2.2.113 Single Layer

There is exactly one recording layer accessible from a given side of the media.

2.2.114 Single Sided

The DVD disc mechanical structure of two transparent substrates joined together such that the recorded layers are on the inside. Single sided discs have one recorded side and one unrecorded side.

2.2.115 Sub-channel

CD media have a main channel and a sub-channel. The sub-channel area has eight parts called P, Q, R, S, T, U, V, and W. The Q-sub-channel contains information useful to the controller and drive, such as the control field and MSF addresses.

2.2.116 SY0

See “Block Sync.”

2.2.117 Title Key

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

2.2.118 TOC (Table Of Contents)

The table of contents has information on the type of disc and the starting address of the tracks. This information is encoded in the Q sub-channel, in the Lead-in area of CD media.

2.2.119 Track Relative Logical Address

An address of a Logical Blocks relative to the beginning of a logical track.

2.2.120 Transition Area

Sector at the beginning or end of logical tracks e.g. Pause Area, Pre-Gap, Lead-Out, Post-gap that are coded with null information are called transition areas. Where required by the media standards, these areas have minimum lengths. The maximum lengths are not specified. Transition areas at the beginning of a logical track are encoded with index zero.

2.2.121 UPC (Uniform Product Code)

Controlled by the UPC Council, located at 8163 Old Yankee Road, Suite J, Dayton, Ohio 45459.

2.2.122 User Data

The data that is normally transferred across the Logical Unit interface by and for read and write Commands.

2.2.123 Volume

1. A side of a medium. 2. The perceived loudness of audio.

2.2.124 Write back cache

During write operation, the data that is to be written to the medium is first stored in the cache memory, then written to the medium at a later time. The Command may complete prior to the data being written to the medium.

2.2.125 Zero

Zero is a false signal value or a false condition of a variable.

2.3 Keyword Definitions

Several keywords are used to differentiate between different levels of requirements and optionality, as follows:

2.3.1 expected

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

2.3.2 may

A keyword that indicates flexibility of choice with no implied preference.

2.3.3 shall

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

2.3.4 should

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

2.3.5 obsolete

A keyword indicating items that were defined in prior standards but have been removed from this document.

2.3.6 mandatory

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

2.3.7 optional

A keyword that describes features which are not required to be implemented by this specification. However, if any optional feature defined by the specification is implemented, it ***shall*** be implemented as defined by the specification. Describing a feature as optional in the text is done to assist the reader. If there is a conflict between text and tables on a feature described as optional, the table ***shall*** be accepted as being correct.

2.3.8 reserved

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

2.4 Symbols and Abbreviations

LSB Least Significant Bit

MSB Most Significant Bit

This Page Intentionally Left Blank

3.0 CD Model

Data transfer can begin with any of the consecutively numbered logical blocks. Data on CD Logical Units is addressed the same as for (magnetic) direct-access Logical Units. Some CD Logical Units support a separate information stream (e.g. audio and/or video but referred to as audio in this Section) transmitted via a connection other than the ATA Bus. This specification defines Commands for controlling these other information streams for CD Logical Units.

CD Logical Units are designed to work with any disc that meets IEC 908. Many new Logical Units read CD data discs, digital audio discs, and audio-combined discs (i.e. some Tracks are audio, some Tracks are data).

3.1 CD Media Organization

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

Discs may contain either audio, data or a mixture of the two. Table 2 gives an example of an audio-combined disc to illustrate the relationship between the logical block addresses reported and the MSF address encoded on the media.

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

Table 2 - Example Mixed Mode CD Disc Layout

Block Description	Logical Address (Decimal)	Absolute MSF Address[a] (Hex)	Track and Index	Sector is Info or is Pause	Mode Audio or Data	CD-ROM Data Mode[b]
Lead-in area[c]	---	---	0/-	---	Audio	---
Pre-gap[c]	---	00/00/00	1/0	Pause	Data	Null
1st Track data	0000[d]	00/02/00[e]	1/1	Info	Data	L-EC
2nd Track data	6000[d]	01/16/00[e]	2/1	Info	Data	L-EC
	7500	01/2A/00	2/2	Info	Data	L-EC
Post-gap	9000	02/02/00	2/3	Pause	Data	Null
Pause-silence	9150	02/04/00	3/0	Pause	Audio	---
3rd Track audio	9300	02/06/00	3/1	Info	Audio	---
	11400	02/22/00	3/2	Info	Audio	---
4th Track audio	21825	04/35/00	4/1	Info	Audio	---
Pre-gap part 1	30000	06/2A/00	5/0	Pause	Audio	---
Pre-gap part 2	30075	06/2B/00	5/0	Pause	Data	Null
5th Track data	30225	06/2D/00	5/1	Info	Data	L-EC
Last information	263999	3A/29/4A	5/1	Info	Data	L-EC
Post-gap	264000	3A/2A/00	5/2	Pause	Data	Null
Lead-out Track	264150	3A/2C/00[f]	AA/0	Pause	Audio	---

a. Absolute MSF address repeated in the header field of data blocks.
b. The CD-ROM data mode is stored in the header of data Tracks. This indicates that the block is part of a data pre-gap or post-gap (null), that this is a data block using the auxiliary field for L-EC symbols (ECC - CD-ROM data mode one), or that this is a data block using the auxiliary field for user data (CD-ROM data mode two).

c. Table of contents information is stored in the sub-channel of lead-in area. The lead-in area is coded as Track zero. Track zero and the initial 150 sector pre-gap (or audio pause) are not accessible with logical addressing.
d. Exact value returned by READ TOC/PMA/ATIP Command.
e. Value stored in Table of Contents with zero tolerance.
f. Value stored in Table of Contents; exact, if lead-out Track is coded as data, or plus or minus 75 blocks if coded as audio.

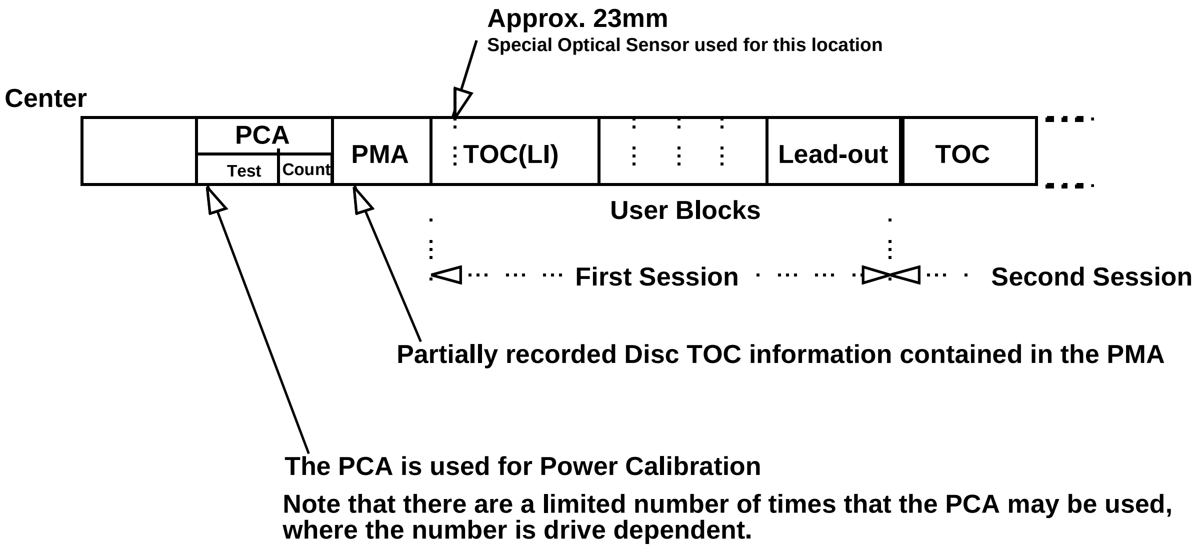

Figure 1 - CD-R/RW Disc Layout

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

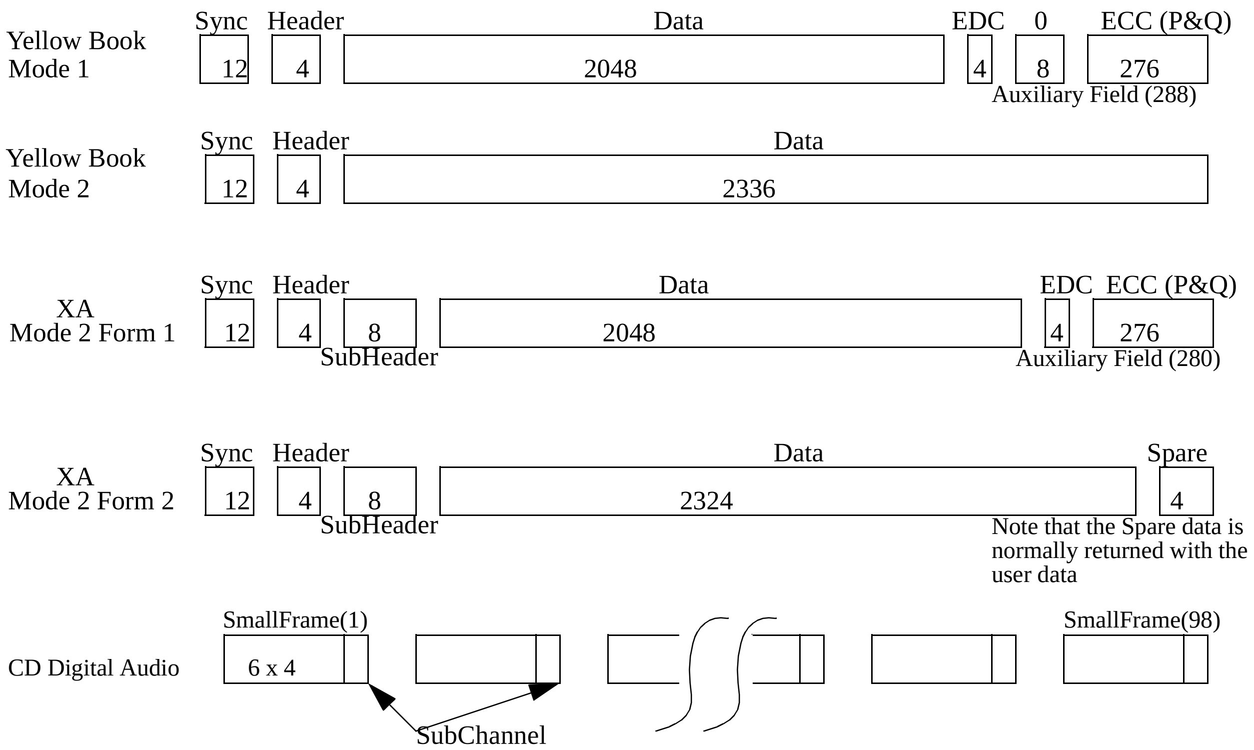

Figure 2 - CD-ROM Sector Formats

A CD logical sector size is 2048, 2052, 2056, 2324, 2332, 2336, 2340 or 2352 bytes per sector. These values correspond to the user data plus various configurations of header, subheader and EDC/ECC.

This same area of the CD-ROM or CD audio media may store 1/75th of a second of two channel audio information formatted according to the CD-DA specification. (These audio channels are usually the left and right components of a stereo pair.) An audio only density code value can be used to declare an area of the media to be invalid for data operations.

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

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

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

The CD media standards require transition areas between Tracks encoded with different types of information. In addition, transition areas may be used at the beginning or end of any Track. For audio Tracks the transition areas are called pause areas. For data Tracks, transition areas are called pre-gap and post-gap areas. See Table 2 - *Example Mixed Mode CD*

Disc Layout on page 41 for an example. The IEC 908 and ISO/IEC 10149 standards specify minimum time durations for these areas. Maximum time durations are not specified.

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

CD is unique in the respect that some logical blocks on a disc may not be accessible by all Commands. SEEK Commands may be issued to any logical block address within the reported capacity of the disc. READ (10) Commands cannot be issued to logical blocks that occur in some transition areas, or to logical blocks within an audio Track. PLAY AUDIO (10) Commands cannot be issued to logical blocks within a data Track.

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

Note: The READ FORMAT CAPACITIES Command returns the logical block address of the last block prior to the lead-out area. This location may be in a transition area and therefore not a valid address for read operations.

The Table of Contents gives the absolute MSF location of the first information sector of each Track. Control information (audio/data, method of audio encoding, etc.) for each Track is also given in the TOC. However, the TOC does not distinguish between the different modes of data Tracks (i.e. CD-ROM Data Mode 1 vs. CD-ROM Data Mode 2).

The MSF locations of the beginning of data Tracks in the TOC are required to be accurate; however, the TOC values for audio Tracks have a tolerance of plus or minus 75 sectors. Information from the TOC can be used to reply to a READ CAPACITY Command. When this is done, the Logical Unit implementor ***shall*** consider the possible tolerances and return a value that allows access to all information sectors.

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

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

The sub-channel information which is part of each sector includes a Track relative MSF location value giving the distance from the first information sector of the Track. On the media, this value decreases during the pre-gap area (sectors with index values of 0) and increases for the rest of the Track. The data, returned by the READ SUBCHANNEL Command with MSF bit set to zero, converts this to a Track relative logical block address (TRLBA). The TRLBA is continually increasing over the whole Track, and pre-gap areas ***shall*** return negative values. When the MSF bit in the read sub- channel Command is set to one, the MSF Track relative location value from the media is reported without change.

Note: The purpose of accessing MSF addresses less than 00/02/00 MSF is to retrieve information, such as packet size, from incrementally written discs. This information exists in the Track Descriptor Block in the pre-gap area. Users can read this information by scanning the area between 00/01/00 MSF to 00/02/00 MSF. While the media may contain multiple redundant copies of the pre-gap data, the Logical Unit ***shall*** *only return one copy. The Logical Unit may not be able to read 00/00/00 MSF since there is no Sub-Q information before this frame. Refer to the Orange Book Part 2 for additional details.*

3.2 CD Physical Data Format

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

A CD 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 with an 8-bit to 14-bit code; then three merging bits are added. The merging bits are chosen to provide minimum low-frequency signal content and optimize phase lock loop performance.

3.2.1 Frame Format for Audio

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

3.2.2 Sector Format for Data

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 2352 bytes of data per sector.)

A sector that contains CD-ROM Data Mode 1 data has the following format:

1. 12-byte synchronization field
2. 4-byte CD-ROM data header:
   - Absolute M field
   - Absolute S field
   - Absolute F field
   - CD-ROM data mode field
3. 2048-byte user data field
4. 4-byte error detection code
5. 8 bytes zero
6. 276-byte layered error correction code

A sector that contains CD-ROM Data Mode 2 data has the following format:

1. 12-byte synchronization field
2. 4-byte CD-ROM data header
   - Absolute M field
   - Absolute S field
   - Absolute F field
   - CD-ROM data mode field
3. 2336-byte user data field (2048 bytes of mode 1 data plus 288 bytes of auxiliary data)

Note: Many Logical Unit*s are capable of returning CD-ROM data mode one data in a CD-ROM data mode two format. This allows the user to investigate the error detection and error correction codes. However data encoded as CD-ROM data mode two cannot be read as CD-ROM data mode one data.*

3.2.3 Sub-channel Information Formats

The sub-channel 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 is a simple flag bit that may be used for audio muting control and Track boundary determination.

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

The sub-channel Q block consists of 98 bits, one bit from each small frame in a sector. Three formats are defined for the sub-channel Q information block. The first format provides location information and is defined as follows:

1. 2-bit sub-channel synchronization field
2. 4-bit ADR field (defines the format)
3. 4-bit control field (defines the type of information in this sector)
4. 8-bit Track number
5. 8-bit index number
6. 24-bit Track relative MSF address
7. 8 bits Reserved (0)
8. 24-bit Absolute MSF address
9. 16-bit CRC error detection code

This format is required to exist in at least nine out of ten consecutive sectors.

The second and third formats are optional. If used, they ***shall*** exist in at least one out of 100 consecutive sectors. They include the absolute frame byte of the MSF address to provide location information continuity.

The second format gives the catalogue number of the disc (UPC/EAN bar code number). This information is constant over the whole media.

The third format gives the International Standard Recording Code (ISRC) for each Track. The ISRC is defined in ISO 3901. This format is not present on lead-in or lead-out Tracks and may change only after the Track number changes.

3.3 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 (which may involve a seek to the starting address). The playback operation continues and may complete without notification to the Host. Error termination of audio operations ***shall not*** be reported to the Host.

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

3.4 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 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:

1. There is no disc mounted.
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 or BLANK.

The Logical Unit ***shall*** spin up and make the disc ready for media accesses when a new 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 “NOT READY” check condition, and others are not. Table 53 - *Not Ready Error & Time-out Unit Attention Reporting (by Command)* on page 150.

3.5 CD Address Reporting Formats (MSF bit)

Several CD specific Commands can return addresses either in logical or in MSF format. The READ HEADER, READ SUBCHANNEL, and READ TOC/PMA/ATIP Commands have this feature.

Table 3 - MSF Address Format

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

An MSF bit of zero requests that the logical block address format be used for the absolute address field or for the offset from the beginning of the current Track expressed as a number of logical blocks in a CD Track relative address field.

An MSF bit of one requests that the MSF format be used for these fields. In certain transition areas, the relative MSF addresses are decreasing positive values. The absolute MSF addresses are always increasing positive values.The M, S, and F fields are expressed as binary numbers.

3.6 Error Reporting

If any of the following conditions occur during the execution of a Command, the CD Logical Unit ***shall*** return CHECK CONDITION status. The appropriate sense key and additional sense code ***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 4 - Error Conditions and Sense Keys

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
Unrecovered 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. The following cases ***shall*** cause CHECK CONDITION Status, 5/63/00 END OF USER AREA ENCOUNTERED ON THIS TRACK:

1. a post-gap area is encountered (i.e. a block with CD-ROM Data Mode 0);
2. a pre-gap area is encountered (i.e. a block with index equal to 0);
3. The information type (Data Mode vs. Audio etc.) changes.

When not performing audio playback, if the logical block address requested is not within a data Track, the Command ***shall*** be terminated with CHECK CONDITION Status, 5/64/00 ILLEGAL MODE FOR THIS TRACK. This applies to audio-combined and audio media.

3.7 Recording for CD media

There are several kinds of writing method of recording data in CD media. Session At Once, Track At Once, and Packet Writing are all used as methods of recording CD 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.

3.7.1 Packet Layout for CD

The layout of a Packet on CD media is shown in Figure 3. Each packet starts with Link block followed by four Run-in blocks. The User data blocks are placed directly after the Run-in blocks. Finally, two Run-out blocks are located following the User data blocks. In the case of Fixed packet writing, the size of each Packet in a Track is constant in length.

.

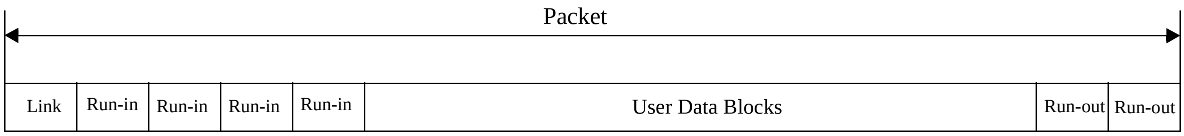

Figure 3 - Packet Layout

Figure 4 shows an example of the layout of packet written Track.

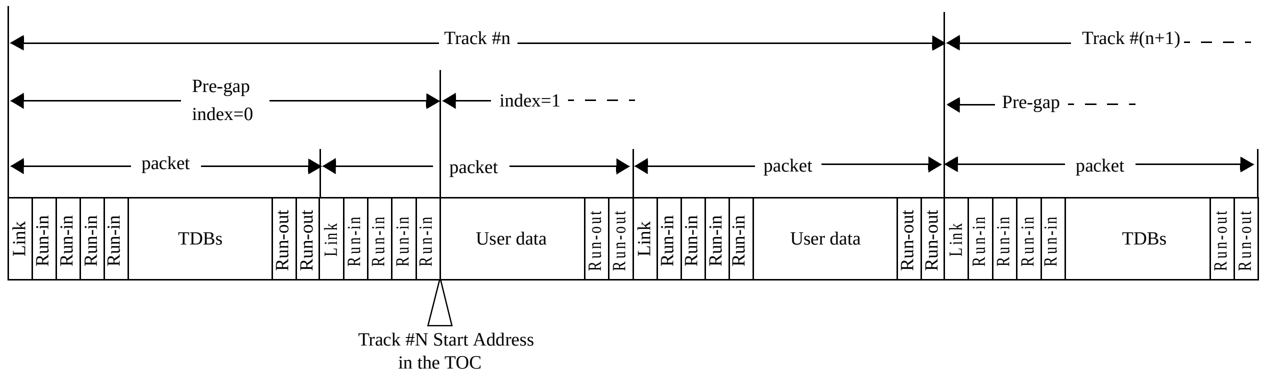

Figure 4 - Example of Packet written Track layout

3.7.2 Addressing Method

For CD media, there are two kinds of addressing. Except for the space within a Fixed Packet written Track, the Logical Block Address has a one-to-one relationship to the physical block number. This type of addressing is called "Method 1 Addressing" and Logical Block Numbers are assigned to Link, Run-in, and Run-out blocks as well as User Data Blocks. In Fixed Packet written Tracks, the Logical Block Address is converted to the physical block number using "Method 2 Addressing." In this case, Logical Block Addresses are not assigned to Link, Run-in, and Run-out blocks.

3.7.3 Track Descriptor Block

Information about current Track attributes is encoded in the Pre-gap in a Track Descriptor Block (TDB). Optionally, all preceding Track attributes are included in the TDB. The TDB is recorded in all sectors in the second half of the Pre-gap. The TDB starts at byte 0 in the user data field of each sector. The TDB consists of Track descriptor table and Track descriptor unit(s). The Track descriptor unit gives the information such as the writing method of the Track and the packet size. The Track descriptor unit ***shall*** be used by the Logical Unit to determine Packet type and Packet size for a Packet recorded Track. If the disc is recorded using Session At Once, the TDB may not be present.

Table 5 - Track Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0 - 7	Track Descriptor Table							
0 - N	Track Descriptor Unit(s)							

Track Descriptor Table consists of 8 bytes and is structured as shown below.

Table 6 - Track Descriptor Table

Bit / Byte	7	6	5	4	3	2	1	0
0	Track Descriptor Identification (54h)							
1	Track Descriptor Identification (44h)							
2	Track Descriptor Identification (49h)							
3	Pre-Gap Length							
4								
5	Type of Track Descriptor Unit							
6	Lowest Track Number							
7	Highest Track Number							

The **Track Descriptor Identification** fields contain the Hexadecimal code: '54 44 49' (ASCII "TDI").

The **Pre Gap length** field contain the number of blocks of the second part of this Pre Gap, encoded in BCD.

The **Type of Track Descriptor Unit** field indicates which Track Descriptor Units are present. When this field set to 00h, indicates that Track Descriptor Units of previous Tracks are present in this Track Descriptor Block. When this field set to 01h, indicates that only the Track Descriptor Units of the current Track is present in this Track Descriptor Block. All other values are reserved for future use.

The **Lowest Track number** field indicates that the lowest Track number described in this Track Descriptor Block, encoded in BCD.

The **Highest Track number** field indicates that the highest Track number described in this Track Descriptor Block, encoded in BCD.

Track Descriptor Unit describes the data attributes of the Track and consists of 16 bytes. The contents of these 16 bytes are shown in Table 7.

Table 7 - Track Descriptor Unit

Bit / Byte	7	6	5	4	3	2	1	0
0	Track Number							
1	(MSB)			Write Method of the Track				(LSB)
2	Packet Size							
3								
4								
5	Reserved							
:								
15								

The **Track Number** field contains that the number of the Track to which this Track Descriptor Unit belongs, BCD encoded.

The **Write Method of the Track** field when Bit 7 through Bit 4 set to 1000b, indicates that the Track is an uninterrupted written data Track that consists of only one packet. In this case, Bit 3 through Bit 0 ***shall*** be reserved and set to 0000b.

When the Bit 7 through Bit 4 set to 1001b, indicates that the Track is an incrementally written data Track that consists of more than one packet. In this condition, when Bit 3 through Bit 0 set to 0000b, indicates that the packet size is variable length. And if Bit 3 through Bit 0 set to 0001b, indicates that the packet size is fixed length. All other values for Bit 3 through Bit 0 are reserved.

When the Bit 7 through Bit 4 set to 0000b, indicates that the Track is an uninterrupted written audio Track. In this condition, Bit 3 through Bit 0 ***shall*** be reserved and set to 0000b.

All other values for Bit 7 through Bit 4 are reserved. And any corresponded values for Bit 3 through Bit 4 are also reserved.

The **Packet Size** field ***shall*** be interpreted as follows:

For Incremental written Tracks with fixed Packet Size (Byte 1 = 91h), these bytes contains the BCD encoded Packet Size in sectors (MSBytes first). For Incremental written Tracks with variable Packet Size (Byte 1=’90’ hex), and Uninterrupted written Data Tracks (Byte 1 = 80h), these three bytes contain the code FFFFFFh.

The **Reserved** field ***shall*** be reserved and set to zero.

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4.0 DVD Model

The DVD has been selected by the industry to be the replacement for the CD of today. It has many advantages over the existing CD technology. The DVD Media Format is not backward compatible with the existing CD devices. The primary reason for this change was driven by the need for very large amounts of data for Digital Video (Movies). Simple increase in density would not accomplish this.

Like CD Logical Units/Media there are three types of DVD Logical Unit/Media: Read Only (DVD-ROM), Write only Once (DVD-R), and Write Multiple times (DVD-RAM, DVD+RW). The capacity of each of these media are different. In addition, each of these media also have 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, CD-R and CD-RW media. This backwards compatibility will allow a DVD Logical Unit to replace a CD-ROM Logical Unit in most systems. Although the DVD Logical Unit will be capable of reading the older CD media, it may not support the same commands as the CD-ROM Logical Unit of today. There will be some simplifications to the command set supported. Commands that were necessary only for legacy support for the existing CD-ROM drivers have been removed.

The play mechanism may be removed from some DVD Logical Units. The DVD media provides several and better types of audio. It is likely that the Host system will provide the needed support for these new and more capable audio data streams.

A DVD Logical Unit will look different to the Host depending on the type of media that is currently being used. The Host system will now need to deal with a Logical Unit that changes the commands that are possible, based on the type of media that is currently in the Logical Unit. This type of operation will be handled via the use of Features, Profiles, and Events. This new concept will allow the Logical Unit to implement various capabilities. The Host will detect and configure the Logical Unit given the various capabilities that are possible.

4.1 DVD Media Description

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

- DVD Media can contain information on one side (Single Sided) or on both sides (Double Sided).
- DVD-ROM disc has two types of layer structure: single layer and double layer.
- Each Layer on either side contains a spiral track. This track contains a Lead-in, 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, having 37856 bytes, consists of 16 sectors.
- There is no TOC nor Sub-channel.
- Addressing from the Host is LBA (Logical Block Address) only.
- Information concerning error correction that has been performed is not usually returned to the Host.
- Some data on DVD Media is used only inside of the DVD Logical Unit and is not transferred to the Host computer. This is due in part because the Physical Addresses (PSN) that the DVD uses are not allowed across the Interface.
- The Host Read & Write unit (User Data) is 2 Kilobytes (2048 Bytes).

4.1.1 DVD Specifications

Table 8 specifies some DVD parameters.

Table 8 - General Parameters of DVD Discs

<table>
<tr><th></th><th>Capacity (120 mm disc) [Gbytes]</th><th>Capacity (80 mm disc) [Gbytes]</th><th>Wavelength for read [nm]</th><th>Wavelength for write [nm]</th><th>Data Bit Length [µm]</th><th>Channel bit length [µm]</th><th>Min Pit/Mark length [µm]</th><th>Max Pit/Mark length [µm]</th><th>Track Pitch [µm]</th><th>User data per sector [bytes]</th><th>Error Correction Code</th><th>ECC Constraint Length</th><th>correctable burst error length [mm]</th><th>scan velocity (Ref.) [m/s]</th><th>channel bit rate [Mbps]</th><th>user data bit rate [Mbps]</th></tr>
<tr><td>DVD-ROM Single Layer</td><td>4.70</td><td>1.46</td><td rowspan="5">635/650</td><td rowspan="2">N/A</td><td>0.267</td><td>0.133</td><td>0.400</td><td>1.866</td><td rowspan="2">0.74</td><td rowspan="5">2048</td><td rowspan="5">RS (208,192,17) x RS (182,172,11)</td><td rowspan="5">16 sectors</td><td>6.0</td><td>3.49</td><td rowspan="4">26.16</td><td rowspan="4">11.08</td></tr>
<tr><td>DVD-ROM Double Layer</td><td>8.54</td><td>2.66</td><td rowspan="2">0.293</td><td rowspan="2">0.147</td><td rowspan="2">0.440</td><td rowspan="2">2.054</td><td>6.5</td><td rowspan="2">3.84</td></tr>
<tr><td>DVD-R</td><td>3.95</td><td>1.23</td><td>635</td><td>0.80</td><td>6.5</td></tr>
<tr><td>DVD-RAM</td><td>2.6</td><td>N/A</td><td>650</td><td>0.409
0.435</td><td>0.205
0.218</td><td>0.614
0.653</td><td>2.863
3.045</td><td>0.74</td><td>9.2</td><td>5.96
6.35</td></tr>
<tr><td>DVD+RW</td><td>3.0</td><td>N/A</td><td>650</td><td>0.353</td><td>0.176</td><td>0.529</td><td>2.469</td><td>0.80</td><td>7.9</td><td>3.02
6.25</td><td>17.2
35.5</td><td>8.6
17.8</td></tr>
</table>

The ranged values for DVD-RAM reflect its Zoned CLV format.

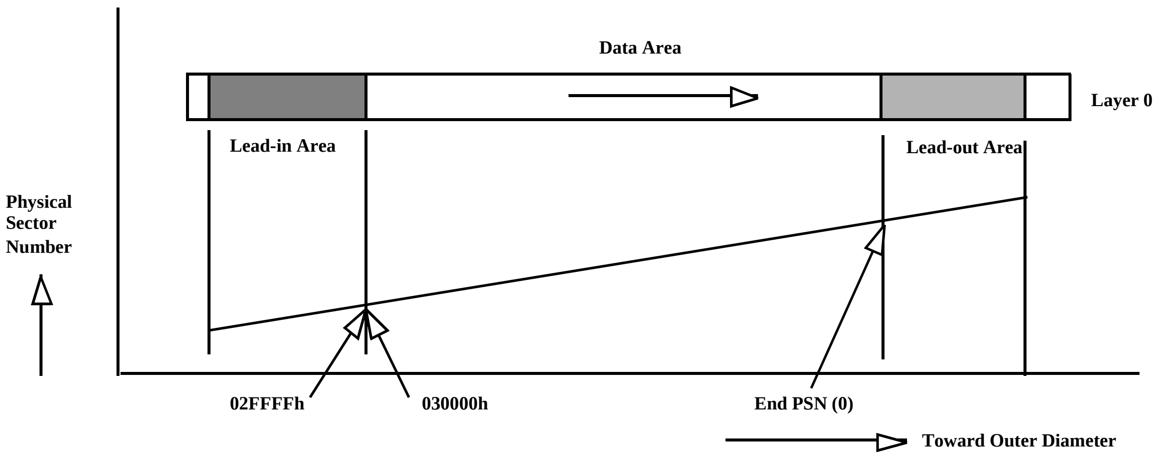
The ranged values for DVD+RW reflect its CAV format.

4.2 Track Structure

There are two types of track path for double layer discs, either parallel or opposite. When the path is parallel each track 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 Host system (LBA). The address used from the Host 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 5 through Figure 9 show examples of LBA to Physical Sector Number translations for DVD media.



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

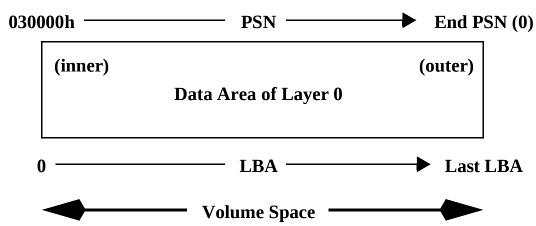
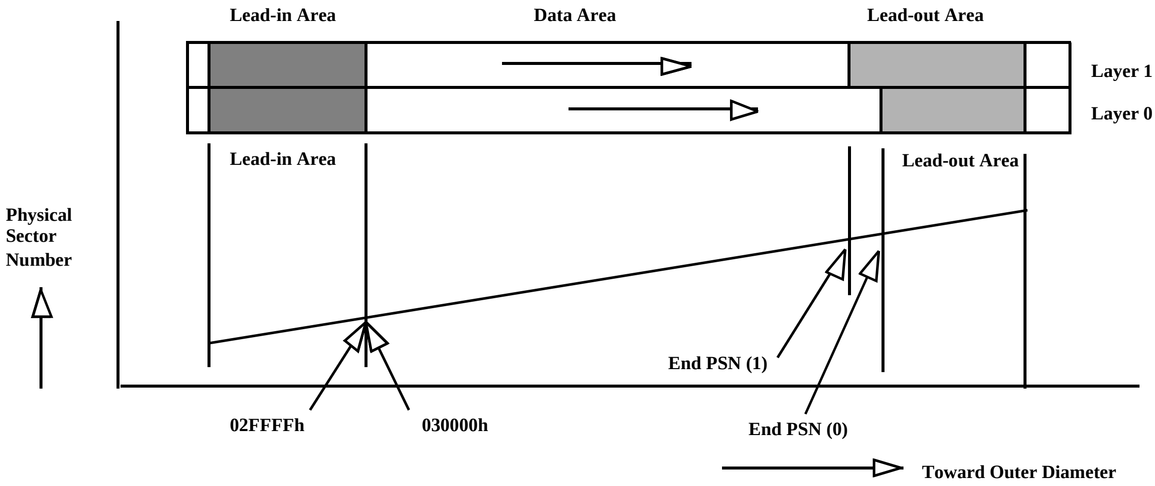


Figure 5 - Physical and Logical Layout of Single Layer DVD-ROM Media



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

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

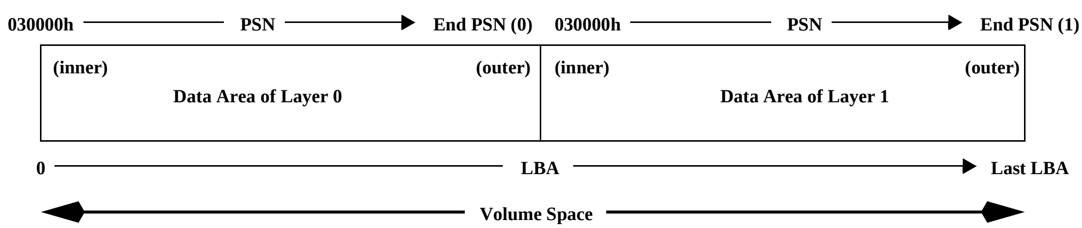
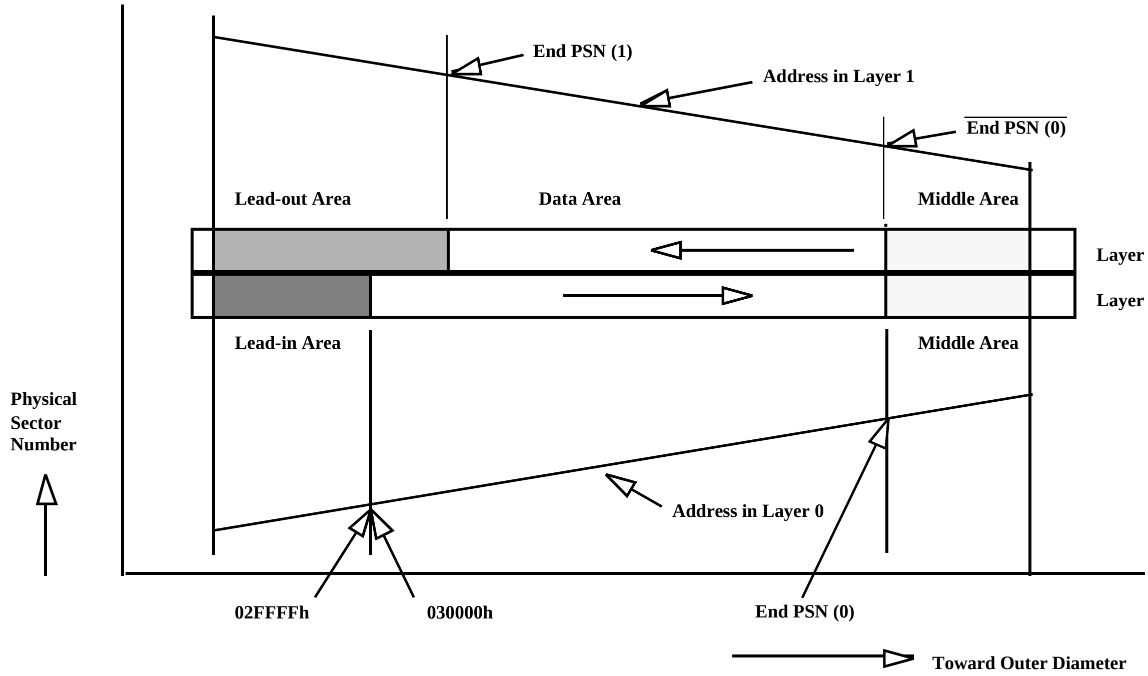


Figure 6 - Physical and Logical Layout of Parallel Track Path DVD-ROM Media



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

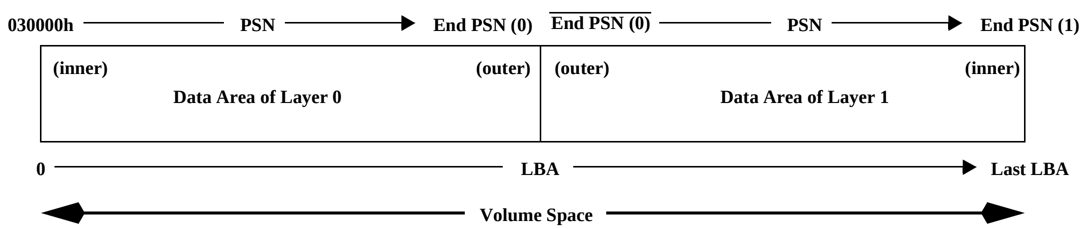
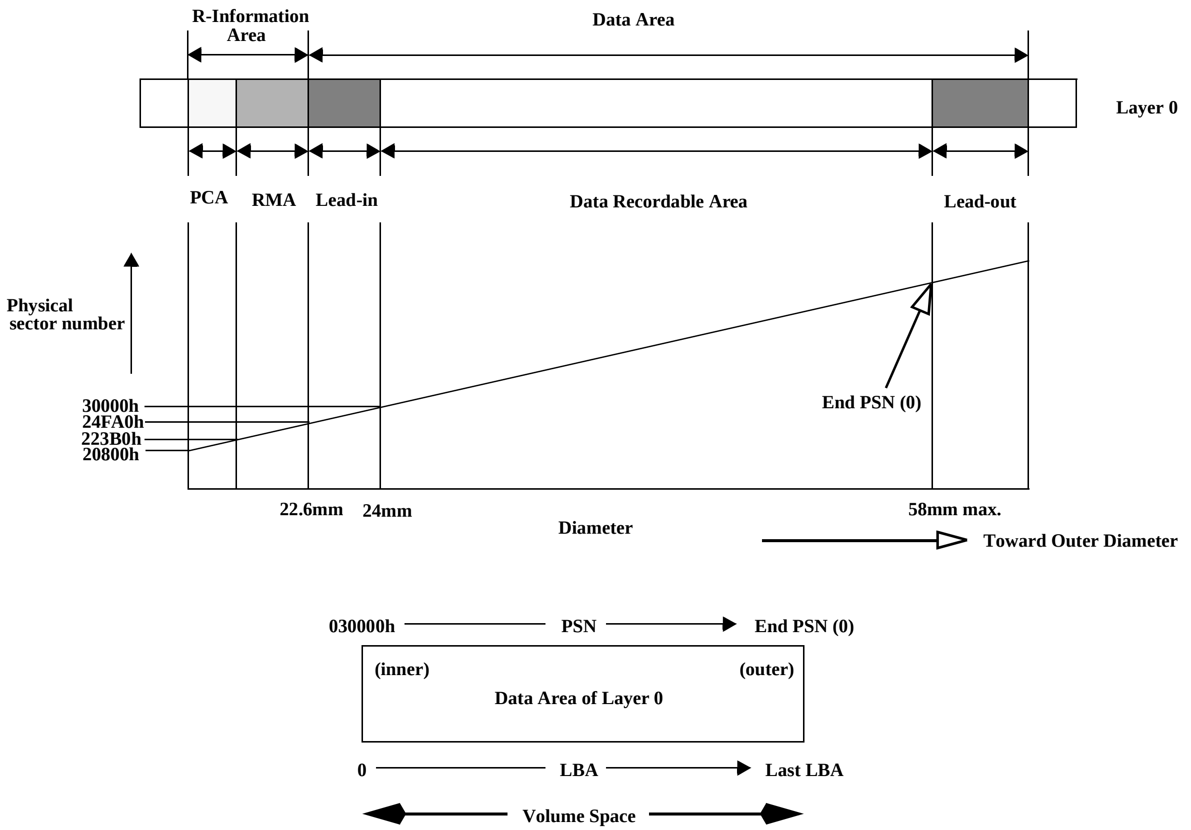
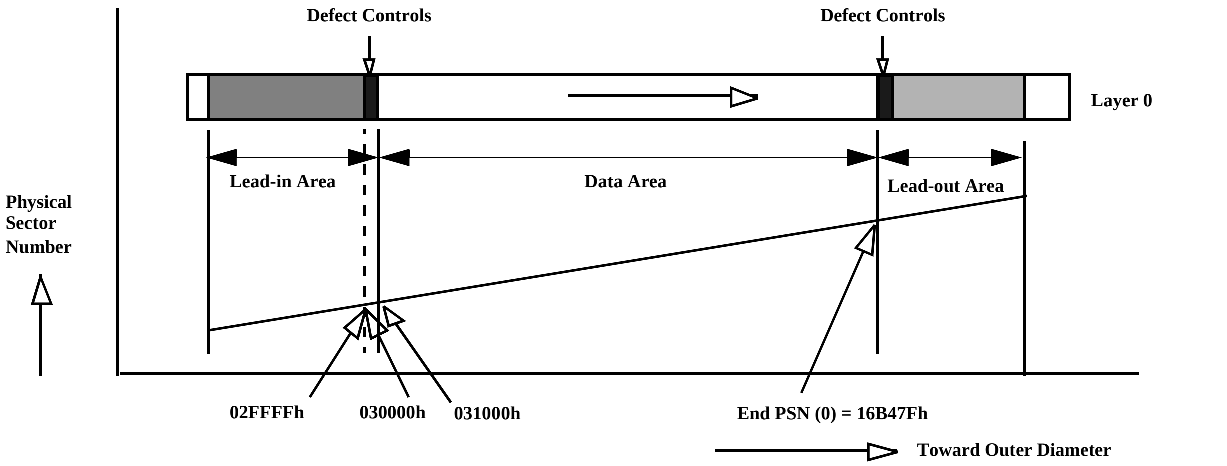


Figure 7 - Physical and Logical Layout of Opposite Track Path DVD-ROM Media



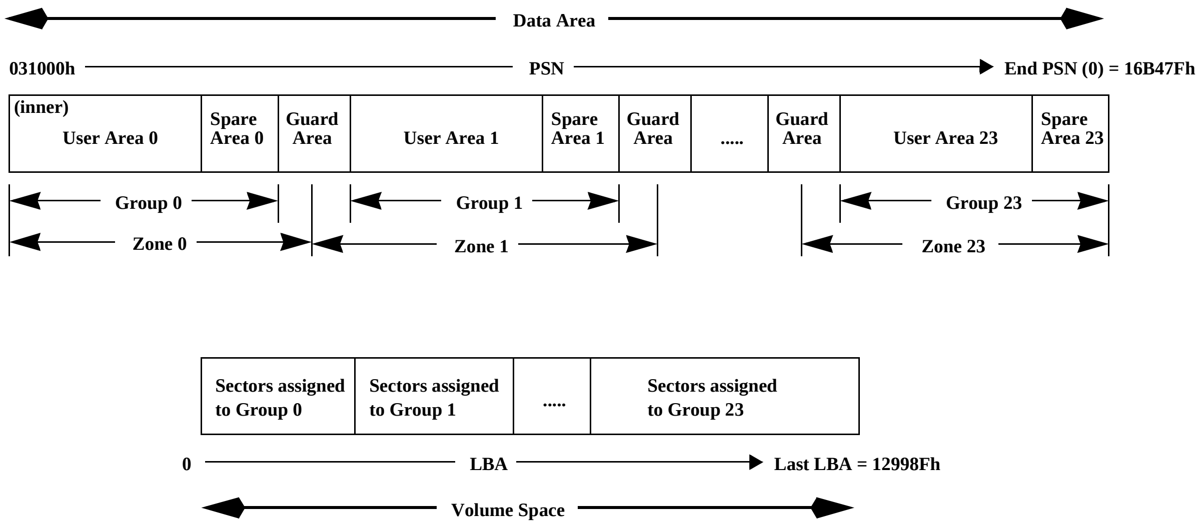
End PSN (0) : The end Physical sector number of Data Area of Layer 0

Figure 8 - Physical and Logical Layout of DVD-R Media



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

Defect Controls are non user addressable blocks, used for drive controlled defect management. These blocks contain Defect management Areas (DMAs). Defect controls begins 030000h. This is the data area for DVD-ROM and for DVD-R. The data area begins 031000h for DVD-RAM.



- DVD-RAM media contains 24 zones.

- Each of these zone has equal radial size, therefore number of ECC blocks per zone increase from 1662 at the Inner Diameter to 4475 at the Outer Diameter.

- The number of sectors in each Spare Area allocated per zone is proportional to the number of sectors in each User Area, approximately 5%.

- The User Area may contain defective sectors which are replaced by sectors in the Spare Area; therefore, the number of user accessible sectors in each zone is kept at a predetermined number.

Figure 9 - Physical and Logical Layout of DVD-RAM Media

4.3 ECC Block

The user data is contained in ECC Blocks. The ECC Blocks are made up of 16 sectors and are used to provide error correction. To read any data, the whole ECC Block must 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.

4.4 Sector Configuration

4.4.1 Physical Sector

The data recorded to the DVD media is in a format called "Data Unit 3," which consists of 2048 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 10. Data Unit 3 is identical among DVD-ROM, DVD-R, DVD-RAM, and DVD+RW. In the case of DVD-ROM, DVD-R, and DVD+RW, only the Data Unit 3 is recorded. DVD-RAM media has other fields in between each Data Unit 3 as shown in Figure 12.

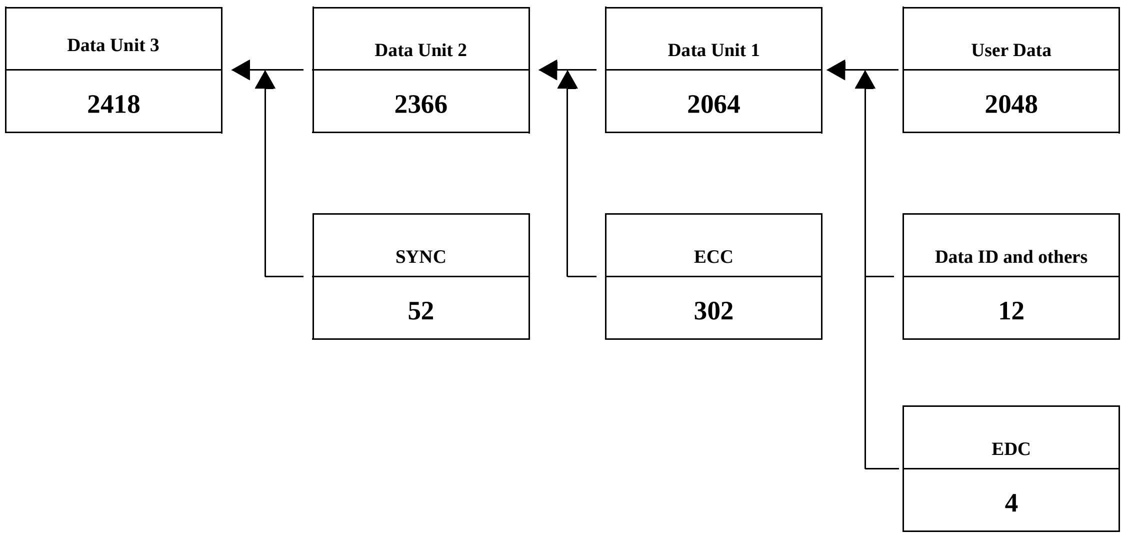


Figure 10 - Formation of Data Unit 3

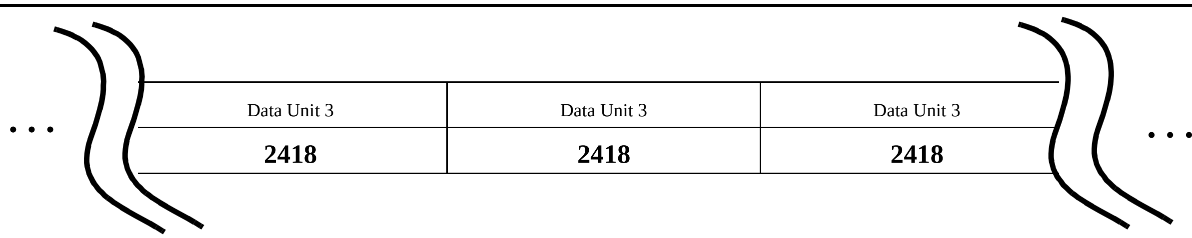


Figure 11 - Physical Sector of DVD-ROM, DVD-R, and DVD+RW Media

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 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 will only use the physical (pre-recorded) ID. After formatting, it is possible for the ID in Data Unit 1 to contain an invalid address.

Embossed Field		Recording field							
Header field	Mirror field	Gap field	Guard1 field	VFO3 field	PS field	Data Unit 3	PA3 field	Guard2 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.

Figure 12 - Physical Sector of DVD-RAM

4.4.2 Data Unit 1

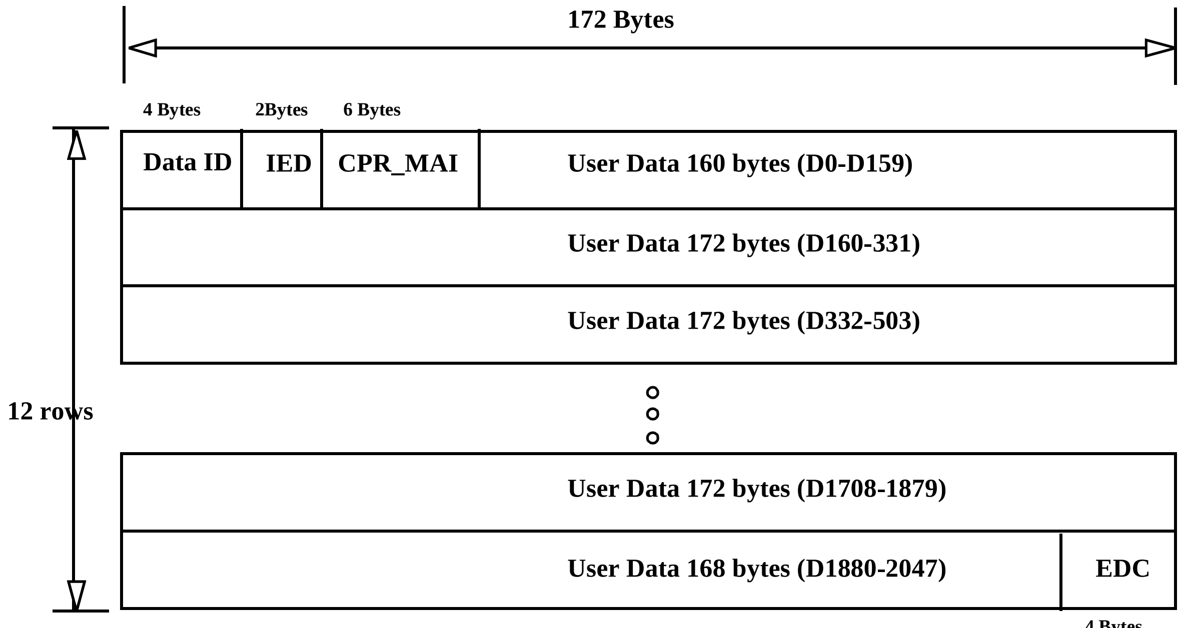


Figure 13 - Data Unit 1

4.4.3 Data Configuration of Data ID Field

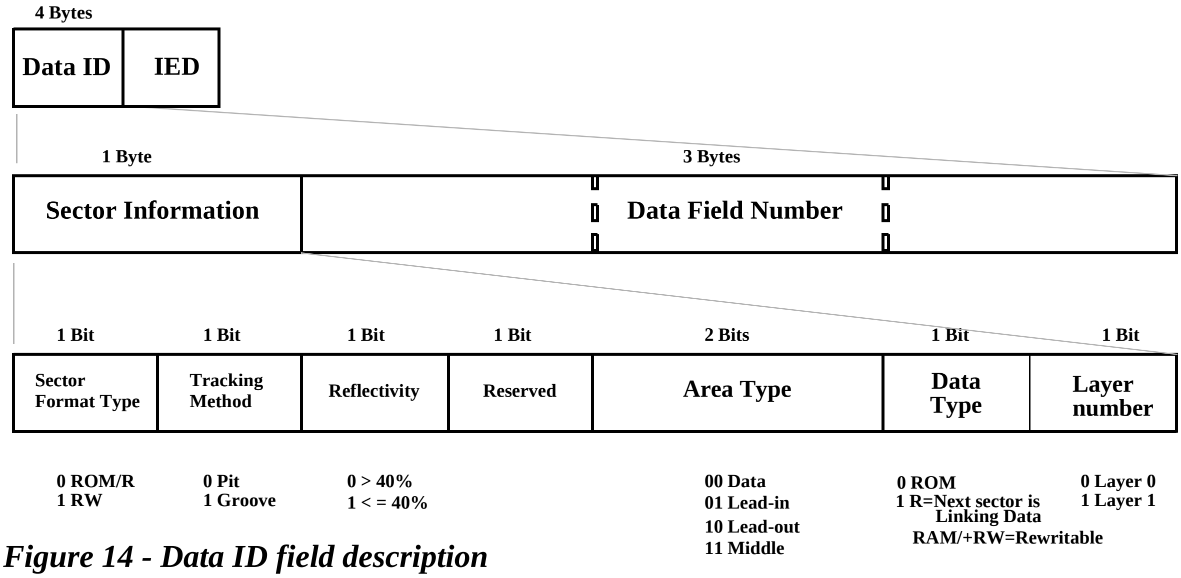


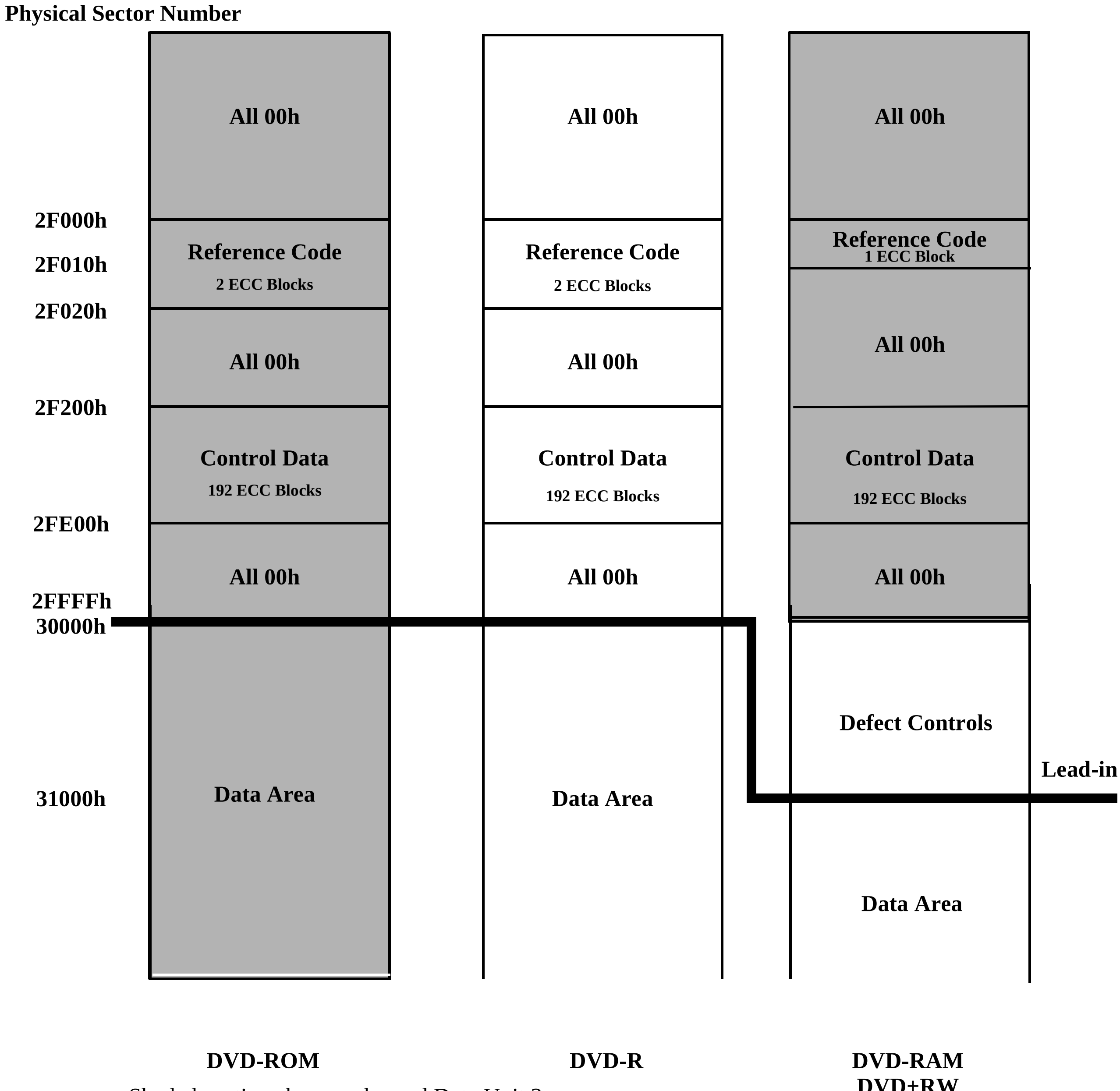
Figure 14 - Data ID field description

The Data Field Number comprises PSN for DVD-ROM and DVD-R. In the case of DVD-RAM, see Table 9.

Table 9 - Data Field Number for DVD Media

Area	Media Type	Description	Contents
Lead-in and Lead out	ROM, R, RAM, +RW	Pre-recorded information	PSN
Data Area	ROM, R	Pre-recorded information or Written for DVD-R Media	PSN (LBA + 30000h)
	RAM	ECC Block Written by the Host	LBA + 31000h
		ECC Block not written by the Host after formatting	Any of the following three cases (1) Initialization pattern (2) Unrecorded (3) Old value of LBA + 31000h assigned before previous re-formatting
	+RW	Written data	PSN (first one in data area is 31000h, sequential thereafter)
		Unwritten	Unrecorded

4.5 Data Structure of Lead-in Area



Shaded portions have embossed Data Unit 3

Reference Code contains repetition of the Data Symbol “172” with added scrambled data. It is about one revolution long.

Control Data comprises repetition of a content of 16 sectors (one ECC Block)

Figure 15 - Data Structure of Lead-in Area

4.5.1 Control Data Area

The Control Data Area contains 192 ECC Blocks. Each of the ECC Blocks (16) Sectors contain one of four distinct types of data. See Table 10 for a generic descriptor.

Table 10 - Control Structure of Control Data Block

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

4.5.2 Control Area Sector Descriptions

Table 11 shows the format of the Physical Format descriptor.

Table 11 - Common Part of Physical Format Information

Bit / Byte	7	6	5	4	3	2	1	0
0	Book Type				Book 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								
. . .								
14								
15								
16	BCA Flag	Reserved						
17-2047	Medium Unique Data							

The Book Type field is described in Table 12.

Table 12 - Book Type Field

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

The **Book Version** field ***shall*** identify the standard level within a medium family.

The **Disc Size** field, when set to 0, ***shall*** indicate a 120mm disc. When set to 1, ***shall*** indicate an 80mm disc. All other values are reserved.

The **Maximum Rate** field ***shall*** identify the maximum data rate found in the video data on the medium. See Table 13.

Table 13 - Maximum Rate field definition

Value	Definition
0000b	2.52 Mb/s
0001b	5.04 Mb/s
0010b	10.08Mb/s
0011b - 1110b	Reserved
1111b	No maximum transfer rate is specified.

The **Number of Layers** field identifies the number of layers on the current side. 00b ***shall*** indicate one layer, 01b ***shall*** indicate two layers, and other values are reserved.

The **Track Path** field, when set to zero, ***shall*** indicate a PTP or single layer disc. When set to one, ***shall*** indicate an OTP disc.

The **Layer Type** field ***shall*** identify the layer according to Table 14.

Table 14 - Layer Type field

Bit	Definition
0	Layer contains embossed area
1	Layer contains writable area
2	Layer contains re-writable area
3	Reserved

The **Linear Density** field ***shall*** identify the bit density according to Table 15.

Table 15 - Linear Density field

Value	Definition
0000b	0.133 µm
0001b	0.147 µm
0010b	0.205 µm - 0.218 µm
1000b	0.176 µm
others	Reserved

The **Track Density** field ***shall*** identify the track density according to Table 16.

Table 16 - Track Density field

Value	Definition
0000b	0.74 µm
0001b	0.80 µm
others	Reserved

Table 17 describes the contents of the **Data Area Allocation** field.

Table 17 - Data Area Allocation Definition

Byte	Single Layer DVD-ROM	Parallel Track Path DVD-ROM	Opposite Track Path DVD-ROM	DVD-R disc at once	DVD-R incremental	DVD-RAM	DVD+RW
4	00h	00h	00h	00h	00h	00h	00
5	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 (031000h)
6							
7							
8	00h	00h	00h	00h	00h	00h	00h
9	End PSN of Data Area	End PSN of Data Area	End PSN of Data Area	End PSN of Data Area	Last Recorded Sector Number of the last RZone in the bordered area	End PSN of Data Area (16B47Fh)	End PSN of Data Area (198FFFh)
10							
11							
12	00h	00h	00h	00h	00h	00h	00h
13	000000h	000000h	End PSN in Layer 0	000000h	000000h	000000h	000000h
14							
15							

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. Blocks in the Data Area may be spared or set aside for replacement.

Table 18, Table 19, Table 20, and Table 21 show the format unique descriptors for each media type.

Table 18 - DVD-ROM Unique Part of Physical Format Information

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

Table 19 - DVD-R 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 20 - DVD-RAM 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 21 - DVD+RW Unique Part of Physical Format Information

Bit / Byte	7	6	5	4	3	2	1	0
32	Recording Velocity							
33	Maximum read power at maximum velocity							
34	P_{IND} at maximum velocity							
35	ρ at maximum velocity							
36	ε1 at maximum velocity							
37	ε2 at maximum velocity							
38	γ_{target} at maximum velocity							
39	Maximum read power at reference velocity							
40	P_{IND} at reference velocity							
41	ρ at reference velocity							
42	ε1 at reference velocity							
43	ε2 at reference velocity							

Table 21 - DVD+RW Unique Part of Physical Format Information (Continued)

Bit / Byte	7	6	5	4	3	2	1	0
44	γ_{target} at reference velocity							
45	Maximum read power at minimum velocity							
46	P_{IND} at minimum velocity							
47	ρ at minimum velocity							
48	ε1 at minimum velocity							
49	ε2 at minimum velocity							
50	γ_{target} at minimum velocity							
51-2047	Reserved							

4.6 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:

1. There is no disc mounted, see *4.9, "Removable medium"* on page 70
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 or BLANK.

The Logical Unit ***shall*** attempt to spin up and make the disc ready for media accesses when a new 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 in the IDLE or STANDBY state ***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.

4.7 DVD Copy Protection

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

4.7.1 Management of Protected Data

Any read by the Host to a disc that contains scrambled content and a sector with a Title Key present, when the Authentication Success Flag (ASF) is set to zero ***shall*** be terminated with a CHECK CONDITION Status, 5/6F/03 READ OF SCRAMBLED SECTOR WITHOUT AUTHENTICATION. For more information on the authentication process, see Figure 16 - *Device Key Exchange and Authentication State Diagram* on page 69. For more information on the Authentication Success Flag, Figure 17 - *Authentication Flag Sequence* on page 69.

4.7.2 Authentication Process

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

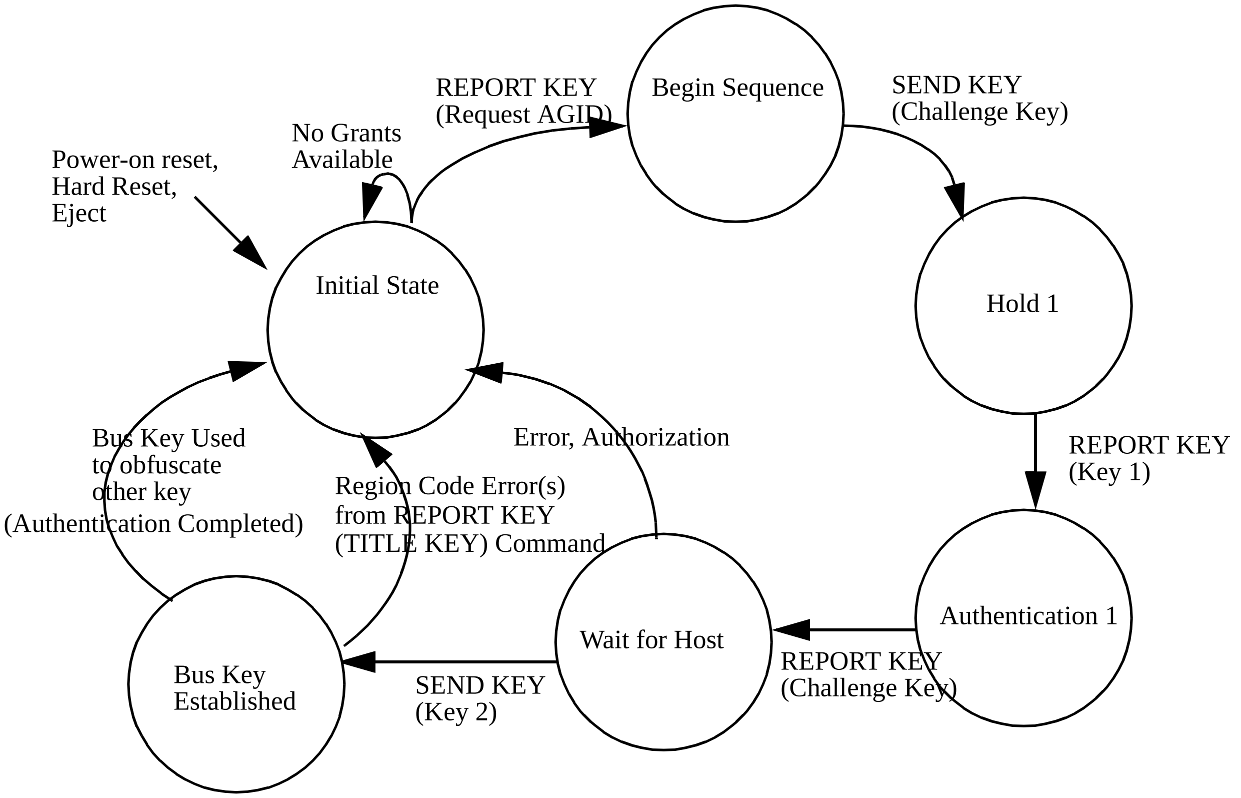


Figure 16 - Device Key Exchange and Authentication State Diagram

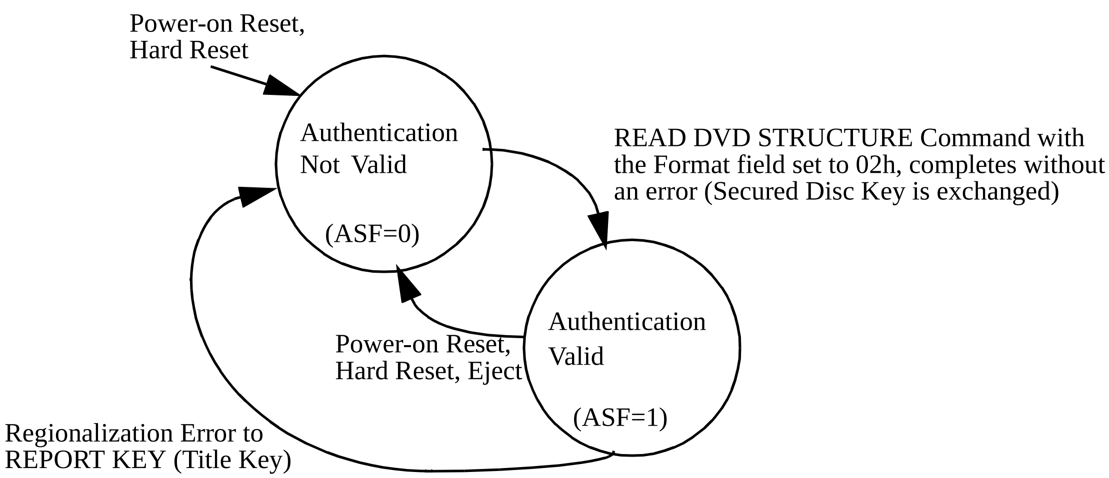


Figure 17 - Authentication Flag Sequence

4.8 Error Reporting

If any of the following conditions occur during the execution of a command, the Logical Unit ***shall*** return CHECK CONDITION status. The appropriate Sense Key and additional sense code ***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 22 - Error Conditions and Sense Keys

Condition	Sense Key
Invalid logical block address	ILLEGAL REQUEST
Unsupported option requested	ILLEGAL REQUEST
Attempt to read a blank block (where illegal)	ILLEGAL REQUEST
Attempt to play a data block as audio	ILLEGAL REQUEST
Logical Unit reset or medium change since last command	UNIT ATTENTION
Self diagnostic failed	HARDWARE ERROR
Unrecovered 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.

4.9 Removable medium

DVD medium is sometimes contained within a cartridge to prevent damage to the recording surfaces. The combination of medium and optional cartridge is often called a volume.

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 or is able to format it. A mounted disc may not be accessible by a Host if it is reserved by another Host. A disc is de-mounted at any other time (e.g. during loading, unloading, or storage).

A Host may check whether a disc is mounted by issuing a TEST UNIT READY Command. In addition, there now exists the Removable Media Feature. This Feature allows the Host to prevent the removal of any media, as well as sensing requests from the user to remove media.

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

4.10 Logical blocks

Blocks of data are stored on the medium along with additional information that the controller uses to manage the storage and retrieval. The format of the additional information is unique and is hidden from the Host during normal read or write operations. This additional information is often used to identify the physical location of the blocks of data and the 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 FORMAT CAPACITIES Command may be issued to determine the value of [n-1]. If a command is issued that requests access to a logical block not within the capacity of the medium, the command is terminated with CHECK CONDITION Status, 5/21/00 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. The block length ***shall not*** be different for each logical block on the medium. The block descriptor in the MODE SENSE (10) data describes the block length that is used on the medium. Note that the block descriptor will not be present for an ATAPI Logical Unit. In addition, the Block Descriptor has been made Obsolete in this specification.

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

4.11 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 accessible by the Host. 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 Host 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 Host may wish to have 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 Host 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 FLUSH CACHE Command is used by the Host to guarantee that data in the cache has been moved to the media.

4.12 Seek

The SEEK Command provides a way for the Host to position the Logical Unit in preparation for access to a particular logical block at some later time. Since this positioning action is implicit in other commands, the SEEK Command may not be useful with some Logical Units.

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4.13 Region Playback Control (RPC)

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

4.13.1 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 with Format Code of 04h (Title Key) is received by a Logical Unit that is in the Bus Key Established state (see Figure 16 - *Device Key Exchange and Authentication State Diagram* on page 69), 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, 5/6F/04 MEDIA REGION CODE IS MISMATCHED TO LOGICAL UNIT REGION. Regionalized CSS media ***shall*** be deemed not playable if the region of the Logical Unit is not set or the voting process is not in progress.

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

The Logical Unit will report the current RPC state using the REPORT KEY Command with Format Code 08h.

4.13.2 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 movie which has a region code included within the information on the disc in this drive.

The Logical Unit has the following four Region States according to the Drive Region setting (see Figure 18):

1. NONE state — The Drive Region has not been set and the Host Computer ***shall*** set the initial Drive Region value in the Logical Unit. The region setting counter ***shall*** be 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 Drive Region has been set and the change of the Region is acceptable. The region setting counter ***shall*** initially be 4, decrementing to 2.

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

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

4.13.2.1 Initial Setting

In the NONE state, the Drive Region has not been set and the Host ***shall*** set the initial Drive Region value in the Logical Unit. The region setting counter ***shall*** be 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 Drive Region ***shall*** be set by one of the two methods specified. In case of the Command method, the drive ignores the region code of the inserted medium. In the Command method, the Host ***shall*** set a preferable region, the value of which is specified in the Preferred Drive Region Code field of the SEND KEY Command with Key Format = 000110b. On execution of this command, the drive ignores the region code of the inserted medium.

After the successful execution of setting the Drive Region, the region setting counter ***shall*** be decremented to 4 and the drive ***shall*** enter SET state.

4.13.2.2 Changing of the drive region

In the SET state, the Drive Region has been already set and may be changed by one of the following two methods. After the successful execution of changing the Drive Region, the region setting counter ***shall*** be decremented. When the region setting counter is 1, the drive ***shall*** enter into the LAST CHANCE state.

In the LAST CHANCE state, the Drive Region may be changed by one of the following two methods. In the case of Command method with a disc, the inserted disc ***shall*** have the same single Region Code value as the Preferred Drive Region Code specified in the SEND KEY Command. After the successful execution of the Drive Region change, the region setting counter ***shall*** be zero and the drive ***shall*** enter into the PERMANENT state.

In the PERMANENT state, user cannot change the Drive Region.

4.13.2.2.1 Command method for changing the drive region with a CSS enabled Disc

To set the drive region, the procedure ***shall*** be executed as follows;

1. Insert a disc having the requested Region, (this is not required for the Initial Setting)
2. Issue a SEND KEY Command with the Key Format = 000110b. The requested Region Code value ***shall*** be specified in the Preferred Drive Region Code field.

When the Logical Unit receives the SEND KEY Command correctly, the drive region is changed to the requested region.

If the disc does not have the same region code value as the Preferred Drive Region Code specified in the SEND KEY Command, then the command ***shall*** be terminated with CHECK CONDITION Status, 5/6F/04 MEDIA REGION CODE IS MISMATCHED TO LOGICAL UNIT REGION.

4.13.2.2.2 Setting Disc method for changing the drive region

The drive region may be set by inserting a special disc which contains a specific region code. This special disc does not require any command intervention.

4.13.3 Limits on Drive Region Changes

Any of the methods defined in this specification may be used up to five times to set 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 Drive Region more than five times, the SEND KEY Command ***shall*** terminate with CHECK CONDITION Status, 5/6F/05 DRIVE REGION MUST BE PERMANENT/REGION RESET COUNT ERROR.

For more information on the region code setting process, see Figure 18.

4.13.4 RPC States

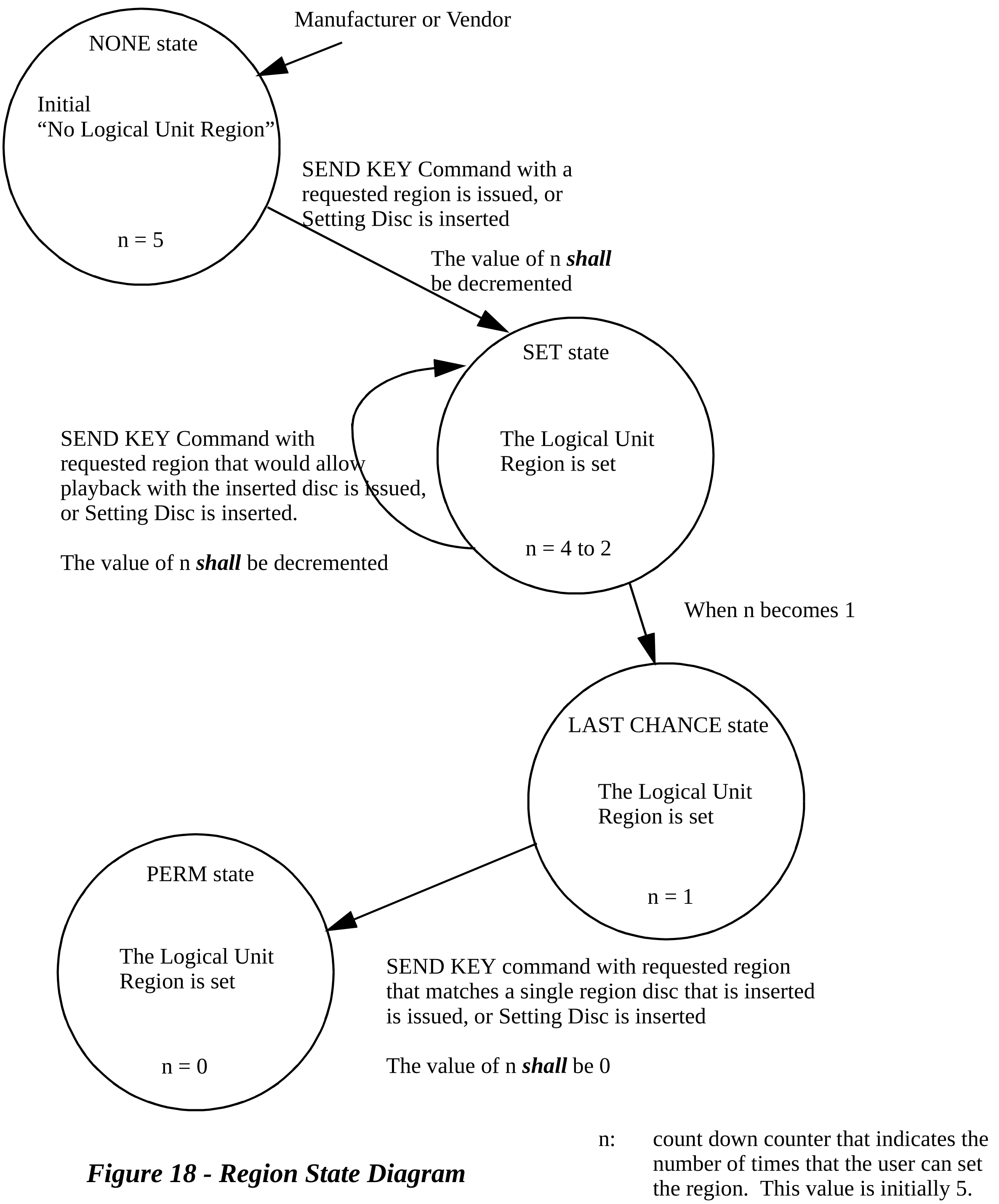

Figure 18 - Region State Diagram

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4.14 Recording and Reading for DVD-RAM Media

DVD-RAM media is directly addressable by a logical block address and permits reading and writing from any of the consecutively numbered logical blocks. Though the Logical Block Addresses are consecutive, the actual data may not be stored in a consecutive manner because of defect management and the existence of physical sectors which do not directly correspond to logical blocks. Such physical sectors comprise spare sectors and unused sectors at each zone boundary.

4.14.1 Logical Layout of DVD-RAM Media

DVD-RAM media is divided into 24 Zones. The first sector of each revolution in these Zones always align. The data is recorded using a constant angular density within each Zone, thus the actual size of the “bits” within a zone increase from the beginning of a zone toward the end of the zone. This keeps the data rate constant for reading and writing within each Zone with constant rotational speed. Each Zone has a fixed radius in width and as such each contains a different number of sectors.

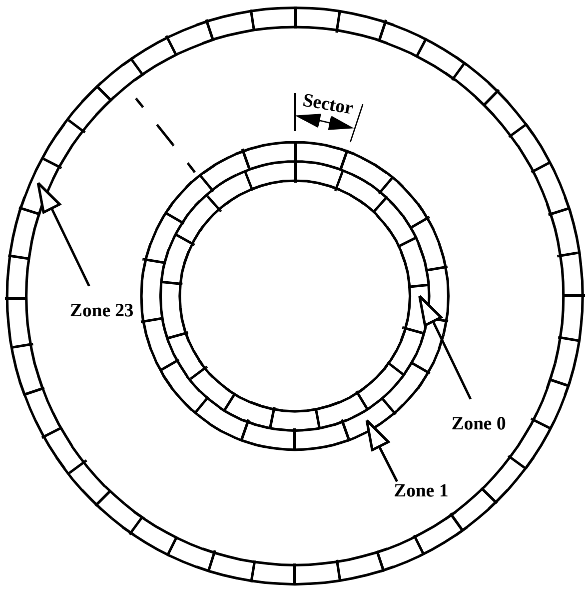

Figure 19 - Zoning of DVD-RAM Media

Each Zone has 3 areas: a User Area, a Spare Area and a Guard Area. See Figure 9 - *Physical and Logical Layout of DVD-RAM Media* on page 59. The User Area and Spare Areas contain user accessible sectors addressed by an LBA. The LBAs increase toward the Outer Diameter. Defective sectors are replaced by sectors in the Spare Area, thus the number of user accessible sectors in each zone is kept at a fixed and predetermined number. The last LBA is 12998Fh.

The Data Area begins at 031000h for DVD-RAM, apart from DVD-ROM and DVD-R, where Data Areas begin at 030000h. This is caused by the existence of Defect Controls. There are two Defect Controls: one is located immediately before the Data Area and starts at 030000h, and the other is located immediately after the Data Area. The Defect Controls are non-user addressable areas. These blocks contain Defect Management Areas (DMAs).

The DMA contains Disc Definition Structure (DDS) for the recording method used for formatting of the disc, a Primary Defect List (PDL) for recording defective sectors identified at formatting of the disc, and a Secondary Defect List (SDL) for recording defective ECC Blocks identified during writing/reading user data.

The number of sectors in the Spare Area allocated per zone is proportional to the number of sectors in each User Area. The total number of Spare sectors is 65392. The combination of the User Area and Spare Area is called a Group. The Guard Area is located at the boundary to prevent signal crosstalk between Zones. (See Table 23)

Table 23 - Allocation of Data Area of DVD-RAM Media

Zone No.	No. of Physical Sectors					LBA of first Sector in the Group
	Guard Area	Group No.	User Area	Spare Area	Guard Area	
0	0	0	26592	1360	48	0
1	48	1	32160	1728	48	26592
2	48	2	33952	1824	48	58572
3	48	3	35744	1920	48	92704
4	48	4	37536	2016	48	128448
5	48	5	39328	2112	48	165984
6	48	6	41120	2208	48	205312
7	48	7	42912	2304	48	246432
8	64	8	44672	2400	64	289344
9	64	9	46464	2496	64	334016
10	64	10	48256	2592	64	380480
11	64	11	50048	2688	64	428736
12	64	12	51840	2784	64	478784
13	64	13	53632	2880	64	530624
14	64	14	55424	2976	64	584256
15	64	15	57216	3072	64	639680
16	80	16	58976	3168	80	696896
17	80	17	60768	3264	80	755872
18	80	18	62560	3360	80	816640
19	80	19	64352	3456	80	879200
20	80	20	66144	3552	80	943552
21	80	21	67936	3648	80	1009696
22	80	22	69728	3744	80	1077632
23	80	23	71600	3840	0	1147360
Total	1488	N/A	1218960	65392	1456	N/A

4.14.2 DVD-RAM ECC Block Boundary Issue

The location of logical sectors is derived from the defect list information. When a physical sector is found defective and newly slipped during formatting, a result is that the ECC block boundaries change and thus the addressing of all the following sectors in that zone changes. Following any new “slipping” of a physical sector, all the following ECC Blocks in that zone must be written with new ECC Block boundaries before reading. The only exception is a case when all the following ECC Blocks have been written with the initialization pattern used at certification which can be determined by the Data ID of the logical block. In this case, the Logical Unit discriminates the initialization pattern even when the ECC Block boundaries are incorrect and ***shall*** treat these ECC Blocks as if all zero data has been written.

4.14.3 Unrecorded ECC Blocks

A DVD-RAM disc which has not been certified may contain unrecorded ECC Blocks to which user data has not been written. The Logical Unit ***shall*** return all zero data in response to an attempt to read logical blocks from such unrecorded ECC Blocks. Further, a logical block may contain an initialization pattern used at certification which can be discriminated by the Data ID of the logical block. The Logical Unit also returns all zero data in response to an attempt to read such Logical Blocks containing the initialization pattern.

4.14.4 Read Modify Write

Any attempt to write data less than one ECC-Block causes a read-modify-write operation in the Logical Unit, which requires more than one rotation to write the data, if data is not cached.

1. Reading an ECC-Block containing the designated logical blocks (First path)
2. Overlay the data to be written onto the read out ECC-Block data
3. Writing the modified ECC-Block data back to the same addresses (Second path)

When an ECC Block designated for Read-Modify-Write operation is physically unwritten or contains the initialization pattern used at certification, which can be discriminated by the Data ID of the Logical Block, the Logical Unit writes all zero data to the logical blocks in the ECC Block other than the designated Logical Blocks from the Host.

A technique to provide better performance with DVD-RAM media is to write data in sizes that are a multiple of 32768 bytes starting at a logical block address that is a multiple of 16, which results in a one path direct overwrite operation. These values can be determined from the Random Readable Feature Descriptor (see *11.5.2.5, "Feature 0010h: Random Readable"* on page 196).

4.14.5 Data ID

DVD-RAM has major differences from DVD-ROM, DVD-R, and DVD+RW in that embossed Headers are used to identify the physical sectors. The address used by the Logical Unit to read or write sectors is the “physical” address, not the Data ID. The Data ID contained in the sector is used only to discriminate the initialization pattern. In all other cases, it is ignored.

4.14.6 Defect Management for DVD-RAM Media

Defective physical sectors in the Data Area of DVD-RAM media are managed by the Logical Unit according to the defect management scheme specified in the DVD Book for Rewritable Disc, Part 1: Physical Specifications.

Two replacement methods are defined for defective physical sectors:

Slipping replacement is the first method in which a defective physical sector is replaced by the first non-defective physical sector following the defective physical sector. The slipping replacement is performed in units of a physical sectors. Defective sectors replaced by the slipping replacement are listed in Primary Defect List (PDL) recorded on the DVD-RAM media during formatting. Contents of the PDL on DVD-RAM media can be changed only by formatting. The number of sectors in a group to be listed in the PDL ***shall*** not exceed the number of sectors in the Spare Area in that group. Entries of the PDL consist of three categories: P-list, G_1-list and G_2-list.

- Defective physical sectors encountered by media manufacturer before shipment of the DVD-RAM media are listed in the P-list. A defect is registered to the P-list in a unit of 1 physical sector. Time to perform the slipping replacement for a defective sector listed in the P-list is minimal, because it requires time only to pass the defective sector. The P-list ***shall*** be preserved during any formatting and ***shall*** be always used in order to avoid possible change of ECC-Block framing by formatting.
- Defective physical sectors encountered by certification after shipment of the DVD-RAM media are listed in the G_1-list. A defect is registered to the G_1-list in a unit of 1 physical sector. Time to perform the slipping replacement for a defective sector listed in the G_1-list is minimal as in the P-list. The G_1-list ***shall*** be always used and ***shall*** only be changed with certification in order to avoid possible change of ECC-Block framing by formatting.
- Defective physical sectors transformed from the SDL by formatting are listed in the G_2-list. A defect registered to the G_2-list consumes 16 entries at once. Time to perform the Slipping Replacement for defective sector listed in the G_2-list is longer than the time for P-list or G_1-list, because it requires time to pass 16 consecutive sector. However, it is still much faster than Linear Replacement because it does not require a Seek operation to the Spare Area. The G_2-list can be changed without certification, however, the G_2-list ***shall*** be disposed at certification in order to avoid possible change of ECC-Block framing by formatting

Linear Replacement is the second method in which a defective physical sector is replaced by the first available physical sector out of spare sectors. The linear replacement is performed in a unit of 16 physical sectors (an ECC-Block). An ECC-Block found to be defective is replaced by the first available good spare ECC-Block of the group. If there is no spare ECC-Block left in that group, the first available good spare ECC-Block of another group is used. Defective ECC-Blocks replaced by the Linear Replacement are listed in the Secondary Defect List (SDL) recorded on the DVD-RAM media. Contents of the SDL on DVD-RAM media is updated whenever an ECC-Block is found to be defective. When a replacement ECC-Block is found to be defective, a new replacement ECC-Block will be substituted and the SDL updated on the media. Chaining of replacement will not be performed. Time to perform the Linear Replacement is longest because it requires seek operation to the Spare Area and writing/reading the replacement ECC-Block. However, this is the only method to register a new defect without formatting the media.

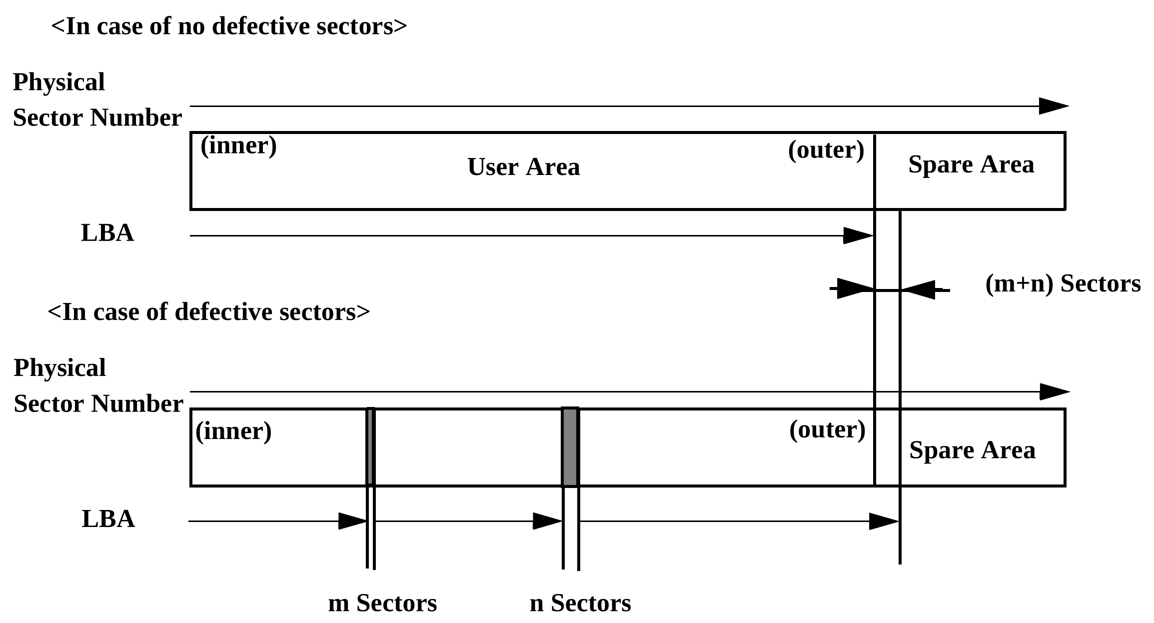

Figure 20 - Slipping Replacement Example

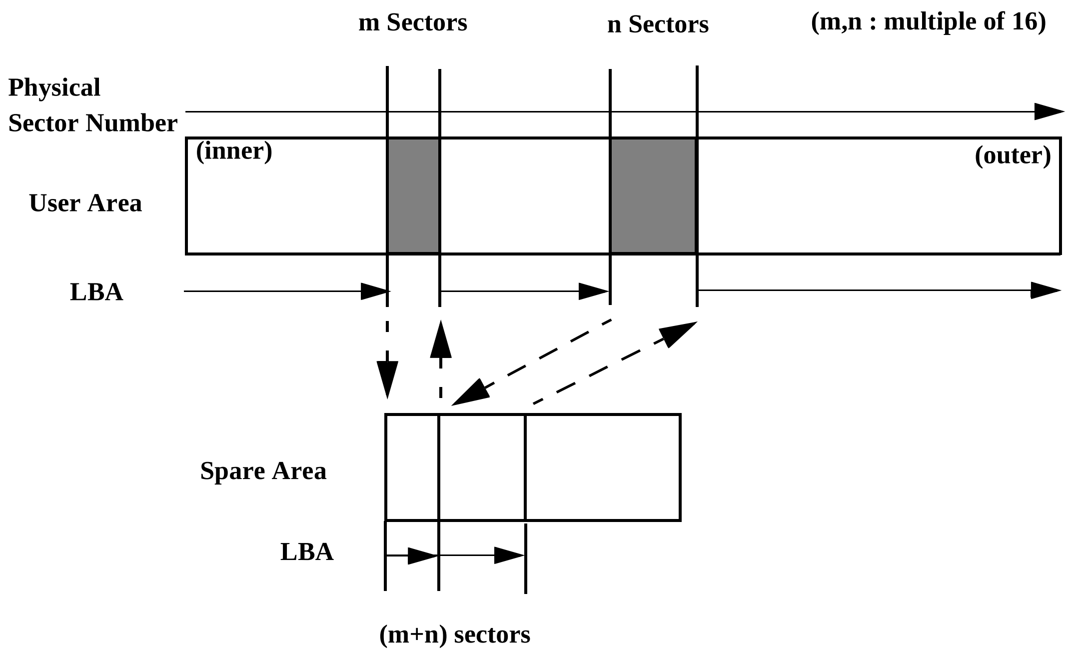

Figure 21 - Linear Replacement Example

4.14.7 DMA Information

The Defect Management Area (DMA) consists of two ECC Blocks. The first ECC Block contains the Disc Definition Structure (DDS) for the recording method used for formatting of the disc, and the Primary Defect List (PDL) for recording defective sectors identified at formatting of the disc. The DDS contains the following information.

- In-process flag indicating formatting operation is completed or not. This flag enables to recover a suspended formatting operation.
- A flag indicating the media has been certified by media manufacturer or not.
- A flag indicating the media has been certified by the Logical Unit or not.

The PDL contains information of defective sectors to be replaced by the slipping replacement. Though the PDL has a capacity to hold defective sector information for up to 7679 sectors, there is another limitation of the maximum number. See Figure 23 - *Limitation of Maximum Number of Sectors for PDL and SDL* on page 84.

The second ECC Block contains the Secondary Defect List (SDL) for recording defective ECC Blocks identified during writing/reading user data. Though the SDL has a capacity to hold the defective ECC Block information up to 3837 ECC Blocks which corresponds to 61392 sectors, there is another limitation of the maximum number. See Figure 23 - *Limitation of Maximum Number of Sectors for PDL and SDL* on page 84.

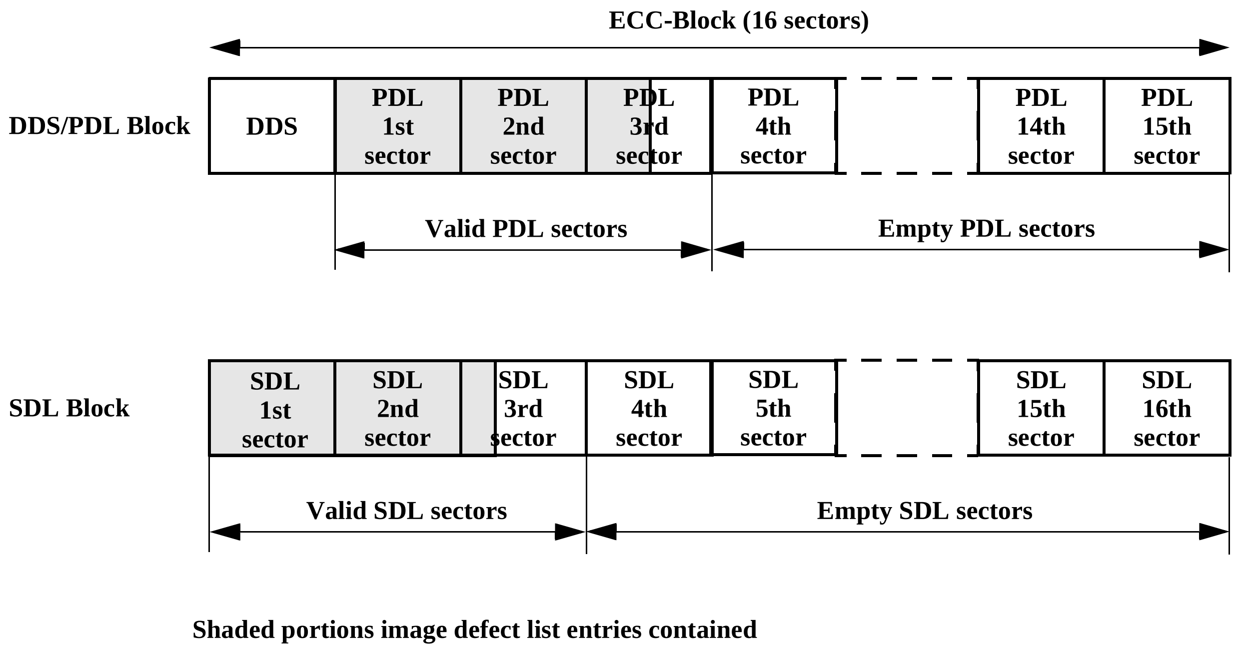

Figure 22 - DDS/PDL Block and SDL Block

Table 24 - DDS Information

Bit / Byte	7	6	5	4	3	2	1	0
0 - 1	DDS Identifier (0A0Ah)							
2	Reserved							
3	Disc Certification Flag							
4 - 7	DDS/PDL Update Counter							
8 - 9	Number of Groups (0018H)							
10 - 15	Reserved							
16	Group Certification Flag for Group 0							
17	Group Certification Flag for Group 1							
18	Group Certification Flag for Group 2							
19	Group Certification Flag for Group 3							
20	Group Certification Flag for Group 4							
21	Group Certification Flag for Group 5							
22	Group Certification Flag for Group 6							
23	Group Certification Flag for Group 7							
24	Group Certification Flag for Group 8							
25	Group Certification Flag for Group 9							
26	Group Certification Flag for Group 10							
27	Group Certification Flag for Group 11							
28	Group Certification Flag for Group 12							

Table 24 - DDS Information (Continued)

Bit / Byte	7	6	5	4	3	2	1	0
29	Group Certification Flag for Group 13							
30	Group Certification Flag for Group 14							
31	Group Certification Flag for Group 15							
32	Group Certification Flag for Group 16							
33	Group Certification Flag for Group 17							
34	Group Certification Flag for Group 18							
35	Group Certification Flag for Group 19							
36	Group Certification Flag for Group 20							
37	Group Certification Flag for Group 21							
38	Group Certification Flag for Group 22							
39	Group Certification Flag for Group 23							
40-2047	Reserved							

Table 25 - Disc Certification Flag

Bit							
7	6	5	4	3	2	1	0
Formatting in-process	Certification full/partial	Formatting for the whole disc/group	Reserved			The whole disc has been certified by user	The disc has been certified by disc manufacturer

Table 26 - Group Certification Flag

Bit							
7	6	5	4	3	2	1	0
Zoned Formatting in-process	Certification full/partial	Reserved				This Group has been certified by user	Reserved

The size of the defect lists will be limited by several factors. As the information about all defects in the PDL and the SDL must be used to access LBAs, the defect lists would normally be kept in the Logical Unit's memory. So that this does not become a problem for some Logical Units, the total size will have a maximum. The total defect list (memory) size ***shall*** not exceed 32 Kbytes. As there are two defect lists, the size of each will be considered. Each list will always contain data from a whole number of sectors. For example, if a single PDL entry is used, the memory size will be 2048 bytes, not 4 only.

$$\boldsymbol{S}_{PDL} + \boldsymbol{S}_{SDL} \leq 16 \qquad (1 \leq \boldsymbol{S}_{PDL} \leq 15,\ 1 \leq \boldsymbol{S}_{SDL} \leq 15)$$

$$\boldsymbol{S}_{PDL} = \mathrm{INT}\left\lceil \frac{(\boldsymbol{E}_{PDL} \times 4 + 4) + 2047}{2048} \right\rceil$$

$$\boldsymbol{S}_{SDL} = \mathrm{INT}\left\lceil \frac{(\boldsymbol{E}_{SDL} \times 8 + 24) + 2047}{2048} \right\rceil$$

$\boldsymbol{S}_{PDL}$ is the number of sectors used to hold PDL entries
$\boldsymbol{S}_{SDL}$ is the number of sectors used to hold SDL entries
$\boldsymbol{E}_{PDL}$ is the number of PDL entries
$\boldsymbol{E}_{SDL}$ is the number of SDL entries

Figure 23 - Limitation of Maximum Number of Sectors for PDL and SDL

4.14.8 Scheduling of Linear Replacement

The DVD-RAM format is designed to enable the following Linear Replacement methods, with some consideration for issues of real-time data recording, where for example the reassignments are disabled during some operations.

- When recording data with verification by the WRITE and VERIFY (10) Command, the Logical Unit has an opportunity to evaluate the written data and if the data is found defective, the Logical Unit may perform a Linear Replacement.
- For data recorded without verification, the Logical Unit has an opportunity to evaluate the written data when the Host attempts to read the data from that LBA and if the data is found defective but correctable by ECC, the Logical Unit may perform the Linear Replacement operation, if read reassignment is enabled.
- For data recorded without verification, the Logical Unit has an opportunity to evaluate the written data when the Host attempts to read the data from that LBA and if the data is found defective but correctable by ECC, the Logical Unit may mark the ECC Block defective to enable future Linear Replacement operation when the Host writes new data to that LBA, if read reassignment is disabled.
- For data recorded without verification, the Logical Unit has an opportunity to evaluate the written data when the Host makes an attempt to read the data from that LBA and if the data is found defective and uncorrectable by ECC, the Logical Unit can mark the ECC Block defective to enable future Linear Replacement operation when the Host writes new data to that LBA.

4.14.9 Formatting

Formatting is required at the beginning of use of DVD-RAM media. During formatting, the Logical Unit defines correspondence between LBAs and physical addresses and records relevant information in the Defect Management Areas. All the user data in the formatted extent is lost during the formatting. Media certification may be included as a part of the formatting. No defect list ***shall*** be transferred from the Host, i.e. there ***shall*** be no D-list for DVD-RAM media.

The certification process included in the formatting should not be confused with media certification from a media manufacturer. The Logical Unit controlled “certification” allows the Logical Unit to write and verify all the sectors on the media. This operation allows some defects to be registered in the G_1-list for the Slipping Replacement. These are not the same as certification defects from the media manufacture which is recorded in the P-list. The result of the “certification” process of the FORMAT UNIT Command is to leave every sector with a special ID content called the

"Initialization pattern." This type of ECC Block ***shall*** be treated as though all zero data has been written. This is the same as an unwritten ECC Block.

There are two cases where the spare sectors available are exhausted:

- During a re-formatting, when SDL entries are converted to G_2-list entries.
- During a formatting with certification, when new defects are found that exceed the available spare sectors in that zone.

When these happen, the Logical Unit ***shall*** place the overflow sectors into the SDL and replace these sectors with spare sectors from another zone. During re-formatting, SDL entries that cannot be converted to PDL entries will be kept in the SDL, but the replacement location may change. During a formatting with certification, when new PDL entries are added that cannot be used because there are not enough spare sectors in that zone, a new SDL entry ***shall*** be created. In both cases, the SDL may not be empty after the FORMAT UNIT Command completes.

If the total number of spare sectors are exhausted during a FORMAT UNIT Command, the format operation will not stop, but will ignore those defects that cannot be replaced and a RECOVERED ERROR ***shall*** be reported at the completion.

If the size of the PDL & SDL are going to exceed the limit in Figure 23, the Logical Unit ***shall*** discard defect entries until the size does not exceed that limit.

There can be considered four kinds of formatting depending on how the certification performed and how the old defect list (G_1-list and G_2-list) is treated:

4.14.9.1 Formatting Type 1 - Slow Initialization

The purpose of Formatting Type 1 is to initialize the medium using the media manufacturer's defect list (P-list), assuming that the media has defects not in the P-list. The Logical Unit performs its own certification. The execution time is long, at least one hour or more. Every physical sector should be written with initialization pattern and verified.

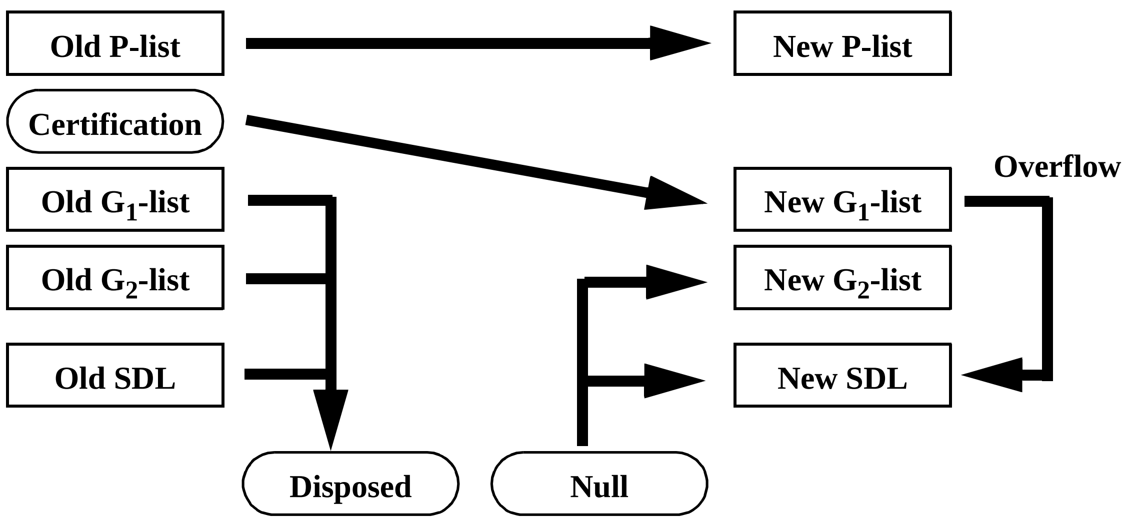

Figure 24 - Formatting Type 1 - Slow Initialization

4.14.9.2 Formatting Type 2 - Quick Improvement

The purpose of Formatting Type 2 is to remove reassigned sectors for Linear Replacement and change them to Slipping Replacement. The total number of Spare sectors available remains the same. The execution time is very little, only several seconds is expected.

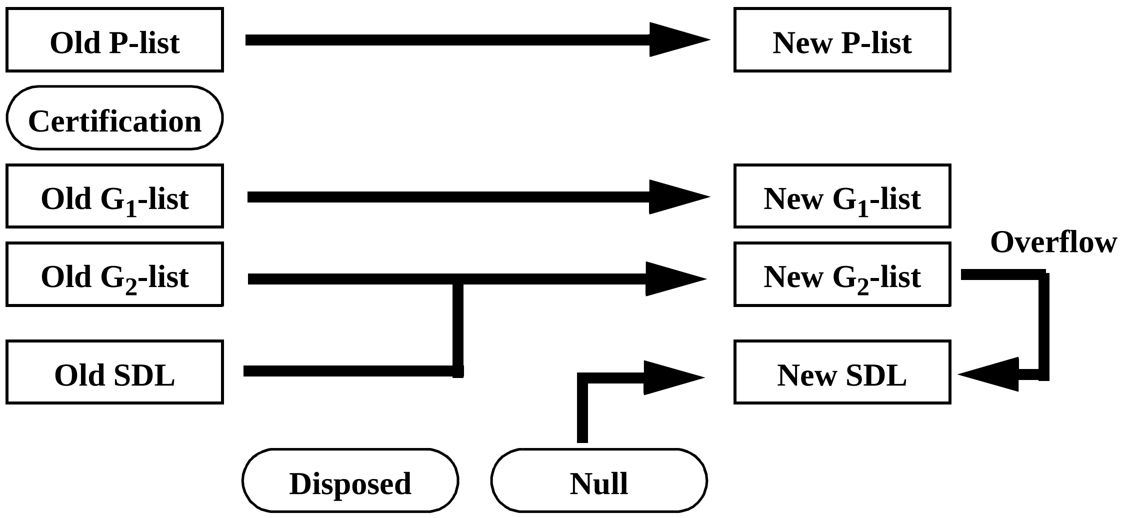

Figure 25 - Formatting Type 2 - Quick Improvement

4.14.9.3 Formatting Type 3 - Medium Fast Partial Certification

The purpose of Formatting Type 3 is to remove reassigned sectors for Linear Replacement and change them to Slipping Replacement, but only the actual defective sector in the Linearly Replaced ECC Block should be Slipped. The total number of Spare sectors available may increase. The execution time depends on the number of Zones in which a sector is appended to the G1-list. Each of these Zones must have every sector written with the initialization pattern following the first sector appended to the G_1-list, including the unused Spare sectors. After the point of G_1-list append, defective sectors listed in the G_2-list or SDL cannot stay as they are. They need to be moved to G_1-list and G_2-list, respectively.

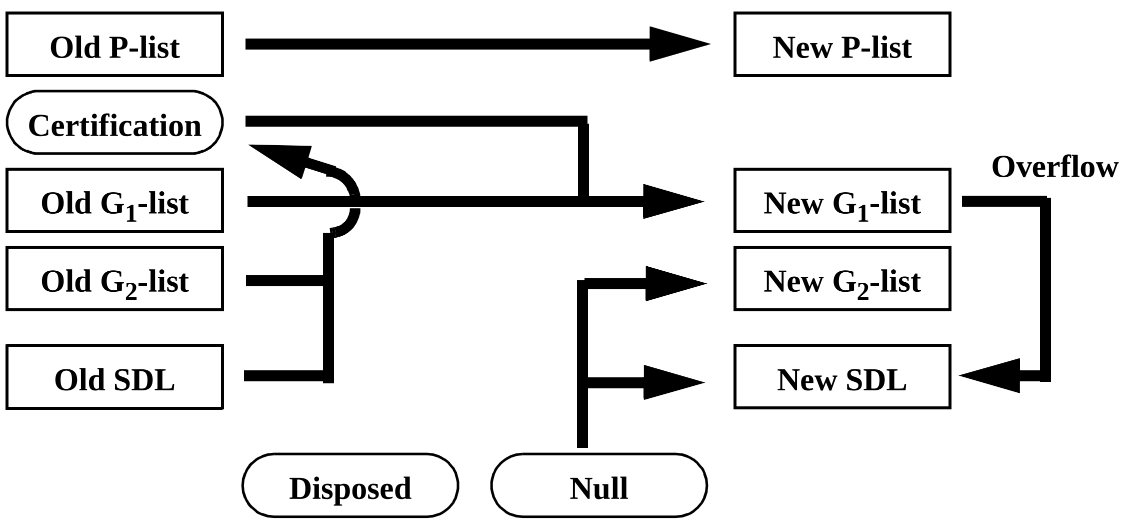

Figure 26 - Formatting Type 3 - Medium Fast Partial Certification

4.14.9.4 Formatting Type 4 - Quick Clearing

The purpose of Formatting Type 4 is to initialize the media for use, using only media manufacturer defect information. Another purpose is to return the media to the latest certified state by removing reassigned sectors for Linear Replacement and the G_2-list. The execution time is very little; only several seconds is expected.

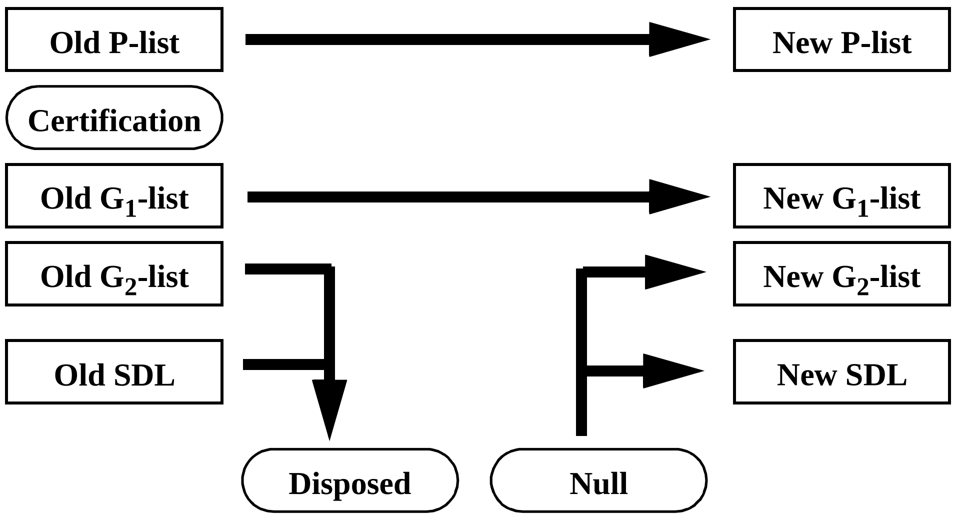

Figure 27 - Formatting Type 4 - Quick Clearing

4.14.10 Interruption of Formatting

An interruption of formatting by reset, or power off may cause the media to be unusable without another formatting operation. In any case, all the user data in the formatting extent ***shall*** be assumed to be lost, because correspondence between the LBAs and physical addresses may have been changed.

- An interruption of formatting Type 1 may cause the media to be unusable because of uncompleted change of the ECC boundaries. Any access to the media in this condition other than a proper FORMAT UNIT Command ***shall*** be terminated with CHECK CONDITION Status, 3/31/00 MEDIUM FORMAT CORRUPTED. The only recovery operation to this case is another formatting by formatting Type 1 only.
- An interruption of formatting Type 2 causes the media to be usable as there is no media certify operation.
- An interruption of formatting Type 3 may cause the media to be unusable because of uncompleted change of the ECC boundaries. Any access to the media in this condition other than proper FORMAT UNIT Commands ***shall*** be terminated with CHECK CONDITION Status, 3/31/00 MEDIUM FORMAT CORRUPTED. The possible recovery operations to this case are another formatting by either formatting Type 1 or formatting Type 3.
- An interruption of formatting Type 4 causes the media to be usable as there is no certification operation.

4.14.11 Zoned Formatting

Formatting of DVD-RAM media can be performed in units of a Zone. Purposes are:

- To remove reassigned sectors of a Zone and change them for Slipping Replacement. *4.14.9.2, "Formatting Type 2 - Quick Improvement"* on page 85
- To remove reassigned sectors of a Zone and encounter really defective sectors by certification for all the sectors of that Zone. *4.14.9.1, "Formatting Type 1 - Slow Initialization"* on page 85
- To remove reassigned sectors of a Zone and change them for Slipping Replacement, but only when actual defective sectors are encountered by partial certification only applied to the Linearly Replaced ECC-Blocks. The Zone must have every sector written with the initialization pattern following the first sector appended to the G_1-list, including the unused Spare sectors. After the point of G_1-list appended, defective sectors listed in the G_2-list or SDL cannot stay as they are. They need to be moved to G_1-list and G_2-list, respectively. *Section 4.14.9.3, "Formatting Type 3 - Medium Fast Partial Certification"* on page 86

During the Zoned Formatting, data of that Zone is lost but data of the other Zones is preserved. This enables the Host to reformat the media without losing the data by using appropriate save/restore operations.

However, as the recovery operation by a Logical Unit to a suspended regular certification is to perform another certification to whole media and this means whole data on the media will be lost, the Logical Unit will not regard the certification by the Zoned Formatting as the regular certification. If certification by the Zoned Formatting is suspended, there may be an mismatch of ECC-Block framing and the Logical Unit will not be aware of that. The Host is responsible for performing an appropriate recovery operation.

If a spare sector of the Zone designated to Zoned Formatting is used from another Zone, the Zoned Formatting terminates with an ERROR and the zone number of another Zone will be reported in the Sense data Information Field.

4.14.12 Responsibilities for dealing with DVD-RAM Media

Table 27 - Responsibilities, use of DVD-RAM Media

Operation	Logical Unit	Host
Detect and Perform Linear Replacement	Responsible	-
Detect Performance Degradation	S.M.A.R.T. and the Real Time Streaming Feature	Some Tools
Reformat	NO	Responsible
Provide Error Free Contiguous Logical Address Space	YES	NO
Maintain Same Number of User Blocks	YES	NO

4.15 Recording/Reading for DVD+RW Media

DVD+RW media is directly addressable by a logical block address and permits reading and writing from any of the consecutively numbered logical blocks. The actual data may not be stored in a consecutive manner, even though the logical blocks are consecutive, because of defect management and the existence of physical sectors which do not directly correspond to logical blocks. Such physical sectors comprise spare sectors and sectors used for media management.

4.15.1 Logical Layout of DVD+RW Media

DVD+RW media is divided into 3 Zones: Lead-in, Data Area, and Lead-out. These three areas are located on a continuous spiral path from the inner diameter to the outer diameter of the disc. The Lead-in area contains information used by the Logical Unit to determine media characteristics and manage the logical layout. The Lead-in has both an embossed area as found on DVD-ROM media and a rewritable area. The Data Area and Lead-out are written using the phase change effect.

The Data Area is divided into Spare Areas and User Data Areas. The size of each is user configurable, allowing flexibility to accomodate both computer and streamed (video) data. The allocation of the Data Area to user data and spare areas is done only at format time.

As in DVD-ROM, LBA 0 does not map to PBA 0. The first data block is at PBA 31000h. DVD+RW places the first spare area there, so if any sparing is allowed, the block at 31000h is reserved for sparing. LBA 0 is assigned to the first non-defective block following the first spare area. The Logical Block Addresses increase monotonically from this point to the outer diameter, skipping each defect listed in the active PDL and each of the areas set aside for sparing.

Sparing parameters are contained in the Defect Management Area (DMA). The DMA contains the active PDL, the inactive PDL, the active SDL, and a list of areas available for sparing. All address mapping and defect management is the responsibility of the Logical Unit. The defect management scheme specifies M spare sectors per N user data sectors, where M and N are user chosen values according to the rules set by the DVD+RW standard. Specifically, M and N must be integral powers of two, with a value of 16 or higher, except that M is allowed to be zero, which sets aside no areas for sparing. In addition, M and N must be chosen such that the total defect list size is less than or equal to 32,768 bytes (including the headers).

4.15.2 Unrecorded DVD+RW ECC Block

A DVD+RW disc which has not been certified may contain an unrecorded ECC Block to which user data has not been written (blank block). The Logical Unit ***shall*** return all zero data in response to an attempt to read any blank block, and no error shall be generated. Please see the VERIFY (10) Command for more information.

4.15.3 Read Modify Write on DVD+RW media

Any attempt to write quantities of data smaller than one ECC-Block shall cause a read-modify-write operation in the Logical Unit. This may require more than one rotation to write the data, if data is not cached. The process for writing this data is:

1. Read an ECC-Block containing the designated logical block(s) (First pass)
2. Overlay the data to be written onto the read ECC-Block data
3. Writing the modified ECC-Block data back to the same addresses (Second pass)

When a write is requested for a sector in an ECC Block that has not yet been recorded, the Logical Unit shall write all zero data to the logical blocks in the ECC Block other than the designated logical blocks from the Host.

If optimum performance is desired, it is recommended that applications that use DVD+RW media read and write data in integral multiples of 16 sectors starting at a logical block address that is an integral multiple of 16. This use model prevents read-modify-write operations within the Logical Unit. It is recommended that Host drivers use the “Blocking Factor” in the Random Readable Feature to determine the value rather than hard coding the value 16.

4.15.4 Data ID

The Data ID in the physical sectors increases linearly from the inner diameter to the outer diameter. The first ECC block of the Lead-in has a Data ID of 2F000h. The first rewritable ECC block of the Lead-in area has a Data ID of 30000h. The first ECC block in the Data Area has a Data ID of 31000h. A unique Data ID is assigned in a contiguous ascending sequence to every physical sector on the medium. The sparing algorithm specified in the DVD+RW standard provides the logical to physical address mapping.

4.15.5 Defect Management for DVD+RW Media

Defective physical sectors in the Data Area of DVD+RW media are managed by the Logical Unit according to the defect management scheme specified in ECMA-274.

Two replacement methods are defined for defective physical sectors:

Slipping replacement is the first method for defect management. Extents of defective physical sectors are skipped when assigning logical block addresses. The slipping replacement is performed in units of ECC blocks (16 physical sectors). Defective ECC blocks skipped by slipping are listed in Primary Defect List (PDL), which is recorded on the DVD+RW media during formatting. Contents of the PDL on DVD+RW media can be changed only by formatting. The number of entiries in the PDL is limited only by the total size of the PDL and SDL, as specified by the DVD+RW standard. Each entry in the PDL has one of four possible defect types.

Entries in the PDL will be referenced by “DT n” where “n” is the Defect Type. All entries in the PDL identify the first physical sector of an ECC block to be skipped when assigning logical block addresses.

DT 0 marks defects identified by the media manufacturer’s certification. DT 1 marks defects identified by a consumer certification. DT 2 marks defects entered by some other means, e.g. transfer from the SDL during a re-format, or list entries provided by the inititiator during a format. There is no operational difference among these three Defect Types except during Format operations.

The fourth Defect Type is Defect Type 3. Defect Type 3 marks defects identified by the manufacturer, but have been ignored by user request (DPRY = 1) during a Format operation. The sole purpose of Defect Type 3 is to retain the manufacturer certification list for future re-format operations that do not have the DPRY bit set.

Linear Replacement is the second method in which a defective ECC block is replaced by the closest available spare ECC block. The identification of the “closest” ECC block is implementation dependent, and may or may not be the ECC block with the smallest physical sector address difference. The linear replacement is performed in a unit of 16 physical sectors (an ECC-Block).

The list of Linear Replacements is contained in the SDL. The SDL also contains the list of all areas set aside for sparing but not yet used for replacing defective blocks. The SDL is updated whenever an ECC block is found to be defective and is reassigned to a block from the Spare Area.

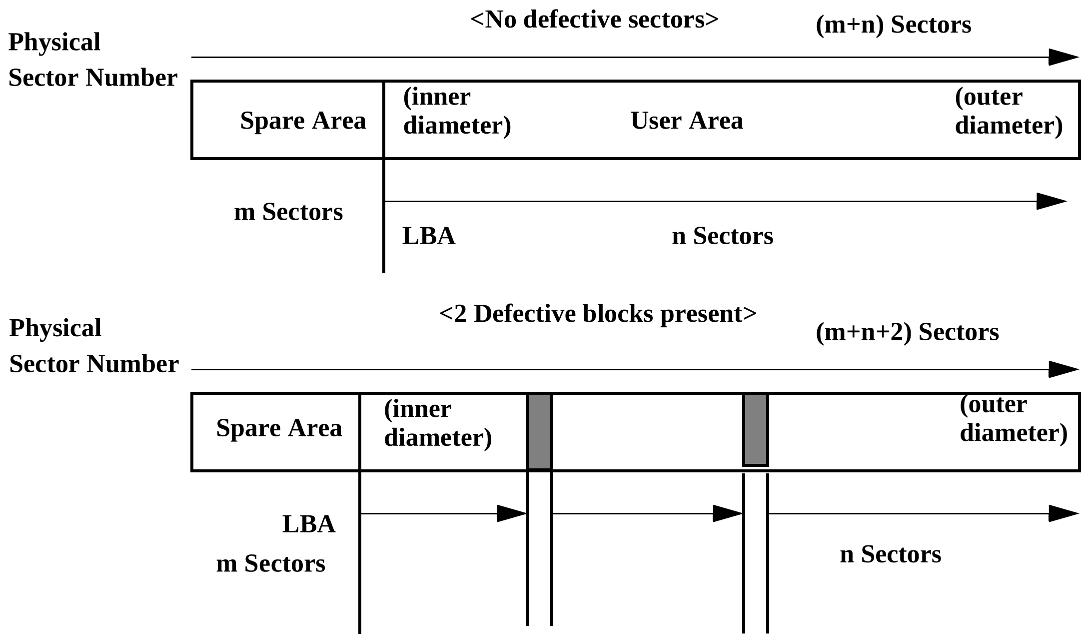

Figure 28 - Slipping Replacement Example

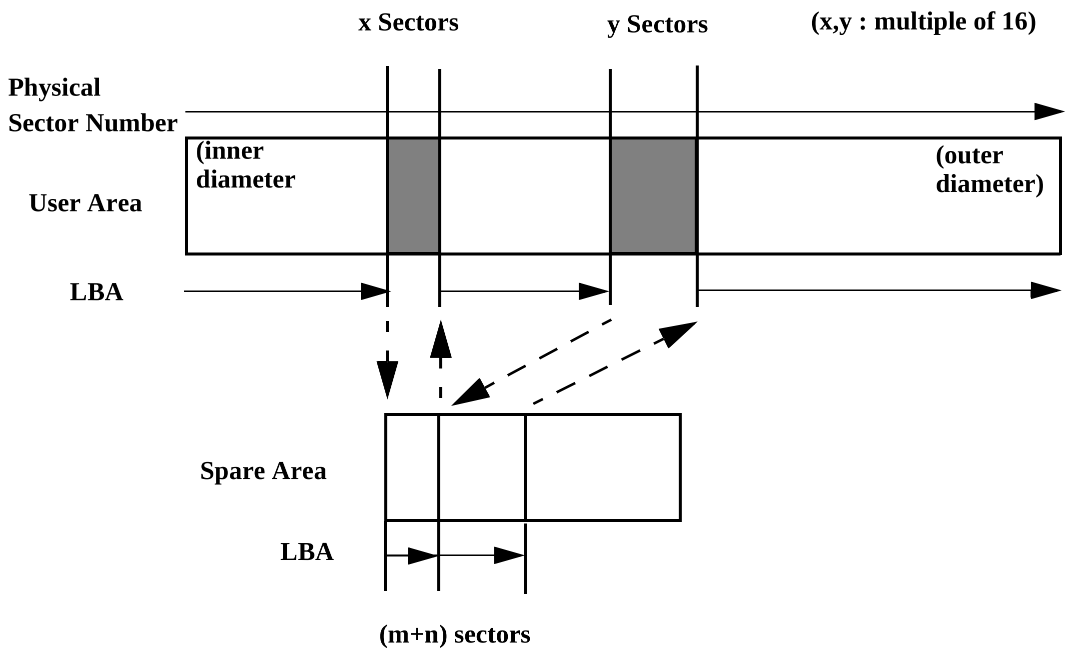

Figure 29 - Linear Replacement Example

4.15.6 DMA Information

There are four duplicate Defect Management Areas (DMA). Each DMA consists of two ECC Blocks. The first ECC Block contains the Primary Defect List (PDL) for identifying defective blocks identified at formatting of the disc. The PDL is always 32 KB, with all data following the PDL entries filled with all zeros. The PDL contains the following information:

- Parameters identifying the number of Sectors per Spare Area (SL) and number of Sectors between each Spare Area.
- A list of ECC blocks identified as defective. The PDL may have up to 8186 entries.

The second ECC Block contains Secondary Defect List (SDL) for recording defective ECC Blocks identified during writing/reading user data. The SDL has a capacity to hold (8186-N_PDL) / 2 entries, where N_PDL is the number of entries in the PDL. The PDL is always 32 KB, with all data following the PDL entries filled with all zeros.

4.15.7 Scheduling of Linear Replacement

The DVD+RW format is designed to enable the following Linear Replacement methods, with some consideration for issues of real-time data recording, where for example the reassignments are disabled during some operations.

- When recording data with a verify operation by a WRITE and VERIFY (10) Command, the Logical Unit has an opportunity to evaluate the written data, and if the data is found defective, the Logical Unit may perform a Linear Replacement.
- For the data recorded without a verify operation, the Logical Unit has an opportunity to evaluate the written data when the Host attempts to read the data from that LBA and if the data is found defective but correctable by ECC, the Logical Unit may perform the Linear Replacement operation, if read reassignment is enabled.
- For the data recorded without a verify operation, the Logical Unit has an opportunity to evaluate the written data when the Host attempts to read the data from that LBA and if the data is found defective but correctable by ECC, the Logical

Unit may mark the ECC Block defective to enable future Linear Replacement operation when the Host writes new data to that LBA, if read reassignment is disabled.

- For the data recorded without verify operation, the Logical Unit has an opportunity to evaluate the written data when the Host make an attempt to read the data from that LBA and if the data is found defective and uncorrectable by ECC, the Logical Unit can mark the ECC Block defective to enable future Linear Replacement operation when the Host writes new data to that LBA.

4.15.8 Formatting

Formatting is required prior to using DVD+RW media. During formatting, the Logical Unit defines correspondence between LBAs and physical addresses and records relevant information in the Defect Management Areas. All the user data in the formatted extent may be lost during the formatting. Media certification may be included as a part of the formatting process.

Certification may be performed by the manufacturer or the Logical Unit or both. The Manufacturer’s certification list is never removed, although it may be inactive. Certification may use any process, but typically involves writing and then reading data.

DVD+RW media does not have any limits on slipping other than the size of the PDL.

Formatting consists of the following steps, which may occur in any order:

- Write the Lead-in. The Lead-in contains information about the disc, including the Defect Management Areas (DMA).
- Write the Lead-out. The Lead-in contains information about the disc, including the Defect Management Areas (DMA).
- Optionally certify the Data Area. The means of certification are vendor specific.
- Optionally write the Data Area. Recorded data should be all 00h.
- Generate the PDL. All entries from the manufacturer’s certification, all entries generated during the Logical Unit’s own certification, all entries transferred from the SDL, and all entries sent from the Initiator shall be recorded in the PDL as requested by the Initiator in the FORMAT UNIT Command.
- Generate the SDL.
- Write the PDL and SDL to the four DMA.

As the allocation for sparing is user selectable for various applications, a mode page is defined for passing these parameters. If SI and SL are chosen to be relatively small, the disc will contain an evenly distributed set of Spare Areas. If large values are used, the disc will contain a typical banded type of Spare Areas.

4.15.9 Interruption of Formatting

An interruption of formatting by reset or power off may cause the DMA to be in an inconsistent state. In this case, the Logical Unit shall use the DMA with the highest sequence number. This means that if formatting is interrupted before the DMA are written, the disc retains its old state (same PDL and SDL), but may have some of the user data information destroyed. If interrupted after writing one or more DMA, the disc is formatted according to the new request. There may be a single uncorrectable block on the disc due to the interruption.

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4.16 Recording for DVD-R media

4.16.1 Basics for DVD-R vs. CD-R

Generally the contents on a DVD Disc are managed using the OSTA Universal Disk Format (UDF) file system. (UDF Bridge may also be used.) A DVD-ROM Disc is similar to a CD-ROM Disc in that it has one Mode 1 data track with Lead-in and Lead-out. A DVD Disc does not have pre-gap or post-gap.

DVD-R is similar to CD-R. It is a write-once media that in most cases will be readable by a DVD-ROM drive. There are some capabilities that are defined by this specification and could cause some media to not be readable by legacy DVD-ROM Logical Units. DVD-R provides data appendability using incremental sequential writing.

One major difference between DVD-R and CD-R is the Track. DVD-R does not have an Audio Track and Sub-channel data, thus there is no Table of Contents like on CD. Data written on a DVD-R disc looks like a Mode 1 data track on a CD-R disc. For DVD-R, Three appendable points are provided. To control (manage) data appendable points in a data recordable area, the concept of an RZone has been introduced. An RZone contains data elements Next Writable Address, Last Recorded Address, Start Address and Length, which is similar to a CD Track.

Both DVD-R and CD-R use a Link sector to stop and resume recording. Because of differences between the cross-interleaved ECC of CD and the 32K ECC blocks of DVD, the linking scheme is a little different. CD-R uses Run-out, Link, and Run-in sectors. DVD-R uses Linking Loss, padding and Block Sync Guarantee Linking Loss sectors (BSGLL). These Linking Loss sectors use Logical Block Address (LBA) space.

DVD-R has a Recording Management Area (RMA) to store Recording Management Data (RMD) including the RZone information, Disc Status and other helpful information for file system management. RMA is located out of the user data area. RMD block size is 32KB.

4.16.2 Recording Model for DVD-R Media

DVD-R media supports two types of recording; disc-at-once (un-interrupted) and incremental. In case of incremental recording, when recording is interrupted, linking ***shall*** be used.

The Write Type field in the *Write Parameters* Mode Page (05h) is used to specify if disc-at-once recording or incremental recording will be used.

4.16.2.1 Sequential Recording

DVD-R media makes use of sequential recording. This type of recording does not permit random access for recording purposes. Recording may only occur at predefined recording (appendable) points.

Multiple Appendable points may exist within management areas for sequential recording. The data ***shall*** be written sequentially from each appendable point. Each start/stop of recording occurs in a special structure called a Linking Loss area.

4.16.2.1.1 NWA (Next Writable Address)

Each appendable point is referred to as NWA (Next Writable Address).

4.16.3 Disc-at-once Recording

Disc-at-once recording is recording data including Lead-in and Lead-out sequentially written to the media without interruption. There are no Linking Loss areas in the recorded data from Lead-in through the end of Lead-out. Disc-at-once recording is used to create fully compatible media which behaves like DVD-VIDEO/ROM media.

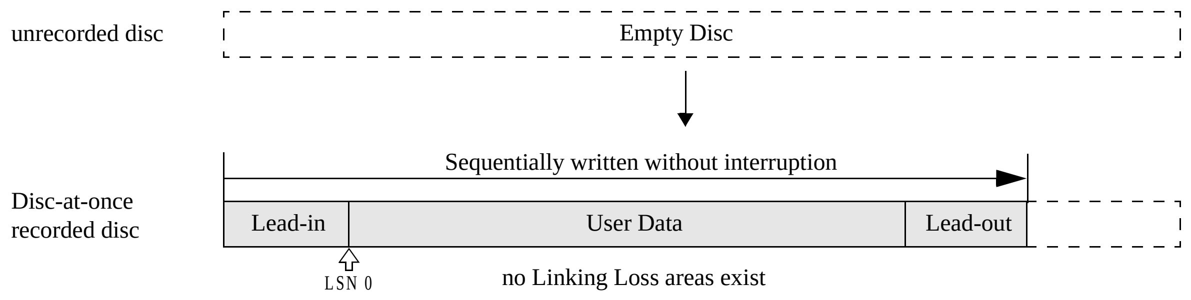

Figure 30 - Disc-at-once Recording

For disc-at-once recording, the Information Area ***shall*** be recorded more than 70mm in diameter. If the recorded length is less than 70mm in diameter, the Logical Unit ***shall*** write Lead-out up to 70mm in diameter. See the DVD-ROM Book Part1.

Sample sequence of disc-at-once recording:

1. Set the Write Type field in the *Write Parameters* Mode Page (05h) to "disc-at-once."
2. Specify transfer user data size by using the RESERVE TRACK/RZONE Command.
3. Issue WRITE (10) Command from logical sector number 0.
   The Logical Unit ***shall*** perform Optimum Power Calibration (OPC).
   Write and verify RMD in RMA.
   The Logical Unit starts writing from the Lead-in through Data Recordable Area.
4. Repeat WRITE (10) Command for all data.

When all user data has been written on the medium, the Logical Unit starts writing Lead-out.

If a buffer under-run occurs, the Logical Unit ***shall*** stop writing immediately and the Logical Unit ***shall*** start writing of Lead-out.

Note: The Lead-out length shall be 0.5mm in radial direction. For DVD-ROM compatibility, if recorded length is less than 70 mm in diameter, the drive ***shall*** *write the Lead-out up to 70 mm in diameter. For DVD-R compatibility, if recorded length is less than 3 mm in the radial direction, the drive* ***shall*** *write the Lead-out up to 3 mm in the radial direction.*

4.16.4 Incremental Recording

In the case of incremental recording, user data is written sequentially from each NWA. A variable amount of user data is written at several distinct times. Each recording begins and ends with a link. Linking Loss and Block Sync Guarantee Linking Loss areas do not contain user data and are used during recording to allow discontinuous recording of data.

For DVD-R media to be readable by DVD-ROM Logical Units, the media ***shall*** contain a Lead-in and a Lead-out or Border-out. The Border-out is similar to the Lead-out. For more information see the DVD-R Book Part 1.

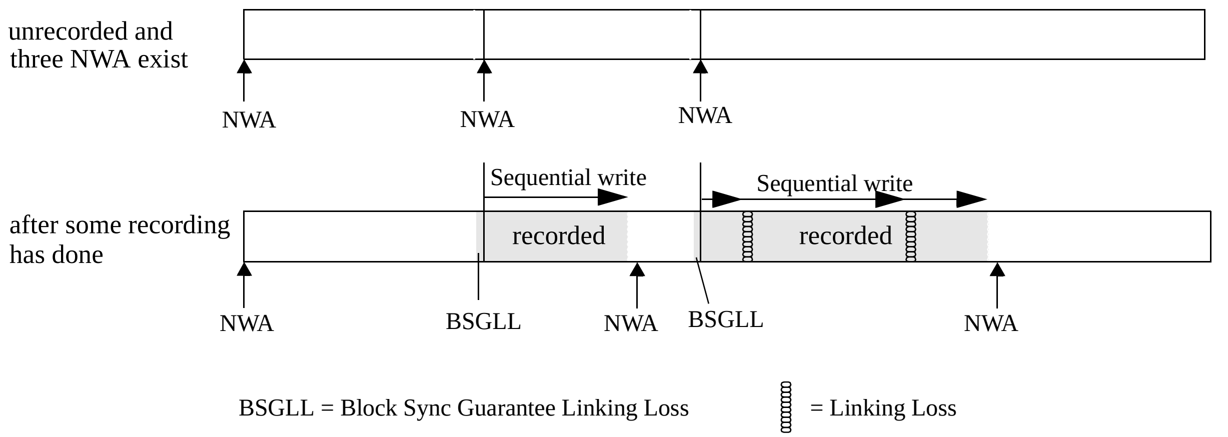

Figure 31 - Example of Incremental Recording

4.16.4.1 Linking and Data Type bit

When recording is interrupted, e.g., due to FLUSH CACHE occurring, the Logical Unit ***shall*** perform linking. Currently, two Linking Loss area sizes are defined: 2KB and 32KB. The Link Size field in the *Write Parameters* Mode Page (05h) is used to specify Linking Loss area size. Mixing the two Linking Loss area sizes on the same disc is allowed.

LBAs are assigned to Linking Loss area sectors. Addressing similar to “Method 2” for CD media is not provided for DVD-R media.

The **Data Type** bit of the Identification Data (first 4 bytes of physical sector) when set to 0, ***shall*** indicate that the next sector is a normal data sector. When the **Data Type** bit is set to 1, ***shall*** indicate that the next sector belongs to a Linking Loss area. If the sector contains a linking position, the **Data Type** bit of the sector ***shall*** always be set to 0, even if the next sector will be a Linking Loss Sector. This exception is due to the possibility of changing the link size. If a sector is part of a Linking Loss area and the Link Flag in the previous sector is readable, no ECC related error ***shall*** be returned to the Host in response to any command that would require the Logical Unit read that sector. This would include commands such as READ (10), VERIFY (10), REPORT KEY, and WRITE and VERIFY (10).

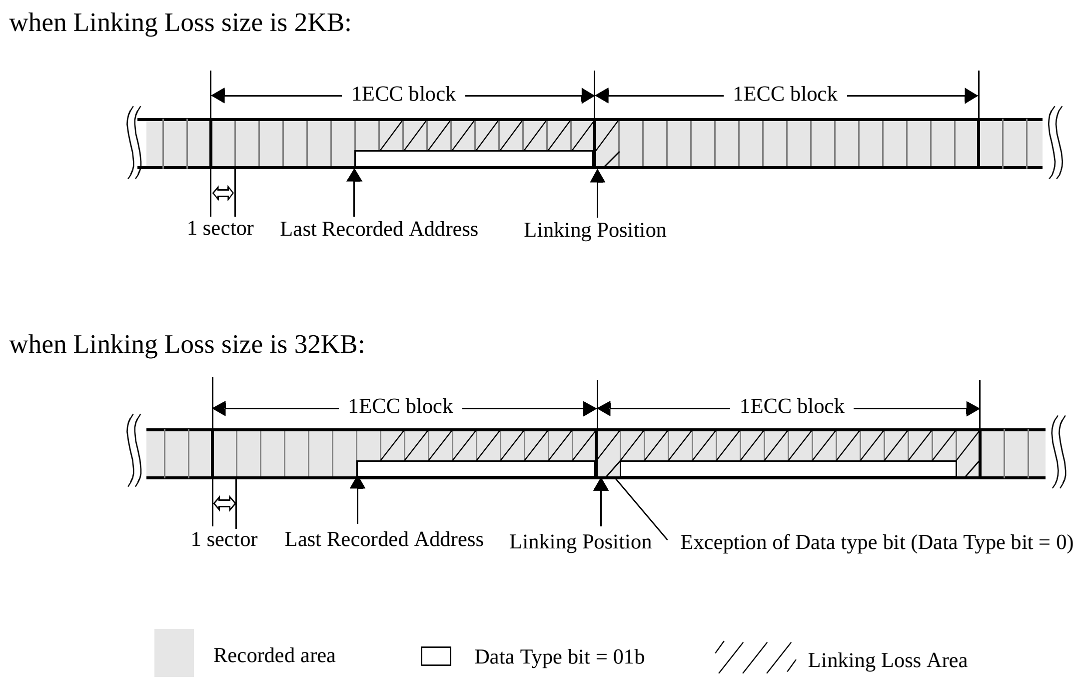

Figure 32 - Relation between Data Type bit and Linking Loss Area

If the Linking Loss area size is set to 32KB, all of the sectors within a linking ECC block are used as Linking Loss. Those ECC blocks can be ignored and no error correction need be provided by the Logical Unit. A drawback however, is that 16 sectors are exhausted by each link operation.

If the Linking Loss area size is set to 2KB, the first sector of the linking ECC block is used as Linking Loss. The remaining 15 sectors of the ECC block are available for valid user data. As the Parity Bytes used for error correction do not include the correct data from the Link Sector, the error correction capability may be degraded. If the Logical Unit uses Erasure Correction techniques and the data contained in the Link Sector has been written with zeros, then the degradation of the error correction capability will be very small.

Table 28 - 2KB Linking vs. 32KB Linking

2KB linking	32KB linking
less overhead (padding is done up to 2KB)	more overhead (padding is done up to 32KB)
ECC may be degraded	ECC not affected

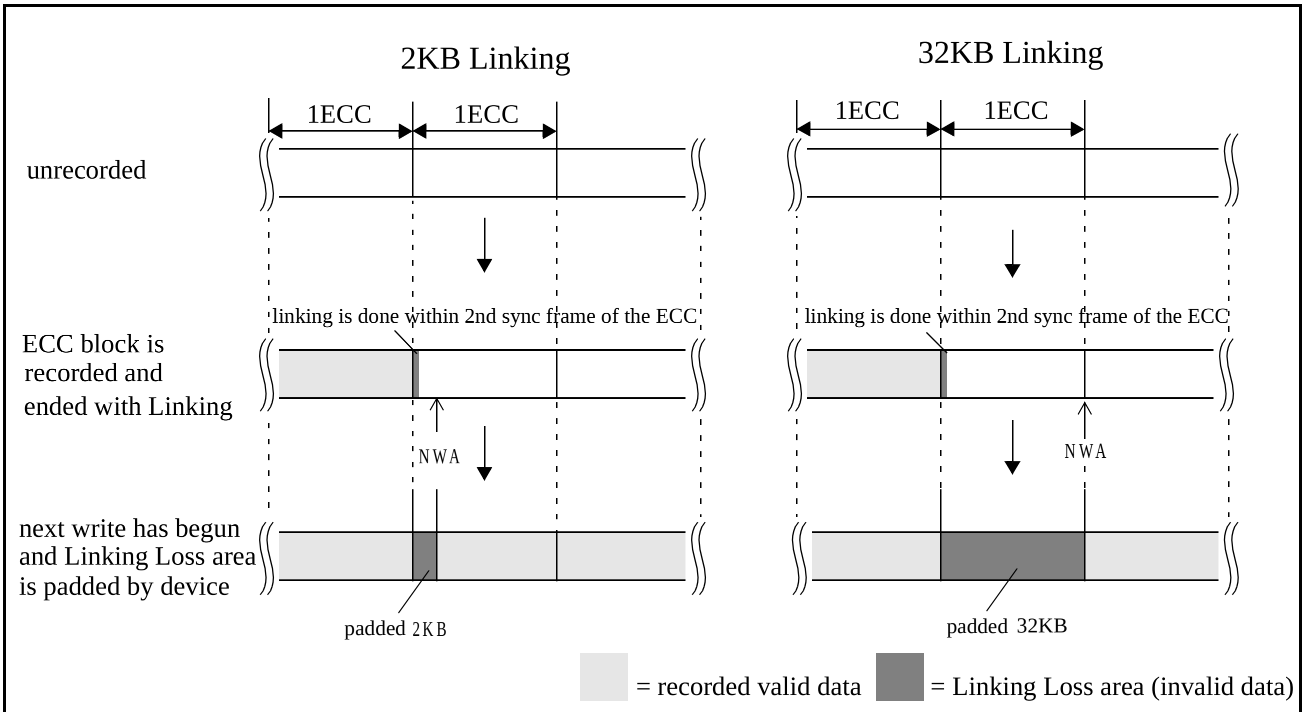

Figure 33 - Difference between 2KB and 32KB Linking

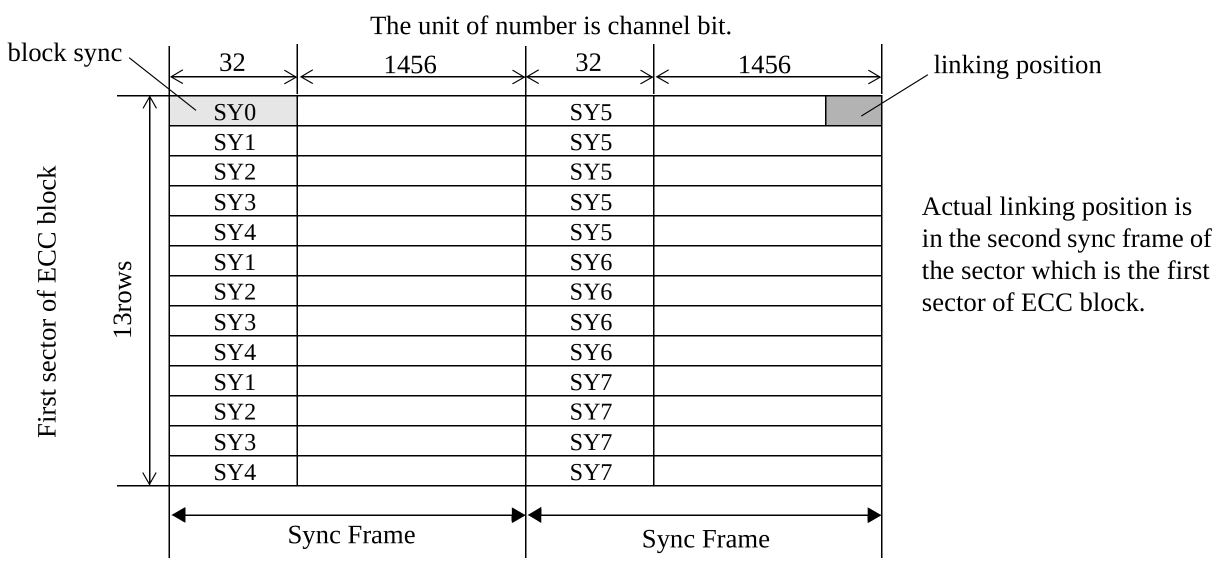

Figure 34 - Linking Position in Physical Sector

Sample Sequence of incremental recording:

1. Set the Write Type field in the *Write Parameters* Mode Page (05h) to “incremental”.
2. Set the Link Size field in the *Write Parameters* Mode Page (05h) to 1 (2KB) or 16 (32KB).
3. If necessary, reserve RZone by using RESERVE TRACK/RZONE Command.
4. Inquire NWA of the specified RZone by using READ TRACK/RZONE INFORMATION Command.
5. Issue WRITE (10) Command from NWA.
   The Logical Unit may perform OPC.
   If an RZone was newly reserved, the Logical Unit ***shall*** store the RZone information in the RMA prior to writing.
   The Logical Unit starts writing from NWA.
6. Repeat WRITE (10) Command for all data.
7. Optionally issue FLUSH CACHE Command.

When all the user data is written on the medium, the Logical Unit ***shall*** perform linking.

Once Write Type is selected and a write operation has begun, Write Type is not changeable. If Write Type does not match the disc status, the command ***shall*** be terminated with CHECK CONDITION Status, 5/26/00 INVALID FIELD IN PARAMETER LIST.

4.16.5 DVD-Video Compatibility issues

To record DVD-VIDEO format on DVD-R media, disc-at-once recording is compatible; compatibility is limited in incremental mode (each file must be recorded as one “packet”). In the case of incremental recording, to record DVD-Video files correctly, the following limitations ***shall*** be taken into consideration.

All DVD Video Title Sets (VTS) are managed by the Video Manager (VMG). The VMG is recorded as files that are named VIDEO_TS.IFO, VIDEO_TS.VOB (optional), and VIDEO_TS.BUP. The order of the files is specified and it is not possible to change the order.

The VMG ***shall*** be placed before any VTS. The VMG contains the information of the VTS location as offset from VMG start logical sector. Once VMG is recorded, VTS that is not registered in the VMG, cannot be further appended.

Each file ***shall*** be recorded as a single extent. Therefore each file ***shall*** be recorded as one packet.

To guarantee the continuous playback of MPEG 2 data stream, VTS files ***shall*** be recorded contiguously and garbage sectors and Linking Loss sectors are not allowed between Video Object (VOB) files within a VTS. This is because the VOB files consist of a continuous video stream.

See *DVD-ROM Book Part 3* for further information on these limitations.

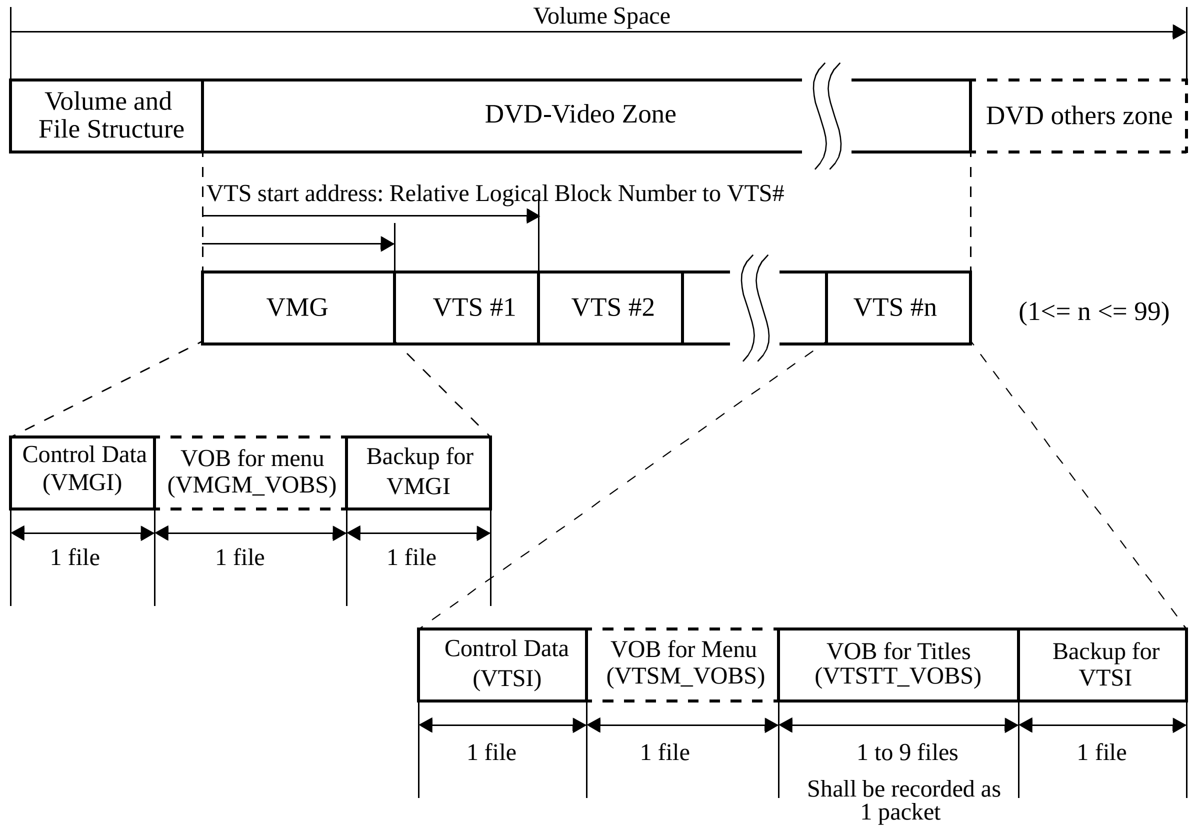

Figure 35 - Example of DVD-Video Volume Structure

4.16.6 RZone Model

The RZone is defined for DVD-R to manage appendable points. The RZone status changes according to its recording stage. These status names are shown in Figure 36 below.

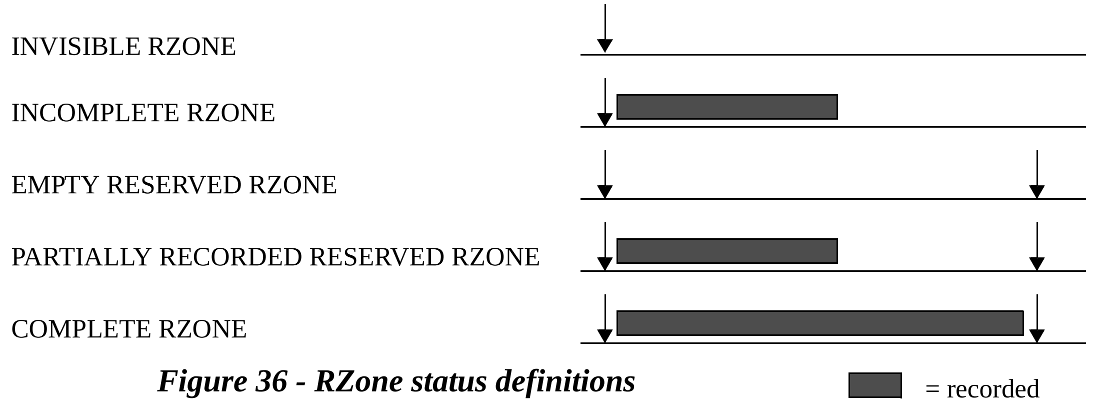

Figure 36 - RZone status definitions

Invisible/Incomplete RZone: The RZone only has a start address. End address is not defined. This kind of RZone is always located on the outermost portion of the media and is data appendable.

Empty Reserved RZone/Partially Recorded Reserved RZone: The RZone has a start address and end address. This kind of RZone is always data appendable.

Complete RZone: The RZone is closed or completely filled with data. This kind of RZone has no NWA and can not append data.

4.16.7 RZone Reservation

4.16.7.1 Limitation for number of Reserved RZones

A part of the disc space can be reserved for an RZone. For DVD, the maximum number of RZones which can be reserved at the same time is two. In other words, the maximum number of data appendable RZones is three (2 Reserved RZone + 1 Invisible/Incomplete RZone). If two RZones are already reserved, no more RZones can be reserved. To reserve a new RZone, either one or both of the current reserved RZones ***shall*** be closed. Once closed, a new RZone can be reserved.

Figure 37 shows an example sequence for making of a UDF Bridge disc on DVD-R media. In the Figure, two RZones are used for recording. One RZone is reserved for UDF Bridge file system. User data is written by Sequential UDF in the Invisible/Incomplete RZone.

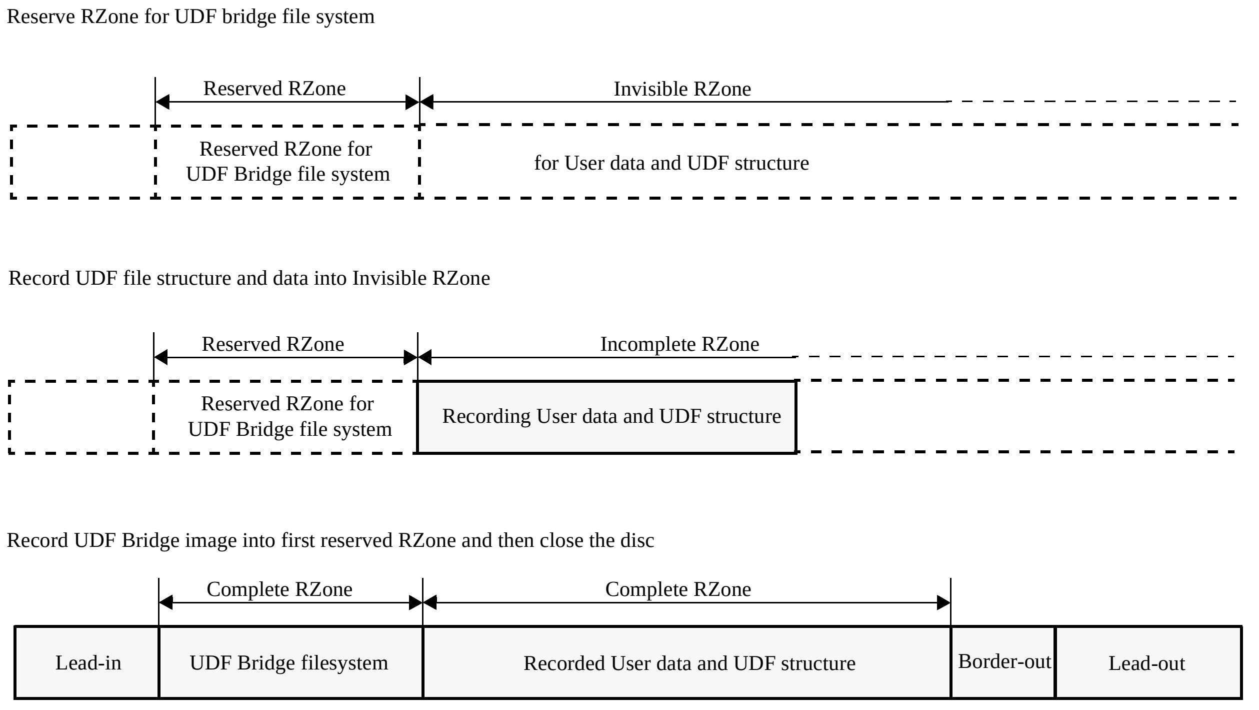

Figure 37 - Typical sequence for make UDF Bridge disc

The RESERVE TRACK/RZONE Command is used to reserve RZones. If attempting to reserve an RZone when two RZones are already reserved, the command ***shall*** be terminated with CHECK CONDITION Status, 5/72/05 NO MORE RZONE RESERVATIONS ARE ALLOWED.

Attempting to reserve an RZone when less than three ECC blocks remain in the RMA, the command ***shall*** be terminated with CHECK CONDITION Status, 3/73/05 PROGRAM MEMORY AREA/RMA IS FULL. Three RMD blocks are required for each of reservation, RZone closure or Border closure.

The BSGLL at the end of each RZone is not writable by the Host. If a Command attempts to write data beyond reserved RZone length during writing in the RZone, the Command ***shall*** be terminated with CHECK CONDITION Status, 5/21/02 INVALID ADDRESS FOR WRITE.

4.16.7.2 RZone numbering

The RZone numbers ***shall*** start from 1. The number of the Invisible RZone is increased by one following a reservation. After the reservation is done, the RZone number given to the new reserved RZone is the RZone number of the old Invisible RZone that existed before the reservation.

4.16.7.3 BSGLL (Block Sync Guarantee Linking Loss)

To read an ECC block correctly, block sync (first SY0) of the ECC block needs to be recorded.

Regardless of Liking Loss area size, if writing occurs for an ECC block immediately following an unwritten ECC block, the block sync (first SY0) is not written due to linking (the linking position is in second sync frame). An ECC block ***shall*** be recorded to guarantee readability of the following ECC block(s). An ECC block which is recorded after a written ECC block is readable. The preceding ECC block is referred to as BSGLL (Block Sync Guarantee Linking Loss) and is always 32KB in size. A BSGLL is the same as a 32KB Linking Loss area. Refer to Figure 38.

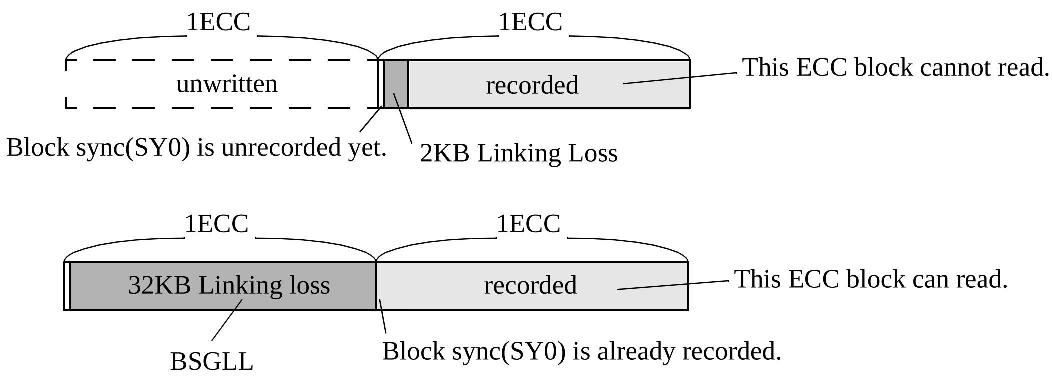

Figure 38 - BSGLL (Block Sync Guarantee Linking Loss)

4.16.7.4 RZone Reservation Scheme

RZone ***shall*** only be reserved from the NWA of the invisible RZone. If an incomplete RZone exists, the incomplete RZone ***shall*** be closed prior to reserving a new RZone. The start address of the new Invisible RZone is the NWA of the previous incomplete RZone.

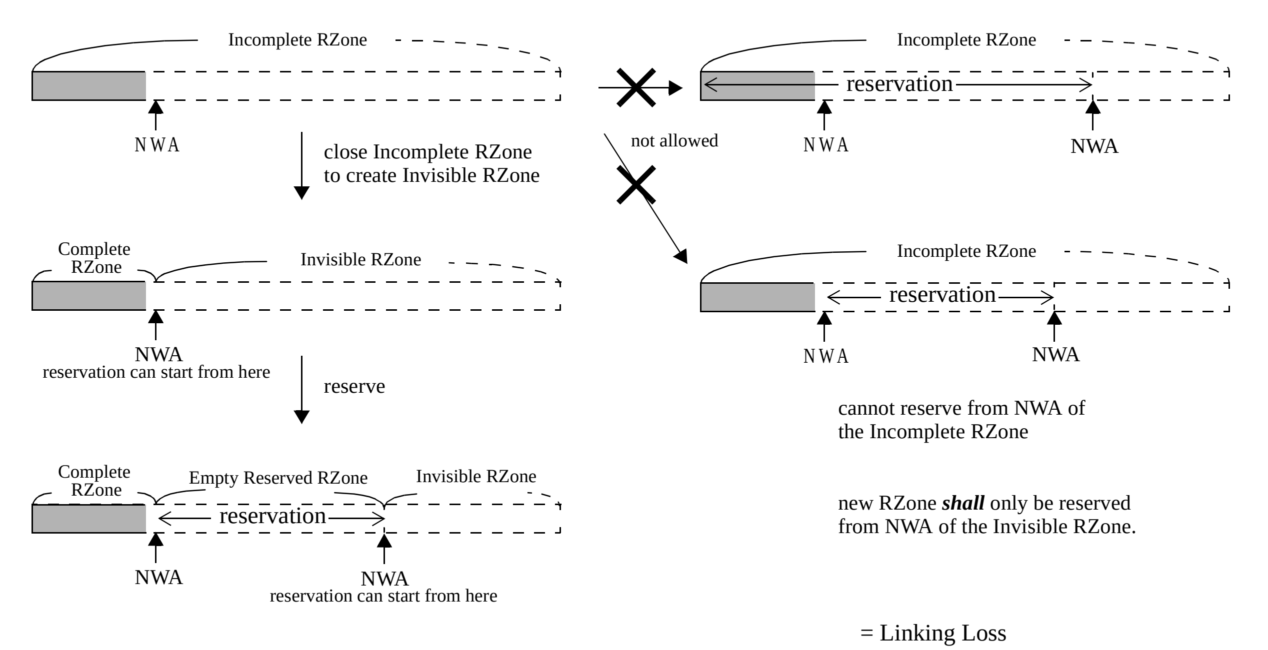

Figure 39 - Start position of RZone reservation

When reservation is required, the Logical Unit ***shall*** allocate appropriate length for the RZone in the Data Recordable Area.

In the case of Disc-at-Once recording, RZone reservation ***shall*** be done only once to specify user data length to be transferred from Host to the Logical Unit. The allocated reserved length is the same as Host required length to keep compatibility with DVD-ROM discs. There is no need to round up the length to ECC block unit and no BSGLL ***shall*** be added to the reserved length. For disc-at-once recording, there is only one RZone and Border.

For incremental recording, allocated length ***shall*** take the Linking Loss area size into consideration. The tail of a reserved RZone is round up to the ECC block unit and one ECC block length is added to the reserved RZone as a BSGLL, except when the reservation size is the same as the remaining disc capacity. If the reservation size is equal to the remaining disc capacity, the BSGLL ***shall not*** be added to the reserved RZone size.

The start address of the RZone following reserved RZone is always on the ECC boundary because of the BSGLL.

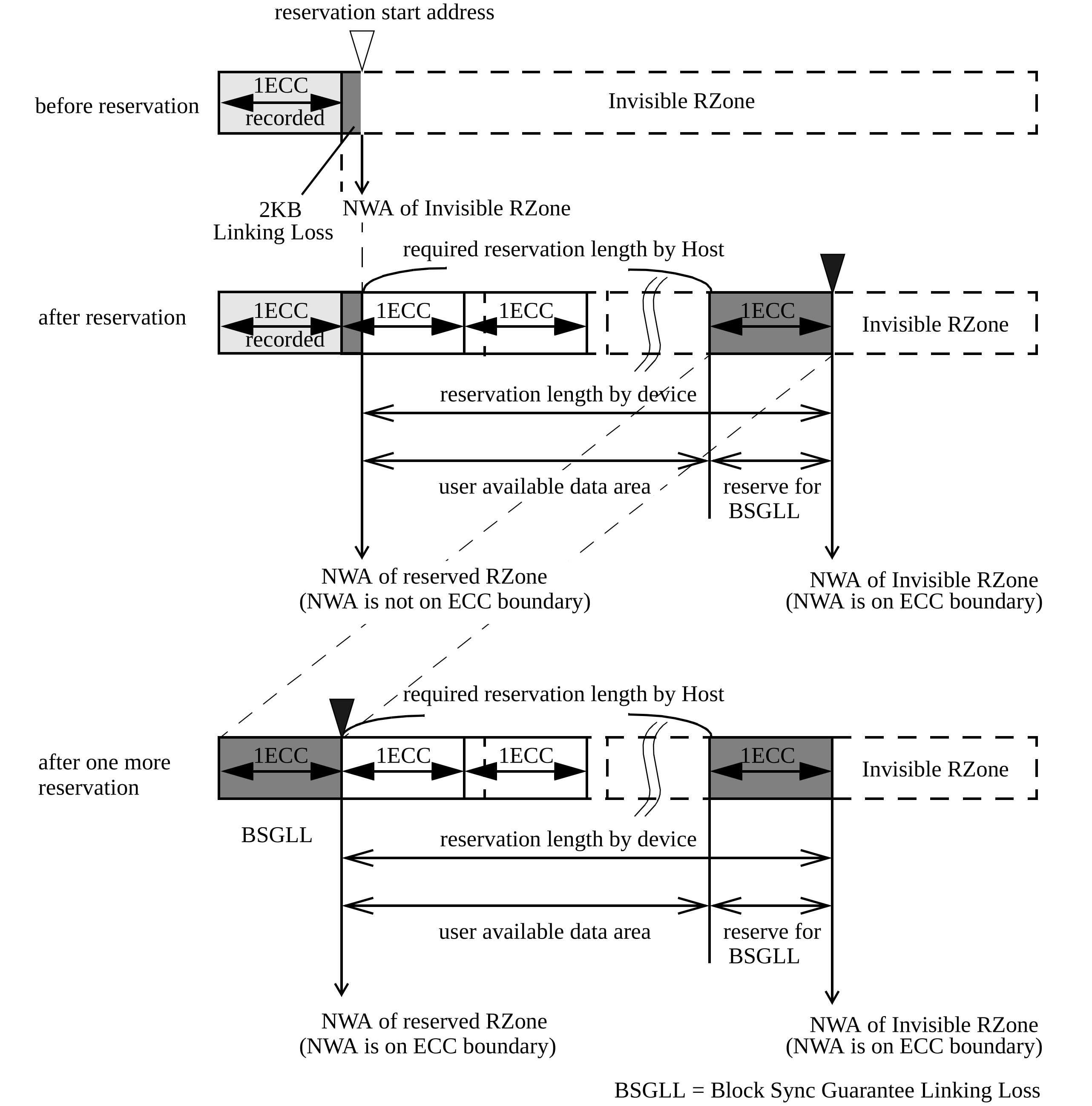

Figure 40 - RZone reservation after 2KB Linking Loss

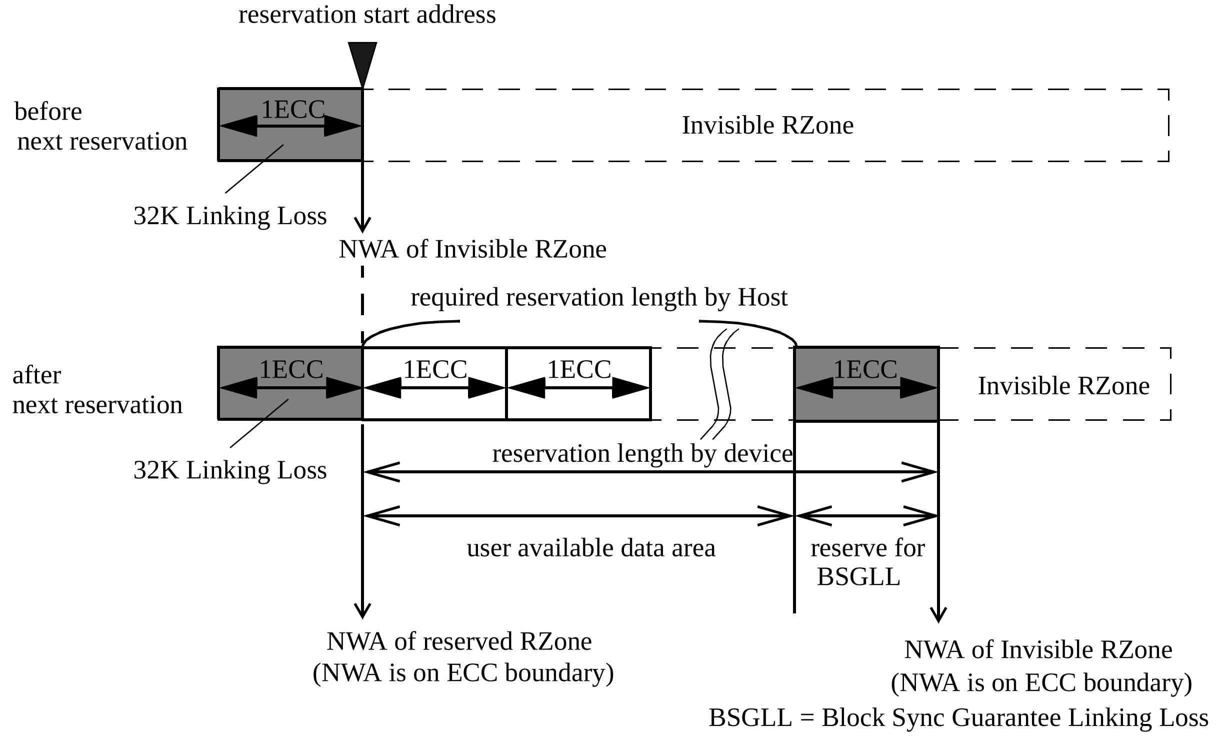

Figure 41 - RZone reservation after BSGLL/32KB Linking Loss

In the case of incremental recording and if Linking Loss area size is set to 2KB, available reserved RZone size may or may not be multiple of 32KB. The available reserved RZone size is depend on its start address. When reserved RZone start address is on an ECC boundary, the available size is $32 \times N$ (KB). For example, the BSGLL of the immediately preceding reserved RZone exists or the RZone starts from the next sector of Lead-in/Border-in. Otherwise, the available data size is $30 + 32 \times N$ (KB). If Linking Loss area size is set to 32 KB, available reserved RZone size is always 32xN (KB).

The Number of free blocks of the RZone may be different between 2KB Linking Loss size and 32KB Linking Loss size. For example, when Linking Loss size is set to 2KB and last ECC block of the reserved RZone is unwritten, remaining free block size that reported by READ TRACK/RZONE INFORMATION Command is 15 blocks. However, if Linking Loss size is changed to 32KB, remaining free blocks that reported by READ TRACK/RZONE INFORMATION Command becomes 0 even if there are unrecorded 15 blocks. Such kind of RZone is still Partially Recorded Reserved RZone and ***shall*** not be considered a Complete RZone. To distinguish this kind of RZone, **RT** bit of the READ TRACK/RZONE Information is used. The **RT** bit of one indicates that the RZone is Empty Reserved or Partially Recorded Reserved status. The **RT** bit of zero indicates that the RZone is Complete, Invisible, or Incomplete status.

4.16.7.5 Sample sequence for RZone Reservation

An example of RZone reservation sequence is shown in Figure 42. Initially, a blank medium has only Invisible RZone. NWA is LSN0 (reference A). When a write operation has begun without reservation, the NWA is proportionally incremented by written data length (reference B).

If reservation is required, the incomplete RZone ***shall*** be closed. Then a new invisible RZone is created. The new reserved RZone is allocated from the NWA of the invisible RZone with required length (reference C).

Sequential writing can begin from each NWA of the RZone (reference D).

When two reserved RZones already exist, no more can be reserved (reference E and F). For reservation of a new RZone, a close RZone operation is required to close one or both of the reserved RZones (reference G). When Close RZone is done, the RZone is complete.

Note: The Linking Loss area except for BSGLL is omitted in Figure 42.

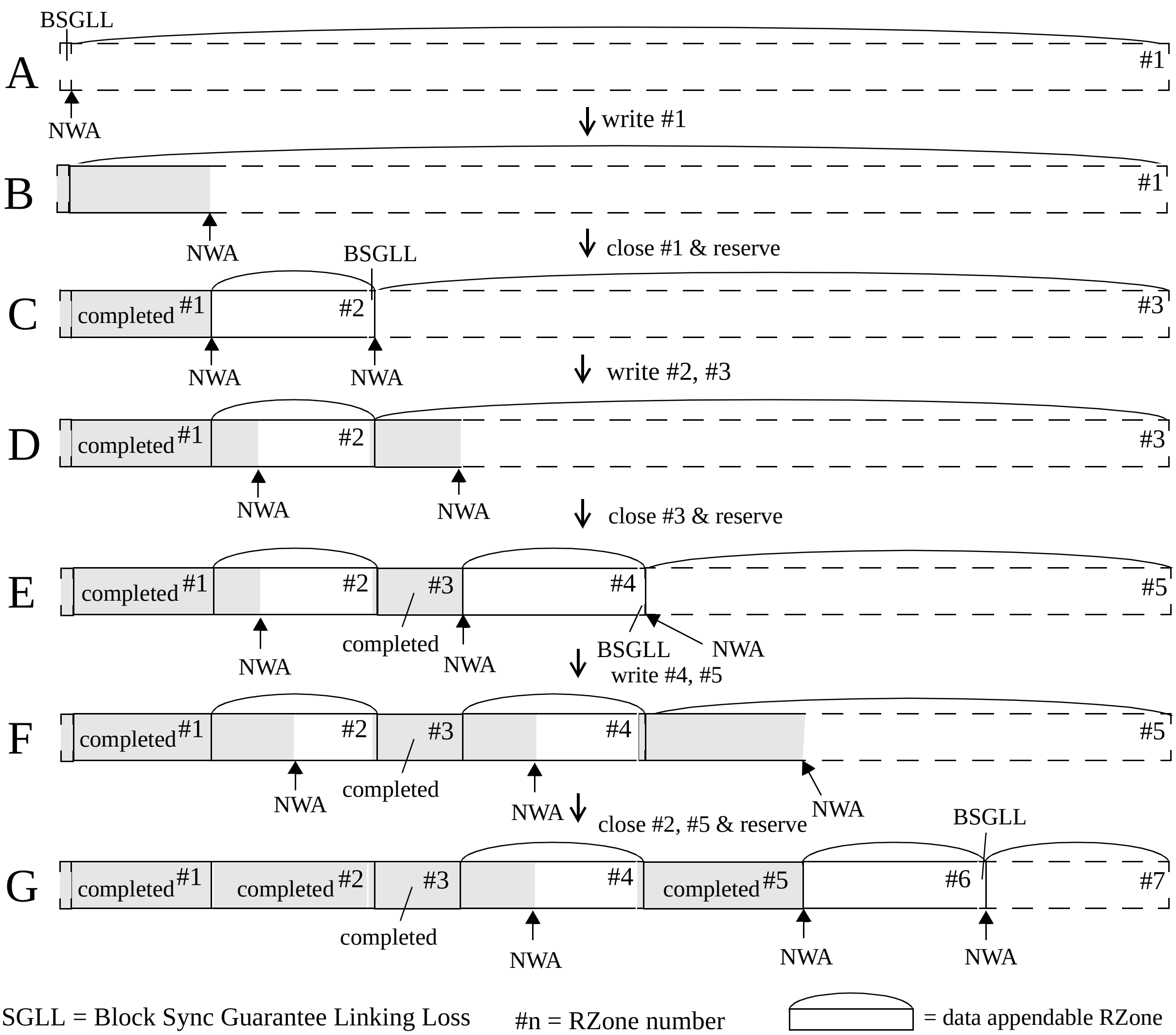

Figure 42 - Example of RZone reservation sequence

4.16.8 RZone Closing

This section explains what ***shall*** be done by a Logical Unit when an RZone is closed.

When a Reserved RZone is closed:

1. Logical Unit ***shall*** write RMD in RMA.
2. Then the Logical Unit ***shall*** pad 00h data until the end of the Reserved RZone with Data Type bit = 0.

When an Incomplete RZone is closed:

1. Logical Unit ***shall*** write RMD in RMA.
2. A new invisible RZone which has RZone number N+1 is created from the NWA of the closed incomplete RZone which has RZone number N.

There are three purpose of closing an incomplete RZone:

1. To reserve a new RZone
2. To close Border
3. To make the Logical Unit write an RMD in RMA for backup against error.

When an Invisible RZone is closed, nothing is done by the Logical Unit.

4.16.9 OPC

OPC (Optimum power calibration) is required to determine the optimum recording laser power for the mounted DVD-R media. If necessary, OPC operation may be executed automatically when the medium has been first inserted into the Logical Unit and the first WRITE (10) Command is issued. When OPC operation is done, RMA may be updated by the Logical Unit.

An OPC ***shall*** be executed against current writing speed only.

The PCA (Power Calibration Area) is located from Physical Sector Numbers (PSN) 20800h to 223AFh. For each OPC, one recording sector (26 sync frames) is assigned. The OPC start address is in descending order within the PCA. As an example, the first power calibration is in PSN 223AFh and the second power calibration is in PSN 223AEh. See Figure 43 below. Typically, power calibration can be done 7,088 times for each medium. However, actual OPC times and timing is Logical Unit dependent.

If Host requires OPC at desired timing, the SEND OPC INFORMATION Command is used.

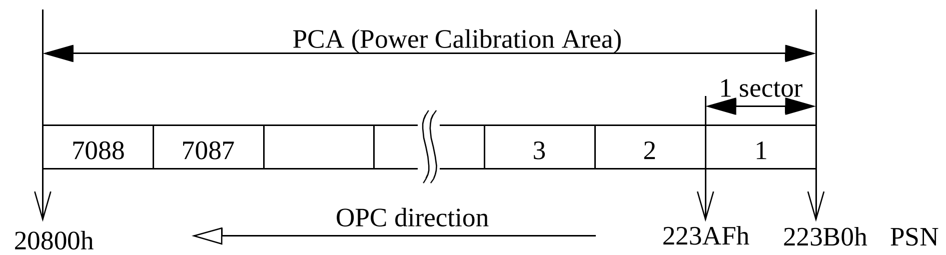

Figure 43 - OPC Scheme

4.16.10 Required Actions during Write operation

4.16.10.1 Linking Check for Sequential Recording

Random writing within an RZone is not allowed (Sequential recording ***shall*** be used for DVD-R).

It is required that writing is always started from NWA of the RZone.

The Logical Unit ***shall*** check Linking Loss to recognize LRA and NWA.

When a WRITE (10) Command is attempting to write to other than the NWA, the command ***shall*** be terminated with CHECK CONDITION Status, 5/21/02 INVALID ADDRESS FOR WRITE.

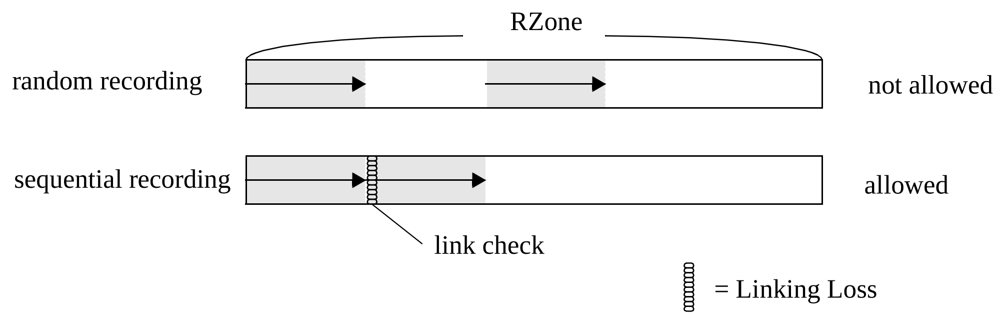

Figure 44 - Sequential recording

4.16.10.2 ECC boundary padding and Data Type Bit in ID field

The Logical Unit writes data to the medium only when multiple ECC data blocks are received or the FLUSH CACHE Command is issued. When the Flush Cache operation has been done and the last recorded data address is less than 1 ECC block boundary address, the Logical Unit ***shall*** pad to the ECC block boundary with value 00h. This padded area is also called a Linking Loss area.

The Last Recorded Address is the address of the last block of user data. The ECC padding ***shall not*** affect the Last Recorded Address.

Note: The READ TRACK/RZONE INFORMATION Command is used to get the Last Recorded Address of the RZone.

A FLUSH CACHE Command may be used to mark the end of the Write data stream.

In the case of buffer under-run, if the WRITE (10) Command is completed without error, the data which is less than one ECC block ***shall*** be padded with 00h and the Logical Unit ***shall*** make a Linking Loss area. (If the data length to be transferred becomes less than a sector boundary, the Host ***shall*** pad to the sector boundary with value 00h.)

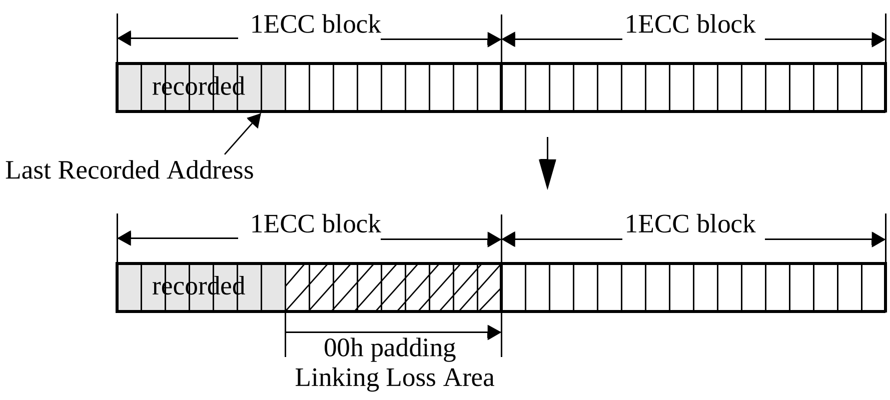

Figure 45 - ECC boundary Padding

Data Type bit of Data ID field, when set to 1, indicates that the next sector belongs to the Linking Loss Area except in the following cases.

- If a sector is used for linking and contains linking position, Data Type of the sector ***shall*** be set to 0.
- If a sector is used for error recovery scheme, Data Type bit of the sector is dependent on the error recovery scheme. See Figure 56 - *Repair Incomplete linking* on page 127

4.16.10.3 Overwrite is prohibited

The Logical Unit ***shall*** avoid overwrites to previously written data. Overwriting may cause data destruction.

When the WRITE (10) Command is attempting to write to a previously written sector, the command ***shall*** be terminated with CHECK CONDITION Status, 5/21/02 INVALID ADDRESS FOR WRITE.

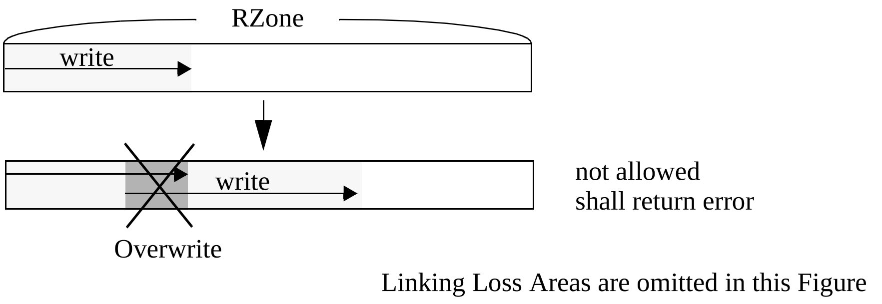

Figure 46 - Forward Overwrite

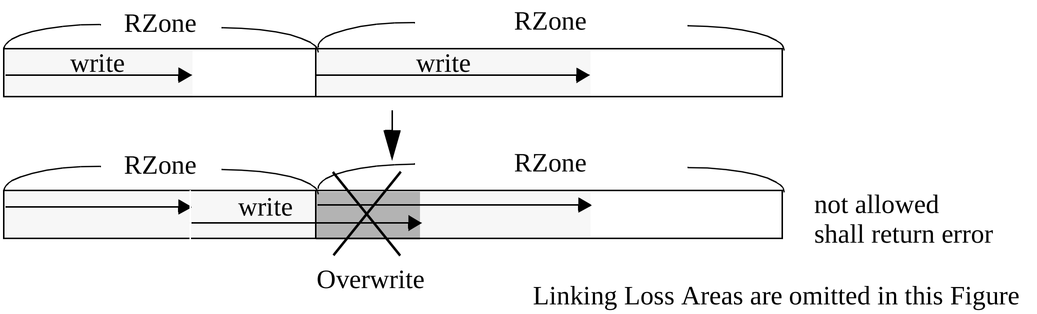

Figure 47 - Backward Overwrite

4.16.11 RMD (Recording Management Data)

The RMD block size is 32KB in version 1.0 of the DVD-R Book. Its physical format is the same as an ECC block. When RMD is written in RMA, 2KB linking is used. Therefore, the valid part of each RMD block is 30KB. The RMA size allows for approximately 700 RMD updates. When the remaining RMA is less than 15 ECC blocks and an RMD update is required by any command, the Logical Unit ***shall*** terminate the command with CHECK CONDITION Status, 1/73/06 PROGRAM MEMORY AREA/RMA IS (almost) FULL. When the remaining RMA is less than 3 ECC blocks and an RMD update is required by any command, the Logical Unit ***shall*** terminate the command with CHECK CONDITION Status, 3/73/05 PROGRAM MEMORY AREA/RMA IS FULL.

The RMA and RMD block structure are shown in Figure 48 below.

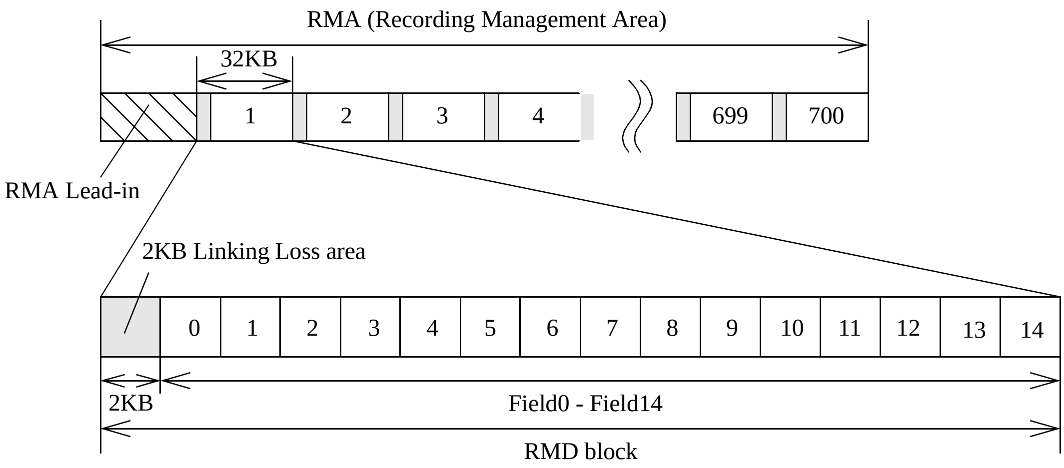

Figure 48 - RMA and RMD block structure

4.16.11.1 The Contents of RMD

The RMD block consists of 15 fields and a Linking Loss area. The contents of each Field (Format Type #1) is defined in the following tables.

Initial value of RMD ***shall*** be 0.

4.16.11.1.1 RMD Field 0 (RMD Header)

RMD Field 0 ***shall*** specify general information of the disc and ***shall*** be recorded as follows.

Table 29 - RMD - Field 0

Byte \ Bit	7	6	5	4	3	2	1	0
0	(MSB)			RMD format				
1								(LSB)
2				Disc Status				
3				Reserved				
4~21	(MSB)			Unique Disc Identifier				(LSB)
22~85	(MSB)			Copy of Pre-recorded Information (64bytes)				(LSB)
86~2047				Reserved				

RMD Format field ***shall*** be recorded and specify the format of following RMD field 1~14 which is used on the medium. RMD Format field is defined in Table 30 below.

Table 30 - RMD Format

Value	Interpretation
0	Reserved
1	***shall*** mean that the following RMD Field1~14 is recorded as Format Type #1.
2 and above	Reserved

Disc Status field ***shall*** indicate the disc status. Disc Status field is defined in Table 31 below.

Table 31 - Disc Status

Value	Interpretation
0	***shall*** mean that the disc has no written data in Data Recordable Area (only RMD is written)
1	***shall*** mean that the disc is in disc-at-once recording mode
2	***shall*** mean that the disc is in incremental recording mode
3	***shall*** mean that the disc is completed and not appendable in the case of incremental recording
4 and above	Reserved

Reserved field ***shall*** be reserved for future standardization and all bytes ***shall*** be set to 00h.

Unique Disc Identifier field ***shall*** be recorded and structured as follows. The Unique Disc Identifier contains time stamp fields. The time format should be UTC 24 hour clock. This field ***shall*** be set by the SEND DVD STRUCTURE Command. This time stamp data sent by the SEND DVD STRUCTURE Command may also be used in the OPC related field in RMD field 1 and may help the judgement to do OPC. The Logical Unit ***shall*** update the time stamp during power on. Strict accuracy of time is not required.

Table 32 - Unique Disc Identifier

Bit / Byte	7	6	5	4	3	2	1	0
0	Reserved							
1	Reserved							
2	(MSB)			Random Data				
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)

Reserved field ***shall*** be reserved for future standardization and all bytes ***shall*** be set to 00h.

Random Data field ***shall*** be a random number.

Year field ***shall*** specify the year coded in ASCII in the range “0001” to “9999”.

Month field ***shall*** specify the month of the year coded in ASCII in the range “01” to “12”.

Day field ***shall*** specify the day of the month coded in ASCII in the range “01” to “31”.

Hour field ***shall*** specify the hour of the day coded in ASCII in the range “00” to “23”.

Minute field ***shall*** specify the minute of the hour coded in ASCII in the range “00” to “59”.

Second field ***shall*** specify the second of the minute coded in ASCII in the range “00” to “59”.

Copy of Pre-recorded Information field ***shall*** contain the copy of Pre-recorded Information data which is recorded as LPP (Land Pre-Pit). Copy of Pre-recorded Information structure is shown in Table 33. Pre-recorded information data is specified by DVD-R Book Part 1.

Table 33 - Copy of Pre-recorded Information

Byte \ Bit	7	6	5	4	3	2	1	0
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							
7	Reserved							
8	Field ID = 2							
9	OPC suggested code							
10	Wavelength code							
11	Writing Strategy code							
12								
13								
14								
15	Reserved							
16	Field ID = 3							
17	Manufacturer ID (17)							
18	Manufacturer ID (16)							
19	Manufacturer ID (15)							
20	Manufacturer ID (14)							
21	Manufacturer ID (13)							
22	Manufacturer ID (12)							
23	Reserved							
24	Field ID = 4							
25	Manufacturer ID (11)							
26	Manufacturer ID (10)							
27	Manufacturer ID (9)							
28	Manufacturer ID (8)							
29	Manufacturer ID (7)							
30	Manufacturer ID (6)							
31	Reserved							
32	Field ID = 5							

Table 33 - Copy of Pre-recorded Information (Continued)

Bit / Byte	7	6	5	4	3	2	1	0
33	Manufacturer ID (5)							
34	Manufacturer ID (4)							
35	Manufacturer ID (3)							
36	Manufacturer ID (2)							
37	Manufacturer ID (1)							
38	Manufacturer ID (0)							
39	Reserved							
40-63	Reserved							

Reserved field ***shall*** be reserved for future standardization and all bytes ***shall*** be set to 00h.

4.16.11.1.2 RMD Field 1 (Format Type #1)

RMD field 1 (Format Type #1) contains some Logical Unit and OPC related information and ***shall*** be recorded as follows. There are four sets of OPC data blocks. These are prepared for the case of four different DVD-R Logical Units writing to a disc. The Logical Unit ***shall*** use an empty set or its own. If there is no owned or empty OPC data block, the Logical Unit may use the oldest time stamp OPC data block.

Table 34 - RMD - Field 1 (Logical Unit & OPC information)

Bit / Byte	7	6	5	4	3	2	1	0
0~31	(MSB)	Vendor Identifier #1 (32 bytes)						(LSB)
32~47	(MSB)	Serial Number #1 (16 bytes)						(LSB)
48~63	(MSB)	Model Number #1 (16 bytes)						(LSB)
64~67	(MSB)	Write Strategy Code #1 (4 bytes)						(LSB)
68~71	(MSB)	Recording Power #1 (4 bytes)						(LSB)
72~79	(MSB)	Timestamp #1 (8 bytes)						(LSB)
80~83	(MSB)	Power Calibration Address #1 (4 bytes)						(LSB)
84~107	(MSB)	Running OPC Information #1 (24 bytes)						(LSB)
108~127	Reserved							
128~159	(MSB)	Vendor Identifier #2						(LSB)
160~175	(MSB)	Serial Number #2						(LSB)
176~191	(MSB)	Model Number #2						(LSB)
192~195	(MSB)	Write Strategy Code #2						(LSB)
196~199	(MSB)	Recording Power #2						(LSB)
200~207	(MSB)	Timestamp #2						(LSB)
208~211	(MSB)	Power Calibration Address #2						(LSB)
212~235	(MSB)	Running OPC Information #2						(LSB)
236~255	Reserved							
256~287	(MSB)	Vendor Identifier #3						(LSB)
288~303	(MSB)	Serial Number #3						(LSB)
304~319	(MSB)	Model Number #3						(LSB)
320~323	(MSB)	Write Strategy Code #3						(LSB)
324~327	(MSB)	Recording Power #3						(LSB)
328~335	(MSB)	Timestamp #3						(LSB)
336~339	(MSB)	Power Calibration Address #3						(LSB)

Table 34 - RMD - Field 1 (Logical Unit & OPC information)

Bit / Byte	7	6	5	4	3	2	1	0
340~363	(MSB)			Running OPC Information #3				(LSB)
364~383				Reserved				
384~415	(MSB)			Vendor Identifier #4				(LSB)
416~431	(MSB)			Serial Number #4				(LSB)
432~447	(MSB)			Model Number #4				(LSB)
448~451	(MSB)			Write Strategy Code #4				(LSB)
452~455	(MSB)			Recording Power #4				(LSB)
456~463	(MSB)			Timestamp #4				(LSB)
464~467	(MSB)			Power Calibration Address #4				(LSB)
468~491	(MSB)			Running OPC Information #4				(LSB)
492~511				Reserved				
512~2047				Reserved				

Vendor Identifier #n field ***shall*** be recorded in binary and ***shall*** specify unique vendor identifier of the Logical Unit.

Serial Number #n field ***shall*** be recorded as ASCII code and ***shall*** specify serial number of the Logical Unit.

Model Number #n field ***shall*** be recorded as ASCII code and ***shall*** specify the recorder model number.

Write Strategy Code #n field ***shall*** be recorded and ***shall*** specify the write strategy code. Write strategy code is specified by DVD-R Book Part 1.

Recording Power #n field ***may*** be used to store the value of the OPC result. The format of this field is vendor-specific. If this field is set to 0, this field is invalid.

Timestamp #n field ***may*** be used to store date and time when OPC is executed. This field, if used, ***shall*** be recorded in Binary Coded Decimal (BCD). If this field is set to 0, this field is invalid.

Power Calibration Address #n field ***may*** be used to specify the start ECC block address of the PCA where the last OPC was performed. The format of this field is vendor-specific. If this field is set to 0, this field is invalid.

Running OPC Information field ***may*** be used to specify values concerning running OPC. The format is vendor-specific. If this field is set to 0, this field is invalid.

Reserved field ***shall*** be reserved for future standardization and all bytes ***shall*** be set to 00h.

4.16.11.1.3 RMD Field 2 (Format Type #1)

RMD Field 2 (Format Type #1) can be used freely and format of this field is user-specific.

Table 35 - RMD - Field 2 (User Specific Data)

Bit / Byte	7	6	5	4	3	2	1	0
0~2047	(MSB)			User Specific Data				(LSB)

The **User Specific Data** field is available for user specific data. This field ***may*** be used, otherwise this field ***shall*** be set to 0.

4.16.11.1.4 RMD Field 3 (Format Type #1)

RMD Field 3 (Format Type #1) may contains Border Zone information and ***shall*** be recorded as follows.

Table 36 - RMD - Field 3 (Border Zone Information)

Bit / Byte	7	6	5	4	3	2	1	0
0~3	(MSB)			Start Sector Number of Border-out #1				(LSB)
4~7	(MSB)			Start Sector Number of Border-out #2				(LSB)
8~11	(MSB)			Start Sector Number of Border-out #3				(LSB)
:				:				
2036~2039	(MSB)			Start Sector Number of Border-out #510				(LSB)
2040~2043	(MSB)			Start Sector Number of Border-out #511				(LSB)
2044~2047	(MSB)			Start Sector Number of Border-out #512				(LSB)

Start Sector Number of Border-out #n field, if it contains other than 0, indicates that the start sector number of the Border-out.

4.16.11.1.5 RMD Field 4 (Format Type #1)

RMD Field 4 (Format Type #1) contains RZone related information and ***shall*** be recorded as follows.

Table 37 - RMD - Field 4 (RZone Information)

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			Invisible/Incomplete RZone Number (Last RZone Number)				
1								(LSB)
2	(MSB)			Current Appendable Reserved RZone Number 1				
3								(LSB)
4	(MSB)			Current Appendable Reserved RZone Number 2				
5								(LSB)
6~15				Reserved				
16~19	(MSB)			Start Sector Number of RZone #1				(LSB)
20~23	(MSB)			Last Recorded Address of RZone #1				(LSB)
24~27	(MSB)			Start Sector Number of RZone #2				(LSB)
28~31	(MSB)			Last Recorded Address of RZone #2				(LSB)
:				:				
2032~2035	(MSB)			Start Sector Number of RZone #253				(LSB)
2036~2039	(MSB)			Last Recorded Address of RZone #253				(LSB)
2040~2043	(MSB)			Start Sector Number of RZone #254				(LSB)
2044~2047	(MSB)			Last Recorded Address of RZone #254				(LSB)

Invisible/Incomplete RZone Number field ***shall*** contain the invisible/incomplete RZone number of the medium.

Current Appendable Reserved RZone Number 1 field, if recorded other than 0, ***shall*** contain the current appendable Reserved RZone number and the value ***shall*** be different from the **Current Appendable Reserved RZone Number 2** field. If this field is set to 0, there is no Empty Reserved RZone or Partially Recorded Reserved RZone corresponding to this field.

Current Appendable Reserved RZone Number 2 field, if recorded other than 0, ***shall*** contain the current appendable Reserved RZone number and the value ***shall*** be different from the **Current Appendable Reserved RZone Number 1** field. If this field is set to 0, there is no Empty Reserved RZone or Partially Recorded Reserved RZone corresponding to this field.

When the Incomplete RZone is closed, the **Invisible/Incomplete RZone Number** field ***shall*** contain the number of the new invisible RZone number (N+1). When Reserved Rzone is closed, the corresponding Current Appendable Reserved Rzone Number field ***shall*** be set to 0.

The **Reserved** field ***shall*** be reserved for future standardization and all bytes ***shall*** be set to 00h.

The **Start Sector Number of RZone #n** field ***shall*** contain the start sector number of the RZone which has RZone number #n.

The **Last Recorded Address of RZone #n** field ***shall*** contain the last recorded address of the RZone which has RZone number #n. If this field is set to 0, this field is not valid. If RZone #n is not closed, the value of this field may not be correct and a link point search is required to determine the correct LRA.

Note: The LRA reported by the READ TRACK/RZONE INFORMATION Command is always correct.

When the RZone is not closed, even if the LRA field contains a value, the Logical Unit ***shall*** determine the current LRA of the RZone. When RZone is closed, LRA field ***shall*** be recorded before RZone padding.

4.16.11.1.6 RMD Field 5 ~ Field 12 (Format Type #1)

RMD field 5 through field 12 may contain continued RZone related information.

Table 38 - RMD - Field 5 ~Field 12 (RZone Information ... continued)

Bit / Byte	7	6	5	4	3	2	1	0
0~3	(MSB)			Start Sector Number of RZone #n				(LSB)
4~7	(MSB)			Last Recorded Address of RZone #n				(LSB)
8~11	(MSB)			Start Sector Number of RZone #(n+1)				(LSB)
12~15	(MSB)			Last Recorded Address of RZone #(n+1)				(LSB)
:				:				
2032~2035	(MSB)			Start Sector Number of RZone #(n+253)				(LSB)
2036~2039	(MSB)			Last Recorded Address of RZone #(n+253)				(LSB)
2040~2043	(MSB)			Start Sector Number of RZone #(n+254)				(LSB)
2044~2047	(MSB)			Last Recorded Address of RZone #(n+255)				(LSB)

Start Sector Number of RZone #n field ***shall*** contain start sector number of the RZone which has RZone number #n.

The **Last Recorded Address of RZone #n** field ***shall*** contain the last recorded address of the RZone which has RZone number #n. If this field is set to 0, this field is not valid. If RZone #n is not closed, the value of this field may not be correct and a link point search is required to determine the correct LRA.

Note: The LRA reported by the READ TRACK/RZONE INFORMATION Command is always correct.

When the RZone is not closed, even if the LRA field contains a value, the Logical Unit ***shall*** determine the current LRA of the RZone. When RZone is closed, LRA field ***shall*** be recorded before RZone padding.

4.16.11.1.7 RMD Field 13 ~ Field 14 (Format Type #1)

RMD Field 13 through Field 14 are reserved for future standardization and ***shall*** be set to 00h.

Table 39 - RMD - Field 13 (Reserved)

Bit / Byte	7	6	5	4	3	2	1	0
0~2047				Reserved				

The **Reserved** field ***shall*** be reserved for future standardization and all bytes ***shall*** be set to 00h.

Table 40 - RMD - Field 14 (Reserved)

Bit / Byte	7	6	5	4	3	2	1	0
0~2047	Reserved							

The **Reserved** field ***shall*** be reserved for future standardization and all bytes ***shall*** be set to 00h.

4.16.11.2 When RMD is written in RMA

Usually, RMD may be cached in the Logical Unit memory. As occasion calls, RMD ***shall*** be written in RMA. By using RMD caching, the Logical Unit can avoid waste of RMA. The timing when RMD is written in RMA is shown in Table 41.

Table 41 - When RMD is written in RMA

condition
When a WRITE (10) Command is issued following a RESERVE TRACK/RZONE Command, before the start of writing, RMD ***shall*** be written in RMA.
When a CLOSE TRACK/RZONE/SESSION/BORDER Command is issued, before the start of the close operation for either RZone or Border, RMD ***shall*** be written in RMA.
When a FLUSH CACHE Command is issued following SEND DVD STRUCTURE Command which specifies User Specific Data.

When writing in the same incomplete RZone for an extended period of time, RMD is not recorded for a long time.

To force writing of the RMD, the Host should close the Incomplete RZone after a certain time has passed. Then the new information is written into the RMA. Although the Invisible RZone number is increased due to the closing of the Incomplete RZone, the NWA of the new Invisible RZone is the same as the NWA of the closed Incomplete RZone.

4.16.11.3 Example of write sequence

This section explains one example of a write sequence. See Table 42 and Table 43.

Table 42 - Example of write sequence (Blank Disc)

Sequence	user/Host	Logical Unit action
1	Insert blank disc	check RMD
2	Specify Write Type (disc-at-once/incremental) and Unique Disc Identifier (MODE SENSE (10), MODE SELECT (10), and SEND DVD STRUCTURE Commands)	cache (RMD Field 0)
3	Specify other Identifier field. (SEND DVD STRUCTURE Command)	cache (RMD Field 1)
4	Specify User Specific Data field of RMD if needed. (SEND DVD STRUCTURE Command)	cache (RMD Field 2)
5	Reserve RZones if needed. (RESERVE TRACK/RZONE Command)	cache (RMD Field 4~12)
6	get NWA (READ TRACK/RZONE INFORMATION Command)	calculate and send to Host
7	start writing from NWA (WRITE (10) Command)	1. do OPC 2. write RMD in RMA if RZone is reserved. 3. start writing 4. if buffer become empty, stop writing with linking.
8	close RZone or bordered area (CLOSE TRACK/RZONE/SESSION/BORDER Command)	1. write RMD in RMA prior to close RZone or bordered area 2. pad RZone or write Border-in/Lead-in and Border-out/Lead-out.

Table 43 - Example of write sequence (Non-blank Disc)

	user/Host	Logical Unit action
1	Insert non-blank disc	check RMD check Write Type
2	Specify User Specific Data field of RMD if needed. (SEND DVD STRUCTURE Command)	cache (RMD Field 2)
3	Reserve RZones if needed. (RESERVE TRACK/RZONE Command)	cache (RMD Field 4~12)
4	get NWA (READ TRACK/RZONE INFORMATION Command)	search and send to Host
5	start writing from NWA (WRITE (10) Command)	1. do OPC, if needed 2. write RMD in RMA if RZone is reserved 3. start writing 4. if buffer becomes empty, stop writing with linking
6	close RZone or bordered area (CLOSE TRACK/RZONE/SESSION/BORDER Command)	1. write RMD in RMA prior to close RZone or bordered area 2. pad RZone or write Border-in/Lead-in and Border-out/Lead-out

4.16.11.4 Border Zone

Border Zone is used for Border Recording to interchange DVD-R media between DVD-R and DVD-ROM Logical Units.

Border Zone provides a solution for DVD-ROM pickup overrun problem. Once Border is closed, there are no unrecorded areas between Lead-in/Border-in and Border-out except for Next Border Marker (See *4.16.11.4.5, "Border-out contents"* on page 122).

Disc structure with Border Zone is shown in Figure 49 below.

Note: Linking Loss and BSGLL is omitted in this figure.

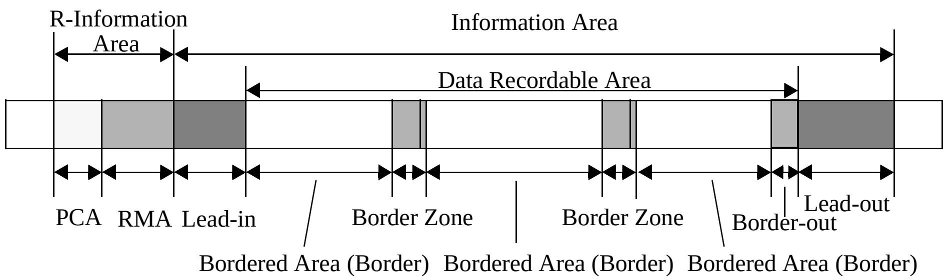

Figure 49 - Border Zone and Bordered Area (Border)

4.16.11.4.1 Border Zone Size and Length

The Border-out start address ***shall*** be located after PSN 3D700h. If a CLOSE TRACK/RZONE/SESSION/BORDER Command is issued when recorded user data end address is less than PSN 3D700h, the Logical Unit ***shall*** pad with 00h data through PSN 3D6FFh. The recorded area width of 3mm in the radial direction is guaranteed by this padding.

Border Zone size is dependent on its starting address and order. See Table 44.

- First Border Zone length is approximately 0.5mm in the radius.
- The other Border Zone length is approximately 0.1mm in the radius except Final Border Zone.

Note: Final Border Zone means that which is written when the Disc is finally closed with Lead-out. See4.16.11.5, "Disc Final Closure" on page 124.

Table 44 - Border Zone Size

Physical sector number of beginning Border Zone	3D700h-9DAFFh	9DB00h-1342FFh	134300h-
First Border Zone Size	1024 ECC blocks 32MBytes[a]	2048 ECC blocks 64MBytes	3072 ECC blocks 96MBytes
Second and above Border Zone Size	192 ECC blocks 6MBytes	384 ECC blocks 12MBytes	576 ECC blocks 18MBytes

a. MByte = 1024 x 1024 bytes

4.16.11.4.2 Recording for Border Zone

Each logical sector in Border Zone ***shall*** be assigned to a Logical Sector Number (LSN). Each logical sector of Data Recordable Area ***shall*** be identified by a unique logical sector number. LSNs ***shall*** be integers assigned in ascending sequence, starting with 0 from the PSN 30000h.

A Border Zone consists of a Border-out, a Data Area, and a Border-in. Border-out/in is written when a CLOSE TRACK/RZONE/SESSION/BORDER Command is issued with Border bit =1, RZone bit =0.

Border Zone is recorded with following sequence.

1. Close all opened (empty reserved/partially recorded reserved/incomplete) RZones by using a CLOSE TRACK/RZONE/SESSION/BORDER Command with the Border bit = 0 and the RZONE bit = 1.
2. Issue CLOSE TRACK/RZONE/SESSION/BORDER Command to close bordered area (Border bit = 1, RZONE bit = 0).
3. Border-out is recorded from NWA of the invisible RZone. Border-in of this Border Zone is still unrecorded at this time. The Border-in will be recorded when next CLOSE TRACK/RZONE/SESSION/BORDER Command is issued.
4. If Lead-in is still unwritten, Lead-in is recorded on the medium. If Lead-in is already written, Border-in is recorded after the previously written Border-out.

When a CLOSE TRACK/RZONE/SESSION/BORDER Command which specifies the closing of the Border, regardless of Linking Loss size, Border Zone ***shall*** be writen from ECC boundary.

When 32KB Linking Loss size is selected, Border Zone is written from NWA of the Invisible RZone. If 32KB Linking Loss size is not selected, Logical Unit ***shall*** pad 00h from the NWA of the Invisible RZone to the end of the ECC block and then Border Zone is written from the beginning of next ECC block. This padded area is referred to as Border-out Padding. Border-out Padding is used to align the start address of the Border-out on the ECC boundary.

If Border Zone start LSN is less than 0D700h, Logical Unit ***shall*** pad with 00h data up to LSN 0D6FFh and then Border Zone is written from LSN 0D700h.

RZone numbers are not assigned to Border Zone. The Invisible RZone number is not incremented due to Border Zone writing.

After Border Zone writing, NWA of the invisible RZone is moved to the following written Border Zone. Figure 50 shows an example of the write sequence and relationship between RZone number and Border Zone.

The Border-in which immediately follows last Border-out ***shall*** remain unrecorded when the Border Zone is written. This unrecorded Border-in will be used for next bordered area. The unrecorded Border-in will be recorded when the next bordered area is closed.

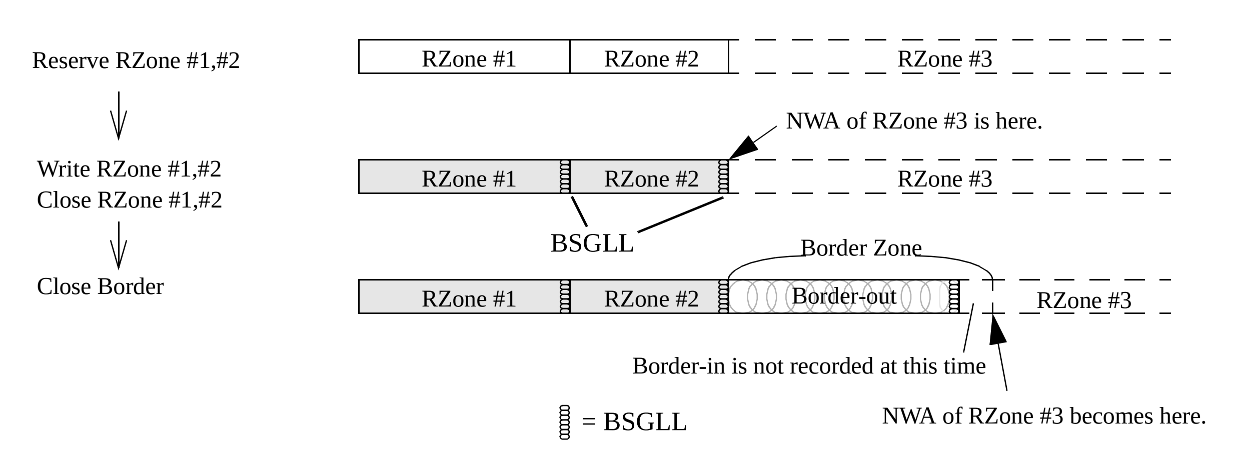

Figure 50 - Relation between RZone number and Border Zone

4.16.11.4.3 Border Zone Status

Bordered Area (Border) status changes according to its recording stage.

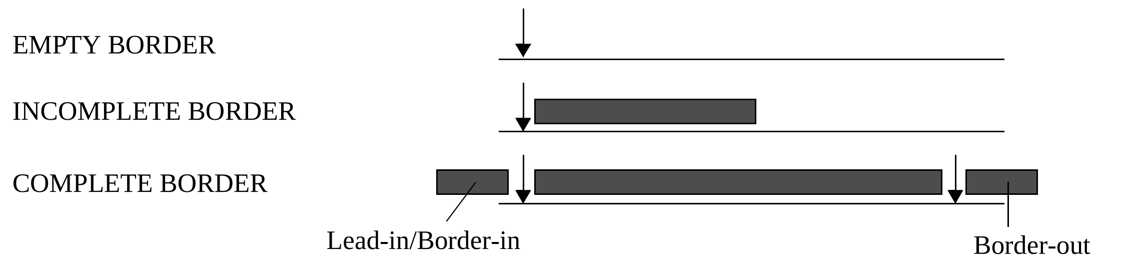

Figure 51 - Bordered Area(Border) status definitions

4.16.11.4.4 Border-in contents

Border-in contains five copies of control area data which has the same structure as Lead-in. (5 ECC blocks)

To provide the information concerning the Border Zone to the DVD-ROM Logical Unit which has no capability of RMA reading, the Physical Format Information field of Lead-in/Border-in contains the pointer to the Border Zone and LRA information for last RZone. See Table 19 - *DVD-R Unique Part of Physical Format Information* on page 67 and Table 17 - *Data Area Allocation Definition* on page 66.

In final closing of a disc, the start PSN of the Next Border-in field in the Physical Format Information ***shall*** be set to 00h.

4.16.11.4.5 Border-out contents

Border-out has Border RMD Area (5 ECC blocks) which has five copies of latest RMD. Border RMD Area is recorded to provide the information concerning the bordered areas to the DVD-ROM Logical Unit which has no capability of RMA reading.

Stop Blocks (2ECC blocks) are located relatively 37th and 38th ECC blocks from the beginning of the Border-out. The Area type of Stop Block ***shall*** have Lead-out attribute. Stop Block prevents the Logical Unit which expects Lead-out existence from pick up over-run.

Border-out also contains Next Border Marker (three occurrences of 2ECC blocks). This specifies whether the next Border exists or not. When next Border does not exist and Lead-out is still unwritten, the Next Border Marker in the last Border-out ***shall*** remain in a mirror state (unwritten). When closing a Border, the previous Next Border Marker ***shall*** be written with 00h. In the final closing of a disc, the Next Border Marker in the final Border-out ***shall*** be padded with 00h and have a Lead-out attribute.

The first Next Border Marker in Border-out is located in half of the Border-out. Its relative location from the beginning of Border-out is shown in Table 45.

Table 45 - Relative Location of Next Border Marker from the beginning of Border-out

Physical sector number of beginning Border Zone	3D700h-9DAFFh	9DB00h-1342FFh	134300h-
First Border Zone	509th ECC block	1021st ECC block	1533rd ECC block
Second and above Border Zone	93rd ECC block	189th ECC block	285th ECC block

The whole structure of Border Zone is shown in Figure 52.

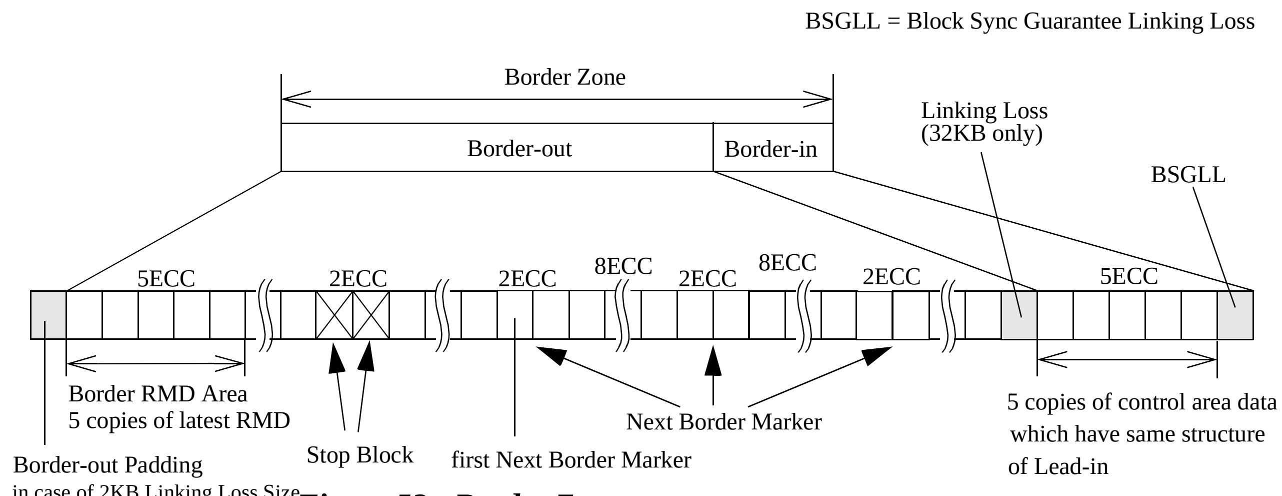

Figure 52 - Border Zone structure

4.16.11.4.6 Example for Multi-Border recognition

To explain how to recognize a Border Zone, a sample recognition sequence for a Multi-Border recorded disc is shown below.

Table 46 - Multi Border example

Sequence	sample sequence
1	insert disc
2	Logical Unit reads Physical format information field in Lead-in data. - check Start Address of Border-out - check Start Address of Border-in
3	Logical Unit reads Next Border Marker in Border-out. - check whether next bordered area is exist or not and find next bordered area
4	Logical Unit reads Physical format information in Border-in. - check whether Book Type is DVD-R or not - check Start Address of Border-out - check Start Address of Border-in
5	Logical Unit reads Next Border Marker in Border-out. - check whether next bordered area is exist or not and find no next bordered area
6	Host reads LSN16 by using READ Command. - check which kind of file system is used on the media - if UDF and a VAT (See OSTA UDF 1.5 or later) is used, read VAT ICB which recorded at the LRA - get LRA by READ TRACK/RZONE INFORMATION Command
7	Host reads VAT ICB at Last Recorded Address by using READ Command. - get VAT address from VAT ICB - read VAT

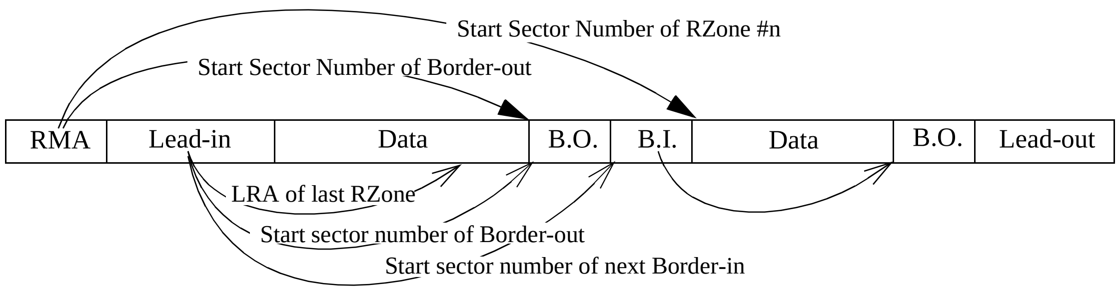

Figure 53 - Pointers for Multi-Border recognition

4.16.11.5 Disc Final Closure

If the **Multi-Session/Border** field in the *Write Parameters* Mode Page (05h) is set to 00b, when CLOSE TRACK/RZONE/SESSION/BORDER Command which intends to close the Border is issued, the final closure operation ***shall*** be started for the disc. After this operation, Lead-out is appended after the last Border-out and data cannot be appended to the disc any more. The total length of the last Border-out and Lead-out ***shall*** be about 0.5mm in the radial direction. Refer to Table 44 - *Border Zone Size* on page 120.

To recognize whether the disc is finalized or not, the following conditions are checked. If one of the following condition is met, the disc ***shall*** be considered a finalized disc and is not appendable.

- Start PSN of the next Border-in field of Lead-in/Border-in contains 0.
- Next Border Marker is recorded as lead-out attribute.
- Disc Status field of RMD contains “Complete” status.

Final Closure operation (Finalize) is done in the following sequence:

1. Set **Multi-Session/Border** field in *Write Parameters* Mode Page (05h) to 00b.
2. Close all opened RZone(s).
3. Issue CLOSE TRACK/RZONE/SESSION/BORDER Command with Border bit 1, RZone bit 0.
4. Updated RMD is written in RMA with Disc Status field “complete”.

If the last bordered area (Border) is incomplete status and Lead-in is already written:

5. Border-out for current incomplete Border and Lead-out are written with the following conditions:
   Border-out ***shall*** be recorded until Stop Block.
   Lead-out ***shall*** be recorded after the Stop Block.
6. Border-in for current Border is written with following condition.
   The Start Sector Number of Next Border-in field ***shall*** be set to 0.
7. Next Border Marker in previous Border-out is padded with 00h and set to Area Type field of Data ID 00b. (normal data sector)

If the last bordered area (Border) is incomplete status and Lead-in is still unwritten:

5. Border-out for current incomplete Border and Lead-out are written with following condition.
   Border-out ***shall*** be recorded until Stop Block.
   Lead-out ***shall*** be recorded after the Stop Block.
6. Lead-in is recorded.
   The Start Sector Number of Next Border-in field ***shall*** be set to 0.

If the last bordered area (Border) is empty status and Lead-in is already written:

5. Lead-out ***shall*** be recorded immediately following the last Border-out where there is reserved space for the next

bordered area's Border-in.

6. Next Border Markers in last Border-out ***shall*** be padded with 00h and set to Area Type field of Data ID 01b. (Lead-out)

The total radial width of last Border-out and Lead-out ***shall*** be about 0.5mm.

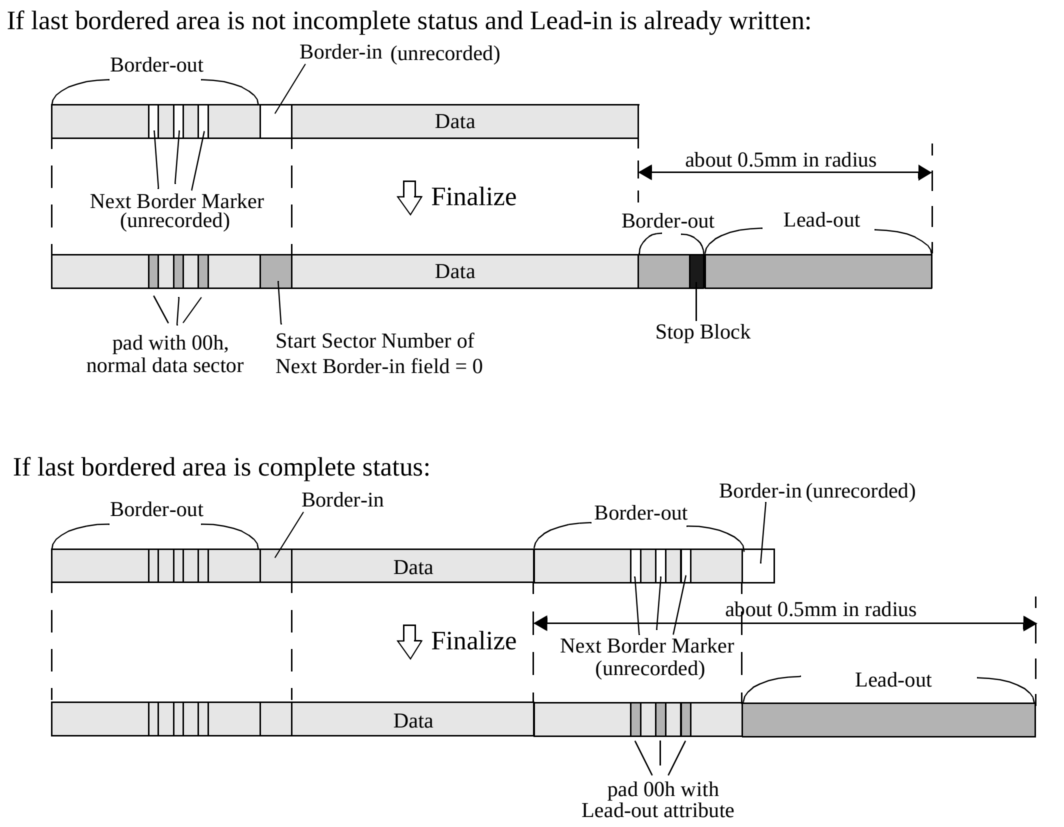

Figure 54 - Finalize

4.16.12 State of Disc for Interchange

To make recorded user data readable by DVD-ROM Logical Units, a Lead-in/Border-in and Border-out/Lead-out ***shall*** be recorded at each end of recorded user data.

In disc-at-once recording, Lead-in through Lead-out is always written in one recording action. Therefore DVD-R media which is written by disc-at-once recording is ready to be read by any DVD-ROM Logical Unit.

In incremental recording, DVD-R media cannot be read by DVD-ROM Logical Units unless Lead-in/Border-in and Border-out is written at each end of bordered areas.

4.16.13 The data which are recordable by DVD-R Logical Units

The data types which are recordable by a DVD-R Logical Unit are listed below.

- User data in data area
- Copyright Management Information in data area
    - CPM
    - CGMS
- Control data in Lead-in area
    - Disc manufacturing Information field (copied from RMD Field-2)
- RMD in RMA area

Note: The Disc manufacturing Information field of DVD-R media contains user specific data. It may be written by authoring software.

4.16.14 Recovery from a damaged disc

An RZone or RMD may be damaged with incomplete status (no linking) at the end of the written data. This may be caused by a HARD RESET or a power-fail condition during an incremental recording.

A recorded data may not be readable due to EDC error. The disc may be dirty or cracked after recording.

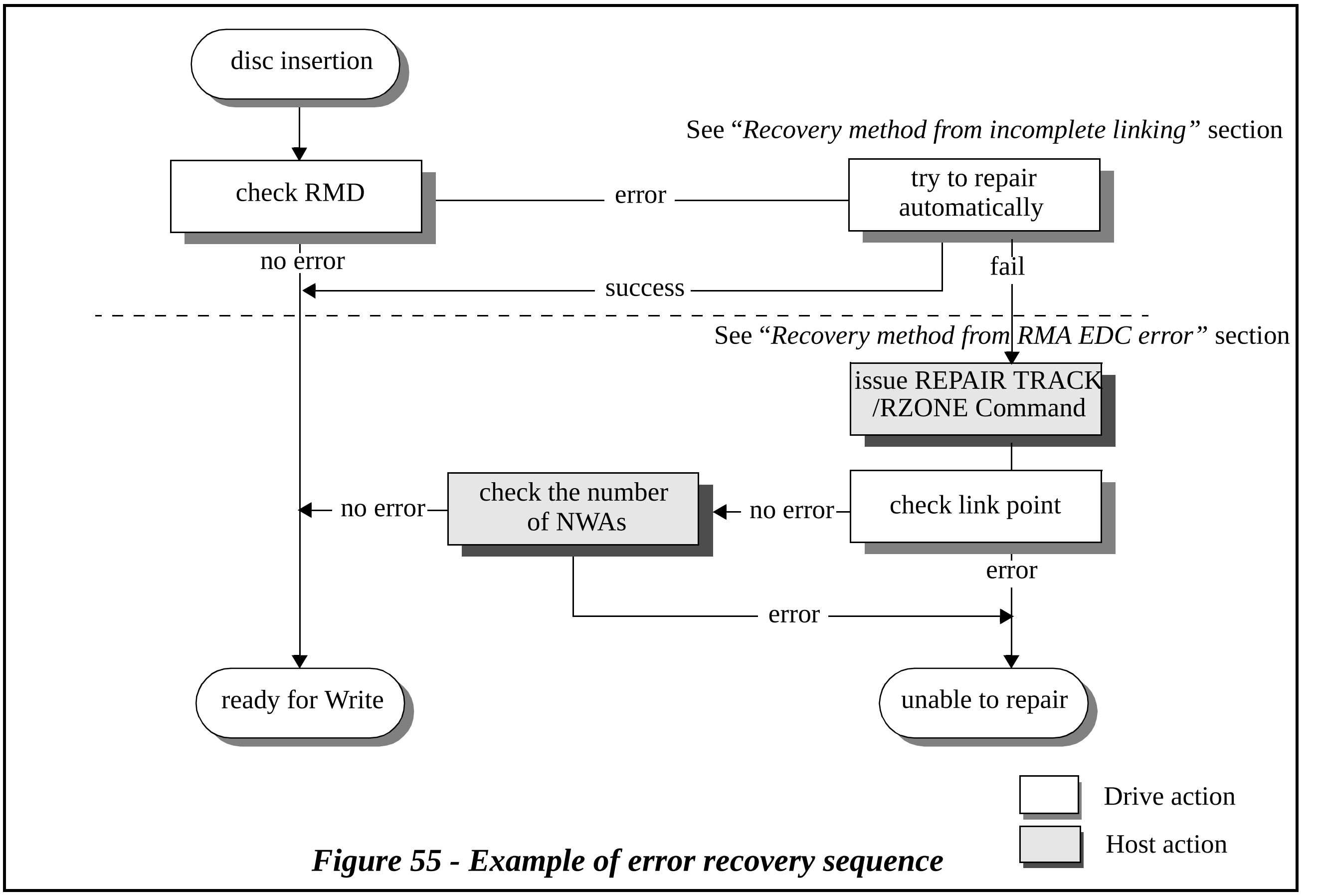

Figure 55 - Example of error recovery sequence

4.16.14.1 Recovery method from incomplete linking

If an ECC block is damaged accidentally, the Logical Unit overwrites from the damaged sector of the ECC block with Data Type bit 1. If an error occurs in the first through 15th sector of the ECC block, the Logical Unit writes one more ECC block with Data Type bit 1 immediately following the damaged ECC block. If an error occurs in the 16th sector of the ECC block, the Logical Unit writes two more ECC blocks with Data Type bit 1 immediately following the damaged

ECC block. See Figure 56. In this case, the Last Recorded Address is the last readable sector and does not belong to the Linking Loss sector. Automatically repaired NWA is the first sector of the ECC block which is followiing padded ECC block(s).

The automatic repair ***shall*** be done by the Logical Unit. The actual padding to the damaged RZone ***shall*** be done when the next write operation is issued to the RZone. The damaged status of the RZone is kept to notice the RZone has damage even if the disc is newly inserted in another Logical Unit before the repair operation is performed.

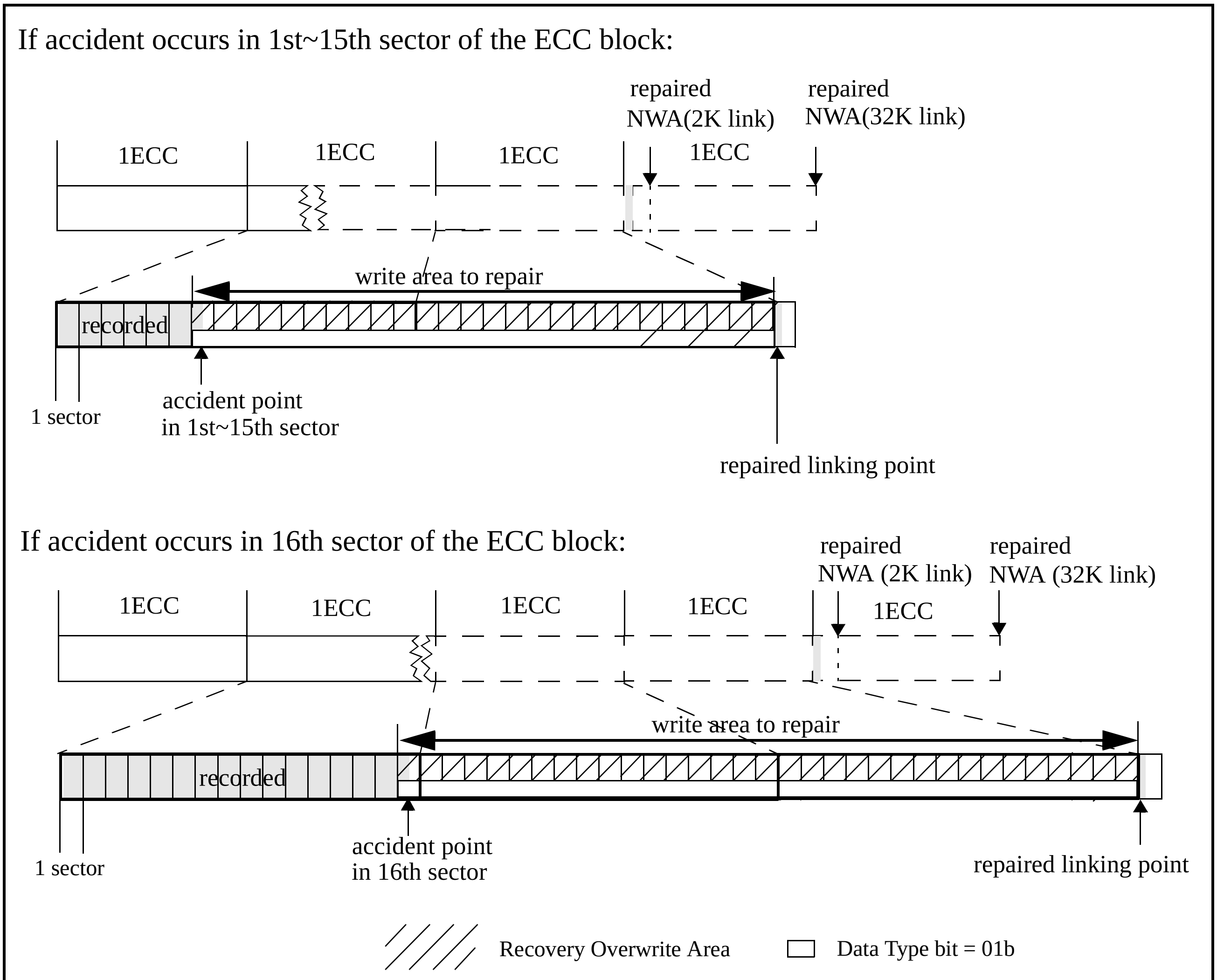

Figure 56 - Repair Incomplete linking

4.16.14.2 Recovery method from RMA write error

The recovery method is the same as 4.16.14.1. In this case, there are no modifications in the data recordable area and previously recorded RMD is available as a valid RMD.

4.16.14.3 Recovery method from RMA EDC error

If the Logical Unit can not read the RMD, the RZone information such as "number of RZones," "start address of RZone," "boundary of RZone" is not recognized by the Logical Unit.

If the last RMD in the RMA is un-recovered because of an EDC error, the Logical Unit ***shall*** report the RMA un-recovered error. The Logical Unit ***shall*** report CHECK CONDITION Status, 3/57/00 UNABLE TO RECOVER TABLE-OF-CONTENTS to any command which requires access to the RMA.

When the last RMD in the RMA is un-recovered because of an EDC error, recovery is as follows:

1. When the Host receives an error, clean the media. Eject the media and check the surface. If the surface is dirty, clean the disc.
2. When the error code UNABLE TO RECOVER TABLE-OF-CONTENTS is reported and the media has been cleaned, Host ***shall*** send a REPAIR RZONE Command with TRACK/RZONE number 0, telling the Logical Unit to try to recover using the old RMD in the RMA. When the REPAIR RZONE Command with RZone number 0 is issued, the Logical Unit ***shall*** try to read the latest readable RMD and check NWAs on the disc. If all NWAs coincide on the disc in the recovered RMD, the Logical Unit ***shall*** report GOOD status to the REPAIR RZONE Command. The system must check the number of NWAs (open RZones) with the READ TRACK/RZONE INFORMATION Command. If the number of NWAs on disc and file system are the same, the recovered RMD of RMA is correct. System can recognize the disc status successfully.

When latest RMD is not readable and if some reserved RZones had been completed/closed since last readable RMD was written, the Logical Unit ***shall*** return CHECK CONDITION Status, 3/57/00 UNABLE TO RECOVER TABLE-OF-CONTENTS. In this case, the new Incomplete/Invisible RZone may exist at the outside of the assumed Incomplete RZone. For example, when the last readable RMD reflects the disc status such as case **F** of Figure 42 - *Example of RZone reservation sequence* on page 107 and actual current disc status is the case **G** of Figure 42, Logical Unit and Host might not be aware of the existence of the RZone number 7 of Figure 42.

To make the backup of RMD in RMA, see *4.16.11.2, "When RMD is written in RMA"* on page 118.

4.16.14.4 Recovery for accident during Border-out writing

To close a Border, Border-out ***shall*** be written prior to writing the Border-in.

When an error occurs while writing the information blocks of the Border-out (copies of RMD), the following action ***may*** be attempted by the Logical Unit. If an error occurs while writing data other than information blocks, the Logical Unit will restart the write at the end of the Border-out.

1. The Logical Unit attempts to repair the damaged ECC block automatically.
2. If repair is successful, the Logical Unit updates the RMA with the latest RMD which contains the new Border-out start address (repaired NWA).
3. Rewrites Border-out from repaired NWA.
4. Writes Border-in (or Lead-in) containing the repaired start address of Border-out

5.0 AS-MO model

The AS-MO (Advanced Storage MO) is designed to store large amounts of coded and image data. The UDF file system is employed to take advantage of complete data interchangeability for multiple PC platforms. In addition, sophisticated security features are also built into the basic drive concept.

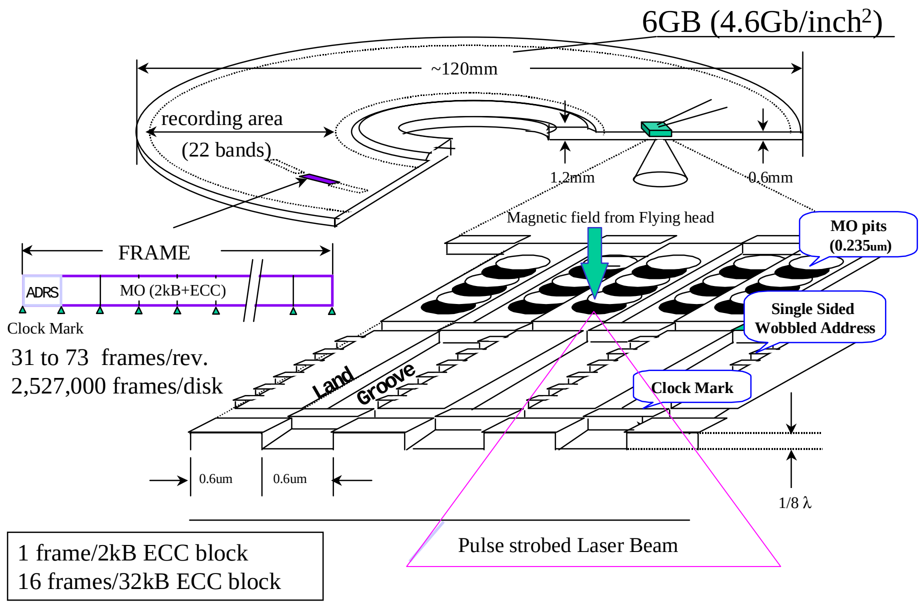

Figure 57 - Disk Structure

An AS-MO disk contains 6 GB of user data on a single sided, 120 mm diameter, 0.6 mm thick substrate. The disk contains land and groove recording in 22 bands. Addressing is done using a single sided wobble groove. Defect management is performed by the drive using standard DMA methods, and has been optimized for real time data capture. The AS-MO disk is contained within a protective cartridge.

5.1 AS-MO specifications

General Parameters of AS-MO Disks are shown in Table 47.

Table 47 - AS-MO Parameters

Specification	Contents
User Capacity (Single layer)	6 GB
Disk Diameter	120mm
Disk thickness	0.6 mm,1.2mm (Clamping Area)
Wavelength for W/R	635/650 nm
NA of Objective lens	0.60
Data bit length(=Channel bit length)	0.235um
Min. Mark length	NRZI plus

Table 47 - AS-MO Parameters

Specification	Contents
Data Encoding	Write:MFM(Magnetic field modulation)
W/R strategy	Read:MSR (Central Aperture Detection)
Track pitch	0.6um (Land and Groove)
User data per sector	2048 bytes
Error Correction Code	Reed-Solomon product code
ECC block size	32kB/2kB
Physical Address	Staggered Wobbled Groove Address
Linear velocity (CAV)	4.5 to 10.9 m/s
Data transfer rate	15.3 to 35.9 Mbps
Starting Physical Number of data area	31000h
End Physical Number of data area	2EFD7Fh

5.2 Physical Structure (32kB ECC block)

An AS-MO disk has approximately 50,000 tracks grouped into 22 physical zones. Each track contains between 31 and 73 frames (1 frame = 1 logical sector). Data is recorded in 32K ECC blocks. Each ECC block contains 16 frames. Each frame consists of 39 contiguous segments. Each segment contains 532 recorded data bits (user data with ECC). In addition, each segment contains an embossed Fine Clock Mark for read/write clocking. The first segment in each frame is an address segment, which contains the physical address data. See Figure 58.

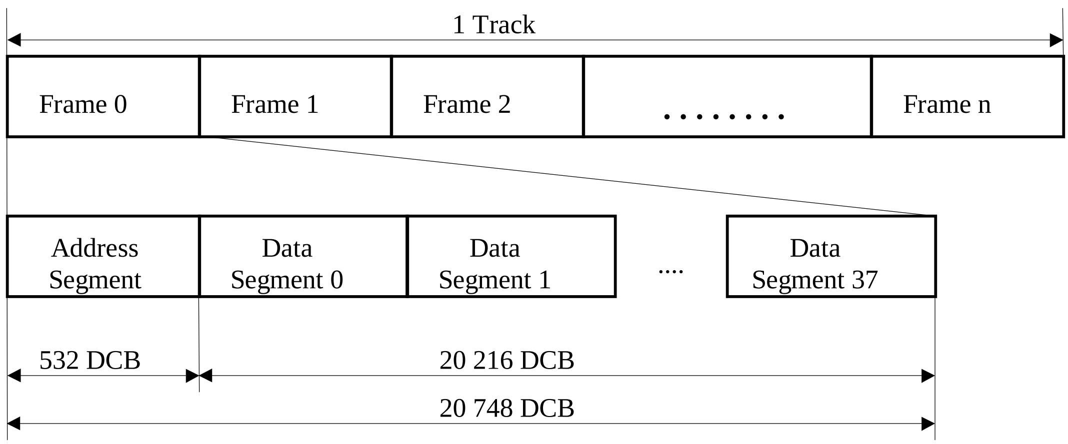

Figure 58 - Physical format

5.2.1 AS-MO Physical Specification Information

Please refer to AS-MO Part 1, physical specification for additional information.

Contact address:

Mitsuru Toriyama
Assistant Manager , DVD Business Center, Sony Corporation
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Fax : +81-3-5448-3458
e-mail : asmo@mift.sony.co.jp

5.3 Logical Structure

An AS-MO disk has two continuous land and groove recording tracks. The recording tracks are divided into 714 logical zones, each containing sophisticated defect management areas. Each logical zone consists of 8 Mbytes (252x32 KB) of user data and 128 KBytes (4x32 KB) spare sectors. This structure is defined to optimize optical head movement and buffer capacity in order to make continuous real time data capture and playback possible.

Defect management tables are located in both Outer Area (Band 1) and Inner Area (Band 22) disk areas.

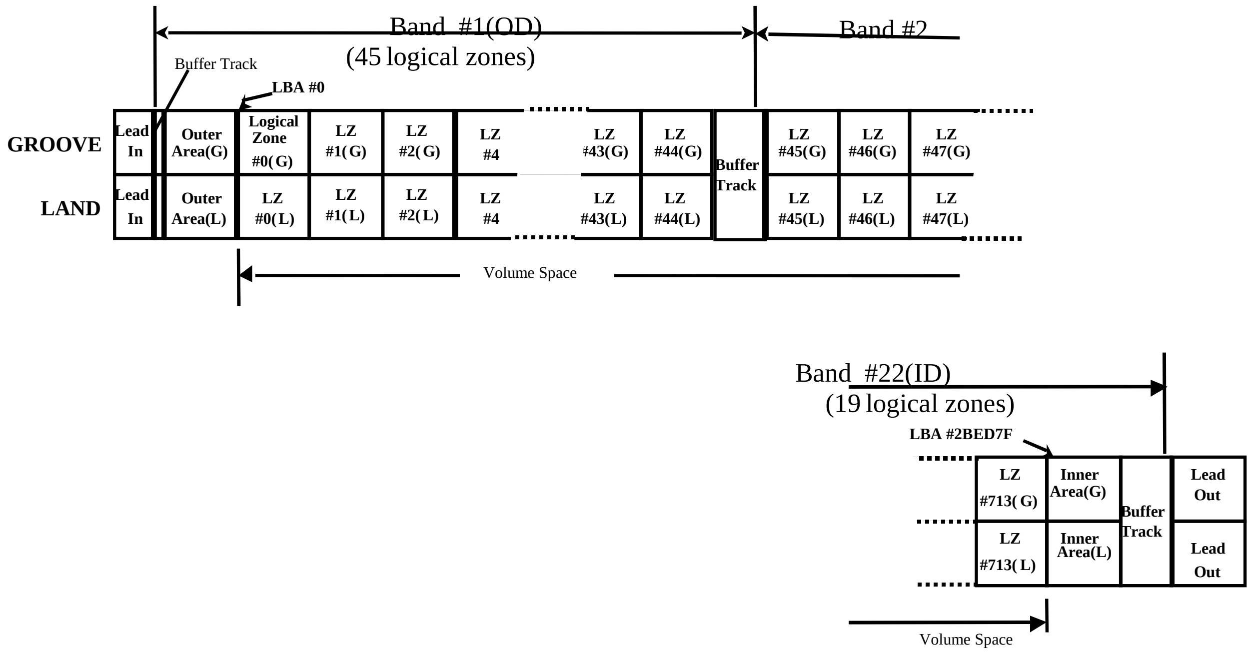


Figure 59 - Physical and Logical Layout of AS-MO Media

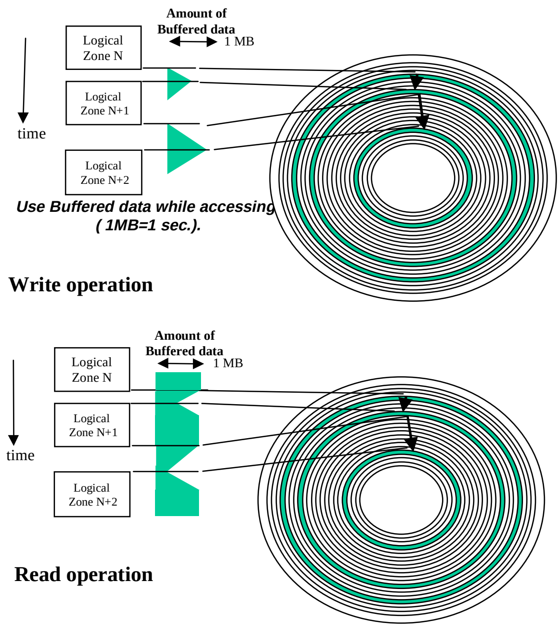


Figure 60 - Concept of Seamless Linking for AV Capture /

5.3.1 Buffer size

The conceptual model of AS-MO is to maintain consistent data transfer of AV data. The 1MB internal buffer is used to guarantee real time capture and playback regardless of the relative location of the data. The size of the buffer is derived from the following:

User data rate (from/to media) .... : 18Mbits/sec (2.25MBytes/sec)

I/O data rate (from/to drive) .... : 8Mbits/sec (1MBytes/sec)

Max. access time (seek time, etc.)... : 0.5sec (including latency)

To guarantee continuous data flow the minimum buffer size should be:

1MByte/sec * 0.5sec = 500kByte

To maintain a buffer full ratio of 50%, a 1 MB buffer is required.

5.4 Recording/Reading for AS-MO Media

5.4.1 AS-MO Features

1. All defect management is handled at the drive level (no OS support is required)
2. Manufacturer certification is not necessary
3. User certification is not necessary
4. Only formatting is required before use for creating the logical file system.
5. Recording in 32K ECC Block is preferred (to prevent read-modify-write), but not required.

5.4.2 Defect Management for AS-MO Media

Each replacement sector area is located within a lens accessible region for the preceding user data area.

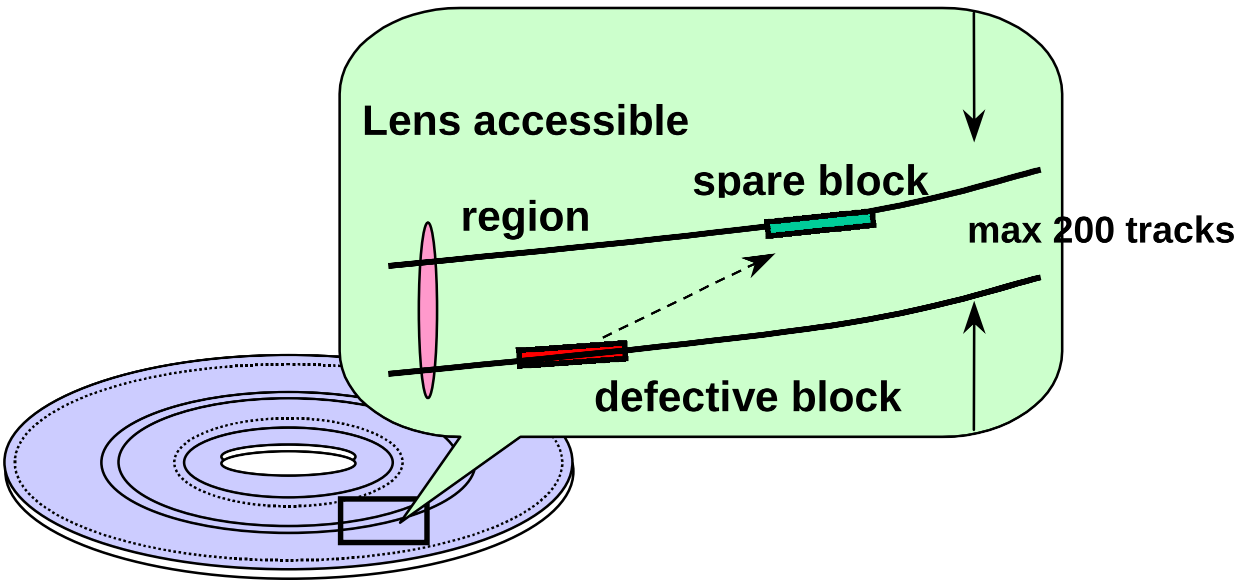


Figure 61 - Spare block allocation in a logical zone

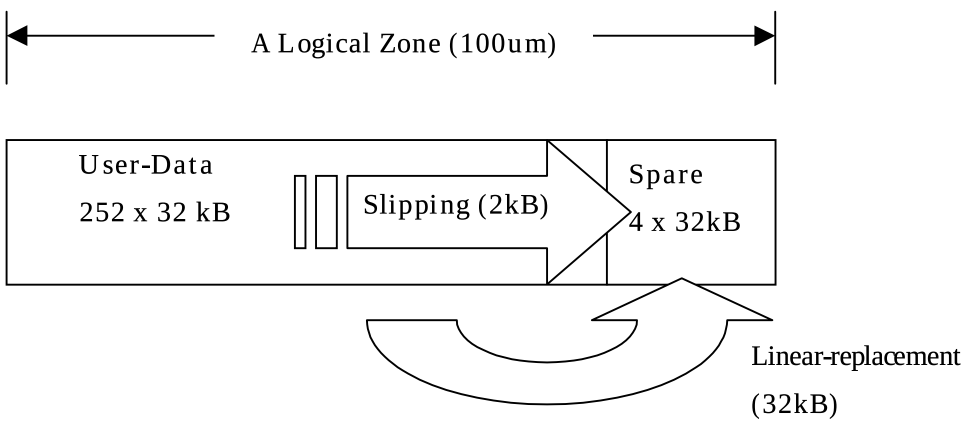


Figure 62 - Defect management in a logical zone

5.4.3 FORMAT UNIT Command and READ FORMAT CAPACITIES Command use

AS-MO Logical Units ***shall*** support format types 00h, 04h, and 05h.

5.5 Features

The following features may be supported by the AS-MO Logical Unit in addition to the AS-MO profile.

1. MultiRead Feature (001Dh)
2. CD Read Feature (001Eh)
3. DVD Read Feature (001Fh)
4. Microcode Upgrade Feature (0104h)

5.6 Profiles

The following profiles may be supported by the AS-MO drive in addition to the AS-MO profile.

1. 02h - Removable disk
2. 12h - DVD-RAM

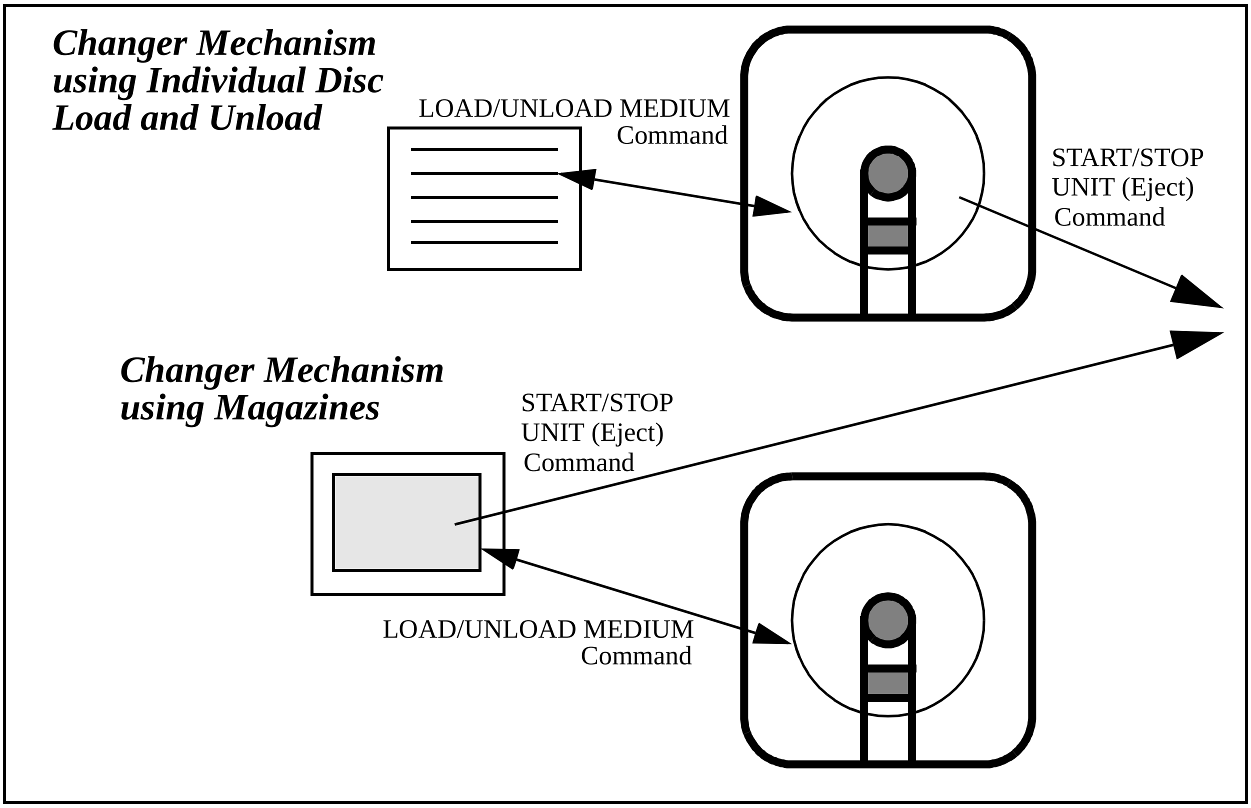
6.0 Changer Model

A changer Logical Unit will perform exactly like a single ATAPI Logical Unit. However it ***shall*** support the Commands MECHANISM STATUS and LOAD/UNLOAD MEDIUM.

A changer Logical Unit provides a storage area for more than one C/DVD Disc. This storage area contains multiple areas called slots. Each slot can contain just one Disc. Once a Disc has been placed in to a given slot, it becomes locked in that position. This specification 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 disc can be changed, while in the later all the stored discs must be changed at one time.

Any time a Disc/Cartridge is installed from the changer, the Logical Unit ***shall*** generate a UNIT ATTENTION Condition. After the Host detects the UNIT ATTENTION on a known changer Logical Unit, the Host may issue a MECHANISM STATUS Command. This will provide the Host with information on what disc is present or was changed.



6.1 Sidedness

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

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

For a Logical Unit that supports changing sides (see *11.5.2.21, "Feature 0102h: Embedded Changer"* on page 211, "Side Change Capable"), the number of Slots reported ***shall*** be even, and every other slot ***shall*** be an alternating side.

6.1.1 Side Changing Only Logical Unit

There can exist a Logical Unit that is capable of changing the side of the Disc, but does not have separate Slots from the playing position. This type of Logical Unit reports that it has a Mechanism type that is not a changer, but also reports Side Change Capable. This style of Logical Unit will still make use of the LOAD/UNLOAD MEDIUM Command to change the currently selected side. This style Logical Unit ***shall*** report two slots available (see Table 167 - *Mechanism Status Header* on page 244).

A side effect of a Logical Unit that only has the capability to change sides is that when unloading a Disc does not actually perform any action. This will appear to the Host as a Logical Unit with Delayed Load type of operation (see *6.5, "Delayed Disc load operation"* on page 138).

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

6.1.2 Error Conditions for Sided Discs

Devices that support changing sides of a Disc ***shall*** use report CHECK CONDITION Status, 2/06/00 NO REFERENCE POSITION FOUND (medium may be upside down) when the currently selected side does not contain valid data.

6.2 Initialization

The Changer ***shall*** perform its initialization routine at power on or receipt of a hard reset from the Host.

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

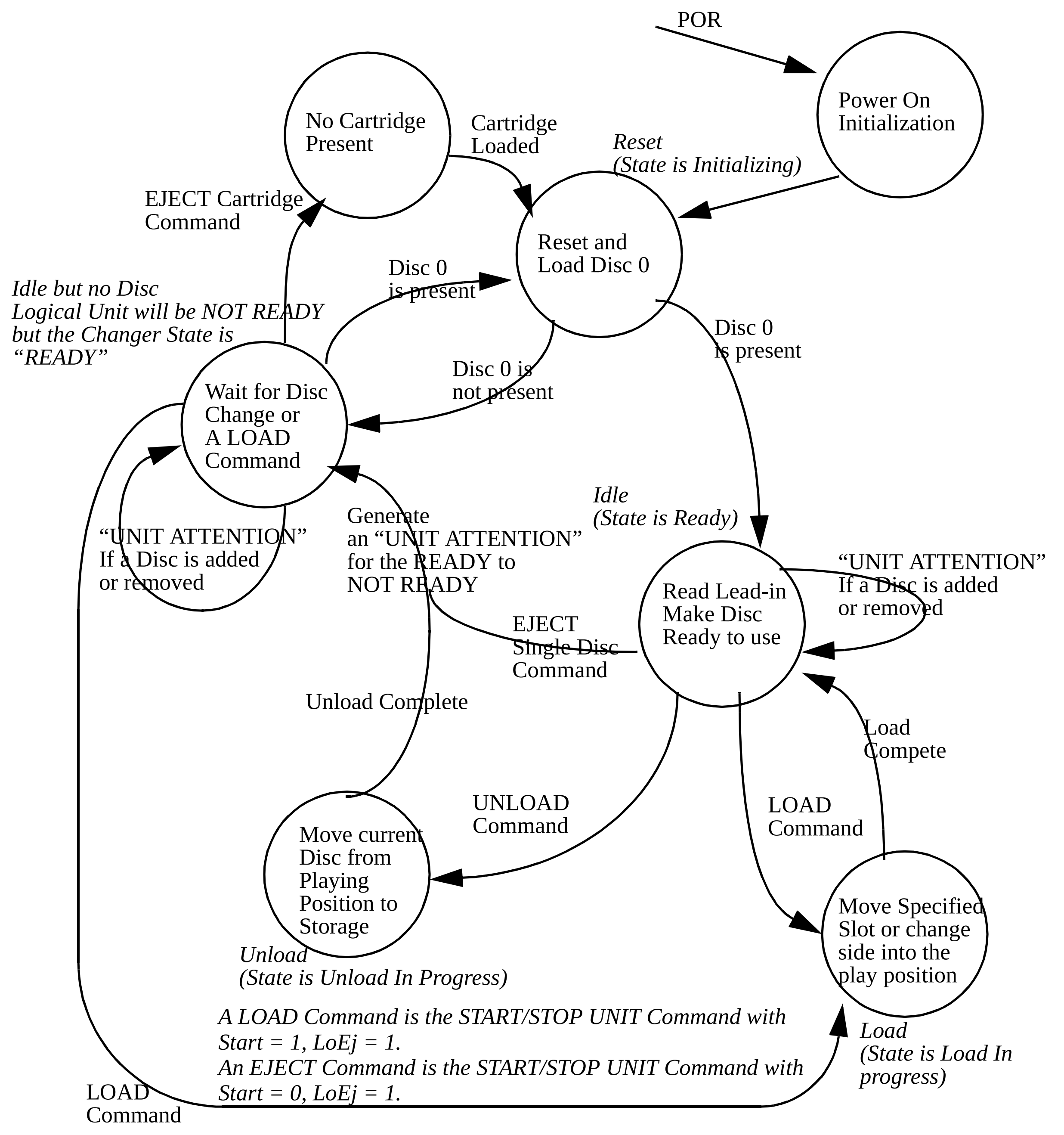


Figure 63 - Changer State Diagram

6.3 Changer Addressing

Several Changer specific commands use addresses called "Slots."

To determine if a Logical Unit is a changer type Logical Unit the Changer Feature ***shall*** be reported in response to an appropriate GET CONFIGURATION Command. A Logical Unit that reports Side Change Capable ***shall*** implement all Changer commands.

6.4 Automatic Load and Unload Operations

After initialization is complete the changer ***shall*** have Slot 0 loaded into the play position. This enables drivers which are not changer aware to work with a changer Logical Unit as if it were a normal single Disc ATAPI Logical Unit. This also insures compatibility with Bootable C/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 MEDIUM Commands.

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

6.5 Delayed Disc load operation

C/DVD Changer Devices may either move a disc into the playing position immediately upon receipt of a LOAD/UNLOAD MEDIUM Command (Load), or delay the loading of the disc until a media access command is received. It is recommended that the Logical Unit not load discs into the playing position until data from a disc that is not cached is requested from the Host. Note that the delayed operation extends to the LOAD/UNLOAD MEDIUM (Unload) operation as well. Both the Load and Unload operations can be delayed.

Note: Host 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 Logical Unit supports delayed loading and the selected disc is not in the play position, then the following commands ***shall*** move the selected disc into the play position When data that has not been cached has been requested by the Host:

Table 48 - Delayed Load Operation by command

Command	Allowed Action
BLANK	Delay in processing command is allowed
CHANGE DEFINITION	No extra delay for medium movement ***shall*** occur
CLOSE TRACK/RZONE/SESSION/BORDER	Delay in processing command is allowed
FLUSH CACHE	Delay in processing command is allowed
FORMAT UNIT	Delay in processing command is allowed
GET CONFIGURATION	No extra delay for medium movement ***shall*** occur
GET EVENT/STATUS NOTIFICATION	No extra delay for medium movement ***shall*** occur
GET PERFORMANCE	No extra delay for medium movement ***shall*** occur
INQUIRY	No extra delay for medium movement ***shall*** occur
LOAD/UNLOAD MEDIUM	Delay in processing command is allowed but is not recommended
LOCK/UNLOCK CACHE	Delay in processing command is allowed
LOG SELECT	No extra delay for medium movement ***shall*** occur
LOG SENSE	No extra delay for medium movement ***shall*** occur
MECHANISM STATUS	No extra delay for medium movement ***shall*** occur
MODE SELECT (10)	No extra delay for medium movement ***shall*** occur
MODE SENSE (10)	No extra delay for medium movement ***shall*** occur
PERSISTENT RESERVE IN/OUT	No extra delay for medium movement ***shall*** occur
PLAY AUDIO (10)	The current slot selected ***shall*** be moved into the play position
PLAY AUDIO MSF	The current slot selected ***shall*** be moved into the play position
PLAY CD	The current slot selected ***shall*** be moved into the play position
PREFETCH	Delay in processing command is allowed
PREVENT/ALLOW MEDIUM REMOVAL	No extra delay for medium movement ***shall*** occur
READ (10) and READ (12)	Delay in processing command is allowed
READ BUFFER	No extra delay for medium movement ***shall*** occur
READ CAPACITY	No extra delay for medium movement ***shall*** occur
READ DISC INFORMATION	Delay in processing command is allowed
READ HEADER	Delay in processing command is allowed
READ SUBCHANNEL	Delay in processing command is allowed

Table 48 - Delayed Load Operation by command (Continued)

Command	Allowed Action
READ FORMAT CAPACITIES	No extra delay for medium movement ***shall*** occur
READ CD	Delay in processing command is allowed
READ CD MSF	Delay in processing command is allowed
READ DVD STRUCTURE	Delay in processing command is allowed
READ TOC/PMA/ATIP	Delay in processing command is allowed
READ TRACK/RZONE INFORMATION	Delay in processing command is allowed
RECEIVE DIAGNOSTIC RESULTS	No extra delay for medium movement ***shall*** occur
RELEASE	No extra delay for medium movement ***shall*** occur
REPORT KEY	No extra delay for medium movement ***shall*** occur
REPORT LUNS	No extra delay for medium movement ***shall*** occur
REQUEST SENSE	No extra delay for medium movement ***shall*** occur
RESERVE	No extra delay for medium movement ***shall*** occur
RESERVE TRACK/RZONE	Delay in processing command is allowed
SEEK	The current slot selected ***shall*** be moved into the play position
SEND DIAGNOSTIC	No extra delay for medium movement ***shall*** occur
SEND DVD STRUCTURE	Delay in processing command is allowed
SEND EVENT	Delay in processing command is allowed
SEND KEY	No extra delay for medium movement ***shall*** occur
SEND OPC INFORMATION	No extra delay for medium movement ***shall*** occur
SET C/DVD SPEED (Obsolete)	No extra delay for medium movement ***shall*** occur
SET READ AHEAD	No extra delay for medium movement ***shall*** occur
SET STREAMING	No extra delay for medium movement ***shall*** occur
STOP PLAY/SCAN	No extra delay for medium movement ***shall*** occur
START/STOP UNIT	The current slot selected ***shall*** be moved into the play position
TEST UNIT READY	No extra delay for medium movement ***shall*** occur
VERIFY (10)	Delay in processing command is allowed
WRITE (10)	Delay in processing command is allowed
WRITE BUFFER	No extra delay for medium movement ***shall*** occur
WRITE and VERIFY (10)	Delay in processing command is allowed

6.6 PREVENT/ALLOW MEDIUM REMOVAL processing

There are two techniques for PREVENT/ALLOW MEDIUM REMOVAL processing: either all the discs ***shall*** be prevented from being ejected by the user or each disc individually ***shall*** be prevented. If the Logical Unit reports support for Software Slot Selection, then each slot ***shall*** be individually controlled by the PREVENT/ALLOW MEDIUM REMOVAL. Note that changer devices that use a Magazine and not individually controlled slots should not report the Software Slot Selection capability.

6.7 Error Reporting

If any of the following conditions occur during the execution of a command, the C/DVD Changer ***shall*** return CHECK CONDITION status. The appropriate sense key and additional sense code ***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 49 - 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
ATAPI 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.

When an error condition is reported to the Host, the disc in the selected slot ***shall*** be moved into the play position.

Attempts to eject a Disc if the changer type is Magazine and there is a Disc in the playing position ***shall*** be rejected with CHECK CONDITION Status, 4/3B/16 MECHANICAL POSITIONING OR CHANGER ERROR.

7.0 Power Management Model

Four power states are defined. These are named Active, Idle, Standby, and Sleep with Active being the “Full-On” state, Sleep the “Off” state and “Idle, Standby and Sleep” progressively more aggressive power managed states. This model differs significantly from previous ATA and SCSI power management definitions. This new model defines power states in terms of the perceived impact on the end user, instead of absolute power levels. The Idle state is optimized for minimal end user performance impact. The Standby state is optimized for power savings.

To provide consistent behavior across Logical Units, standard definitions are used for the power states of Logical Units. These states are defined in terms of the following criteria.

- Power Consumption: How much power the Logical Unit uses.
- Logical Unit Context: How much of internal state of the Logical Unit is retained by hardware and what must be restored by the responsible software.
- Restore time: How long it takes to raise the power level to the active power state and to put the Logical Unit into operational condition (including mechanical operation such as spin up) required before entering into the Active power state. Restoring is vendor specific and any mechanism can be employed here to raise the power consumption and to put the Logical Unit in operation condition required in a higher power state. For example, “turning on or raising internal Vcc’s 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’s 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 50 - Power Management Model States

Logical Unit **State**	**Power Consumption**	Logical Unit **Context Retained**	**Restore Time**
Active (D0)	As needed for operation.	All	None
Idle (D1)	Less than Active	All	The Logical Unit ***shall*** be restored to active state within 1 second on any request to enter active state, independent of the de-powering process.
Standby(D2)	Less than Idle	All buffers are empty before entering Standby state.	Vendor specific: Greater than or equal to Idle to Active
Sleep(D3)	Less than Standby	None, Buffer & All of Command queues are empty before entering Sleep state.	Greater than or equal to Standby to Active. Vendor Specific. May Need full initialization. The Host may remove Vcc.

Transitions between these power states may occur at the request of the Host or the Logical Unit. Transitions to a higher power state from a lower power state ***shall*** occur after restoring the Logical Unit to the operating conditions (including mechanical operation if applicable, such as spin up) required in the higher power state. When the Logical Unit transitions from a higher power state to a lower power state, the Logical Unit ***shall*** be considered to be in the lower power state when the Logical Unit is assured of reaching the lower power condition. Actual de-powering occurs after the Logical Unit enters the lower power state. The Logical Unit ***shall*** generate a power Event when the Logical Unit is considered to have entered a power state.

In order to create a robust power management environment, Logical Units ***shall*** support the following:

- The Power Management Feature.
- Four power states: Active(D0), Idle(D1), Standby(D2) and Sleep(D3).
- Idle Timer. Provides a method for the Logical Unit to enter Idle state from Active state, following a programmed period of inactivity.
- Standby Timer. Provides a method for the Logical Unit to enter Standby state from either Active or Idle state, following a programmed period of inactivity.
- START/STOP UNIT Command and the Power Condition Field: Provides a method for the Host to request the Logical Unit to enter a power state.
- GET EVENT/STATUS NOTIFICATION Command: Notifies the Host of power state changes and current power status.
- *Power Condition* Mode Page (1Ah): Enables or disables timers and specifies the reload value of the Idle and Standby timers.

7.1 Power State Transitions

Active State (D0): The Logical Unit is completely active and responsive. The Logical Unit is consuming its highest level of power. During the execution of a media access Command (commands that reload both timers) the Logical Unit ***shall*** be in active state.

The Logical Unit should minimize power consumption at all times, even when in the active state. Any mechanism can be employed, as long as it is transparent to software and does not prevent the Logical Unit from performing expected functions. For example, the Logical Unit may dynamically gate on/off internal clocks by monitoring bus activities and internal activities.

Idle State (D1): In Idle state, the Logical Unit is capable of responding to commands but may take up to one second longer to complete commands than the Active state. The Logical Unit is consuming less power than the Active state. Any mechanism can be employed as long as the restoring time is less than one second. The Logical Unit may, for example:

- Reduce internal clock frequency
- Lower the internal Vcc for digital circuits
- Dynamically gate internal clocks by monitoring bus/internal activities

Standby State (D2): In Standby state the Logical Unit ***shall*** only be required to accept commands from the Host. All other mechanisms are in the power save condition. In Standby state, the Logical Unit is capable of responding to commands but the Logical Unit takes longer to complete commands than when in Idle state. Buffers ***shall*** be emptied before entering into Standby state. The Logical Unit context ***shall*** be preserved. The Logical Unit is consuming less power than when in Idle state.

Sleep State (D3): Maximum power saving state. Buffers and all Command queues, including GET EVENT/STATUS NOTIFICATION Commands, ***shall*** be emptied before entering into the Sleep state. When the Logical Unit enters the sleep state, any 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 Host software ***shall*** fully initialize the Logical Unit after exiting Sleep state, as all context may be lost in the Sleep state. Therefore, disc(s)/cassette may be manually ejected or inserted while in sleep state, independent of any lock/unlock mechanism employed. For the Host to consistently rely on the Logical Unit Media Status Notifications, when the Logical Unit is unable to determine if media has been changed while the Logical Unit was in the sleep state, the Logical Unit ***shall*** report a New Media Event on the next GET EVENT/STATUS NOTIFICATION (Media Status) Command.

In the Sleep state, the Host may completely remove power from the device by turning off Vcc.

7.1.1 State Diagram

The state diagram in Figure 64 - *State Transition, Events and Status* on page 144 and Table 51 - *State Transition, Events and Status* on page 145 define state transitions for the power management model.

A power-on or hard reset always returns the Power State to the Standby state. A Device Reset does not alter the current power state, unless the current power state is Sleep. A Device Reset received while in sleep state returns the power state to Standby.

The Sleep state is entered when the Logical Unit has been commanded to go to Sleep but Vcc is still applied to the device. Removing Vcc always takes the device to the Power Off state. Removing Vcc is recommended only when all Logical Units on a given bus are in sleep state.

Table 51 - *State Transition, Events and Status* on page 145 shows transition conditions for this model, and shows the Initial state, the Resultant state, Notification class, and Event class (Media or Power). Notification class and Event class fields specify the Events that ***shall*** be generated during the transitions as outlined in the GET EVENT/STATUS NOTIFICATION Command.

In Idle or Standby states, the Logical Unit should attempt to maintain the minimal power level for that state at all times. However, the Logical Unit may create transitory, higher power level conditions as needed. The transitory power conditions ***shall not*** affect the reported power state, or generate power state Events. Example transitory conditions are: flushing the buffers, emptying Command queues, media insertion spin up, or auto off-line, etc. On insertion of new media, the Logical Unit may enter a transitory, higher power condition and stay in this condition for vendor specific time period. If the Logical Unit has not received a media access Command (commands which reload both timers) during this period, the Logical Unit ***shall*** return to the normal power level for the current power state. This prevents excessive power consumption while the Host is off-line.

It is permissible to enter intermediate states while in transition between states, however, the Logical Unit ***shall not*** report power change Events for the intermediate states. If the Logical Unit fails to enter the target power state, the Logical Unit ***shall*** return to the original power state. Simultaneous expiration of multiple timers, ***shall*** cause the Logical Unit to enter the lower power state, and ***shall*** only report the result of the transition to that state.

When no media is mounted, the Logical Unit should enter the Standby State.

If a power change Event has not been reported to the Host, when a new Event is generated, the Logical Unit may choose only to report the most recent power Event.

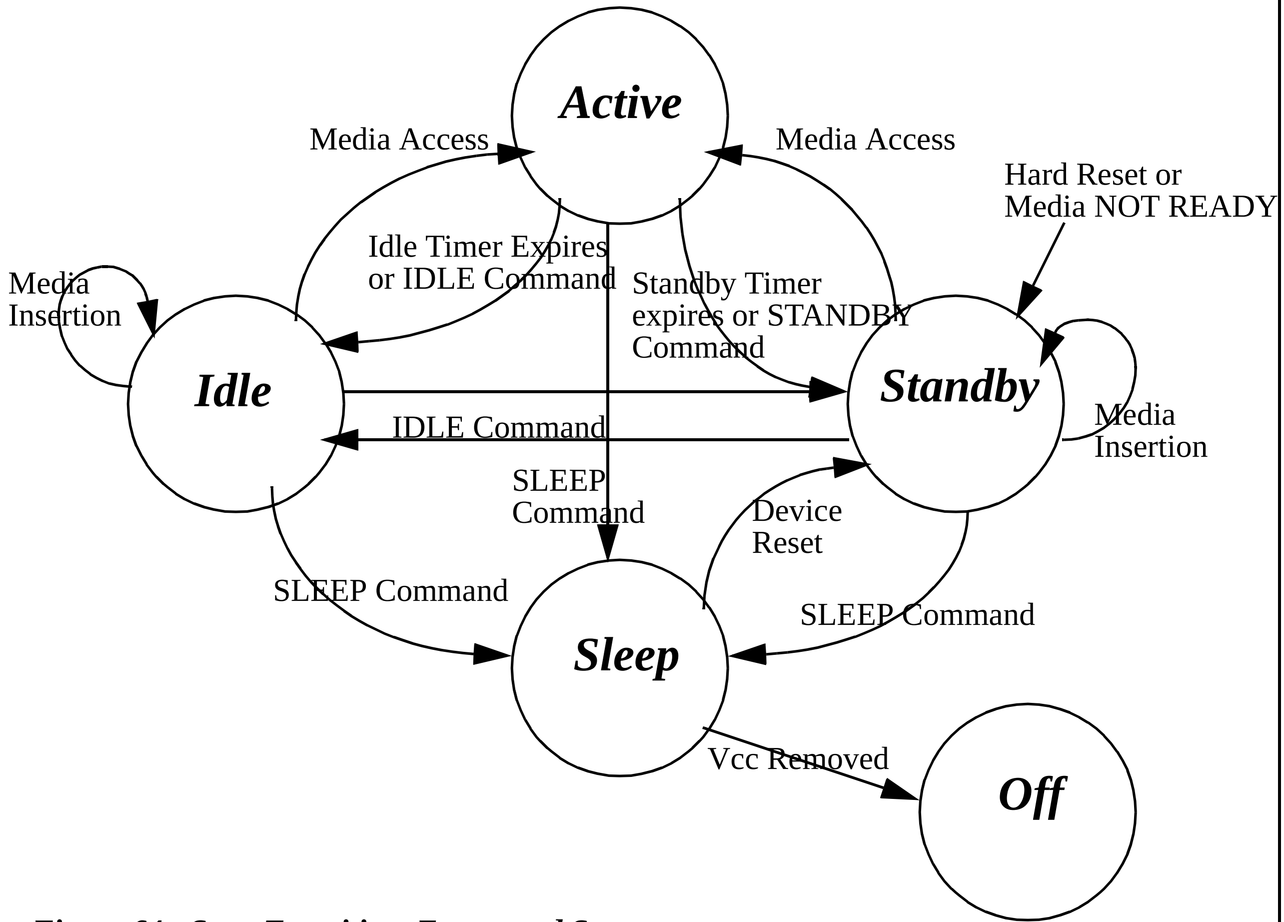


Figure 64 - State Transition, Events and Status

Table 51 - 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 an IDLE Command	Power	PwrChg-Succ
	Idle	Insertion of media and ready to use	Media	NewMedia
	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	Reception of a Command which reloads both timers	Power	PwrChg-Succ
Standby	Standby	Successful completion of STANDBY Command	Power	PwrChg-Succ
	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	Reception of a Command which reloads both timers	Power	PwrChg-Succ
Any	Standby	A power-on, or hard reset occurred, or the Logical Unit becomes NOT READY	Power	PwrChg-Succ
Sleep	Standby	Device Reset	Power	PwrChg-Succ

7.1.2 Timers

The Idle and Standby timers provide a method for the Logical Unit to enter lower power states after a Host programmable period of inactivity, without direct Host Command.

A timer is deactivated (no longer used by the Logical Unit, regardless of Enable / Disable setting provided from the Host) when the Logical Unit is in the associated power state or a lower power state.

A timer is both reactivated (the Logical Unit ***shall*** use the timer if enabled) and reloaded when a Logical Unit transitions to power state higher than the associated timer.

Timers ***shall*** be reloaded, as specified in Table 52, using the current timer value from the *Power Condition* Mode Page (1Ah).

Timers ***shall*** be disabled/enabled as specified in the *Power Condition* Mode Page (1Ah).

Timers ***shall*** be set to default conditions upon receiving a power-on, or hard reset. The default condition for the Timers ***shall*** be enabled with the values of the timers vendor specific.

7.1.2.1 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 52 - Effects of Host Actions on Timers

Host Action	Timer Effects	Comments
BLANK	Reload Both	Recordables only
CLOSE TRACK/RZONE/SESSION/BORDER	Reload Both	Recordables only
COMPARE	Reload Both	SCSI only
EXECUTE DRIVE DIAGNOSTIC	Reload Both	ATA Command
FLUSH CACHE	Reload Both	
FORMAT UNIT	Reload Both	Rewritable only
GET CONFIGURATION	None	
GET EVENT/STATUS NOTIFICATION	None	
GET PERFORMANCE	Reload Both	May need to access media
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	None	SCSI only
LOG SENSE	None	SCSI only
MECHANISM STATUS	None	
MODE SELECT (10)	May reload timers	A MODE SELECT (10) Command that changes the Standby or Idle timers ***shall*** reload the timer.
MODE SENSE (10)	None	
PLAY AUDIO (10)	Reload Both	
PLAY AUDIO MSF	Reload Both	
PLAY CD	Reload Both	
PRE-FETCH	Reload Both	SCSI only
PREVENT/ALLOW MEDIUM REMOVAL	Reload Standby	
READ (10) / READ (12)	Reload Both	
READ BUFFER	Reload Standby	
READ CAPACITY	Reload Both	
READ CD	Reload Both	
READ CD MSF	Reload Both	
READ DISC INFORMATION	Reload Both	
READ DVD STRUCTURE	Reload Both	
READ FORMAT CAPACITIES	Reload Standby	
READ HEADER	Reload Both	
READ SUBCHANNEL	Reload Both	
READ TOC/PMA/ATIP	Reload Both	
READ TRACK/RZONE INFORMATION	Reload Both	
RELEASE (10)	None	SCSI only
REPAIR RZONE	Reload Both	Sequential CD/DVD Recordable
REPORT KEY	Reload Both	
REQUEST SENSE	None	
RESERVE (10)	None	SCSI only
RESERVE TRACK/RZONE	Reload Both	Recordables only
SCAN	Reload Both	
SEEK	Reload Both	

Table 52 - Effects of Host Actions on Timers (Continued)

Host Action	Timer Effects	Comments
SEND DVD STRUCTURE	Reload Both	Sequential DVD Recordable
SEND EVENT	Reload Both	May effect media access
SEND KEY	Reload Both	
SEND OPC INFORMATION	Reload Both	Recordables only
SET READ AHEAD	Reload Both	
SET STREAMING	Reload Both	
START/STOP UNIT	See START/STOP UNIT Command	
STOP PLAY/SCAN	Reload Both	
TEST UNIT READY	None	
VERIFY (10)	Reload Both	
WRITE (10)	Reload Both	Recordables only
WRITE and VERIFY (10)	Reload Both	Recordables only
WRITE BUFFER	Reload Standby	
Device Reset	Reload Both	Reset operation, the Logical Unit ***shall not*** return to default timer conditions
Other Commands	Vendor Specific	

7.1.3 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 Host to query the current power state, irrespective of state transitions.

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8.0 Time-out and Reset Models

8.1 Time-outs

Currently, it is difficult for an operating system to determine a correct time-out value to use when issuing commands to a Logical Unit. Specifically, in instances of commands that may take a long time complete, but usually complete in a relatively short time. An example would be a read command after the Logical Unit has entered a low power state, and the media must spin up before completing the request. This model allows for a method for the Logical Unit to complete the request with an error that indicates to the Host operating system that the request should be retried, but with a longer time-out.

The Logical Unit will specify two time-out parameters in the *Time-out & Protect* Mode Page (1Dh). The first parameter is the minimum time-out that an operating system must use for all commands in Group 1. The second parameter is the minimum time-out that an operating system must use for all commands in Group 2.

For commands in Group 1, the Logical Unit shall start an internal timer when the command is received. If the command is unable to complete before the time specified in the Group 1 Time-out field of the*Time-out & Protect* Mode Page (1Dh), bytes 6 and 7, the Logical Unit may terminate the command, at any time before the Group 1 Time-out expires, with CHECK CONDITION Status, 6/2E/00 INSUFFICIENT TIME FOR OPERATION. In addition, the Logical Unit shall set the Command Specific Information sense bytes (Bytes 8-11) to the value in seconds that corresponds to the minimum time-out that the Host should use when retrying this command. Upon receiving this Check Condition, the operating system ***shall*** retry the command with the requested time-out.

Note: A Logical Unit may return this check condition at any point after the command is received, it may even return prior to initiating command.

All commands in Group 2 are commands that may not be able to complete successfully if they are retried. Thus, the Host must ensure that it uses a time-out that is large enough to allow the command to complete under worst case scenarios. This time-out is specified by the Logical Unit in the Group 2 Time-out parameter of the *Time-out & Protect* Mode Page (1Dh) (Bytes 8-9).

For a complete list of command groupings see Table 53.

Table 53 - Not Ready Error & Time-out Unit Attention Reporting (by Command)

Command	Returns Not Ready Status	Time-out	Comment
BLANK	Yes	Group 2	
CLOSE TRACK/RZONE/SESSION/BORDER	Yes	Group 2	Recordables only
COMPARE	Yes	Group 1	Not Defined in this specification
FLUSH CACHE	Yes	Group 2	
FORMAT UNIT	Yes	Group 2	
FORMAT UNIT (Immediate)	Yes	Not Allowed	
GET CONFIGURATION	No	Not Allowed	
GET EVENT/STATUS NOTIFICATION	No	Not Allowed	
GET PERFORMANCE	No	Group 1	
INQUIRY	No	Not Allowed	
LOAD/UNLOAD MEDIUM	No	Group 2	
LOG SELECT	No	Group 1	Not Defined in this specification
LOG SENSE	No	Group 1	Not Defined in this specification
MECHANISM STATUS	No	Group 1	
MODE SELECT (10)	No	Group 1	
MODE SENSE (10)	No	Group 1	
PAUSE/RESUME	Yes	Group 1	
PLAY AUDIO (10)	Yes	Group 1	
PLAY AUDIO MSF	Yes	Group 1	
PLAY CD	Yes	Group 1	
PREVENT/ALLOW MEDIUM REMOVAL	See Table 214 - *Actions for Lock/Unlock/Eject (Persistent bit = 0)* on page 286	Group 1	
READ (10) / READ (12)	Yes	Group 1	
READ BUFFER	No	Group 1	Not Defined in this specification
READ CAPACITY	Yes	Group 1	
READ CD	Yes	Group 1	
READ CD MSF	Yes	Group 1	
READ DISC INFORMATION	Yes	Group 1	
READ DVD STRUCTURE	Yes	Group 1	
READ FORMAT CAPACITIES	No	Group 1	
READ HEADER	Yes	Group 1	
READ SUBCHANNEL	Yes	Group 1	
READ TOC/PMA/ATIP	Yes	Group 1	
READ TRACK/RZONE INFORMATION	Yes	Group 1	
RECEIVE DIAGNOSTIC RESULTS	No	Not Allowed	Not Defined in this specification
RELEASE (10)	No	Not Allowed	Not Defined in this specification
REPAIR RZONE	Yes	Group 1	Not Defined in this specification
REPORT KEY	Yes	Group 1	
REQUEST SENSE	No	Not Allowed	
RESERVE (10)	No	Not allowed	Not Defined in this specification
RESERVE TRACK/RZONE	Yes	Group 2	Recordables only
SCAN	Yes	Group 1	

Table 53 - Not Ready Error & Time-out Unit Attention Reporting (by Command)

Command	Returns Not Ready Status	Time-out	Comment
SEEK	Yes	Group 1	
SEND DIAGNOSTIC	No	Not Allowed	Not Defined in this specification
SEND DVD STRUCTURE	No	Group 1	
SEND EVENT	Yes	Group 1	
SEND KEY	Yes	Group 1	
SEND OPC INFORMATION	No	Group 1	Recordables only
SET READ AHEAD	Yes	Group 1	
SET STREAMING	Yes	Group 1	
START/STOP UNIT	Yes	Group 1	
STOP PLAY/SCAN	Yes	Group 1	
TEST UNIT READY	Yes	Group 1	
VERIFY (10)	Yes	Group 2	
WRITE (10)	Yes	Group 1	
WRITE and VERIFY (10)	Yes	Group 1	
WRITE BUFFER	No	Group 1	

Note: The references to "Not Defined in this specification" in the table are to indicate that these commands are currently defined in the SCSI SPC-2, SBC and MMC-2 standards. As these commands are not defined in this specification the usage and actual operation of these commands is specified elsewhere, their reference here are only recommendations to provide better compatibility.

Note: These recommendations are based on common transfer lengths. Long transfer lengths may affect timeouts.

8.2 Reset Model

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

- Power On Reset
- Hard Reset
- Device Reset

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

8.2.1 Power On Reset

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

8.2.2 Hard Reset

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

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

8.2.3 Device Reset

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

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

8.2.4 Mapping of reset functions

The following table shows how the different reset functions specified in the various ATAPI and SCSI specifications are used in this specification. Note that this table is not intended to show all possible resets or their mapping. See Table 54

Table 54 - Example Reset Function Mapping in ATAPI and SCSI

Reset Type	ATAPI	SCSI
Power-On Reset	Same as Power-On Reset	Same as Power-On Reset
Hard Reset	Hard Reset	TARGET RESET task management function
	ATA SRST. This is a channel reset and as such is treated as a Hard Reset. However the SRST ***shall*** not reset any mode parameters to the default state.	SAM Reset events. Note that this is SCSI protocol dependent
		SPI Reset Signal
Device Reset	Device Reset in ATA/ATAPI-4	ABORT TASK SET task management function
	ATAPI Soft Reset in SFF8020i	CLEAR TASK SET task management function

9.0 Features

Features are sets of Commands, Mode Pages, and behaviors or operations specified for a Logical Unit. Each Feature must be implemented entirely to its standard description in order to claim compliance with the Feature. Except as explicitly identified, all Commands, Mode Pages, and behaviors within a Feature are mandatory.

Features were designed primarily to support multi-function devices that could only function as one device at a time, e.g. DVD-RAM drives act as either a DVD-RAM or DVD-ROM depending on the medium. Virtually all removable medium devices are in effect multi-function devices: they can use their medium when present, but cannot perform any media operations when no medium is present.

Mode Pages described and required by Features ***shall*** always be present if the Feature is reported by the Logical Unit, regardless of whether or not the Feature is current. For example, the *CD Audio Control* Mode Page (0Eh) ***shall*** be available for reading and writing if the CD Audio analog play Feature is supported by the device, even if no audio media is present. The current values and changeable masks ***shall not*** change, even across morphing. Default values may change when morphing occurs. Default values ***shall*** always reflect a usable set of values for the loaded medium. Changes to the default values ***shall not*** generate a Unit Attention condition.

The use of Features allows generic Host drivers to use Logical Units that have among their many Features some core functionality. For example, the Random Readable Feature may be reported by a very large variety of devices: magnetic disk, CD, DVD, or Magneto-Optical. A common driver to read data would be usable with all of these devices; special code would be needed only to manage extensions unique to each technology.

Features implemented by a Logical Unit are reported to the Host via the GET CONFIGURATION Command. This Command should be used to identify all possible Features, and those Features that are current. A Feature ***shall not*** be current if any of its mandatory Commands or behaviors are not available. For example, a Logical Unit with writable media loaded and a mechanical write protect active ***shall not*** report any writable Features as available. A DVD-ROM Logical Unit with a non-CSS-protected DVD-ROM loaded ***shall not*** report the DVD CSS Feature as being available. A Logical Unit with no medium present ***shall*** have no read or write or other medium dependent Features active. Commands within a Feature that is not current may still operate normally, especially when those Commands are described in more than one Feature.

The introduction of Features are not intended to change device behavior. The use of Commands that are not current will generate the same errors as legacy devices. Features simply provide a method for avoiding errors and avoids using errors to convey state information. When Features are used properly by the Host, the Host should see only true medium errors and not need to do any informational discovery through error codes.

This standard also specifies techniques for the Logical Unit to notify the Host of changes in the list of current Features. In addition, a technique for preventing changes until Host approval is granted is defined. The GET EVENT/STATUS NOTIFICATION Command is used for notification of changes or change requests; the PREVENT/ALLOW MEDIUM REMOVAL (Persistent) and SEND EVENT Commands are used to notify the Logical Unit of a Host control request and for the Host to notify the Logical Unit of permission to change.

For a Feature to be considered current, all Commands and behaviors described by that Feature should be available to the Host. Even if a Feature is not current, its components should function if appropriate for the Logical Unit’s state. Commands received by a Logical Unit that are a member of a supported Feature that is not current ***shall*** either execute normally or return an appropriate error (i.e. incompatible medium, medium not present, etc.). Logical Units ***shall not*** terminate any Command that is a member of any supported Feature with an INVALID COMMAND OPERATION CODE Error. For example, if the Formattable Feature is implemented, the READ FORMAT CAPACITIES Command should return valid data regardless of whether or not the Formattable Feature is Current. An attempt to format a medium that cannot be formatted by the Logical Unit may return CHECK CONDITION Status, 5/30/06 CANNOT FORMAT MEDIUM - INCOMPATIBLE MEDIUM.

Each Feature Descriptor may contain information specific to that Feature. The Feature specific information in the Feature Descriptor may not be valid if the Feature is not current.

Commands, Pages, and behavior not described by a Feature may exist in the Logical Unit.

See *11.5, "GET CONFIGURATION Command"* on page 185 for more information on the individual Features.

9.1 Implementation of Features

9.1.1 What's a Feature?

This specification introduces Features. Features were designed to be atomic units of functionality. On the first level, Features are only a description in a document. Traditional drivers work without modification with Logical Units that implement Features. Features were a part of the documentation in SFF-8020i, SFF-8090, and MMC; however they were not comprehensive, typically documenting only optional behavior. This specification associates all normal functionality with Features. Detection of a whole group of functions (a "Feature") was typically accomplished by the Host by issuing a Command unique to that Feature and examining the completion status of that Command.

The SFF and T10 (MMC) groups have been consciously trying to avoid using errors as a method for status detection. Error handling code is typically one of the more complex parts of implementing drivers; reducing the number of cases that need to be handled helps implementations by reserving error status for only true errors. Status information is reported via explicit status reporting Commands such as GET EVENT/STATUS NOTIFICATION and GET CONFIGURATION.

The descriptions of Features in this specification appear complex, and they are. However, these descriptions describe almost nothing new; they are simply the descriptions of existing legacy behavior. The only new parts are the descriptors themselves, which are either static identification blocks or groups of information that the Logical Unit must already have to operate, even in a legacy behavior. For example, a Logical Unit must internally identify whether or not a PLAY AUDIO (10) Command may succeed; Features are simply a way to let the Host in on the secret.

Previously, new devices had to make a choice: to look completely like an old device with added functionality, or as a new device not compatible with old drivers. Feature and Profiles, a Host can first determine if the "right" driver is available by examining the profiles. If "the" right driver isn't available, the Host can identify operable subsets when multiple profiles are reported. Finally, the Host can identify basic functions to use the device via the Feature reporting.

9.1.2 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 Logical Unit. 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 Host (according to the Logical Unit).

Features **do not** replace legacy behavior. Features, in most cases, define a subset of legacy behavior. Several Features, taken together, are generally equivalent to legacy devices of the same type. Error and status reporting in legacy Host environments is the same as legacy devices, without any special mode setting.

The Features described in this specification add something new: reporting. Legacy devices, while implementing the content of the Features, did not have any mechanism to report specifically the Logical Unit'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 (10) 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 (10) 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 functionless device when the medium is removed. Multi-function devices can change their behavior even more radically when they accept a variety of physical and logical formats.

Before Features, Hosts had to use a trial and error method for determining what would or would not function. Medium codes became outdated even before publication of the relevant standard, and still were not adequate to describe all media. The Profiles, also introduced in this specification, 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 (10), READ TOC/PMA/ATIP, 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.

9.1.3 Implementation of Features

There are only two requirements to fully implement Features. The first is the GET CONFIGURATION Command. This Command is a very basic reporting Command that reports some very static information; only a few Features have any dynamic fields; most Features have only one bit that changes. The Command is a form of Inquiry: a technique for the Host to identify the device on the bus. The GET CONFIGURATION Command simply provides more detail, and the information reported is expected to be dynamic.

Implementation of Feature reporting via the GET CONFIGURATION Command is simple: the image of the result data can be copied from device ROM to its buffer, a few fields set with information already known to the 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. As it is important for the Host to know what operations will function with the Logical Unit at any given moment, pre-emptive reporting of Feature changes greatly eases Host implementations by reducing the number of error conditions that must be handled. The GET EVENT/STATUS NOTIFICATION Command is used for status change reporting (an "Event.") In many drives, implementation simply requires recording an event whenever a UNIT ATTENTION is generated.

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 must interact well to provide seamless and solid support. Feature reporting provides a method for clean interaction.

9.1.4 Compatibility

Logical Units implementing Feature reporting are fully compatible with legacy systems.

The GET CONFIGURATION Command changes no behavior of the Logical Unit; it simply reports existing state information. Repeated GET CONFIGURATION Commands will report the same information (unless the user inserts or removes the medium, etc.). The GET CONFIGURATION Command never changes any state information in the Logical Unit, including UNIT ATTENTION conditions.

9.1.5 Summary

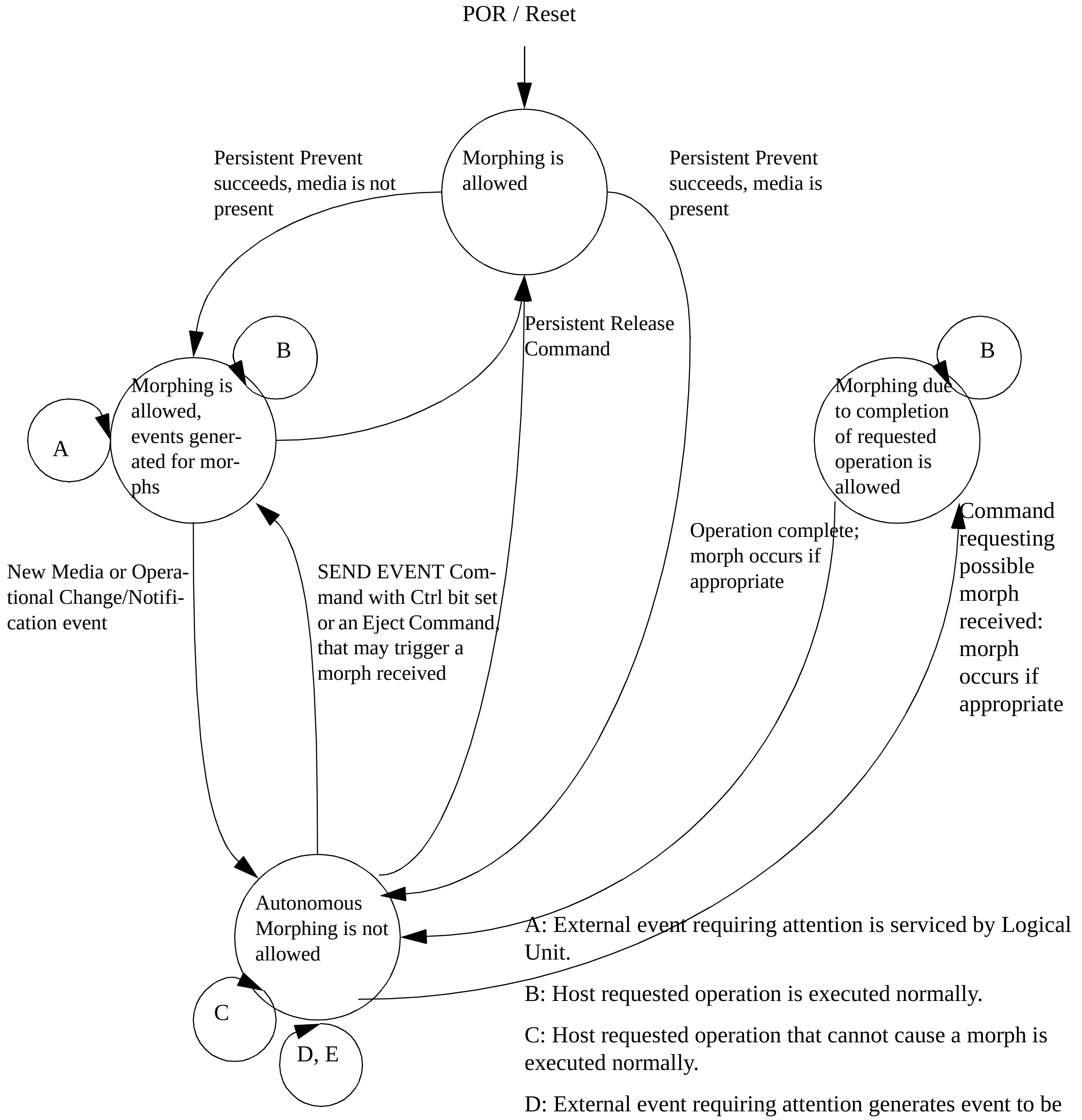
Features do not radically modify any legacy behavior or functionality. The only new parts involve reporting of behavior, and typically reflect state information already required of any firmware implementation, via two new Commands. One Command reports status, and the other notifies the Host that the status may have changed.

The benefits include easier coding of highly robust drivers, fewer error conditions, and forward and backward compatibility with operating system drivers.

9.2 Morphing Commands and functionality

The GET CONFIGURATION Command is used to discover a Logical Unit's behavior. The result data of the GET CONFIGURATION Command may be dynamic. A Morph occurs whenever the data that would be returned to a GET CONFIGURATION Command changes. Figure 65 shows a state diagram for Logical Units that lock the tray when the

New Media Event is generated. Figure 66 shows a state diagram for Logical Units that lock the tray when the New Media Event is reported.



A: External event requiring attention is serviced by Logical Unit.

B: Host requested operation is executed normally.

C: Host requested operation that cannot cause a morph is executed normally.

D: External event requiring attention generates event to be reported to the Host.

E: Non-preventable morph generates event to be reported to the Host.

Figure 65 - Morphing States - Event Generation

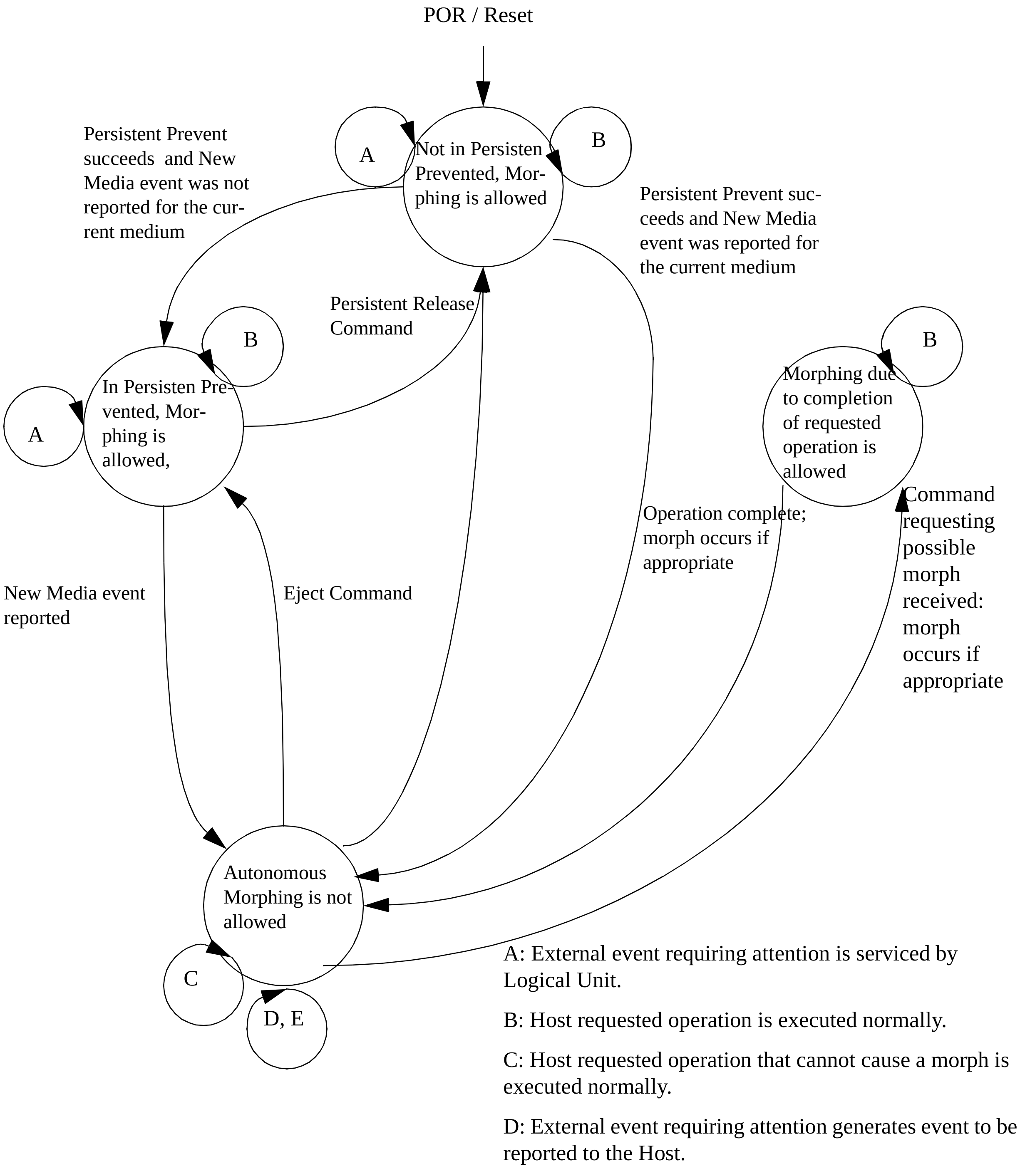


Figure 66 - Morphing States - Event Reporting

9.2.1 Morphing Operation

The Host may issue a PREVENT/ALLOW MEDIUM REMOVAL Command with the Persistent Prevent bit set to indicate to the Logical Unit that it ***shall not*** change its behavior without Host notification for any preventable action. This will, for example, prevent any front panel buttons from causing an eject, play, or other operation that affects device operation.

When the Persistent Prevent state is entered, the media ***shall*** remain locked in the Logical Unit and the Logical Unit ***shall not*** change its behavior, until the Host issues an eject request, or a power on or hard reset condition occurs. The Persistent Prevent state ***shall*** be maintained after the eject request. New media that is inserted into the Logical Unit ***shall*** be locked in the Logical Unit after the Logical Unit generates or reports the New Media event. Prior to generating or reporting the New Media event, the Logical Unit may eject media without an explicit eject Command from the Host. This allows the user to remove incorrectly inserted media without having to wait for Host intervention. In this condition neither the new media event nor the eject event should be reported by the Logical Unit. Locking the tray after generating the event allows for a simpler implementation; locking the tray after reporting the event allows a longer window of direct user 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 Host receives the Eject Request, and determines that it is safe to eject the medium, a START/STOP UNIT Command with the LoEj bit set will be issued, at which time the Logical Unit ***shall*** eject the medium. The Persistent Prevent state ***shall*** be retained.

In the Polling Mode of Event Notification, the Host ***shall*** repeatedly issue GET EVENT/STATUS NOTIFICATION Commands with an Immediate bit of 1. The interval should be sufficiently short to provide quick user feedback but long enough to avoid performance impacts within the system. The Logical Unit ***shall*** complete these Commands upon receipt, supplying the Host with information on the most recent event occurrences, as described in the GET EVENT/STATUS NOTIFICATION Command.

If Command queuing is supported, the Host may issue a GET EVENT/STATUS NOTIFICATION Command with an immediate bit of 0. This is the Asynchronous mode of operation. The Command ***shall not*** complete until an event occurrence of the class(es) requested is either in the event queue or occurs.

The Logical Unit ***shall*** maintain a separate queue for each class of Event Notification(s) supported. There ***shall*** be one set of queues per Host. Events that are generated ***shall*** be placed at the tail of the event queue(s). The depth of the queue(s) is vendor specific, although it ***shall*** be at least one. If an overflow occurs, the Logical Unit ***shall*** maintain the most recent Events in the queue. All event classes other than Class 3 were designed such that a queue depth of 1 is sufficient.

Each GET EVENT/STATUS NOTIFICATION Command ***shall*** report only one event. If multiple Event Classes are requested and multiple events are available, the Logical Unit ***shall*** report the Event in the Event Class with the lowest Notification Class ordinal.

9.2.2 Morphing Compatibility Considerations

To maintain compatibility with existing BIOS implementations and operating systems, the Logical Unit ***shall*** default to Persistent Prevent disabled. When the Host enables the support using the PREVENT/ALLOW MEDIUM REMOVAL Command, the Logical Unit ***shall*** respond as described in this specification. When the Host disables this Feature, the Logical Unit must default to normal operating modes. A power on or hard reset ***shall*** cause the Logical Unit to clear the Persistent Prevent state.

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

Commands must be processed exactly the same as they would be if Persistent Prevent was not enabled. For compatibility reasons, UNIT ATTENTION status conditions must still be returned. However, the Logical Unit ***shall not*** return the UNIT ATTENTION status on a GET EVENT/STATUS NOTIFICATION Command. For example, if the user inserts a new medium and the Logical Unit is accessed with a Command, the CHECK CONDITION with UNIT ATTENTION ***shall*** be reported, but the Logical Unit ***shall*** also report the New Media Event with the next available GET EVENT/STATUS NOTIFICATION (Media Status) Command. If the GET EVENT/STATUS NOTIFICATION Command is received after a UNIT ATTENTION Condition is generated, and before it is reported to the Host, the GET EVENT/STATUS NOTIFICATION Command ***shall*** report the Event.

9.3 Vendor Unique

All Vendor Unique Features ***shall*** be a multiple of 4 bytes in length. Use of Reserved fields in the Feature Descriptor Header is prohibited. Vendors are encouraged to take steps to choose a Feature number unique among all products.

The Logical Unit's Vendor ID and Product ID ***shall*** be used to qualify which set of Vendor Unique Features may be available.

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10.0 Profiles

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 should 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 drive with unformatted media loaded may claim compliance to the DVD-RAM Profile; A DVD-RAM drive with no media loaded ***shall*** claim no Profile as current.

10.1 Profile 0001h: Non-removable disk

Logical Units identifying Profile 1 as current ***shall*** support the Features listed in Table 55:

Table 55 - 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	Mandatory behavior for all devices
0010h	Random Readable	Read ability for storage devices with random addressing
0020h	Random Writable	Write support for randomly addressed writes
0024h	Defect Management	Ability of the drive/media system to provide an apparently defect-free space
0100h	Power Management	Host and device directed power management
0101h	S.M.A.R.T.	Self Monitoring Analysis and Reporting Technology (Failure prediction)

10.2 Profile 0002h: Removable disk

Logical Units identifying Profile 2 as current ***shall*** support the Features listed in Table 56:

Table 56 - Mandatory Features for Removable Disks

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	Ability to notify host about operational changes and accept host 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 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 drive/media system to provide an apparently defect-free space
0100h	Power Management	Host and device directed power management
0105h	Time-out	Ability to respond to all commands within a specific time

10.3 Profile 0003h: MO Erasable

Logical Units identifying Profile 3 as current ***shall*** support the Features listed in Table 57:

Table 57 - 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	Mandatory behavior for all devices
0002h	Morphing	Ability to notify host about operational changes and accept host 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 devices with random addressing.
0020h	Random Writable	Write support for randomly addressed writes
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 drive/media system to provide an apparently defect-free space
0100h	Power Management	Host and device directed power management
0105h	Time-out	Ability to respond to all commands within a specific time

10.4 Profile 0004h: MO Write Once

Logical Units identifying Profile 4 as current ***shall*** support the Features listed in Table 58:

Table 58 - Mandatory Features for Magneto-Optical Write Once

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	Ability to notify host about operational changes and accept host 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 devices with random addressing.
0024h	Defect Management	Ability of the drive/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	Host and device directed power management
0105h	Time-out	Ability to respond to all commands within a specific time

10.5 Profile 0005h: AS-MO

Logical Units identifying Profile 5 as current ***shall*** support the Features listed in Table 59:

Table 59 - Mandatory Features for AS-MO

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	Ability to notify host about operational changes and accept host 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 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 drive/media system to provide an apparently defect-free space
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

10.6 Profile 0008h: CD-ROM

Logical Units identifying Profile 8 as current ***shall*** support the Features listed in Table 60:

Table 60 - Mandatory features for CD-ROM

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	Ability to notify host about operational changes and accept host 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 devices with random addressing.
001Eh	CD Read	The ability to read CD-specific structures
0100h	Power Management	Host and device directed power management
0105h	Time-out	Ability to respond to all commands within a specific time

10.7 Profile 0009h: CD-R

Logical Units identifying Profile 9 as current ***shall*** support the Features listed in Table 61:

Table 61 - Mandatory features for CD-R

Feature Number	Feature Name	Description
0000h	Profile List	A list of all Profiles supported by the device
0001h	Core	Mandatory behavior for all devices
0002h	Morphing	Ability to notify host about operational changes and accept host 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 devices with random addressing
001Eh	CD Read	The ability to read CD-specific structures
0021h	Incremental Streaming Writable	Write support for sequential recording
002Dh	CD Track at Once	Ability to write CD with Track at Once recording
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

Note: The Logical Unit Serial Number is intended to aid host based OPC management.

10.8 Profile 000Ah: CD-RW

Logical Units identifying Profile Ah as current ***shall*** support the Features listed in Table 62:

Table 62 - Mandatory features for CD-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 events external to the host
0003h	Removable Medium	The medium may be removed from the device
0010h	Random Readable, PP = 1	Read ability for storage devices with random addressing
001Dh	MultiRead	The Logical Unit complies with OSTA MultiRead
001Eh	CD Read	The ability to read CD-specific structures
0021h	Incremental Streaming Writable	Write support for sequential recording
0023h	Formattable	Support for formatting of media
0026h	Restricted Overwrite	Write support for media that must be written in multiples of logical blocks
002Dh	CD Track at Once	Ability to write CD with Track at Once recording
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

Note: The Logical Unit Serial Number is intended to aid host based OPC management.

10.9 Profile 0010h: DVD-ROM

Logical Units identifying Profile 10h as current ***shall*** support the Features listed in Table 63.

Table 63 - Mandatory Features for DVD-ROM

Feature Number	Feature Name	Description
0000h	Profile List	A list of all Profiles supported by the device
0001h	Core	Mandatory behavior for all devices
0002h	Morphing	The device changes its operational behavior due to events external to the host
0003h	Removable Medium	The medium may be removed from the device
0010h	Random Readable, PP = 1	Read ability for storage devices with random addressing
001Fh	DVD Read	The ability to read DVD specific structures
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 using host requested performance parameters

10.10 Profile 0011h: DVD-R

Logical Units identifying Profile 11h as current ***shall*** support the Features listed in Table 64:

Table 64 - Mandatory Features for DVD-R

Feature Number	Feature Name	Description
0000h	Profile List	A list of all Profiles supported by the device
0001h	Core	Mandatory behavior for all devices
0002h	Morphing	The device changes its operational behavior due to events external to the host
0003h	Removable Medium	The medium may be removed from the device
0010h	Random Readable, PP = 1	Read ability for storage devices with random addressing
001Fh	DVD Read	The ability to read DVD specific structures
0021h	Incremental Streaming Writable	Write support for sequential recording
002Fh	DVD-R Write	The ability to write DVD specific structures
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
0108h	Logical Unit serial number	The Logical Unit has a unique identifier

10.11 Profile 0012h: DVD-RAM or DVD+RW

Logical Units identifying Profile 12h as current ***shall*** support the Features listed in Table 65:

Table 65 - Mandatory Features for DVD-RAM and 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 events external to the host
0003h	Removable Medium	The medium may be removed from the device
0010h	Random Readable, PP = 1	Read ability for storage devices with random addressing
001Fh	DVD Read	The ability to read DVD specific structures
0020h	Random Writable	Write support for randomly addressed writes
0023h	Formattable	Support for formatting of media
0024h	Defect Management	Ability of the drive/media system to provide an apparently defect-free space
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

10.12 Profile FFFFh: Logical Units Not Conforming to a Standard Profile

Logical Units identifying Profile FFFFh as current ***shall*** support the Features listed in Table 66:

Table 66 - 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	Mandatory behavior for all devices

11.0 Packet Commands

The first byte of all Command Packets ***shall*** contain an operation code as defined in this Specification. This specification is broken down into separate sections. This section describes all commands that are specified in this document.

Table 67 - Packet Commands for C/DVD Logical Units

Opcode	Feature	Command Description	Reference
A1h	Incremental Streaming Writable, CD Track at Once	BLANK	section 11.1 on page 169
5Bh	Incremental Streaming Writable	CLOSE TRACK/RZONE/SESSION/BOR-DER	section 11.2 on page 173
39h		COMPARE	SPC
2Ch	Sector erasable	ERASE (10)	SBC
35h	Random Writable, Incremental Streaming Writable, Write Once, Restricted Overwrite, CD Track at Once, CD Mastering	FLUSH CACHE	section 11.3 on page 177
04h	Formattable	FORMAT UNIT	section 11.4 on page 179
46h	Core, Morphing	GET CONFIGURATION	section 11.5 on page 185
4Ah	Core, Morphing, Power Management	GET EVENT/STATUS NOTIFICATION	section 11.6 on page 219
ACh	Real-Time Streaming	GET PERFORMANCE	section 11.7 on page 231
12h	Core	INQUIRY	section 11.8 on page 235
A6h	Embedded Changer	LOAD/UNLOAD MEDIUM	section 11.9 on page 241
36h		LOCK/UNLOCK CACHE	SBC
4Ch		LOG SELECT	SPC
4Dh		LOG SENSE	SPC
BDh	Removable Medium, Embedded Changer	MECHANISM STATUS	section 11.10 on page 243
55h	Core	MODE SELECT (10)	section 11.11 on page 247
5Ah	Core	MODE SENSE (10)	section 11.12 on page 249
4Bh	CD Audio analog play	PAUSE/RESUME	section 11.13 on page 273
45h	CD Audio analog play	PLAY AUDIO (10)	section 11.14 on page 275
47h	CD Audio analog play	PLAY AUDIO MSF	section 11.15 on page 279
BCh		PLAY CD	section 11.16 on page 281
34h		PRE-FETCH	SBC
1Eh	Morphing, Removable Medium	PREVENT/ALLOW MEDIUM REMOVAL	section 11.17 on page 285
28h	Random Readable, MultiRead, DVD Read	READ (10)	section 11.18 on page 287
A8h	DVD Read	READ (12)	section 11.19 on page 289
3Ch	Microcode Upgrade	READ BUFFER	SPC
25h	Random Readable, Random Writ-able, Write Once, Restricted Over-write	READ CAPACITY	section 11.21 on page 295
BEh	CD Read	READ CD	section 11.22 on page 297
B9h	CD Read	READ CD MSF	section 11.23 on page 307
51h	MultiRead, Incremental Streaming Writable, Restricted Overwrite, CD Track at Once, CD Mastering, DVD-R Write	READ DISC INFORMATION	section 11.24 on page 309

Table 67 - Packet Commands for C/DVD Logical Units (Continued)

Opcode	Feature	Command Description	Reference
ADh	DVD Read, DVD CSS, Disc Control Blocks	READ DVD STRUCTURE	section 11.25 on page 315
23h	Formattable	READ FORMAT CAPACITIES	section 11.26 on page 331
44h		READ HEADER	section 11.27 on page 337
42h	CD Audio analog play	READ SUBCHANNEL	section 11.28 on page 339
43h	CD Read, DVD Read	READ TOC/PMA/ATIP	section 11.29 on page 347
52h	MultiRead, Incremental Streaming Writable, Restricted Overwrite, CD Track at Once, CD Mastering, DVD-R Write	READ TRACK/RZONE INFORMATION	section 11.30 on page 361
1C		RECEIVE DIAGNOSTIC RESULTS	SPC
17h		RELEASE (6)	SPC
57h		RELEASE (10)	SPC
58h		REPAIR RZONE	section 11.31 on page 369
A4h	DVD CSS	REPORT KEY	section 11.32 on page 371
03h	Core, Formattable	REQUEST SENSE	section 11.33 on page 377
16h		RESERVE (6)	SPC
56h		RESERVE (10)	SPC
53h	Incremental Streaming Writable, DVD-R Write	RESERVE TRACK/RZONE	section 11.34 on page 383
BAh	CD Audio analog play	SCAN	section 11.35 on page 385
2Bh	CD Audio analog play	SEEK	section 11.36 on page 389
5Dh	CD Mastering	SEND CUE SHEET	section 11.37 on page 391
1Dh		SEND DIAGNOSTIC	SPC
BFh	DVD-R Write, Disc Control Blocks	SEND DVD STRUCTURE	section 11.38 on page 399
A2h	Morphing	SEND EVENT	section 11.39 on page 403
A3h	DVD CSS	SEND KEY	section 11.40 on page 405
54h	Incremental Streaming Writable, CD Track at Once	SEND OPC INFORMATION	section 11.41 on page 409
A7h	Real-Time Streaming	SET READ AHEAD	section 11.42 on page 411
B6h	Real-Time Streaming	SET STREAMING	section 11.43 on page 413
1Bh	Removable Medium, Power Management	START/STOP UNIT	section 11.44 on page 417
4Eh	CD Audio analog play	STOP PLAY/SCAN	section 11.45 on page 421
00h	Core	TEST UNIT READY	section 11.46 on page 423
2Fh	Sector erasable, Formattable	VERIFY (10)	section 11.47 on page 425
2Ah	Random Writable, Incremental Streaming Writable, Sector erasable, Write Once, Restricted Overwrite, CD Track at Once, CD Mastering, DVD-R Write	WRITE (10)	section 11.48 on page 427
2Eh	Random Writable, Write Once	WRITE and VERIFY (10)	section 11.49 on page 431
3Bh	Microcode Upgrade	WRITE BUFFER	SPC

11.1 BLANK Command

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

The SET STREAMING Command may affect the speed at which the blanking operation is performed.

Table 68 - BLANK Command

<table>
<tr><th>Bit
Byte</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>0</td><td colspan="8">Operation Code (A1h)</td></tr>
<tr><td>1</td><td colspan="3">LUN (Obsolete)</td><td>Immed</td><td>Reserved</td><td colspan="3">Blanking Type</td></tr>
<tr><td>2</td><td colspan="8" rowspan="4">(MSB)
Start Address / Track Number
(LSB)</td></tr>
<tr><td>3</td></tr>
<tr><td>4</td></tr>
<tr><td>5</td></tr>
<tr><td>6</td><td colspan="8">Reserved</td></tr>
<tr><td>7</td><td colspan="8">Reserved</td></tr>
<tr><td>8</td><td colspan="8">Reserved</td></tr>
<tr><td>9</td><td colspan="8">Reserved</td></tr>
<tr><td>10</td><td colspan="8">Reserved</td></tr>
<tr><td>11</td><td colspan="2">Vendor-Specific</td><td colspan="3">Reserved</td><td>NACA</td><td>Flag</td><td>Link</td></tr>
</table>

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

The **Immed** bit, when set to zero, shall indicate that the command shall complete after the blank operation has been performed. When set to one, shall indicate that the command shall complete after validating the CDB.

Note: ATAPI devices may require that the **Immed** *bit be set to one.*

Blanking Type identifies the method and coverage of blanking. The codes for Blanking Type are defined in Table 69.

Table 69 - Blanking Types for CD-RW

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

Start Address/Track Number is the address at which erasure shall begin:

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

Morphing may occur when the BLANK operation is requested (to indicate changing to the NOT READY condition) and when the BLANK operation completes (to indicate the Restricted Overwrite Feature and others becoming Current).

During the blank operation, the Logical Unit ***shall*** respond to commands as follows:

1. In response to all commands that can return NOT READY status, the Logical Unit ***shall*** return CHECK CONDITION Status, 2/04/07 LOGICAL UNIT NOT READY, OPERATION IN PROGRESS. INQUIRY, GET CONFIGURATION, GET EVENT/STATUS NOTIFICATION, and REQUEST SENSE are among the commands that ***shall not*** return a NOT READY error (Sense Key 2).
2. In response to the INQUIRY, GET CONFIGURATION, and GET EVENT/STATUS NOTIFICATION Commands, the Logical Unit ***shall*** respond as commanded.
3. In response to the REQUEST SENSE Command, unless an error within the Command itself has occurred, the Logical Unit ***shall*** return GOOD Status, 2/04/07 LOGICAL UNIT NOT READY, OPERATION IN PROGRESS

indicated in the result data and the sense key specific bytes set for progress indication. Refer to the description of deferred error handling that may occur during the format operation.

4. In response to an ATA SRST, the Logical Unit ***shall*** provide the diagnostic results and the ATAPI signature. The blank operation ***shall not*** be affected.

Table 70 describes errors that may occur during the operation of the Command or which may cause a CHECK CONDITION status to be reported.

Table 70 - BLANK Command Errors

Error Description
A-1.1, "Deferred Error Reporting" on page 437
Table 421 - *Basic Error Codes* on page 445
Table 422 - *Media Access Error Codes* on page 449
Table 423 - *Write Error Codes* on page 452

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11.2 CLOSE TRACK/RZONE/SESSION/BORDER Command

The CLOSE TRACK/RZONE/SESSION/BORDER Command allows closure of a CD track, a DVD RZone, a CD Session or a DVD Border.

Table 71 - CLOSE TRACK/RZONE/SESSION/BORDER Command

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation code (5Bh)							
1	Reserved							Immed
2	Reserved						Session/ Border	Track/ RZone
3	Reserved							
4	(MSB) Track/RZone Number							
5								(LSB)
6	Reserved							
7	Reserved							
8	Reserved							
9	Vendor-Specific		Reserved			NACA	Flag	Link
10	PAD							
11								

The **Immed** bit allows execution of the CLOSE TRACK/RZONE/SESSION/BORDER function as an immediate operation. If **Immed** is set to 0, then the requested Close 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.

For DVD, DVD-R Logical Units may write cached RMD into the RMA immediately upon receipt of a CLOSE TRACK/RZONE/SESSION/BORDER Command. DVD-R Logical Units may delay the Close operation and writing of cached RMD into RMA to allow multiple CLOSE TRACK/RZONE/SESSION/BORDER Commands to be issued quickly. In this case, it is recommended that the Logical Unit not write RMD into the RMA until the last CLOSE TRACK/RZONE/SESSION/BORDER Command in a sequence has been received.

During the close operation, the Logical Unit ***shall*** respond to commands as follows:

1. While a CLOSE TRACK/RZONE/SESSION/BORDER operation is in process, the Logical Unit may respond to Commands that can return NOT READY status with CHECK CONDITION Status, 2/04/07 LOGICAL UNIT NOT READY, OPERATION IN PROGRESS. See *4.6*, on page 68, *3.4*, on page 46, and Table 53 - *Not Ready Error & Time-out Unit Attention Reporting (by Command)* on page 150.
2. In response to the INQUIRY, GET CONFIGURATION, and GET EVENT/STATUS NOTIFICATION Commands, the Logical Unit ***shall*** respond as commanded.
3. In response to the REQUEST SENSE Command, unless an error within the Command itself has occurred, the Logical Unit ***shall*** return GOOD Status, 2/04/07 LOGICAL UNIT NOT READY, OPERATION IN PROGRESS or 2/04/08 LOGICAL UNIT NOT READY, LONG WRITE IN PROGRESS indicated in the result data and the sense key specific bytes set for progress indication. Refer to the description of deferred error handling that may occur during the close operation.
4. In response to an ATA SRST, the Logical Unit ***shall*** provide the diagnostic results and the ATAPI signature. The close operation ***shall not*** be affected.

Note: Determining the end of a sequence of CLOSE TRACK/RZONE/SESSION/BORDER Commands is vendor specific.

The **Session/Border** and **Track/RZone** bits are defined in Table 72.

Table 72 - Session/Border and Track/RZone Bits Definitions

Session/ Border	Track/ RZone	Close Actions
0	0	This condition is reserved and not valid. The Logical Unit ***shall*** report CHECK CONDITION Status, 5/24/00 INVALID FIELD IN CDB.
0	1	Close the Track/RZone associated with the Track/RZone 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 is to be done. In the case of an empty reserved track, the Logical Unit ***shall*** write the track according to the *Write Parameters* Mode Page (05h). If the *Write Parameters* Mode Page (05h) is inconsistent with the PMA or TDB, the Logical Unit ***shall*** return CHECK CONDITION Status, 5/64/00 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, if this is the Partially Recorded Reserved RZone or the Empty Reserved RZone, the Logical Unit ***shall*** pad the RZone with 00h bytes. If the RZone status is Invisible, no close operation is to be done. In the case of an Incomplete RZone, no padding is to be done and cached RMD ***shall*** be written into the RMA.
1	0	Close Session/Border. If all Tracks/RZones in the last Session/Border are not complete, generate CHECK CONDITION Status, 5/72/03 SESSION FIXATION ERROR - INCOMPLETE TRACK IN SESSION or if empty or partially recorded reserved Tracks/RZones exist in the incomplete Session/Border, generate CHECK CONDITION Status, 5/72/04 EMPTY OR PARTIALLY WRITTEN RESERVED TRACK. Behavior of the closing operation is dependent on the MultiSession/Border field in the *Write Parameters* Mode Page (05h). Closing an empty Session/Border ***shall*** produce no error and ***shall not*** write to the medium.
1	1	This condition is reserved and not valid. The Logical Unit ***shall*** report CHECK CONDITION Status, 5/24/00 INVALID FIELD IN CDB.

If a Session/Border or Track/RZone is to be closed that is already closed, no error ***shall*** be reported. Closing a Session when the last Session/Border is empty ***shall not*** be considered an error. In both cases, no action is taken and no error ***shall*** be returned.

If the Session/Border bit is set to zero and Track/RZone bit is set to one, the **Track/RZone number** field indicates the number of the Track/RZone to close. Bytes 4 through 5 of the CDB ***shall*** be ignored if the Session/Border bit is set to 1.

For CD, in order 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 bounds of the track are determined and a PMA entry is written for track N+1.

Closing a Track or RZone ***shall*** cause cached information for the specified Track or RZone 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.

For DVD, closing a Border ***shall*** cause the Lead-in or Border-in and Border-out to be written for the incomplete Border. If the Multi-Session/Border field in the *Write Parameters* Mode 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 ***shall not*** be appended to the medium.

Closing a Session/Border when the last Session/Border is empty ***shall not*** be considered an error. If partially recorded or empty Tracks/RZones exist in the incomplete Session/Border, the Logical Unit ***shall*** report CHECK CONDITION Status, 5/72/04 EMPTY OR PARTIALLY WRITTEN RESERVED TRACK. If an Incomplete Track/RZone exists, the Logical Unit ***shall*** report CHECK CONDITION Status, 5/72/03 SESSION FIXATION ERROR - INCOMPLETE TRACK IN SESSION. If the **MultiSession/Border** field in the *Write Parameters* Mode Page (05h) is set to 11b and there is not sufficient space for the next Session/Border, the Session/Border to be closed ***shall*** be closed and next Session/Border

shall not be allowed. For CD, the Session is closed without the B0 pointer. For DVD, the Border is closed with Lead-out and the **Start PSN of the next Border-in** field of Lead-in/Border-in set to 0.

Note: 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 Host should change the MultiSession/Border field in the Write Parameters Mode Page (05h) *and retry the Command.*

Closing a Track, RZone, Session, or Border ***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 unwritable. Other Class 1 Events may occur due to closing a Track, RZone, Session, or Border.

Table 73 describes errors that may occur during the operation of the Command or which may cause a CHECK CONDITION status to be reported.

Table 73 - CLOSE TRACK/RZONE/SESSION/BORDER Command Errors

Error Description
A-1.1, "Deferred Error Reporting" on page 437
Table 421 - *Basic Error Codes* on page 445
Table 422 - *Media Access Error Codes* on page 449
Table 423 - *Write Error Codes* on page 452
Table 424 - *Session/Border Error Codes* on page 453

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11.3 FLUSH CACHE Command

The FLUSH CACHE Command ensures that logical blocks in the cache memory have their most recent data value recorded on the physical medium. If a more recent data value for a logical block exists in the cache memory than on the physical medium, then the logical blocks from the cache memory shall be written to the physical medium. Logical blocks are not necessarily removed from the cache memory as a result of the cache flush operation. Table 74 describes the Command Packet.

Note: This command does not make use of the range allowed in the SCSI version of this command. This definition replaces the definition in the SCSI Standard.

Table 74 - FLUSH CACHE Command

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation code (35h)							
1	LUN (Obsolete)			Reserved			Immediate	Reladr (0)
2	(MSB) Logical Block Address							
3								
4								
5								(LSB)
6	Reserved							
7	Block Count							
8								
9	Vendor-Specific		Reserved			NACA	Flag	Link
10	PAD							
11								

The **Immediate** bit, when set to zero, indicates that the FLUSH CACHE operation shall complete before completing the command. When set to one, shall indicate that the command shall return after the command parameters have been verified.

The **Logical Block Address** and the **Block Count** fields may be ignored by the Logical Unit.

Table 75 describes errors that may occur during the operation of the Command or which may cause a CHECK CONDITION status to be reported.

Table 75 - FLUSH CACHE Command Errors

Error Description
A-1.1, "Deferred Error Reporting" on page 437
Table 421 - *Basic Error Codes* on page 445
Table 422 - *Media Access Error Codes* on page 449
Table 423 - *Write Error Codes* on page 452
Table 424 - *Session/Border Error Codes* on page 453

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11.4 FORMAT UNIT Command

The FORMAT UNIT Command formats the medium into Host addressable logical blocks per the Host defined options.

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

The SET STREAMING Command may affect the speed used to Format the medium.

Table 76 - FORMAT UNIT Command

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code (04h)							
1	LUN (Obsolete)			FmtData(1)	CmpList	Format Code (001b)		
2	Reserved							
3	(MSB) Interleave Value (0)							
4								(LSB)
5	Vendor-Specific		Reserved			NACA	Flag	Link
6	PAD							
7								
8								
9								
10								
11								

A Format Data (**FmtData**) bit ***shall*** be set to one indicating that a parameter list ***shall*** be transferred from the host.

A **CmpList** bit is used in conjunction with the DCRT bit to determine usage of existing defect lists (e.g. the existing G_1-list, G_2-list and SDL to construct new G_1-list and G_2-list on DVD-RAM media). See Table 77.

Table 77 - DVD-RAM Defect List Handling

CmpList	DCRT	Certification	PDL			SDL	Remarks
			P-list	G_1-list	G_2-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)	Preserved	Old plus New from Certification	Disposed	Disposed	Create new defect list by disposing all except P-list and G_1-list
1	1	No	Preserved	preserved	Disposed	Disposed	Return to original slipping at the latest certification, quickly

The **Format Code** ***shall*** be set to 001b.

The **Interleave Value** field specifies the interleave that is used when performing the format operation. This field ***shall*** be set to zero.

During the format operation, the Logical Unit ***shall*** respond to commands as follows:

1. In response to all commands that can return NOT READY status, the Logical Unit ***shall*** return CHECK CONDITION Status, 2/04/04 LOGICAL UNIT NOT READY, FORMAT IN PROGRESS. INQUIRY, GET CONFIGURATION, GET EVENT/STATUS NOTIFICATION, and REQUEST SENSE are among the commands that ***shall not*** return a NOT READY error (Sense Key 2).
2. In response to the INQUIRY, GET CONFIGURATION, and GET EVENT/STATUS NOTIFICATION Commands, the Logical Unit ***shall*** respond as commanded.
3. In response to the REQUEST SENSE Command, unless an error within the Command itself has occurred, the Logical Unit ***shall*** return GOOD Status, 2/04/04 LOGICAL UNIT NOT READY, FORMAT IN PROGRESS indicated in the result data and the sense key specific bytes set for progress indication. Refer to the description of deferred error handling that may occur during the format operation.
4. In response to an ATA SRST, the Logical Unit ***shall*** provide the diagnostic results and the ATAPI signature. The format operation ***shall not*** be affected.

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 Host.

A format data (**FmtData**) bit of one indicates that the FORMAT UNIT parameter list (see Table 78) ***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 (which may have zero length), followed by one Format descriptor. The Format descriptor ***shall*** be one of the Formattable Capacity Descriptors returned by the READ FORMAT CAPACITIES Command.

Table 78 - Format Unit Parameter List

Bit / Byte	7	6	5	4	3	2	1	0
0	Format List Header							
-	Initialization Pattern Descriptor (Not Present)							
	Format Descriptor (only 1 is allowed)							
4 – 11	Format Descriptor 0							

The Format list header provides several format control bits. Logical Units that implement these bits give the Host additional control over the formatting operation. If the Host attempts to select any function not implemented by the Logical Unit, the Logical Unit ***shall*** terminate the command with CHECK CONDITION Status, 5/26/00 INVALID FIELD IN PARAMETER LIST.

The Initialization Pattern Descriptor ***shall not*** be included in the Format Unit Parameter data sent to the Logical Unit.

Table 79 - Format List Header

Bit / Byte	7	6	5	4	3	2	1	0
0	Reserved							
1	FOV	DPRY (0)	DCRT	STPF (0)	IP (0)	Try-out	Immed	VS
2 – 3	(MSB) Format Descriptor Length (0008h) (LSB)							

A format options valid (**FOV**) bit of zero indicates that the Logical Unit ***shall*** use its default settings for the **DCRT**, **STPF**, **Try-out** and **Immed** bits (see below). 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, 5/26/00 INVALID FIELD IN PARAMETER LIST.

A **FOV** bit of one indicates that the Logical Unit ***shall*** examine the setting of the **DCRT**, **STPF**, **Try-out** and **Immed** bits. When the **FOV** bit is one, the **DCRT**, **STPF**, **Try-out** and **Immed** bits are defined as follows.

A disable primary (**DPRY**) bit set to zero ***shall*** indicate that the Logical Unit ***shall*** retain the manufacturer's certification list (PList). When set to one, ***shall*** indicate that the manufacturer's certification list be retained but not used for defect management. **DPRY** ***shall*** be set to zero for DVD-RAM media.

A disable certification (**DCRT**) bit of zero indicates that the Logical Unit ***shall*** perform a vendor-specific medium certification operation to generate a G_1-list (C-list). A **DCRT** bit of one indicates that the Logical Unit ***shall not*** perform any vendor-specific medium certification process or format verification operation while executing the FORMAT UNIT Command.

The **STPF** bit ***shall*** be set to zero.

The **IP** bit ***shall*** be set to zero.

A **Try-out** bit of one indicates that the Logical Unit ***shall not*** change media but ***shall*** examine whether the specified FORMAT UNIT Command can be performed without error, based on available informations before starting the formatting.

An immediate (**Immed**) bit of zero indicates that status ***shall*** be returned after the format operation has completed. An **Immed** bit 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 was set to one or the FORMAT UNIT Command was queued, then in response to the REQUEST SENSE Command during the formatting operation, unless an error in the Command has occurred, the Logical Unit ***shall*** return no CHECK CONDITION Status, 2/04/04 LOGICAL UNIT NOT READY, FORMAT IN PROGRESS in the result data and the Sense Key Specific bytes set to the percentage of the operation that has completed. Please see Table 351 - *Progress Indication* on page 380 for details.

The Logical Unit may morph when the Format operation begins and again when it ends. For example, the medium may become inaccessible during the Format operation, and the Random Writable Feature may become current after Formatting.

The **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*** return CHECK CONDITION Status, 5/26/00 INVALID FIELD IN PARAMETER LIST.

Table 80 - Format Descriptor - From READ FORMAT CAPACITIES

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. The Format Type values are defined in Table 285 - *Format Types* on page 333.

11.4.1 Formatting on Format Type = 00h (Full Format)

Formatting for the whole media is specified.

On DVD-RAM media, the defect list handling is specified by the combination of the CmpList bit and the DCRT bit as shown in Table 77 - *DVD-RAM Defect List Handling* on page 179. 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 *11.26, "READ FORMAT CAPACITIES Command"* on page 331.

On DVD+RW media, the Logical Unit ***shall*** use its default parameters for SI and SL and format the whole medium.

On CD-RW media, the whole media ***shall*** be formatted using the *Write Parameters* Mode Page (05h).

11.4.2 Formatting on 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 in Table 77 - *DVD-RAM Defect List Handling* on page 179. 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 CHECK CONDITION Status, 3/31/02 ZONED FORMATTING FAILED DUE TO SPARE LINKING, with the sense key specific bytes set to zone number of the first zone which has a spare linking into the designated zone.

The discarding of G_1-list, G_2-list, and SDL is only applicable to defects within the zone being reformatted.

11.4.3 Formatting on 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 labelled 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 *11.26, "READ FORMAT CAPACITIES Command"* on page 331, inclusive.

11.4.4 Formatting on Format Type = 10h (CD-RW Full Format)

Formatting to create a Session on CD-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. 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 packet size. The Packet Size field may not be adjusted. If a different Fixed Packet Size is desired, the Write Parameters Page must be modified by the Host.

11.4.5 Formatting on Format Type = 11h (CD-RW Grow Session)

Formatting to expand the last session of a CD-RW medium 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 may not be adjusted.

11.4.6 Formatting on Format Type = 12h (CD-RW Add Session)

Formatting to add a new session to a CD-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. 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 packet size. The Packet Size field may not be adjusted. If a different Fixed Packet Size is desired, the Write Parameters Page must be modified by the Host.

11.4.7 Formatting on Format Type = 20h (Full Format with sparing parameters)

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 drive ***shall*** verify that SL and SI are usable values (will not cause overflow of the SDL).

Table 81 describes errors that may occur during the operation of the Command or which may cause a CHECK CONDITION status to be reported.

Table 81 - FORMAT UNIT Command Errors

Error Description
A-1.1, "Deferred Error Reporting" on page 437
Table 421 - *Basic Error Codes* on page 445
Table 422 - *Media Access Error Codes* on page 449
Table 423 - *Write Error Codes* on page 452

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11.5 GET CONFIGURATION Command

This Command is intended to provide information to the Host about the overall capabilities of the Logical Unit and the current capabilities of the Logical Unit. Configurations reported by Logical Units, for example, are used by the Host for Driver Identification/loading and other user presentation processes.

The GET CONFIGURATION Command requests that the Logical Unit respond with the configuration of the Logical Unit and medium. The configuration of the Logical Unit is described by Features (see *Section 9.0, "Features"* on page 153). The maximum number of Features is 65,536; the maximum number of bytes that a Logical Unit may return to describe its Features in one Command is 65,534. Feature lists longer than 65,534 bytes require multiple Commands.

Persistent Prevent may be used to control when morphing occurs. If a Persistent Prevent is enabled, the configuration should not change except under Host control. Please see *9.2, "Morphing Commands and functionality"* on page 155 for more information on the interoperation of these Commands.

Table 82 - GET CONFIGURATION Command

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation code (46h)							
1	LUN (Obsolete)			Reserved			RT	
2	(MSB) Starting Feature Number							
3								(LSB)
4	Reserved							
5	Reserved							
6	Reserved							
7	(MSB) Allocation Length							
8								(LSB)
9	Vendor-Specific		Reserved			NACA	Flag	Link
10	PAD							
11								

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

Table 83 - 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** indicates the first Feature number to be returned. See Table 83 for a more complete definition.

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.

11.5.1 GET CONFIGURATION response data

The Response Data is a Configuration Data list and ***shall*** contain a header followed by zero or more variable length Feature Descriptors. The format of the Configuration Data is shown in Table 84.

Table 84 - 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** ***shall*** be returned as shown in Table 85.

The **Feature Descriptor**(s) ***shall*** be returned as shown in Table 87 - *Feature Descriptor generic format* on page 190 and in each individual Feature description.

Table 85 - 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 adjusted 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** will be required for the Host 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 with their **CurrentP** bit set. If no Profile is current, this field ***shall*** contain zero.

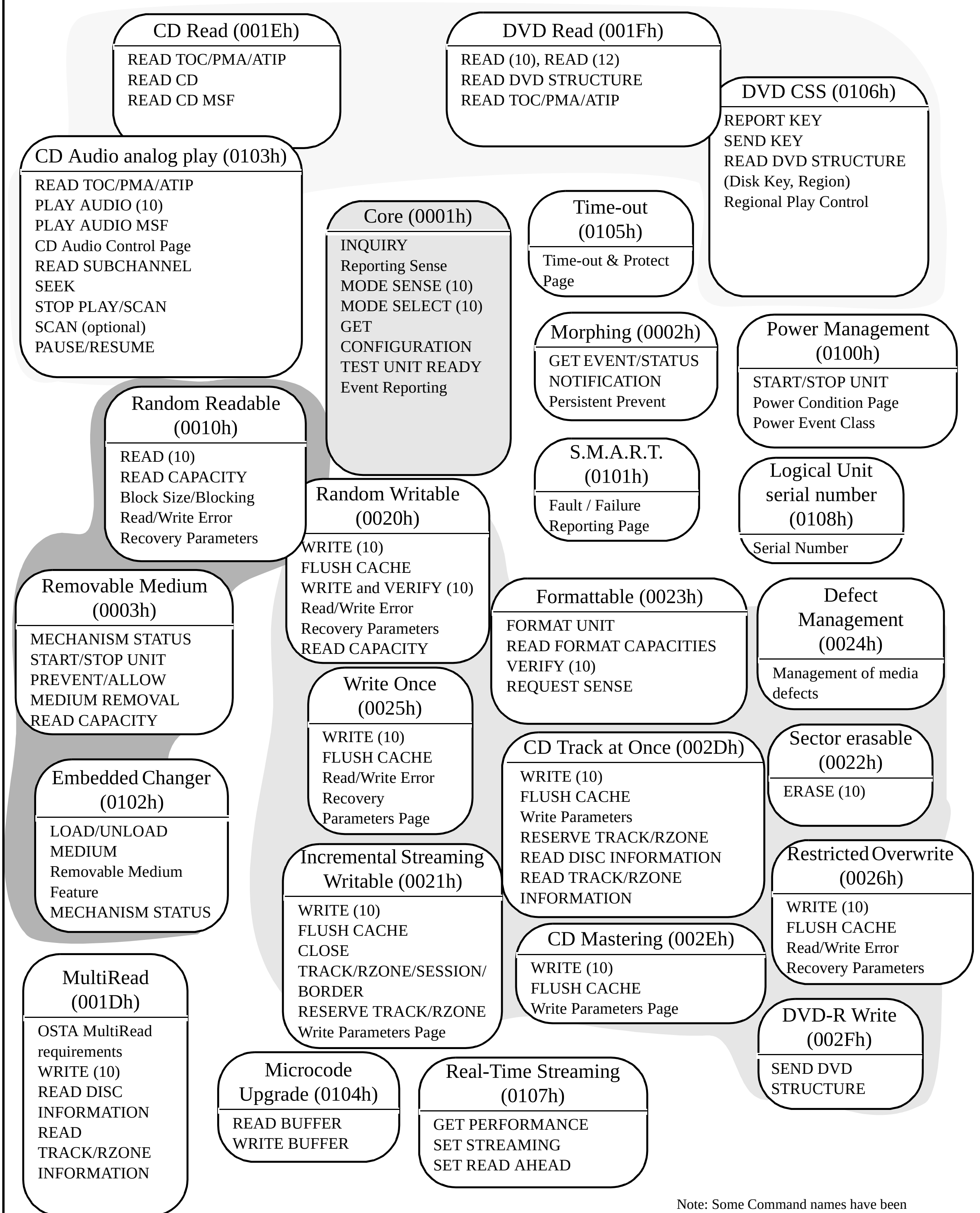
11.5.2 Features

Features are the smallest implementable set of Commands, Pages, and behavior. Table 86 lists defined Features.

Table 86 - Feature List

Feature Number	Feature Name	Description
0000h	Profile List	A list of all Profiles supported by the Logical Unit
0001h	Core	Mandatory behavior for all Logical Units
0002h	Morphing	Ability to notify Host about operational changes and accept Host requests to prevent operational changes.
0003h	Removable Medium	The medium may be removed from the Logical Unit
0004h - 000Fh	Reserved	
0010h	Random Readable	Read ability for storage Logical Units with random addressing
0011h - 001Ch	Reserved	
001Dh	MultiRead	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 drive/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 must be written in multiples of logical blocks
0027h - 002Bh	Reserved	
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.
002Fh	DVD-R Write	The ability to write DVD specific structures
0030h - 00FFh	Reserved	
0100h	Power Management	Host and Logical Unit directed power management
0101h	S.M.A.R.T.	Self Monitoring Analysis and Reporting Technology (Failure prediction)
0102h	Embedded Changer	Single mechanism multiple disc changer
0103h	CD Audio analog play	Ability to play audio CDs via the drive’s own analog output
0104h	Microcode Upgrade	Ability for the Logical Unit 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 authentication and RPC
0107h	Real-Time Streaming	Ability to read and write using Host 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 - FEFFh	Reserved	
FF00h - FFFFh	Vendor Unique	

Features are related by Profiles. An example of some of the relationships is shown in Figure 67. This diagram shows in a graphic form Features that are defined in this specification. Each Feature is represented by a block in the diagram. Each Feature also shows an abbreviated list of the requirements for that Feature. This diagram serves as an example to help the reader understand the Features described in this specification, but **should not be used as a reference** for Feature implementation. For information on the exact Features and their requirements please see *Section 9.0, "Features"* on page 153. In some cases, Features are independent of other Features. The hierarchical relationship shown in the diagram is given by Profiles. If a Feature is placed underneath another Feature, then the overlaying Feature is usually not implemented without the functionality of the underlying Feature. Items in quotes indicate a functionality that is required but is not a specific Command or Page.



Note: Some Command names have been abbreviated.

Figure 67 - Example Feature Relationships

Each Feature supported by a Logical Unit ***shall*** be described by a Feature Descriptor. Each Feature Descriptor has its own parameters. All Features ***shall*** be a multiple of four bytes long. The format of a Feature Descriptor is shown in Table 87.

Table 87 - 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.

The **Version** field ***shall*** be set to zero unless specified otherwise within the Feature description. Future versions of a Feature will be backward compatible, but may contain extra information; incompatible changes will 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.

11.5.2.1 Feature 0000h: Profile List

The Profile List Feature is a Feature to report a list of all Profiles supported by a Logical Unit. This Feature is always current. The only change allowed in the Profile List Feature during morphing is the setting of the CurrentP bits for each Profile. Logical Units that support removable media ***shall not*** have any current Profiles listed. Profile 0 ***shall not*** be reported in the Profile List, but may be reported in the **Current Profile** field of the GET CONFIGURATION header to indicate compliance to no Profile.

Profiles provide a quick method for identifying the basic functionality of Logical Units. Logical Units may conform to more than one Profile at a time. For example, a DVD-RAM drive with DVD-RAM media loaded may report both the Removable Disk and DVD-RAM Profiles. This allows generic removable disk drivers to work with DVD-RAM media while also reporting the additional capabilities required by the DVD-RAM Profile.

Table 88 - Profile List Feature Descriptor

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			Feature Code = 0000h				
1								(LSB)
2	Reserved		Version				Persistent = 1	Current = 1
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 will be backward compatible; incompatible changes will 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 89. All Profiles supported by the Logical Unit ***shall*** be always 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 89 - Profile Descriptor

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB) Profile Number							
1	Profile Number							(LSB)
2	Reserved							CurrentP
3	Reserved							

The **Profile Number** identifies a Profile to which the Logical Unit conforms. SeeTable 90.

The **CurrentP** bit, when set to one, ***shall*** indicate that this Profile is active. If no medium is present, no Profile should be active. Multifunction Logical Units ***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 85 - *Feature Header* on page 186.

Table 90 - Profile List

Profile Number	Profile Name	Description
0000h	Reserved	
0001h	Non-removable disk	Rewritable disk capable with unchanging behavior
0002h	Removable disk	Writable disk capable with removable media
0003h	MO Erasable	Magneto-Optical disk with sector erase capability
0004h	MO Write Once	Magneto-Optical write once
0005h	AS-MO	AS-MO
0006h - 0007h	Reserved	
0008h	CD-ROM	Read only Compact Disc capable
0009h	CD-R	Write once Compact Disc capable
000Ah	CD-RW	ReWritable Compact Disc capable
000Bh - 000Fh	Reserved	
0010h	DVD-ROM	Read only DVD
0011h	DVD-R	Write once DVD
0012h	DVD-RAM or DVD+RW	Rewritable DVD
00134h - FFFEh	Reserved	

Table 90 - Profile List

Profile Number	Profile Name	Description
FFFFh	Logical Units Not Conforming to a Standard Profile	The Logical Unit does not conform to any Profile.

Example: A DVD-ROM with CD-ROM read capability would always report two Profiles. If no medium were present, the **Current Profile** field in the Feature Header would contain 0, and the **CurrentP** bits in both Profile Descriptors would be set to zero. If DVD-ROM media were inserted, the only change would be to set the **CurrentP** bit of the DVD-ROM Profile to one. If CD-ROM media were then inserted, the **CurrentP** bit of the DVD-ROM Profile would be set to zero and the **CurrentP** bit of the CD-ROM Profile would be set to one.

11.5.2.2 Feature 0001h: Core

This Feature describes basic Logical Unit functionality. This Feature ***shall*** always be current. All Commands and functions described ***shall*** always function normally.

The INQUIRY Command (see *11.8, "INQUIRY Command"* on page 235) ***shall*** be supported. The INQUIRY Command ***shall*** always complete without an error if the Command Packet is valid.

Logical Units ***shall*** be able to report sense to the Host. For logical interfaces that report automatic delivery of Logical Unit Sense Information to the Host ***shall*** use the transport's mechanism. For other logical interfaces, the REQUEST SENSE Command ***shall*** be supported. The REQUEST SENSE Command ***shall not*** generate any new sense information unless the Command Packet is invalid.

The MODE SENSE (10) Command (see *11.12, "MODE SENSE (10) Command"* on page 249) ***shall*** be supported. Logical Units may not return Block Descriptors. PC field values of 00b, 01b, and 10b ***shall*** be implemented for all supported Mode Pages. Logical Units ***shall*** be able to report Mode Pages whether or not appropriate media is loaded.

The MODE SELECT (10) Command (see *11.11, "MODE SELECT (10) Command"* on page 247) ***shall*** be supported. The SP bit may not be supported. Logical Units ***shall*** be able to accept Mode Pages whether or not appropriate media is loaded.

The GET CONFIGURATION Command (see *11.5, "GET CONFIGURATION Command"* on page 185) ***shall*** be supported. UNIT ATTENTION Conditions ***shall not*** be reported to the GET CONFIGURATION Command.

The TEST UNIT READY Command (see *11.46, "TEST UNIT READY Command"* on page 423) ***shall*** be supported. TEST UNIT READY is a legacy Command used to check for the existence of media and to discover UNIT ATTENTION Conditions. The GET CONFIGURATION or GET EVENT/STATUS NOTIFICATION Commands should be used instead to determine media status.

Logical Units ***shall*** be able to report Events to the Host. For logical interfaces that support Event reporting to the Host ***shall*** use the transport's mechanism. For other logical interfaces, the GET EVENT/STATUS NOTIFICATION Command (see *11.6, "GET EVENT/STATUS NOTIFICATION Command"* on page 219) ***shall*** be supported. The Host should determine supported events by issuing a GET EVENT/STATUS NOTIFICATION Command with the Immed bit set. Zero or more event classes may be supported.

Table 91 - Core Feature Descriptor

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB) Feature Code = 0001h							
1								(LSB)
2	Reserved		Version				Persistent	Current
3	Additional Length = 04h							
4	(MSB) Physical Interface Standard							
5								
6								
7								(LSB)

The **Feature Code** field ***shall*** be set to 0001h.

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 **Physical Interface Standard** field ***shall*** be set to the current Host to Logical Unit communication path as shown in Table 92.

Table 92 - Physical Interface Standard

Physical Interface Standard	Description	Application
00000000h	Unspecified	
00000001h	SCSI Family	See *Appendix C - "SCSI Implementation Notes (Normative)"* on page 467
00000002h	ATAPI	See *Appendix B - "ATAPI Implementation Notes (Normative)"* on page 455
00000003h	IEEE 1394-1995 Family	
00000004h	IEEE 1394A Family	
00000005h - 000000FEh	Reserved	
0000FFFFh	Vendor Unique	
00010000h - 0001FFFFh	Defined by NCITS	
00020000h - 0002FFFFh	Defined by SFF	
00030000h - 0003FFFFh	Defined by IEEE	
00040000h - FFFFFFFFh	Reserved	

11.5.2.3 Feature 0002h: Morphing

The Morphing Feature provides a method for identifying changes in Logical Unit behavior, and to some extent, preventing changes in Logical Unit behavior without Host involvement. This Feature includes a mechanism for notifying the Host about events that have occurred and requests for operational changes, a mechanism for identifying the Logical Unit's current behavior, and a mechanism for allowing the Logical Unit to change its behavior. This Feature, if implemented, ***shall*** always be current.

The PREVENT/ALLOW MEDIUM REMOVAL Command and the Persistent Prevent bit ***shall*** be supported. When a Persistent Prevent is in place, the Logical Unit ***shall not*** allow, to the limit of its design, non-Host events to change the operational behavior of the Logical Unit. Logical Units with a mechanical eject may not be able to prevent ejecting the media. When a persistent prevent is in place, events are reported to the Host via the GET EVENT/STATUS NOTIFICATION Command instead of causing action within the Logical Unit. For example, if the user presses the eject button while a persistent prevent is in effect, the only action is to report the button press to the Host. The Logical Unit ***shall*** behave as shown in Figure 65 - *Morphing States - Event Generation* on page 156.

The SEND EVENT Command ***shall*** be supported for any Notification Event Class 3 events that the Logical Unit may generate. This Command is used to tell the Logical Unit to perform an action that was previously requested by the Logical Unit via a Class 3 event notification. The Host, after receiving a Class 3 notification, prepares for a possible Logical Unit change by notifying its drivers and flushing buffers as needed. After the Host is prepared for a possible Logical Unit change, it sends the Class 3 event descriptor back to the Logical Unit for processing. Support for Notification Event Class 3 Events is optional.

The GET CONFIGURATION Command ***shall*** be supported.

The GET EVENT/STATUS NOTIFICATION Command ***shall*** be supported.

Table 93 - Morphing Feature Descriptor

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			Feature Code = 0002h				
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 **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 (Immediate bit set to one). When set to one, indicates that the Logical Unit supports both polling and asynchronous GET EVENT/STATUS NOTIFICATION (Immediate bit set to zero or one).

11.5.2.4 Feature 0003h: Removable Medium

This Feature ***shall*** indicate that the Logical Unit has removable media. Media ***shall*** be considered removable if it can be removed from the loaded position, i.e. a single mechanism changer, even if the media is captive to the changer. The Feature Descriptor contains information about the Logical Unit and the loading of media. In particular, the Lock bit indicates the ability of the Logical Unit to honor at least one aspect of Persistent Prevent.

The Logical Unit ***shall*** generate Events for media changes. Event Notification Class 4 ***shall*** be suported.

The START/STOP UNIT Command ***shall*** be supported. The **Immed** and **Start** bits ***shall*** be supported. The **LoEj** bit ***shall*** be supported if the Eject bit in the Removable Medium Feature descriptor is set to one. A Power Condition value of 0 ***shall*** be supported.

The MECHANISM STATUS Command ***shall*** be supported.

The PREVENT/ALLOW MEDIUM REMOVAL Command with the Persistent bit cleared ***shall*** be supported.

Table 94 - Removable Medium Feature Descriptor

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB) Feature Code = 0003h							
1								(LSB)
2	Reserved		Version				Persistent (1)	Current (1)
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 **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 **Loading Mechanism Type** field ***shall*** be set according to Table 95.

Table 95 - 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	Reserved
111b	Reserved

The **Eject** bit, when set to zero, indicates that the Logical Unit cannot eject the medium or cartridge via the normal START/STOP UNIT Command with the **LoEj** bit set. When set to one, indicates that the Logical Unit can eject the medium or cartridge.

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 Command (allow) 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.

11.5.2.5 Feature 0010h: Random Readable

The Random Readable Feature is for basic sector reading ability found on most storage class Logical Units for which data are recorded in independently addressable logical blocks which are readable in any order.

The READ (10) Command ***shall*** be supported for any recorded sector. The **FUA** bit ***shall*** be supported when a writable Feature is current. The operation of the READ (10) Command is modified by the *Read/Write Error Recovery Parameters* Mode Page (01h) settings.

The READ CAPACITY Command ***shall*** be supported.

The **Block Size** ***shall*** be reported in the Feature Descriptor. The block size for a medium may change for the entire medium after a format operation.

If the **PP** bit in the Feature Descriptor is set, the **TB**, **RC**, **PER**, **DTE**, and **DCR** bits of the *Read/Write Error Recovery Parameters* Mode Page (01h) ***shall*** be supported. An Error Recovery Parameter field of 0 in the *Read/Write Error Recovery Parameters* Mode Page (01h) ***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 Host ***shall*** be able to change changeable values whether or not media is loaded.

Table 96 - Random Readable Feature Descriptor

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							

The **Feature Code** field ***shall*** be set to 0010h.

The **Persistent** bit ***shall*** be defined as in Table 87 - *Feature Descriptor generic format* on page 190.

Note: This bit is set to zero if the medium is removable.

The **Current** bit ***shall*** be defined as in Table 87 - *Feature Descriptor generic format* on page 190.

Note: This bit is set to zero if random readable media is not present.

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 Logical Unit readable unit. The **Blocking** field reported in the Feature Descriptor is for performance optimization only. Reads of any sector or sector count ***shall*** be allowed.

Note: For most CDs and hard disks, this value is 1. For DVD Logical Units*, this number is 10h. The Blocking field is used by the Host only for performance optimization. If there is more than one Blocking on the medium possible, the Blocking field* ***shall*** *be set to zero. Please see 11.30, "READ TRACK/RZONE INFORMATION Command"* on page 361 *for more information.*

The **PP** (Page Present) bit, when set to zero, ***shall*** indicate that the *Read/Write Error Recovery Parameters* Mode Page (01h) may not be present. When set to one, ***shall*** indicate that the *Read/Write Error Recovery Parameters* Mode Page (01h) is present.

11.5.2.6 Feature 001Dh: MultiRead

This Feature identifies a Logical Unit that can read all CD media types. The Logical Unit ***shall*** conform to the OSTA MultiRead specification 1.00 or greater, 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.

The READ (10) Command ***shall*** be supported.

The READ DISC INFORMATION Command ***shall*** be supported. Logical Units that do not have logical Tracks/RZones or logical Sessions ***shall*** identify the media as having one session and one Track/RZone, numbered as Track/RZone 1. Fields that do not apply to the loaded media ***shall*** be marked as invalid or set to zero, as appropriate.

The READ TRACK/RZONE INFORMATION Command ***shall*** be supported. Logical Units that do not have logical Tracks/RZones ***shall*** report information as if the medium contains one Track/RZone encompassing all logical blocks on the medium.

Table 97 - MultiRead Feature Descriptor

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 **Persistent** bit ***shall*** be defined as in Table 87 - *Feature Descriptor generic format* on page 190.

The **Current** bit ***shall*** be defined as in Table 87 - *Feature Descriptor generic format* on page 190.

The **Additional Length** field ***shall*** be set to 0.

11.5.2.7 Feature 001Eh: CD Read

This Feature indicates that the Logical Unit is capable of reading CD Media, e.g. CD-ROM, CD-R and CD-RW, with logical formats including fixed and variable packets. When reading fixed packets, the drive ***shall*** perform Method 2 address translation. Reading of digital audio via the READ CD Command ***shall*** be supported. The reading of Audio Data ***shall*** be aligned such that contiguous READ CD Command return contiguous information, even if buffer overruns or underruns occur.

This Feature ***shall*** indicate support for reading structures specific to CD. This Feature ***shall*** be current only if CD specific structures are available for reading.

The READ TOC/PMA/ATIP Command with format codes of 0h, 1h, and 2h ***shall*** be supported. If the CD-Text bit is set, code 5h ***shall*** be supported.

The READ CD and READ CD MSF Commands ***shall*** be supported. All data forms shaded in Table 234 - *Number of Bytes Returned Based on Data Selection Field* on page 301 ***shall*** be supported; non-shaded forms are optional.

Table 98 - CD Read Feature Descriptor

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	CD-Text
5	Reserved							
6	Reserved							
7	Reserved							

The **Feature Code** field ***shall*** be set to 001Eh.

The **Version** field ***shall*** be set to one.

The **Persistent** bit ***shall*** be defined as in Table 87 - *Feature Descriptor generic format* on page 190. Note: this bit ***shall*** be set to zero if the medium is removable.

The **Current** bit ***shall*** be defined as in Table 87 - *Feature Descriptor generic format* on page 190. Note: this bit ***shall*** be set to zero if CD media is not present.

The **Additional Length** field ***shall*** be set to 04h.

The **C2** bit, when set to 1, ***shall*** indicate that the Logical Unit returns C2 error data.

The **CD-Text** bit, when set to 1, ***shall*** indicate that the Logical Unit supports the READ TOC/PMA/ATIP Command with Format = 5.

11.5.2.8 Feature 001Fh: DVD Read

This Feature identifies a Logical Unit that can read DVD specific information from the media.

This Feature ***shall*** indicate support for reading DVD specific structures. This Feature ***shall*** be current only if DVD specific structures are available for reading.

The READ DVD STRUCTURE Command with Format Codes of 00h, 01h, 03h and 04h ***shall*** be supported. If the Logical Unit also reports the DVD-RAM Profile (*10.11, "Profile 0012h: DVD-RAM or DVD+RW"* on page 165) or supports reading of DVD-RAM media, then Format code of 08h ***shall*** be supported if DVD-RAM media is present.

The READ (10) Command ***shall*** be supported. The READ (12) Command ***shall*** be supported.

The READ TOC/PMA/ATIP Command ***shall*** be supported, along with fabrication of data for DVD Media as specified in the Command description.

Table 99 - DVD Read Feature Descriptor

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 **Persistent** bit ***shall*** be defined as in Table 87 - *Feature Descriptor generic format* on page 190. Note: this bit ***shall*** be set to zero if the medium is removable.

The **Current** bit ***shall*** be defined as in Table 87 - *Feature Descriptor generic format* on page 190. Note: this bit ***shall*** be set to zero if DVD media is not present.

The **Additional Length** field ***shall*** be set to 0.

11.5.2.9 Feature 0020h: Random Writable

This Feature identifies a Logical Unit that can write data to logical blocks specified by a WRITE (10) Command. There is no requirement that the addresses in sequences of writes occur in any particular order. This Feature ***shall*** be present only if writable media is present. Write protected media ***shall not*** be considered writable.

The WRITE (10) Command ***shall*** be supported.

The FLUSH CACHE Command ***shall*** be supported. The **Immediate** bit ***shall*** be supported.

The WRITE and VERIFY (10) Command ***shall*** be supported.

The READ CAPACITY Command ***shall*** be supported.

Table 100 - Random Writable Feature Descriptor

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								
6	Last LBA							
7								(LSB)
8	(MSB)							
9								
10	Logical Block Size							
11								(LSB)
12	(MSB)	Blocking						
13								(LSB)
14	Reserved							PP
15	Reserved							

The **Feature Code** field ***shall*** be set to 0020h.

The **Persistent** bit ***shall*** be defined as in Table 87 - *Feature Descriptor generic format* on page 190. Note: this bit ***shall*** be set to zero if the medium is removable.

The **Current** bit ***shall*** be defined as in Table 87 - *Feature Descriptor generic format* on page 190. Note: this bit ***shall*** be set to zero if randomly writable media is not present.

The **Version** field ***shall*** be set to 1.

Note: Earlier versions of this standard had the Version field set to zero, and the additional length was 4.

The **Additional Length** field ***shall*** be set to 0Ch.

The **Last LBA** field is the address of the last addressable data block.

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 reported in the Feature Descriptor is for performance optimization only. Writes of any sector or sector count ***shall*** be allowed

If the **PP** bit is set to one, all fields in the *Read/Write Error Recovery Parameters* Mode Page (01h) ***shall*** be supported.

11.5.2.10 Feature 0021h: Incremental Streaming Writable

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.

This Feature ***shall*** indicate support for sequential recording, such as CD Packet, and DVD Incremental recording to write once or rewritable media. This Feature ***shall*** become not current after a final fixation is performed.

The WRITE (10) Command ***shall*** be implemented. Writing may be limited to locations identified by the READ DISC INFORMATION and READ TRACK/RZONE INFORMATION Commands. If sequential WRITE (10) Commands occur to contiguous locations at a sufficient rate, the Logical Unit ***shall*** stream the data to the medium without interruption or link generation occurring. If the writing is interrupted due to insufficient data (“underrun”) or is forced by a FLUSH CACHE or other Command, a link ***shall*** be generated. The nominal size of the link ***shall*** be that specified by the *Write Parameters* Mode Page (05h). The number of padding and link blocks actually recorded may also depend on blocking: the data from the Host may first be padded to fill a Blocking unit and then a link ***shall*** be appended. Please see *4.16.10.2, "ECC boundary padding and Data Type Bit in ID field"* on page 109 for an example with DVD-R media.

While a streaming write is in progress (data are in the Logical Unit’s buffer but not committed to the medium), the Commands in Table 101 ***shall*** execute normally without interrupting the writing. All other Commands ***shall*** execute normally, but may interrupt recording. All other Commands may force a FLUSH CACHE before execution. Logical Units should execute all other Commands without flushing the write buffer. This is possible if writing to the medium has not yet started. Normal execution is defined as the behavior the Command would have if no data were in the write buffer.

If the Host closes the Session or Border, and there is insufficient space for another Session or Border to follow, the Logical Unit ***shall*** close the Session or Border with no next Session or Border pointer (on CD, point B0 would not exist).

Note: The CD MultiSession standard allows B0 = FF/FF/FF to indicate the same thing, but some legacy drives do not properly handle this means of marking the last Session.

Table 101 - Commands that shall not interrupt streaming writing

COMMAND	COMMENT
TEST UNIT READY	
READ TRACK/RZONE INFORMATION	Required only for current Track/RZone
GET EVENT/STATUS NOTIFICATION	
GET CONFIGURATION	
REQUEST SENSE	
INQUIRY	
READ BUFFER CAPACITY	Please see T10/1048D for a description of this Command.
WRITE (10)	For NWA in current Track/RZone

The FLUSH CACHE Command ***shall*** be implemented. The FLUSH CACHE Command ***shall*** force the underrun condition regardless of the state of the **Immediate** bit.

The *Write Parameters* Mode Page (05h) ***shall*** be supported. If CD media is present, the Packet recording write type ***shall*** be available. If DVD media is present, the Incremental recording write method ***shall*** be available. The *Write Parameters* Mode Page (05h) may contain or be actively set to settings that are incompatible with the current medium, or be set when no medium is present. If writing is attempted when the *Write Parameters* Mode Page (05h) is not compatible with the current track, RZone, or medium, the Logical Unit ***shall*** return CHECK CONDITION Status, 5/64/00 ILLEGAL MODE FOR THIS TRACK, and the sense key specific information set to the byte and field of the incompatible parameter in the Mode Page.

The CLOSE TRACK/RZONE/SESSION/BORDER Command ***shall*** be supported.

The RESERVE TRACK/RZONE Command ***shall*** be supported.

The READ DISC INFORMATION Command ***shall*** be supported.

The READ TRACK/RZONE INFORMATION Command ***shall*** be supported.

If the **Erasable** flag in the READ DISC INFORMATION Command is set to one, the BLANK Command ***shall*** be supported with Blanking Types of 000b, 001b, and 100b.

If OPC information is ever returned via the READ DISC INFORMATION Command, the SEND OPC INFORMATION Command ***shall*** be supported.

Table 102 - Incremental Streaming Writable Feature Descriptor

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	Reserved							
5	Reserved							
6	Reserved							
7	Number of Link Sizes							
8 - n	Link Size							
n - ?	Pad							

The **Feature Code** field ***shall*** be set to 0021h.

The **Persistent** bit ***shall*** be defined as in Table 87 - *Feature Descriptor generic format* on page 190. Note: this bit ***shall*** be set to zero if the medium is removable.

The **Current** bit ***shall*** be defined as in Table 87 - *Feature Descriptor generic format* on page 190. Note: this bit ***shall*** be set to zero if sequential write media is not present.

The **Additional Length** field ***shall*** be set to 4 + (Number of Link Sizes) + (Number of Pad bytes).

The **Number of Link Sizes** ***shall*** specify the number of link sizes available for the current media. Note: for CD 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. Note: this field is 7 for CD-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.

11.5.2.11 Feature 0022h: Sector erasable

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.

Note: This Feature does not apply to DVD-RAM or DVD+RW, which use a direct overwrite technology.

This Feature ***shall*** identify a system in which sectors must be erased before overwriting. The default operation of the Logical Unit is to perform an erase pass before writing.

The Logical Unit ***shall*** generate a CHECK CONDITION status, BLANK CHECK if the Host attempts to read an erased logical block.

The **EBP** bit in the WRITE (10) Command ***shall*** be supported. If the **EBP** bit is set to one, the Host is indicating to the Logical Unit that the block(s) addressed are known to be erased and therefore don't require erasure before recording. If the **EBP** bit is set to zero, the Logical Unit ***shall*** perform an erase pass before recording

The ERASE (10) Command ***shall*** be supported.

The **BlkVfy** bit of the VERIFY (10) Command ***shall*** be supported.

Table 103 - Sector erasable Feature Descriptor

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 = 00h							

The **Feature Code** field ***shall*** be set to 0022h.

The **Persistent** bit ***shall*** be defined as in Table 87 - *Feature Descriptor generic format* on page 190. Note: this bit ***shall*** be set to zero if the medium is removable.

The **Current** bit ***shall*** be defined as in Table 87 - *Feature Descriptor generic format* on page 190. Note: this bit ***shall*** be set to zero if non-sector eraseable media is present.

The **Additional Length** field ***shall*** be set to 0.

11.5.2.12 Feature 0023h: Formattable

This Feature identifies the ability to format media. The type of formatting that may be performed is defined in the FORMAT UNIT Command (see Table 78 - *Format Unit Parameter List* on page 180).

The READ FORMAT CAPACITIES Command ***shall*** be supported. All descriptors returned ***shall*** be valid for the current medium. A **Format Type** of 00h ***shall*** be supported.

The FORMAT UNIT Command with a **Format Code** of 001b ***shall*** be supported. Format Type of 00h ***shall*** be supported.

The VERIFY (10) Command ***shall*** be supported.

The REQUEST SENSE Command ***shall*** be supported.

Table 104 - Formattable Feature Descriptor

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 **Persistent** bit ***shall*** be defined as in Table 87 - *Feature Descriptor generic format* on page 190. Note: this bit ***shall*** be set to zero if the medium is removable.

The **Current** bit ***shall*** be defined as in Table 87 - *Feature Descriptor generic format* on page 190. Note: this bit ***shall*** be set to zero if non-formattable media is present.

The **Additional Length** field ***shall*** be set to 0.

11.5.2.13 Feature 0024h: Defect Management

The Logical Unit ***shall*** be able to perform defect management to provide the Host with an apparently defect-free contiguous address space. This Feature ***shall*** be current only if media with defect management capability is present. If reading of defect managed media type(s) is supported, even if write operations are not supported, the Defect Management Feature ***shall*** be reported.

If the current media is writable by the Logical Unit, the **AWRE** and **ARRE** bits (see *11.12.3.1, "Read/Write Error Recovery Parameters Page"* on page 253) and associated functionality of those bits ***shall*** be supported.

Table 105 - Defect Management Feature Descriptor

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 = 00h							

The **Feature Code** field ***shall*** be set to 0024h.

The **Persistent** bit ***shall*** be defined as in Table 87 - *Feature Descriptor generic format* on page 190. This bit ***shall*** be set to zero if the medium is removable.

The **Current** bit ***shall*** be defined as in Table 87 - *Feature Descriptor generic format* on page 190. This bit ***shall*** be set to zero if managed media is not present.

Note: Defect Managed media may have no defects.

The **Additional Length** field ***shall*** be set to 0.

11.5.2.14 Feature 0025h: Write Once

This Feature identifies a Logical Unit that has 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.

This Feature identifies a Logical Unit that can write data to randomly addressed logical blocks specified by a WRITE (10) Command. There is no requirement that the addresses in sequences of writes occur in any particular order. This Feature ***shall*** be present only if write once media is present. Write protected media ***shall not*** be considered writable. After being written once, the Logical Unit cannot record the same block again. If the Logical Unit detects that all logical blocks are recorded, this Feature ***shall*** become not current.

The Random Readable Feature ***shall*** be current when this Feature is current.

The WRITE (10) and WRITE and VERIFY (10) Commands ***shall*** be supported. Writing may occur to any previously unrecorded logical block. If recording is attempted to any recorded logical block, the Logical Unit ***shall*** generate CHECK CONDITION Status, 8/--/-- BLANK CHECK.

The READ CAPACITY Command ***shall*** be supported.

The FLUSH CACHE Command ***shall*** be supported. The Immediate bit ***shall*** be supported.

The *Read/Write Error Recovery Parameters* Mode Page (01h) ***shall*** be supported.

Table 106 - Write Once Feature Descriptor

<table>
<tr><th>Bit
Byte</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>0</td><td colspan="8" rowspan="2">(MSB)
Feature Code = 0025h
(LSB)</td></tr>
<tr><td>1</td></tr>
<tr><td>2</td><td colspan="2">Reserved</td><td colspan="4">Version</td><td>Persistent</td><td>Current</td></tr>
<tr><td>3</td><td colspan="8">Additional Length = 08h</td></tr>
<tr><td>4</td><td colspan="8" rowspan="4">(MSB)
Logical Block Size
(LSB)</td></tr>
<tr><td>5</td></tr>
<tr><td>6</td></tr>
<tr><td>7</td></tr>
<tr><td>8</td><td colspan="8" rowspan="2">(MSB)
Blocking
(LSB)</td></tr>
<tr><td>9</td></tr>
<tr><td>10</td><td colspan="7">Reserved</td><td>PP</td></tr>
<tr><td>11</td><td colspan="8">Reserved</td></tr>
</table>

The **Feature Code** field ***shall*** be set to 0025h.

The **Persistent** bit ***shall*** be defined as in Table 87 - *Feature Descriptor generic format* on page 190. This bit ***shall*** be set to zero if the medium is removable.

The **Current** bit ***shall*** be defined as in Table 87 - *Feature Descriptor generic format* on page 190. This bit ***shall*** be set to zero if write once media is not present.

The **Additional Length** field ***shall*** be set to 8.

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 reported in the Feature Descriptor is for performance optimization only. Writes of any sector or sector count ***shall*** be allowed

If the **PP** bit is set to one, all fields in the *Read/Write Error Recovery Parameters* Mode Page (01h) ***shall*** be supported.

11.5.2.15 Feature 0026h: Restricted Overwrite

The Restricted Overwrite Feature ***shall*** indicate the ability to perform writing only on **Blocking** boundaries. 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 only when Restricted Overwritable media, such as CD-RW with a single track containing fixed packets, 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.

On CD-RW, this Feature should be current only if the first track on the media is formatted for fixed packets and is complete. The Blocking field in the Random Readable Feature ***shall*** be equal to the packet size. The Last Addressable Block ***shall*** be the last addressable block in the first track. If more than one track is present on the media, the Host must use *11.30, "READ TRACK/RZONE INFORMATION Command"* on page 361 to obtain a description of the medium.

Writing from the Host into the first track ***shall*** be in units of **Blocking**. Writing ***shall*** begin at **Blocking** boundaries. The writable units may be sent via multiple WRITE (10) Commands. If the Logical Unit receives a Write that does not begin on a **Blocking** boundary and is not contiguous with a previous Write that did begin on a **Blocking** boundary ***shall*** return CHECK CONDITION Status, 5/21/02 INVALID ADDRESS FOR WRITE. If an incomplete set of blocks is received and the Logical Unit is required to flush its cache via Flush Cache or other implied causes, the Logical Unit ***shall*** generate CHECK CONDITION Status, 1/0C/0A WRITE ERROR - PADDING BLOCKS ADDED.

The WRITE (10) Command ***shall*** be supported.

The READ DISC INFORMATION Command ***shall*** be supported.

The READ TRACK/RZONE INFORMATION Command ***shall*** be supported.

The READ CAPACITY Command ***shall*** be supported.

The FLUSH CACHE Command ***shall*** be supported.

The *Write Parameters* Mode Page (05h) ***shall*** be supported.

Table 107 - Restricted Overwrite Feature Descriptor

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 **Persistent** bit ***shall*** be defined as in Table 87 - *Feature Descriptor generic format* on page 190. This bit ***shall*** be set to zero if the medium is removable.

The **Current** bit ***shall*** be defined as in Table 87 - *Feature Descriptor generic format* on page 190. This bit ***shall*** be set to zero if write once media is not present.

The **Additional Length** field ***shall*** be set to 0.

11.5.2.16 Feature 002Dh: CD Track at Once

This Feature ***shall*** indicate support for sequential Track at Once recording to write once or rewritable media. This Feature ***shall*** become not current after a final fixation is performed.

The WRITE (10) Command ***shall*** be implemented. Writing may be limited to locations identified by the READ DISC INFORMATION and READ TRACK/RZONE INFORMATION Commands. If sequential WRITE (10) Commands occur to contiguous locations at a sufficient rate, the Logical Unit ***shall*** stream the data to the medium without interruption or link generation occurring. If the writing is interrupted due to insufficient data (“underrun”) or is forced by a flush cache or other Command, run-out and link ***shall*** be generated after padding. Padding ***shall*** consist of (1) sufficient blocks of zeros to make the track the minimum length and (2) padded to fill an existing reservation for the track. If the track is of minimum length and is not reserved, no padding blocks ***shall*** be added.

While a Track at Once write is in progress (data are in the Logical Unit’s buffer but not committed to the medium), the Commands inTable 101 - *Commands that shall not interrupt streaming writing* on page 201 ***shall*** execute normally without interrupting the writing. All other Commands ***shall*** execute normally, but may interrupt recording. All other Commands may force a FLUSH CACHE before execution. Logical Units should execute all other Commands without flushing the write buffer. This is possible if writing to the medium has not yet started. Normal execution is defined as the behavior the Command would have if no data were in the write buffer.

Table 108 - Commands that shall not interrupt Track at Once writing

COMMAND	COMMENT
GET CONFIGURATION	
GET EVENT/STATUS NOTIFICATION	
INQUIRY	
READ BUFFER CAPACITY	Please see T10/1048D for a description of this Command.
READ TRACK/RZONE INFORMATION	Required only for current Track/RZone
REQUEST SENSE	
TEST UNIT READY	
WRITE (10)	For NWA in current Track/RZone

The FLUSH CACHE Command ***shall*** be implemented. The flush cache Command ***shall*** force the underrun condition regardless of the state of the immediate bit.

The *Write Parameters* Mode Page (05h) ***shall*** be supported. If CD media is present, the Track at Once recording write type ***shall*** be available. The *Write Parameters* Mode Page (05h) may contain or be actively set to settings that are incompatible with the current medium, or be set when no medium is present. If writing is attempted when the *Write Parameters* Mode Page (05h) is not compatible with the current Track, RZone, or medium, the Logical Unit ***shall*** return CHECK CONDITION Status, 5/64/00 ILLEGAL MODE FOR THIS TRACK, and the sense key specific information set to the byte and field of the incompatible parameter in the Mode Page.

The CLOSE TRACK/RZONE/SESSION/BORDER Command ***shall*** be supported.

The RESERVE TRACK/RZONE Command ***shall*** be supported.

The READ DISC INFORMATION Command ***shall*** be supported.

The READ TRACK/RZONE INFORMATION Command ***shall*** be supported.

If the CD-RW flag is set in the CD Track at Once Feature Descriptor is set, the Erasable bit in the READ DISC INFORMATION result data may be set to one and the BLANK Command ***shall*** be supported. Blanking types 000b, 001b ***shall*** be supported. Overwriting of previously recorded tracks ***shall*** be allowed. Overwriting of previously recorded tracks is performed as if the track had been reserved and not recorded (the PMA entry is unchanged).

If OPC information is ever returned via READ DISC INFORMATION, the SEND OPC INFORMATION Command ***shall*** be supported.

Table 109 - CD Track at Once Feature Descriptor

Byte \ Bit	7	6	5	4	3	2	1	0
0	(MSB) Feature Code = 002Dh							
1								(LSB)
2	Reserved		Version				Persistent	Current
3	Additional Length = 4h							
4	Reserved			R-W Raw	R-W Pack	Test Write	CD-RW	R-W Subcode
5	Reserved							
6	Reserved							
7	Reserved							

The **Feature Code** field ***shall*** be set to 002Dh.

The **Persistent** bit ***shall*** be defined as in Table 87 - *Feature Descriptor generic format* on page 190. Note: this bit ***shall*** be set to zero if the medium is removable.

The **Current** bit ***shall*** be defined as in Table 87 - *Feature Descriptor generic format* on page 190. Note: this bit ***shall*** be set to zero if CD-R or CD-RW media is not present.

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 **Test Write** bit indicates that the Logical Unit can perform test writes. See *11.12.3.7, "Write Parameters Page"* on page 267.

The **CD-RW** bit indicates support for overwriting a Track at Once track with another.

The **R-W Subcode** bit indicates that the Logical Unit can record the R-W subchannels with user supplied data.

The **R-W Raw** bit, if set to 1, ***shall*** indicate that the Logical Unit supports writing R-W subcode in the Raw mode. The **R-W Subcode** 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 subcode in the Packed mode. The **R-W Subcode** bit ***shall*** be set if this bit is set.

11.5.2.17 Feature 002Eh: CD Mastering

Two fundamental types of CD mastering are possible - raw and session at once. A Logical Unit with this Feature ***shall*** support at least one of Raw or Session at Once recording. The type of recording is identified in the Feature Descriptor. This Feature ***shall*** be current only if the last session status is empty. Note: the raw mode offers additional control but bypasses Logical Unit data checking and has larger data transfer size. The session at once mode offers Logical Unit control and supervision but has greater Logical Unit complexity.

The *Write Parameters* Mode Page (05h) is mandatory.

The **Raw** bit ***shall*** indicate that the Logical Unit can record using the raw write type. The Session at Once bit ***shall*** indicate that the Logical Unit can record using the Session at Once write type. Each write type is described in the following sections.

The **Test Write** bit ***shall*** indicate that the Logical Unit can perform test writes. In test write mode, the Logical Unit ***shall*** behave as if data were committed to the medium, but writing to the medium ***shall not*** occur.

If OPC information is ever returned via the READ DISC INFORMATION Command, the SEND OPC INFORMATION Command ***shall*** be supported.

11.5.2.17.1 CD Mastering - Raw

The READ DISC INFORMATION Command ***shall*** be supported.

The READ TRACK/RZONE INFORMATION Command ***shall*** be supported.

The Raw write type in the *Write Parameters* Mode Page (05h) ***shall*** be supported. Data Block Type 1 ***shall*** be supported. If the R-W bit in the Feature Descriptor is set, then Data Block Types 2 and 3 ***shall*** also be supported.

The WRITE (10) Command ***shall*** be supported. The Host ***shall*** send all data, from the beginning of lead-in to the end of lead-out. The number of bytes per block is determined by the Data Block Type in the *Write Parameters* Mode Page (05h). The Writes ***shall*** occur to a contiguous sequence of addresses. When an underrun occurs, the Logical Unit ***shall*** write the last block sent from the Host as a link. If the Raw MS bit is set, the Logical Unit ***shall*** also generate valid PMA entries for the information sent by the Host. The Logical Unit may use the TOC and approximations, or TOC and scanning to determine PMA parameters.

The FLUSH CACHE Command ***shall*** be supported.

11.5.2.17.2 CD Mastering - Session at Once

The **SAO** bit ***shall*** indicate that the Logical Unit can record using the Session at Once write type.

The READ DISC INFORMATION Command ***shall*** be supported.

The READ TRACK/RZONE INFORMATION Command ***shall*** be supported.

The SAO write type in the *Write Parameters* Mode Page (05h) ***shall*** be supported. The Data Block Type field is ignored; the data block type changes dynamically according to the cue sheet.

The WRITE (10) Command ***shall*** be supported. The number of bytes per block is determined by the cue sheet. Writes must be issued for every user data block, even if the cue sheet indicates that those blocks require no data be sent from the Host. In that case, the number of bytes transferred is zero. WRITE (10) Commands ***shall*** be issued by the Host with an ascending sequence of Logical Block Addresses. The number of blocks per write may change over the course of recording. If an underrun occurs, the Logical Unit may pad the rest of the session or abort the recording. Underruns may be detected by the Host at the next write, which will not be a valid address for writing due to the underrun.

The SEND CUE SHEET Command ***shall*** be supported. The Logical Unit ***shall*** accept cue sheets up to the size specified in the **Maximum Cue Sheet** Size field.

Table 110 - 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 = 4h							
4	Reserved		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 **Persistent** bit ***shall*** be defined as in Table 87 - *Feature Descriptor generic format* on page 190. Note: this bit ***shall*** be set to zero if the medium is removable.

The **Current** bit ***shall*** be defined as in Table 87 - *Feature Descriptor generic format* on page 190. Note: this bit ***shall*** be set to zero if CD-R or CD-RW media is not present.

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 **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 multisession 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 subchannels 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.

11.5.2.18 Feature 002Fh: DVD-R Write

This Feature indicates the ability to master a DVD disc on DVD-R media.

The *Write Parameters* Mode Page (05h) ***shall*** be supported. A Write Type of Session at Once ***shall*** be supported.

The READ DISC INFORMATION Command ***shall*** be supported.

The READ TRACK/RZONE INFORMATION Command ***shall*** be supported.

The RESERVE TRACK/RZONE Command ***shall*** be supported.

The WRITE (10) Command ***shall*** be supported. The number of bytes per block is determined by the block size in the Random Read Feature. Writes must be issued for every user data block. WRITE (10) Commands ***shall*** be issued by the Host with a contiguous sequence of Logical Block Addresses. The number of blocks per write may change over the course of recording. If an underrun occurs, the Logical Unit may pad the rest of the disc or abort the recording. Underruns may be detected by the Host at the next write, which will not be a valid address for writing due to the underrun.

The SEND DVD STRUCTURE Command ***shall*** be supported.

Table 111 - DVD-R Write Feature Descriptor

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)	Feature Code = 002Fh						
1								(LSB)
2	Reserved		Version				Persistent	Current
3	Additional Length = 04h							
4	Reserved	BUF	Reserved			Test Write	Reserved	
5	Reserved							
6	Reserved							
7	Reserved							

The **Feature Code** field ***shall*** be set to 002Fh.

The **Persistent** bit ***shall*** be defined as in Table 87 - *Feature Descriptor generic format* on page 190. Note: this bit ***shall*** be set to zero if the medium is removable.

The **Current** bit ***shall*** be defined as in Table 87 - *Feature Descriptor generic format* on page 190. Note: this bit ***shall*** be set to zero if DVD-R media is not present.

The **Additional Length** field ***shall*** be set to 04h.

The **BUF** (Buffer Underrun Free) bit, when set to 1, ***shall*** indicate that the Logical Unit supports Buffer Underrun 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.

11.5.2.19 Feature 0100h: Power Management

This Feature identifies a Logical Unit that can perform Host managed and Host directed power management.

The Power Conditions field of the START/STOP UNIT Command ***shall*** be supported.

The *Power Condition* Mode Page (1Ah) ***shall*** be supported.

The Power Event class of the GET EVENT/STATUS NOTIFICATION Command ***shall*** be supported.

Table 112 - Power Management Feature Descriptor

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 **Persistent** bit ***shall*** be set to one.

The **Current** bit ***shall*** be set to one.

The **Additional Length** field ***shall*** be set to 0.

11.5.2.20 Feature 0101h: S.M.A.R.T.

This Feature identifies a Logical Unit that can perform Self Monitoring Analysis and Reporting Technology.

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

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

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

Table 113 - S.M.A.R.T. Feature Descriptor

<table>
<tr><th>Bit
Byte</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>0</td><td colspan="8" rowspan="2">(MSB)
Feature Code = 0101h
(LSB)</td></tr>
<tr><td>1</td></tr>
<tr><td>2</td><td colspan="2">Reserved</td><td colspan="4">Version</td><td>Persistent</td><td>Current</td></tr>
<tr><td>3</td><td colspan="8">Additional Length = 04h</td></tr>
<tr><td>4</td><td colspan="7">Reserved</td><td>PP</td></tr>
<tr><td>5</td><td colspan="8">Reserved</td></tr>
<tr><td>6</td><td colspan="8">Reserved</td></tr>
<tr><td>7</td><td colspan="8">Reserved</td></tr>
</table>

The **Feature Code** field ***shall*** be set to 0101h.

The **Persistent** bit ***shall*** be defined as in Table 87 - *Feature Descriptor generic format* on page 190.

The **Current** bit ***shall*** be defined as in Table 87 - *Feature Descriptor generic format* on page 190.

The **Additional Length** field ***shall*** be set to 04h.

If the **PP** bit is set in the S.M.A.R.T Feature Descriptor, *11.12.3.4, "Fault / Failure Reporting Page"* on page 260 ***shall*** be supported. If the *Fault / Failure Reporting* Mode Page (1Ch) is not supported the Logical Unit ***shall*** use the following default values:

1. **Perf** bit ***shall*** be 0 (Delays are acceptable).
2. **EWasc** bit ***shall*** be 0 (Disable WARNING Sense Code reporting).
3. **DExcept** bit ***shall*** be 0 (Do not Disable reporting of exception conditions).
4. **Test** bit ***shall*** be 0.
5. **MRIE** ***shall*** be 4 (Unconditionally generate recovered error).
6. **Interval Timer** ***shall*** be set to 6000.

11.5.2.21 Feature 0102h: Embedded Changer

This Feature identifies a Logical Unit that can move media from a storage area to the mechanism and back.

For more information on changers, see the description of the Changer Model. If this Feature is current, the Removable Medium Feature ***shall*** also be current.

The LOAD/UNLOAD MEDIUM Command ***shall*** be supported.

The MECHANISM STATUS Command ***shall*** be supported.

Table 114 - Embedded Changer Feature Descriptor

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB) Feature Code = 0102h							
1								(LSB)
2	Reserved		Version				Persistent	Current
3	Additional Length = 04h							
4	Reserved			SCC	Reserved	SDP	Reserved	
5	Reserved							
6	Reserved							
7	Reserved			Highest Slot Number				

The **Feature Code** field ***shall*** be set to 0102h.

The **Persistent** bit ***shall*** be defined as in Table 87 - *Feature Descriptor generic format* on page 190.

The **Current** bit ***shall*** be defined as in Table 87 - *Feature Descriptor generic format* on page 190.

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 will contain valid Disc is Present status information for all slots.

Highest Slot Number ***shall*** be set to the number of slots minus one.

11.5.2.22 Feature 0103h: CD Audio analog play

This Feature identifies C/DVD Logical Units that have an analog audio output port and that can play media that contain CD-DA tracks.

To allow for the legacy method for the Host Computer to determine if audio operations are supported, C/DVD Logical Units ***shall*** respond to a PLAY AUDIO (10) Command which has a transfer length of zero, with GOOD status, regardless of whether or not this Feature is current.

The PLAY AUDIO (10), and PLAY AUDIO MSF Commands ***shall*** be supported.

The PAUSE/RESUME Command ***shall*** be supported.

The STOP PLAY/SCAN Command ***shall*** be supported.

The SCAN Command may be implemented, dependent on the bit in the Feature descriptor.

The SEEK Command ***shall*** be supported. The SEEK Command ***shall*** halt the playing of audio and set the current position to the LBA specified in the Command. This current position may be used by a future PLAY AUDIO (10) or PLAY AUDIO MSF Commands.

The READ SUBCHANNEL Command ***shall*** be supported.

The READ TOC/PMA/ATIP Command ***shall*** be supported.

The *CD Audio Control* Mode Page (0Eh) ***shall*** be implemented. This Page ***shall not*** be affected by the insertion or removal of CD Audio media.

Table 115 - CD Audio analog play Feature Descriptor

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								(LSB)

The **Feature Code** field ***shall*** be set to 0103h.

The **Persistent** bit ***shall*** be defined as in Table 87 - *Feature Descriptor generic format* on page 190.

The **Current** bit ***shall*** be defined as in Table 87 - *Feature Descriptor generic format* on page 190.

The **Additional Length** field ***shall*** be set to 04h.

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 will have the same volume level. When set to one, ***shall*** indicate that audio channel volume may be set independently.

The **Scan** bit, when set to zero, ***shall*** indicate that the SCAN Command is not supported. The Scan bit, when set to one, ***shall*** indicate that the SCAN Command ***shall*** be supported.

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.

11.5.2.23 Feature 0104h: Microcode Upgrade

This Feature identifies Logical Units that can upgrade their microcode via the logical interface. While the download technique is standard, the microcode data is vendor unique. Logical Units ***shall*** validate microcode data before making the microcode permanent.

The READ BUFFER Command, Descriptor Mode (011b) ***shall*** be supported.

The WRITE BUFFER Command, Download Microcode with Offsets and Save Mode (111b) ***shall*** be supported. Buffer 0 ***shall*** be usable for microcode upgrades.

Table 116 - Microcode Upgrade Feature Descriptor

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 **Persistent** bit ***shall*** be defined as in Table 87 - *Feature Descriptor generic format* on page 190.

The **Current** bit ***shall*** be defined as in Table 87 - *Feature Descriptor generic format* on page 190.

The **Additional Length** field ***shall*** be set to 0.

11.5.2.24 Feature 0105h: Time-out

This Feature identifies a Logical Unit that can always respond to Commands within a set time period. If a Command cannot complete normally within the allotted time, it completes with an error.

The *Time-out & Protect* Mode Page (1Dh) ***shall*** be implemented. See *11.12.3.5, "Time-out & Protect Page"* on page 262.

Commands that cannot complete normal execution within their specified time limit ***shall*** complete within the specified time limit with CHECK CONDITION Status, 6/2E/00 INSUFFICIENT TIME FOR OPERATION.

Event Notification Class 6 ***shall*** be suported if queuing is supported.

Table 117 - Time-out Feature Descriptor

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 **Persistent** bit ***shall*** be defined as in Table 87 - *Feature Descriptor generic format* on page 190.

The **Current** bit ***shall*** be defined as in Table 87 - *Feature Descriptor generic format* on page 190.

The **Additional Length** field ***shall*** be set to 0.

11.5.2.25 Feature 0106h: DVD CSS

This Feature identifies a Logical Unit that can perform DVD CSS authentication and key management.

This Feature identifies Logical Units that supports DVD CSS for DVD-Video. The Logical Unit ***shall*** maintain the integrity of the keys by only using DVD CSS procedures. This Feature ***shall*** be current only if a DVD CSS protected DVD-Video medium is loaded.

The REPORT KEY Command (see *11.32, "REPORT KEY Command"* on page 371) ***shall*** be supported.

The SEND KEY Command (see *11.40, "SEND KEY Command"* on page 405) ***shall*** be supported.

The READ DVD STRUCTURE Command, Format Code of 02h ***shall*** be supported.

Table 118 - DVD CSS Feature Descriptor

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 **Persistent** bit ***shall*** be defined as in Table 87 - *Feature Descriptor generic format* on page 190.

The **Current** bit ***shall*** be defined as in Table 87 - *Feature Descriptor generic format* on page 190. This bit ***shall*** be set to zero if DVD CSS media is not present.

The **Additional Length** field ***shall*** be set to 4.

The **CSS version** ***shall*** be set to 01h.

11.5.2.26 Feature 0107h: Real-Time Streaming

This Feature identifies Logical Units that support reporting and setting of performance parameters. The Host may request that the Logical Unit perform at a certain data rate. A Host may request a lower rate than the Logical Unit's maximum to identify a need for a continuous stream of data. This is desired because many applications need their average data rate to be constant, even over short periods of time. If a drive must physically slow the medium to avoid "once around" access delays, this Feature provides the Host requirements to the Logical Unit without specifying how that behavior is to be achieved.

The GET PERFORMANCE Command (see *11.7, "GET PERFORMANCE Command"* on page 231) ***shall*** be supported.

The SET STREAMING Command (see *11.43, "SET STREAMING Command"* on page 413) ***shall*** be supported.

The SET READ AHEAD Command (see *11.42, "SET READ AHEAD Command"* on page 411) ***shall*** be supported.

Table 119 - Real-Time Streaming Feature Descriptor

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 = 00h							

The **Feature Code** field ***shall*** be set to 0107h.

The **Persistent** bit ***shall*** be defined as in Table 87 - *Feature Descriptor generic format* on page 190.

The **Current** bit ***shall*** be defined as in Table 87 - *Feature Descriptor generic format* on page 190.

The **Additional Length** field ***shall*** be set to 0.

11.5.2.27 Feature 0108h: Logical Unit serial number

This Feature identifies a Logical Unit that has a unique serial number. A Logical Unit can be uniquely identified by checking its vendor ID, model ID, and serial number.

Table 120 - 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 (1)	Current (1)
3	Additional Length							
4-n	Serial Number							

The **Feature Code** field ***shall*** be set to 0108h.

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.

11.5.2.28 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.

The READ DVD STRUCTURE Command with a Format Code of 30h ***shall*** be supported.

If any DCBs are identified as writable, the SEND DVD STRUCTURE Command ***shall*** be supported.

Table 121 - 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 **Persistent** bit ***shall*** be defined as in Table 87 - *Feature Descriptor generic format* on page 190. Note: this bit ***shall*** be set to zero if the medium is removable.

The **Current** bit ***shall*** be defined as in Table 87 - *Feature Descriptor generic format* on page 190. Note: this bit ***shall*** be set to zero if no DCBs can be read or written.

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** (see Table 271 - *Content Descriptors* on page 327) of a supported DCB. Entries ***shall*** be sorted in ascending order.

Table 122 describes errors that may occur during the operation of the Command or which may cause a CHECK CONDITION status to be reported.

Table 122 - GET CONFIGURATION Command Errors

Error Description	
5/24/00	INVALID FIELD IN CDB

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11.6 GET EVENT/STATUS NOTIFICATION Command

The GET EVENT/STATUS NOTIFICATION Command requests the Logical Unit to report event(s) and status as specified in the Notification Class field and provides asynchronous notification. Two modes of operation are defined here. They are polling and asynchronous modes.

In polling mode, the Host will issue GET EVENT/STATUS NOTIFICATION Commands at periodic intervals with an **Immed** (immediate) bit of 1 set. The Logical Unit ***shall*** complete this Command with the most recently available event status requested. The Logical Unit ***shall*** support polling mode.

In asynchronous mode, the Host will issue a single GET EVENT/STATUS NOTIFICATION Command with an **Immed** (immediate) bit of 0 requested. If the Logical Unit supports Asynchronous event status notification (through tagged queuing) the model outlined here ***shall*** be used. If the Logical Unit does not support Asynchronous Mode, the Command ***shall*** fail as an illegal request. If the Host requests Asynchronous Mode using a non-queable or non-overlappable request, the Command ***shall*** fail with CHECK CONDITION Status, 5/24/00 INVALID FIELD IN CDB.

When Asynchronous Event Status reporting is supported, the Logical Unit ***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 Logical Unit ***shall*** complete the GET EVENT/STATUS NOTIFICATION Command as soon after the event occurs as possible. It will report the event as outlined below.

Note: Only one Event Descriptor per GET EVENT/STATUS NOTIFICATION Command ***shall*** *be reported. The priority of event or status reporting* ***shall*** *be by Event Class number. The lower the class number, the higher the priority.*

This Command ***shall not*** return a CHECK CONDITION Status due to a pending UNIT ATTENTION Condition. Any pending UNIT ATTENTION Condition for which a corresponding event is reported ***shall not*** be cleared for the Logical Unit issuing the GET EVENT/STATUS NOTIFICATION Command.

Implementation notes for Logical Units can be found in *Appendix E - "Example Event Implementation Notes (Informative)"* on page 477, and examples for Hosts can be found in *Appendix I - "Sample Applications of Events (Informative)"* on page 495.

Table 123 - GET EVENT/STATUS NOTIFICATION Command

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation code (4Ah)							
1	LUN (Obsolete)			Reserved				Immed
2	Reserved							
3	Reserved							
4	Notification Class Request							
5	Reserved							
6	Reserved							
7	(MSB) Allocation Length							
8	(LSB)							
9	Vendor-Specific		Reserved			NACA	Flag	Link
10	PAD							
11								

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

If the **Immed** bit is set to zero (and the Logical Unit supports tagged Command queuing) and if there is no event to report, the GET EVENT/STATUS NOTIFICATION Command ***shall*** be queued by the Logical Unit until there is an Event to report.

If the **Immed** bit is set to zero and the Logical Unit does not support tagged Command queuing, the Logical Unit ***shall*** return CHECK CONDITION Status, 5/24/00 INVALID FIELD IN CDB.

The **Notification Class Request** field requests the Logical Unit to report event(s) from the event classes listed requested in this field. See Table 124.

The **Allocation Length** field indicates the maximum number of bytes that ***shall*** be transferred from the Logical Unit. An event ***shall*** be considered reported even if the result data was truncated due to an insufficient **Allocation Length**. An **Allocation Length** of zero ***shall not*** be considered an error.

Table 124 - Notification Class Request

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

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

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

Host Software that manages media event status, may or may not be linked to other software that manages power states This notification field provides a way that power and media event status notifications can be independently managed by the responsible software. If a driver manages media, power management and Busy Device events, the driver can issue this Command with notification field set to 01010100b to request the Logical Unit to report power, media, and busy Events.

The result data format is shown in Table 125. The Event Header is shown in Table 126.

Table 125 - Notification Status List

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

Table 126 - Event Status Header

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

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

The **Notification Class** field specifies the class of notification by number. See Table 127.

Table 127 - 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	Multi-Host
110b	Device Busy
111b	Reserved.

The **NEA** bit, when set to one, ***shall*** indicate that none of the requested notification classes are supported. When set to zero, shall indicate that at least one of the requested notification classes is supported.

The **Supported Event Classes** field specifies the event classes that the Logical Unit supports as per the Notification Class Field of Table 124 - *Notification Class Request* on page 220. If an Event Class is supported, the corresponding bit ***shall*** be set to one.

11.6.1 Operational Change Request/Notification

This Event notifies the Host of changes in the Logical Unit behavior.

Table 128 - Operational Change/Notification Descriptor

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)

The **Operational Event** field reports drive requests to change state and notifications of changes in drive state. If a persistent prevent is in place, any action request that can be reported before performing the action ***shall not*** be performed by the drive, and the drive ***shall*** notify the Host of the requested action. In all other cases, the drive ***shall*** notify the Host of actions that change drive state. An example of an action that must be reported after the action is taken is termination of a format operation due completion of formatting.

Upon reporting operational change notification to the Host, this field is reported as 0h on subsequent GET EVENT/STATUS NOTIFICATION Commands until a new change in operational state occurs.

Table 129 - Operational Event Format

Code	Event	Description
0h	NoChg	No changes in operational state performed or requested
1h	Operational Change Request	The unit requests to change operational state (morph request)
2h	Drive has changed Operational State	The unit has changed operational state
3h-Fh	Reserved	

If a new Event occurs before an existing Event is reported to the Host, the new event ***shall*** replace the old Event if the new Event has a higher Code than the old Event. Otherwise, the new Event ***shall*** be deleted.

The **Persistent Prevented** bit reports the current state of the Persistent Prevent for the Logical Unit.

The **Operational Status** field reports the Logical Unit's ability to respond to the Host.

Table 130 - Operational Status Codes

Code	Status	Description
0h	Available	The Logical Unit is ready for operation
1h	Temporarily busy	The Logical Unit is performing a task that will self-terminate
2h	Busy	The Logical Unit is performing operations that will take an indefinite amount of time to terminate.
3h-Fh	Reserved	

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

Table 131 - Operational Request/Report Codes

Code	Event	Description
0h	NoChg	No changes in operational state performed or requested
1h	Change	The Feature list may have changed.
2h	AddChange	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 Host action. The Host should respond to Events 1h through 5h with a GET CONFIGURATION Command to determine the Logical Unit configuration.

11.6.2 Power Management Class Events

Power Management Class Events notify the Host about changes in the Logical Unit's power state.

Table 132 - Power Management Class Descriptor

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

The **Power Event** field reports the current change in the power status. This field is set to a new power event if a change in power state occurs.

Upon reporting the current power status change to the Host, this field is reported as 0h on subsequent GET EVENT/STATUS NOTIFICATION Commands until a new change in power state occurs.

If the Logical Unit is commanded to go the same state as the Logical Unit is currently in, the next GET EVENT/STATUS NOTIFICATION Command (Power Class) ***shall*** report a Power Change Successful event.

Table 133 - Power Event Codes

Code	Event	Description
0h	NoChg	No changes in power state, or in power state transition
1h	PwrChg-Succ	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	

Table 134 - Power Status Codes

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

Note: Status 4 is only likely reported with asynchronous event notification.

11.6.3 External Request Class Events

External Request Class Events notify the host of changes in behavior due to requests from the Logical Unit front panel or another Host. If a Persistent Prevent is active, the Event is a request to change rather than a notification of a change.

Table 135 - 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 Host, the action ***shall not*** be performed by the Logical Unit. If a Persistent Prevent is not in place for the Host, the drive ***shall*** notify the Host of actions that change drive state. Upon reporting operational change notification to the Host, 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 136.

Table 136 - External Request Event Format

Code	Event	Description
0h	NoChg	No changes in operational state performed or requested
1h	Logical Unit Key Down	A front, back, or remote button has been pressed.
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 Host that would require an action that may interfere with the Persistent Prevent owner's operation.
4h-Fh	Reserved	

The Host may respond to Events 1-3 with no action, an appropriate action, or with a SEND EVENT Command. The Host 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 1 if any Host has performed a persistent reservation.

The **External Request Status** field reports the Logical Unit's ability to respond to the Host.

Table 137 - External Request Status Codes

Code	Status	Description
0h	Ready	The Logical Unit is ready for operation.
1h	OtherPrevent	Indicates that another Host has an active Persistent Prevent. The Persistent Prevent bit ***shall*** be set to 1.
2h-Fh	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 138 - External Request Codes

Code	Event	Description
0h	NoRequest	No requests are pending.
1h	Overrun	The Request Queue has overflowed, External Request Events may be lost.
2h-FFh	Reserved	
100h-1FFh	ASCIIButton	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.
101h	Play	The play button was pressed or another initiator sent a play request
102h	Rewind/back	The rewind/back button was pressed or another initiator send a rewind/back request
103h	Fast Forward	The fast forward button was pressed or another initiator sent a fast forward request
104h	Pause	The pause button was pressed or another initiator sent a pause request.
105h	Reserved	
106h	Stop	The stop button was pressed or another initiator requested a stop.
107h-EFFFh	Reserved	
F000h - FFFFh	Vendor Unique	

11.6.4 Media Event Class

The Media Event Class describes events related to the insertion and removal of media.

Table 139 - Media Event Class Descriptor

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

Table 140 - Media Event Codes

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	MediaChange	The user has requested that the media in the specified slot be loaded.
5h - Fh	Reserved	

Note: Usually two events are generated when the user requests an eject: first, an EjectRequest, and then a MediaRemoval.

Table 141 - Media Status Byte Format

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

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

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

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 by Table 167 - *Mechanism Status Header* on page 244.

11.6.5 Multi-Host Class Events

Multi-Host Class Events notify the Host of requests for control by other Hosts.

Table 142 - Multi-Host Descriptor

Bit / Byte	7	6	5	4	3	2	1	0
0	Reserved				Multi-Host Event			
1	Persistent Prevented	Reserved			Multi-Host Status			
2	(MSB)	Multi-Host Priority						
3								(LSB)

The **Multi-Host Event** field reports requests for control of and reporting of changes in Logical Unit state. If a Persistent Prevent is in place for that Host, the action ***shall not*** be performed by the Logical Unit. If a Persistent Prevent is not in place for that Host, the drive ***shall*** notify the Host of actions that change drive state. Upon reporting Multi-Host Events to the Host, this field is reported as 0h on subsequent GET EVENT/STATUS NOTIFICATION Commands until a new Multi-Host Event occurs. The External Request Events are listed in Table 136.

Table 143 - Multi-Host Event Format

Code	Event	Description
0h	NoChg	No changes in operational state performed or requested
1h	Control Request	Another Host has requested Logical Unit control.
2h	Control Grant	Another Host has received Logical Unit control.
3h	Control Release	Another Host has released Logical Unit control.
4h-Fh	Reserved	

The Host 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 **Multi-Host Status** field reports the Logical Unit's ability to respond to the Host.

Table 144 - Multi-Host Status Codes

Code	Status	Description
0h	Ready	The Logical Unit is ready for operation.
1h	OtherPrevent	Indicates that another Host has an active Persistent Prevent. The Persistent Prevent bit ***shall*** be set to 1.
2h-Fh	Reserved	

The **Multi-Host Priority** field reports the other Host's relative priority. See Table 145.

Table 145 - Multi-Host Priority Codes

Code	Event	Description
0h	NoRequest	No requests are pending.
1h	Low	There are no tasks pending on the Host for this Logical Unit.
2h	Medium	There are no critical tasks pending on the Host for this Logical Unit.
3h	High	There are critical tasks pending on the Host for this Logical Unit.
4h-FFFFh	Reserved	

11.6.6 Device Busy Events

Device Busy Events are used to notify the Host of commands that are executing but that require an abnormally long time to complete. See *Section 8.0, "Time-out and Reset Models"* on page 149.

Table 146 - Device Busy Event Class 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 **Time** field is the predicted amount of time remaining for the device to become not busy, in units of 100ms.

Table 147 - 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	

Table 148 - Device Busy Status Format

Code	Status	Description
0h	NoEvent	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, such as write.
4h - FFh	Reserved	

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 Logical Unit 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 an GET EVENT/STATUS NOTIFICATION Command with the Device Busy class bit set is queued, the Logical Unit ***shall*** complete the Command after a timeout as defined in the timeout section has occurred. However, instead of generating a UNIT ATTENTION, the only action is to complete this Command. If this event is to be used via polling in the immediate mode, the Logical Unit should disable the Logical Unit timeouts.

Table 149 describes errors that may occur during the operation of the Command or which may cause a CHECK CONDITION status to be reported.

Table 149 - GET EVENT/STATUS NOTIFICATION Command Errors

Error Description	
5/24/00	INVALID FIELD IN CDB

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11.7 GET PERFORMANCE Command

The GET PERFORMANCE Command provides a method for the Host to profile the performance of the Logical Unit. 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.

Table 150 - GET PERFORMANCE Command

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation code (ACh)							
1	LUN (Obsolete)			Tolerance		Write	Except	
2	(MSB)							
3	Starting LBA							
4								
5								(LSB)
6	Reserved							
7	Reserved							
8	(MSB)							
9	Maximum Number of Descriptors							(LSB)
10	Reserved							
11	Vendor-Specific		Reserved			NACA	Flag	Link

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

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 may not be included in the 10b list, but would be included in the 01b list. An **Except** field of 11b is reserved.

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 **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** field ***shall*** indicate the maximum number of descriptors that the Logical Unit returns.

The result data ***shall*** be formatted as listed in Table 151:

Table 151 - GET PERFORMANCE Result Data

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

Table 152 - Performance Header

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB) Performance Data Length							
1								
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 that follows the Performance Data Length field.

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. When set to one, ***shall*** indicate that the result data is for exception conditions.

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 for nominal performance are intended to give the Host an approximation of Logical Unit performance. All numbers are nominal. On CD media, all sectors shall be reported as 2352 byte sectors.

For example, a 4X-6X CD-ROM Logical Unit (CAV/CLV combination) with a data disc loaded may return two nominal performance descriptors. The first would indicate a Start LBA of 0, Start Performance of 706 kB/s, and an end LBA in the middle and a performance of 1058 kB/s. The second would indicate a start LBA adjacent to the ending LBA of the previous descriptor, an ending performance of 1058 kB/s, and an end LBA at the end of the medium and an ending performance of 1058 kB/s. The data rate may vary according to the mounted medium, i.e. CD Audio Tracks may have a different spin rate than Data Tracks.

1kB/s is 1000 Bytes per second.

Table 153 - Performance Descriptor - Nominal Performance

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB) Start LBA							
1								
2								
3								(LSB)
4	(MSB) Start Performance							
5								
6								
7								(LSB)

Table 153 - Performance Descriptor - Nominal Performance (Continued)

Bit / Byte	7	6	5	4	3	2	1	0
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 in kB/s.

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 in kB/s.

Table 154 - 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.

Table 155 describes errors that may occur during the operation of the Command or which may cause a CHECK CONDITION status to be reported.

Table 155 - GET PERFORMANCE Command Errors

	Error Description
	A-1.1, "Deferred Error Reporting" on page 437
5/24/00	INVALID FIELD IN CDB

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11.8 INQUIRY Command

The INQUIRY Command requests that information regarding parameters of the Logical Unit be sent to the Host Computer. An option allows the Host to request additional information about the Logical Unit.

Table 156 - INQUIRY Command

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code (12h)							
1	LUN (Obsolete)			Reserved			CmdDt	EVPD
2	Page Code or Operation Code							
3	Reserved							
4	Allocation Length							
5	Vendor-Specific		Reserved			NACA	Flag	Link
6	PAD							
7								
8								
9								
10								
11								

The INQUIRY Command ***shall*** return CHECK CONDITION status only when the Logical Unit cannot return the requested INQUIRY data. The INQUIRY data should be returned even though the peripheral Logical Unit may not be ready for other Commands.

If an INQUIRY Command is received with a pending UNIT ATTENTION Condition (i.e. before the Logical Unit reports CHECK CONDITION status), the Logical Unit ***shall*** perform the INQUIRY Command and ***shall not*** clear the UNIT ATTENTION condition.

The Enable Vital Product Data (**EVPD**) bit is optional. When set to zero, ***shall*** indicate that INQUIRY data shall be returned as shown in Table 157. When set to one, ***shall*** indicate that the page identified by the **Page Code** field be returned.

The **Page Code** field is valid when the **EVPD** bit is set to one. The **Page Code** field shall identify the requested INQUIRY Page.

The Command Support Data (**CmdDt**) is used to request the Logical Unit return the Command support data specified by the operation code field. This capability is not used by C/DVD Logical Units. If this bit is set to one, the Logical Unit ***shall*** return CHECK CONDITION Status, 5/24/00 INVALID FIELD IN CDB.

The **Allocation Length** field ***shall*** indicate the maximum number of bytes that may be transferred to the Host.

The INQUIRY data should be returned even though the Logical Unit is not ready for other Commands. To minimize delays after a power on or hard reset, the standard INQUIRY data should be available without incurring any media access delays. If the Logical Unit does store some of the INQUIRY data on the media, it may return zeros or ASCII spaces (20h) in those fields until the data is available from the media.

11.8.1 Standard INQUIRY Data

The standard INQUIRY data contains 36 required bytes, followed by a variable number of vendor-specific parameters. Bytes 58 through 95, if returned, are reserved for future standardization.

Table 157 - INQUIRY Data Format

<table>
<tr><th>Bit
Byte</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>0 SCSI</td><td colspan="3">Peripheral Qualifier</td><td colspan="5" rowspan="2">Peripheral Device Type</td></tr>
<tr><td>0 ATAPI</td><td colspan="3">Reserved</td></tr>
<tr><td>1</td><td>RMB</td><td colspan="7">Reserved</td></tr>
<tr><td>2 SCSI</td><td colspan="2" rowspan="2">ISO Version (0)</td><td colspan="3" rowspan="2">ECMA Version (0)</td><td colspan="3">ANSI Version (>0)</td></tr>
<tr><td>2 ATAPI</td><td colspan="3">ANSI Version (0)</td></tr>
<tr><td>3 SCSI</td><td>AERC</td><td>Obsolete</td><td>NormACA</td><td>HiSupport</td><td colspan="4" rowspan="2">Response Data Format</td></tr>
<tr><td>3 ATAPI</td><td colspan="4">ATAPI Transport Version (3)</td></tr>
<tr><td>4</td><td colspan="8">Additional Length (Number of bytes following this one)</td></tr>
<tr><td>5</td><td>SCCS</td><td colspan="7">Reserved</td></tr>
<tr><td>6 SCSI</td><td>BQue</td><td>EncServ</td><td>VS</td><td>MultiP</td><td>MChngr</td><td>AckReqQ</td><td>Addr32</td><td>Addr16</td></tr>
<tr><td>6 ATAPI</td><td colspan="8">Reserved</td></tr>
<tr><td>7 SCSI</td><td>RelAdr</td><td>WBus32</td><td>WBus16</td><td>Sync</td><td>Linked</td><td>TranDis</td><td>CmdQue</td><td>VS</td></tr>
<tr><td>7 ATAPI</td><td colspan="8">Reserved</td></tr>
<tr><td>8</td><td colspan="8" rowspan="2">Vendor Identification</td></tr>
<tr><td>15</td></tr>
<tr><td>16</td><td colspan="8" rowspan="2">Product Identification</td></tr>
<tr><td>31</td></tr>
<tr><td>32</td><td colspan="8" rowspan="2">Product Revision Level</td></tr>
<tr><td>35</td></tr>
<tr><td>36</td><td colspan="8" rowspan="2">Vendor-specific</td></tr>
<tr><td>55</td></tr>
<tr><td>56</td><td colspan="8">Reserved</td></tr>
<tr><td>57</td><td colspan="8">Reserved</td></tr>
<tr><td>58</td><td colspan="8" rowspan="2">Reserved</td></tr>
<tr><td>95</td></tr>
<tr><td>96</td><td colspan="8" rowspan="2">Vendor Specific Parameters</td></tr>
<tr><td>n</td></tr>
</table>

The **Peripheral Qualifier** value is defined in Table 158.

Table 158 - Peripheral Qualifier Definitions

Peripheral Qualifier	Definition
000b	The specified peripheral device type is currently connected to this Logical Unit. If the Logical Unit cannot determine whether or not a physical device is currently connected, it also ***shall*** use this peripheral qualifier when returning the INQUIRY data. This peripheral qualifier does not mean that the device is ready for access by the initiator.
001b	The Logical Unit is capable of supporting the specified peripheral device type on this Logical Unit. However, the physical device is not currently connected to this Logical Unit.
010b	Reserved
011b	The Logical Unit is not capable of supporting a physical device on this Logical Unit. For this peripheral qualifier the peripheral device type shall be set to 1Fh to provide compatibility with previous versions of SCSI. All other peripheral device type values are reserved for this peripheral qualifier.
1xxb	Vendor Specific

The peripheral device-type field identifies the device as defined in Table 159. The Peripheral Device Type ***shall*** be set to 05h to indicate a C/DVD Logical Unit.

Table 159 - Peripheral Device Types

Code	Description
00h	Direct-access Logical Unit (e.g. magnetic disk)
01h - 04h	Reserved
05h	C/DVD Logical Unit (ROM, R, RW, RAM and +RW types)
06h	Reserved
07h	Optical memory Logical Unit (e.g. some optical disks)
08h - 1Eh	Reserved
1Fh	Unknown or no Logical Unit type

A Removable Medium Bit (**RMB**) of zero indicates that the medium is not removable. A **RMB** bit of one indicates that the medium is removable. C/DVD-ROM Logical Units should always report “Removable.”

The usage of non-zero code values in the ISO version and ECMA version fields are defined by the International Organization for Standardization and ECMA, respectively.

The **ANSI-approved version** field ***shall*** contain a non-zero value to comply with this version of the Specification for a SCSI Logical Unit or zero for an ATAPI Logical Unit.

The **ATAPI Transport Version** field ***shall*** contain 03h to comply with this version of the Specification. This field indicates the version of the ATAPI Transport that is being used. For more information on the transport, see the X3T13/1153D Standard. For a SCSI Logical Unit this field is defined by the SCSI SPC Standard.

The asynchronous event reporting capability (**AERC**) bit indicates that the Logical Unit supports the asynchronous event reporting capability as defined in SAM. The **AERC** bit is qualified by the peripheral device type field as follows:

a) Processor device-type definition: An **AERC** bit of one indicates that the processor device is capable of accepting asynchronous event reports. An **AERC** bit of zero indicates that the processor device does not support asynchronous event reports; or

b) All other device-types: This bit is reserved.

Details of the asynchronous event reporting support are protocol-specific.

The Normal ACA Supported bit (**NormACA**) of one indicates that the Logical Unit supports setting the NACA bit to one in the Control Byte of the CDB (as defined in SAM). A **NormACA** bit of zero indicates that the Logical Unit does not support setting the NACA bit to one.

A hierarchical support (**HiSupport**) bit of zero indicates the Logical Unit does not use the hierarchical addressing model to assign LUNs to Logical Units. A **HiSupport** bit of one indicates the Logical Unit uses the hierarchical addressing model to assign LUNs to Logical Units. When the **HiSupport** bit is one, the Logical Unit shall support the REPORT LUNS command (see 7.19).

A **Response Data Format** value of 02h indicates that the data ***shall*** be in the format specified in this Specification.

The **Additional Length** field ***shall*** specify the length in bytes of the parameters. If the allocation length of the Command Packet is too small to transfer all of the parameters, the additional length ***shall*** not be adjusted to reflect the truncation.

An SCC Supported (**SCCS**) bit of one indicates that the device contains an embedded storage array controller component. See SCC-2 for details about storage array controller devices. An **SCCS** bit of zero indicates that the device does not contain an embedded storage array controller component.

Note: The embedded changer model is not the one presented in this document.

The basic queuing (**BQue**) bit shall be zero if the **CmdQue** bit is one. When the **CmdQue** bit is zero, the **BQue** bit shall have the following meaning. A **BQue** bit of zero indicates that the device does not support tagged tasks (command queuing) for this Logical Unit. A value of one indicates that the device supports, for this Logical Unit, the basic task management model defined by SAM-2.

An Enclosure Services (**EncServ**) bit of one indicates that the device contains an embedded enclosure services component. See SES for details about enclosure services, including a device model for an embedded enclosure services device. An **EncServ** bit of zero indicates that the device does not contain an embedded enclosure services component.

A Multi Port (**MultiP**) bit of one shall indicate that this is a multi-port (2 or more ports) device and conforms to the SCSI-3 multi-port device requirements found in the applicable standards. A value of zero indicates that this device has a single port and does not implement the multi-port requirements.

A medium changer (**MChngr**) bit of one indicates that the device is embedded within or attached to a medium transport element. See SMC for details about medium changers, including a device model for an attached medium changer device. The **MChngr** bit is valid only when the **RMB** bit is equal to one. A **MChngr** bit of zero indicates that the device is not embedded within or attached to a medium transport element.

Note: The MChngr bit is unrelated to the changer model described in this standard.

A relative addressing (**RelAdr**) bit of one indicates that the Logical Unit supports the relative addressing mode. If this bit is set to one, the linked command (**Linked**) bit shall also be set to one; since relative addressing is only allowed with linked commands. A **RelAdr** bit of zero indicates the Logical Unit does not support relative addressing.

A linked command (**Linked**) bit of one indicates that the Logical Unit supports linked commands (see SAM). A value of zero indicates the Logical Unit does not support linked commands.

A command queuing (**CmdQue**) bit of one indicates that the device supports tagged tasks (command queuing) for this Logical Unit (see SAM-2). A value of zero indicates the Logical Unit may support tagged tasks for this Logical Unit (see the **BQue** bit, above). Table 160 summarizes the relationship of the **BQue** and **CmdQue** bits.

Table 160 - Relationship of BQue and CmdQue bits

BQue	CmdQue	Description
0	0	No command queuing of any kind supported.
0	1	Command queuing with all types of task tags supported.
1	0	Basic task set model supported (see SAM-2)
1	1	Illegal combination of BQue and CmdQue bits.

ASCII data fields ***shall*** contain only graphic codes (i.e. code values 20h through 7Eh). Left-aligned fields ***shall*** place any unused bytes at the end of the field (highest offset) and the unused bytes ***shall*** be filled with space characters (20h). Right-aligned fields ***shall*** place any unused bytes at the start of the field (lowest offset) and the unused bytes ***shall*** be filled with space characters (20h).

The **Vendor Identification** field contains 8 bytes of ASCII data identifying the vendor of the product[1]. The data ***shall*** be left aligned within this field.

The **Product Identification** field contains 16 bytes of ASCII data as defined by the vendor. The data ***shall*** be left-aligned within this field.

The **Product Revision Level** field contains 4 bytes of ASCII data as defined by the vendor. The data ***shall*** be left-aligned within this field.

11.8.2 Using the INQUIRY Command

The INQUIRY Command may be used by a Host to determine the configuration of the Logical Unit. Logical Units respond with information that includes their type and Specification level and may include the vendor's identification, model number and other useful information.

Table 161 describes errors that may occur during the operation of the Command or which may cause a CHECK CONDITION status to be reported.

Table 161 - INQUIRY Command Errors

Error Description	
5/24/00	INVALID FIELD IN CDB

1. It is intended that this field provide a unique vendor identification of the manufacturer of the Logical Unit. In the absence of a formal registration procedure, X3T10 maintains a list of vendor identification codes in use. Vendors are requested to voluntarily submit their identification codes to X3T10 to prevent duplication of codes.

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11.9 LOAD/UNLOAD MEDIUM Command

The LOAD/UNLOAD MEDIUM Command requests that the Logical Unit changer load or unload a Disc. New LOAD/UNLOAD MEDIUM Commands issued before the changer posts a state of READY, will cause the changer to abort the LOAD/UNLOAD MEDIUM Command in progress and begin processing the new LOAD/UNLOAD MEDIUM Command.

Table 162 - LOAD/UNLOAD MEDIUM Command

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code (A6h)							
1	LUN (Obsolete)			Reserved				Immed
2	Reserved							
3	Reserved							
4	Reserved						LoUnlo	Start
5	Reserved							
6	Reserved							
7	Reserved							
8	Slot							
9	Reserved							
10	Reserved							
11	Vendor-Specific		Reserved			NACA	Flag	Link

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.

A **Start** bit of one requests the Logical Unit be made ready for use. A **Start** bit of zero requests that the Logical Unit be stopped (media cannot be accessed by the Host).

Table 163 - Load/Unload or Optional Selection 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	Either Move the Disc in the selected Slot to the play position or select the Slot specified for use with future Media Access Commands

The **Slot** field indicates the Slot to be loaded. Changers compatible with the Bootable CD specification should always initialize (Load) Slot 0 on Power On or Hard Reset.

Any attempt to Load or Unload a Disc when the Logical Unit does not support that capability ***shall*** result in CHECK CONDITION Status, 5/24/00 INVALID FIELD IN CDB.

Loading when the slot does not contain a Disc will be rejected with CHECK CONDITION Status, 2/3A/00 MEDIUM NOT PRESENT. When this error is returned there are two possible actions by the Logical Unit. If the Logical Unit reports Software Slot Selection (**SSS**) = 1, then the slot specified ***shall*** be selected for use. The **SSS** bit is defined in *11.12.3.6, "C/DVD Capabilities & Mechanical Status Page (obsolete)"* on page 263. If the Logical Unit reports **SSS** = 0 then the previously used slot ***shall*** continue to 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 Host (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 for the Host issuing the LOAD/UNLOAD MEDIUM Command when discs are loaded or unloaded from the playing position.

Unloading when the Play Position does not contain a Disc will be rejected CHECK CONDITION Status, 5/24/00 INVALID FIELD IN CDB for the Slot Byte.

Table 164 describes errors that may occur during the operation of the Command or which may cause a CHECK CONDITION status to be reported.

Table 164 - LOAD/UNLOAD MEDIUM Command Errors

	Error Description
	A-1.1, "Deferred Error Reporting" on page 437
	Table 421 - *Basic Error Codes* on page 445
4/3B/16	MECHANICAL POSITIONING OR CHANGER ERROR
4/53/00	MEDIA LOAD OR EJECT FAILED

11.10 MECHANISM STATUS Command

The MECHANISM STATUS Command requests that the Logical Unit respond with the current status of the Logical Unit, including any Changer Mechanism that adheres to this specification. This Command is intended to provide information to the Host about the current operational state of the Logical Unit. The Logical Units take operational direction from both the Host and the user (Person). Movement of media in/out of the Logical Unit as well as external conditions beyond the control of the Host. This Command has been provided to allow the Host to know what as transpired at the user level.

Table 165 - MECHANISM STATUS Command

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code (BDh)							
1	LUN (Obsolete)			Reserved				
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	Reserved							
8	(MSB) Allocation Length							
9								(LSB)
10	Reserved							
11	Vendor-Specific		Reserved			NACA	Flag	Link

The **Allocation Length** field specifies the maximum length in bytes of the Returned 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 Mechanism Status List contains a header, followed by zero or more fixed-length Slot Tables. If the Logical Unit does not support the changer Feature, then the number of slot tables returned to the Host ***shall*** be zero. The number of slot tables returned ***shall*** be same as reported in the Number of Slots Available (Byte 5 of the Mechanism Status Header) field.

Table 166 - Mechanism Status Parameter List

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

Each Slot Table contains the a slot number and status information.

Table 167 - Mechanism Status Header

Byte \ Bit	7	6	5	4	3	2	1	0
0	Fault	Changer State		Current Slot				
1	C/DVD Mechanism State			DoorOpen	Reserved			
2	(MSB)							
3	Current LBA							
4								(LSB)
5	Reserved		Number of Slots Available					
6	(MSB)							
7	Length of Slot Table(s)							(LSB)

Bit 0-4, Current Slot — This field indicates the current Changer Slot selected. Changers compatible with a Bootable CD specification/standard, should always initialize (Load) Slot 0 on Power On or Hard Reset. This value ***shall*** only be changed when a LOAD/UNLOAD MEDIUM 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.

Bit 5-6, Changer State — This field indicates the current state of the Logical Unit.

- 0h Ready
- 1h Load in Progress
- 2h Unload in Progress
- 3h Initializing

Bit 7, Fault — This bit indicates that the changer failed to complete the operation reported in the Changer State field. If the Logical Unit is not a changer, then this bit is reserved.

Bit 4, DoorOpen — This bit indicates that the Door(s) or Tray(s) is open or the Magazine is not present.

Bit 7-5, C/DVD Mechanism State — This field encodes the current operation of the Logical Unit.

- 0h Idle
- 1h Active with Audio Port in use (i.e. Playing, Paused)
- 2h Scan in progress
- 3h Active with Host, Composite or Other Ports in use (i.e. READ, PLAY CD, SCAN during a PLAY CD). Note that MMC does not make use of this value.
- 4-6h Reserved
- 7h No State Information Available

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 will contain the LBA of the current block being processed.

The **Number of Slots** Available field ***shall*** return the number of logical Slots that the Logical Unit supports and ***shall*** be a maximum of 32.

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 168 - Slot Table Response format

<table>
<tr><th>Bit
Byte</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>0</td><td>Disc Present</td><td colspan="6">Reserved</td><td>Change</td></tr>
<tr><td>1</td><td colspan="8">Reserved</td></tr>
<tr><td>2</td><td colspan="8">Reserved</td></tr>
<tr><td>3</td><td colspan="8">Reserved</td></tr>
</table>

Bit 0, **Change (mandatory)** Change indicates that the Disc in that slot has been changed since the last time the Disc was loaded.

Bit 7, **Disc Present (Optional)** This bit reports the presence of a Disc in a Slot, or if the Disc for a given Slot is in the Playing Position. A value of 1 indicates the Disc is present, and 0 indicates that it is not.

SDP=0 Changer Logical Units may not support the capability of reporting the presence of a Disc in each of the slots after reset or a Magazine change. In this case the Logical Unit must report this in the Changer Feature (See *11.5.2.21, "Feature 0102h: Embedded Changer"* on page 211 “Supports Disc Present Reporting bit (**SDP**)”). In this case the Logical Unit ***shall*** report that ALL Discs are present, until the Logical Unit can determine that there is no Disc present (i.e. when a LOAD/UNLOAD MEDIUM Command is processed for an empty slot).

SDP=1 If the Changer Logical Unit does support the reporting of the Disc Present then this bit ***shall*** be valid for all slots. It is not acceptable for the Logical Unit to actually load and unload each slot to compute this information.

Table 169 describes errors that may occur during the operation of the Command or which may cause a CHECK CONDITION status to be reported.

Table 169 - MECHANISM STATUS Command Errors

Error Description
A-1.1, "Deferred Error Reporting" on page 437
Table 421 - *Basic Error Codes* on page 445

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11.11 MODE SELECT (10) Command

The MODE SELECT (10) Command provides a means for the Host to specify medium or Logical Unit parameters to the Logical Unit. Hosts should issue a MODE SENSE (10) Command prior to each MODE SELECT (10) Command to determine supported Pages, Page Lengths, and other parameters.

Table 170 - MODE SELECT (10) Command

Byte \ Bit	7	6	5	4	3	2	1	0
0	Operation code (55h)							
1	LUN (Obsolete)			PF (1)	Reserved			SP
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	(MSB) Parameter List Length							
8								(LSB)
9	Vendor-Specific		Reserved			NACA	Flag	Link
10	PAD							
11								

A Save Pages (**SP**) bit of zero indicates the Logical Unit ***shall*** perform the specified MODE SELECT (10) operation, and ***shall not*** save any Pages. An **SP** bit of one indicates that the Logical Unit ***shall*** perform the specified MODE SELECT (10) operation, and ***shall*** save to a non-volatile vendor-specific location all the savable Pages. If a Logical Unit supports saved Pages, it ***shall*** save only one copy of the Page. The **SP** bit is optional, even when Mode Pages are supported by the Logical Unit. Pages that are saved are identified by the parameter savable bit that is returned in the Page Header by the MODE SENSE (10) Command. If the **PS** bit is set in the MODE SENSE (10) data then the Page ***shall*** be savable by issuing a MODE SELECT (10) Command with the **SP** bit set. If the Logical Unit does not implement saved Pages and the SP bit is set to one, the Command ***shall*** be terminated with CHECK CONDITION Status, 5/24/00 INVALID FIELD IN CDB.

The **Parameter List Length** field specifies the maximum length in bytes of the mode parameter list that ***shall*** be transferred from the Host to the Logical Unit after the Command Packet is transferred. A **Parameter List Length** of zero indicates that no data ***shall*** be transferred. This condition ***shall not*** be considered as an error.

If the **Parameter List Length** results in the truncation of any mode parameter header or Mode Page, the Logical Unit ***shall*** terminate the Command with CHECK CONDITION Status, 5/1A/00 PARAMETER LIST LENGTH ERROR.

The mode parameter list for the MODE SELECT (10) and MODE SENSE (10) Commands is defined in *11.12.3, "Mode Select/Sense Parameters"* on page 251.

The Logical Unit ***shall*** terminate the MODE SELECT (10) Command with CHECK CONDITION Status, 5/26/00 INVALID FIELD IN PARAMETER LIST, and ***shall not*** change any mode parameters for the following conditions:

1. If the Host sets any field (except for reserved fields) that is reported as not changeable by the Logical Unit to a value other than its current value.
2. If the Host sets any unreserved field in the mode parameter header to an unsupported value.
3. If a Host sends a Mode Page with a Page Length not equal to the Page Length returned by the MODE SENSE (10) Command for that Page.
4. If the Host sends an unsupported value for a mode parameter and rounding is not implemented for that mode parameter.

If the Host sends a value for a mode parameter that is outside the range supported by the Logical Unit and rounding is implemented for that mode parameter, the Logical Unit may either:

1. round the parameter to an acceptable value and terminate the Command with CHECK CONDITION Status, 1/37/00 ROUNDED PARAMETER;
2. terminate the Command with CHECK CONDITION Status, 5/26/00 INVALID FIELD IN PARAMETER LIST.

A Logical Unit may alter any mode parameter in any Mode Page (even those reported as non-changeable) as a result of changes to other mode parameters[1].

The Logical Unit validates the non-changeable mode parameters against the current values that existed for those mode parameters prior to the MODE SELECT (10) Command.

Mode Pages are maintained per Logical Unit. The Pages are thus used for multiple media insertions/removals. In the case of a Changer Mechanism all the media in the changer make use of the same Mode Pages. Changing of media ***shall not*** cause a CHECK CONDITION Status, 6/2A/01 MODE PARAMETERS CHANGED, nor ***shall*** any Mode Parameter change.

Table 171 describes errors that may occur during the operation of the Command or which may cause a CHECK CONDITION status to be reported.

Table 171 - MODE SELECT (10) Command Errors

	Error Description
	A-1.1, "Deferred Error Reporting" on page 437
	Table 421 - *Basic Error Codes* on page 445
5/39/00	SAVING PARAMETERS NOT SUPPORTED

1. If the current values calculated by the Logical Unit affect the Host's operation, the Host ***shall*** issue a MODE SENSE (10) Command after each MODE SELECT (10) Command.

11.12 MODE SENSE (10) Command

The MODE SENSE (10) Command provides a means for a Logical Unit to report parameters to the Host. It is a complementary Command to the MODE SELECT (10) Command.

Table 172 - MODE SENSE (10) Command

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code (5Ah)							
1	LUN (Obsolete)			Reserved	DBD	Reserved		
2	PC		Page Code					
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	(MSB)			Allocation Length				
8								(LSB)
9	Vendor-Specific		Reserved			NACA	Flag	Link
10	PAD							
11								

The **Disable Block Descriptor** (**DBD**), when set to zero, ***shall*** specify that a Block Descriptor may be returned. When set to one, it ***shall*** specify that the Block Descriptor ***shall not*** be returned. This bit ***shall*** always be set to one for an ATAPI Logical Unit. For a SCSI Logical Unit this bit may be set to zero only in a legacy environment.

11.12.1 Page Control

The Page Control (**PC**) field defines the type of mode parameter values to be returned in the Mode Pages. See Table 173 and 11.12.1.1 - 11.12.1.4.

Table 173 - Page Control Field

Code	Type of Parameter	Section
00b	Current values	11.12.1.1
01b	Changeable values	11.12.1.2
10b	Default values	11.12.1.3
11b	Saved values	11.12.1.4

*Note: The Page Control field only affects the mode parameters within the Mode Pages, however the PS bit, Page Code and Page Length fields **shall** return current values since they have no meaning when used with other types. The mode parameter header **shall** return current values. (see also 11.12.3, "Mode Select/Sense Parameters"* on page 251*)*

The **Page Code** specifies which Mode Page(s) to return[1]. See Table 176 - *Mode Page Codes* on page 251 for a description of the Mode Pages.

A Host may request any one or all of the supported Mode Pages from a Logical Unit. If a Host issues a MODE SENSE (10) Command with a Page Code value not implemented by the Logical Unit, the Logical Unit ***shall*** return CHECK CONDITION Status, 5/24/00 INVALID FIELD IN CDB.

1. Mode Pages ***shall*** be returned in ascending Page code order except for Mode Page 00h.

A Page Code of 3Fh indicates that all Mode Pages implemented by the Logical Unit ***shall*** be returned to the Host. If the mode parameter list exceeds 65534 bytes for ATAPI or 65535 for SCSI in a MODE SENSE (10) Command, the Logical Unit ***shall*** return CHECK CONDITION Status, 5/24/00 INVALID FIELD IN CDB.

Mode Page 00h, if implemented, ***shall*** be returned after all other Mode Pages.

11.12.1.1 Current Values

A **PC** field value of 0h requests that the Logical Unit return the current values of the mode parameters. The current values returned are:

1. the current values of the mode parameters established by last successful MODE SELECT (10) Command.
2. the saved values of the mode parameters if a MODE SELECT (10) Command has not successfully completed since the last power-on, hard RESET condition.
3. the default values of the mode parameters, if saved values, are not available or not supported.

11.12.1.2 Changeable Values

A **PC** field value of 1h requests that the Logical Unit return a mask denoting those mode parameters that are changeable. In the mask, the fields of the mode parameters that are changeable ***shall*** be set to all one bits and the fields of the mode parameters that are non-changeable (i.e. defined by the Logical Unit) ***shall*** be set to all zero bits.

An attempt to change a non-changeable mode parameter (via MODE SELECT (10)) results in an error condition.

The Host should issue a MODE SENSE (10) Command with the PC field set to 1h and the Page Code field set to 3Fh to determine which Mode Pages are supported, which mode parameters within the Mode Pages are changeable, and the supported length of each Mode Page prior to issuing any MODE SELECT (10) Commands.

11.12.1.3 Default Values

A **PC** field value of 2h requests that the Logical Unit return the default values of the mode parameters. Parameters not supported by the Logical Unit ***shall*** be set to zero. Default values are accessible even if the Logical Unit is not ready.

11.12.1.4 Saved Values

A **PC** field value of 3h requests that the Logical Unit return the saved values of the mode parameters. Implementation of saved Page parameters is optional. Mode parameters not supported by the Logical Unit ***shall*** be set to zero. If saved values are not implemented, the Command ***shall*** be terminated with CHECK CONDITION Status, 5/39/00 SAVING PARAMETERS NOT SUPPORTED.

The method of saving parameters is vendor-specific. The parameters are preserved in such a manner that they are retained when the Logical Unit is powered down. All savable Pages can be considered saved when a MODE SELECT (10) Command issued with the SP bit set to one has returned a “good” status.

Note: As C/DVD Logical Units do not have writable media and the media is removable, most will not support Saved Values. It is recommended that the Host software not make use of saved Pages.

11.12.2 Initial Responses

After a power-up condition or hard reset condition or for ATAPI the DEVICE RESET, the Logical Unit ***shall*** respond in the following manner:

1. If default values are requested, report the default values.
2. If saved values are requested, report valid restored mode parameters, or restore the mode parameters and report them. If the saved values of the mode parameters are not able to be accessed from the non-volatile, vendor-specific location, terminate the Command with 5/39/00SAVING PARAMETERS NOT SUPPORTED. If saved parameters are not implemented, respond as defined in 11.12.1.4.
3. If current values are requested and the current values of the mode parameters have not been sent by the Host (via a MODE SELECT (10) Command), the Logical Unit may return either the default or saved values as defined above. If current values have been sent, the current values ***shall*** be reported.

Table 171 describes errors that may occur during the operation of the Command or which may cause a CHECK CONDITION status to be reported.

Table 174 - MODE SENSE (10) Command Errors

Error Description	
	A-1.1, "Deferred Error Reporting" on page 437
	Table 421 - *Basic Error Codes* on page 445
5/39/00	SAVING PARAMETERS NOT SUPPORTED

11.12.3 Mode Select/Sense Parameters

This section describes the Pages used with MODE SELECT (10) and MODE SENSE (10) Commands.

The Mode Parameter List contains a header, followed by zero or more variable-length Pages.

Table 175 - Mode Parameter List

Bit Byte	7	6	5	4	3	2	1	0
0 - n	Mode Parameter Header							
0 - m	Page(s)							

Each Mode Page contains a Page code, a Page Length, and a set of mode parameters.

Table 176 - Mode Page Codes

Page Code	Page Description	Section
00h	Vendor-specific (does not require Page Format)	
01h	Read/Write Error Recovery Parameters	11.12.3.1
02h - 04h	Reserved	
05h	Write Parameters	11.12.3.7
06h - 0Dh	Reserved	
0Eh	CD Audio Control	11.12.3.3
0Fh - 19h	Reserved	
1Ah	Power Condition	11.12.3.2
1Bh	Reserved	
1Ch	Fault / Failure Reporting	11.12.3.4
1Dh	Time-out & Protect	11.12.3.5
1Eh - 1Fh	Reserved	
20h - 29h,	Vendor-specific (Page Format required)	
2Ah	C/DVD Capabilities & Mechanical Status	11.12.3.6
2Bh - 3Eh	Vendor-specific (Page Format required)	
3Fh	Return all Pages (valid only for the MODE SENSE (10) Command)	

Table 177 - Mode Page Format

Bit / Byte	7	6	5	4	3	2	1	0
0	PS/ Reserved	Reserved	Page Code					
1	Page Length (n-1)							
2	Mode Parameters							
n								

When using the MODE SENSE (10) Command, a Parameters Savable (**PS**) bit of one ***shall*** indicate that the Mode Page can be saved by the Logical Unit in a non-volatile, vendor-specific location. A **PS** bit of zero ***shall*** indicate that the supported parameters cannot be saved. When using the MODE SELECT (10) Command, the PS bit is reserved.

The **Page Code** field identifies the format and parameters defined for that Mode Page.

When using the MODE SENSE (10) 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 (10) Command, this Page ***shall*** be sent last.

The **Page Length** field specifies the length in bytes of the mode parameters that follow. If the Host does not set this value to the value that is returned for the Page by the MODE SENSE (10) Command, the Logical Unit ***shall*** terminate the Command with CHECK CONDITION Status, 5/26/00 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 for each Page are defined here. Mode parameters not implemented by the Logical Unit ***shall*** be set to zero.

Table 178 - Mode Parameter 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	(MSB)	Block Descriptor Length 0 (8 for legacy SCSI Logical Units)						
7								(LSB)

When using the MODE SENSE (10) 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 (10) Command, this field is reserved.

The block descriptor associated with the MODE SELECT (10) and MODE SENSE (10) Commands is used for legacy system support for SCSI systems. If supported, block sizes (see Table 179) ***shall*** include 2048 for C/DVD media and may include 512, 2056, 2324, 2332, 2336, 2340, 2352, 2368, and 2448 bytes. The Table of Block Sizes for Read shows the implementation of the various block sizes. These definitions apply for reading with the Read Commands. Other block sizes are allowed and the contents of those blocks are not specified by this specification.

Table 179 - Block Descriptor Block Sizes for Read

Size	Readable block types
512	Mode 1 or Mode 2 Form 1 sectors divided into four blocks each.
2048	Mode 1, Mode 2 Form 1, or DVD
2056	Mode 2 Form 1 with subheader. Equivalent to READ CD, Flag = 50h.
2324	Mode 2 Form 2 with no subheader. Note: There is no mapping to READ CD, as the 4 spare bytes are not returned.
2332	Mode 2, form 1 or 2 data. The drive ***shall*** operate as specified for 2048 byte blocks except: Both forms send 2332 byte blocks. Form 1 blocks return the third layer ECC with the user data. Note: There is no mapping to READ CD, as the 4 spare bytes are not returned.
2336	Mode 2 data The drive ***shall*** operate as specified for 2048 byte blocks lengths. This mode will include all data, including Yellow Book Mode 2 sectors and Form 1 and Form 2. Equivalent to READ CD, Flag = 58h.
2340	All bytes except the synchronization field. Equivalent to READ CD, Flag = 78h.
2352	Audio or raw blocks. The drive ***shall*** operate as specified for 2048 byte blocks. Reads of data mode sectors ***shall*** return descrambled data. Equivalent to READ CD, Flag = F8h.
2448 or 2368	Audio or raw blocks with raw sub-channel. The drive ***shall not*** perform the data descrambling operation. Equivalent to READ CD, Flag = F8, Sub-channel data selection = 010b (2448) or Sub-channel data selection = 001b (2368).

11.12.3.1 Read/Write Error Recovery Parameters Page

The Read/Write Error Recovery Parameters Page specifies the error recovery parameters the Logical Unit ***shall*** use during any Command that performs a data read or write operation from or to the media (e.g. READ (10), READ TOC/PMA/ATIP, WRITE (10), etc.).

Table 180 - Read/Write Error Recovery Parameters Page Format

<table>
<tr><th>Bit
Byte</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>0</td><td>PS</td><td>Reserved</td><td colspan="6">Page Code (01h)</td></tr>
<tr><td>1</td><td colspan="8">Page Length (0Ah)</td></tr>
<tr><td rowspan="2">2</td><td colspan="8">Error Recovery Parameter, Default 0</td></tr>
<tr><td>AWRE</td><td>ARRE</td><td>TB</td><td>RC</td><td>Reserved</td><td>PER</td><td>DTE</td><td>DCR</td></tr>
<tr><td>3</td><td colspan="8">Read Retry Count</td></tr>
<tr><td>4</td><td colspan="8">Correction Span</td></tr>
<tr><td>5</td><td colspan="8">Head Offset count</td></tr>
<tr><td>6</td><td colspan="8">Data Strobe Offset Count</td></tr>
<tr><td>7</td><td colspan="8">Reserved</td></tr>
<tr><td>8</td><td colspan="8">Reserved for Write Retry Count</td></tr>
<tr><td>9</td><td colspan="8">Reserved</td></tr>
<tr><td>10</td><td colspan="8" rowspan="2">(MSB)
Reserved for Recovery Time Limit
(LSB)</td></tr>
<tr><td>11</td></tr>
</table>

The Parameters Savable (**PS**) bit is only used with the MODE SENSE (10) Command. This bit is reserved with the MODE SELECT (10) Command. A **PS** bit of one indicates that the Logical Unit is capable of saving the Page in a non-volatile vendor-specific location.

Note: The implementation of error recovery procedures for C/DVD Logical Units is markedly different from those used for magnetic medium disk drives. At least one level of error correction is required to transfer the data stream. Therefore, the performance of the Logical Unit may differ substantially from what would be expected by sending the same error recovery parameters to a magnetic medium Logical Unit.

An automatic write reallocation enabled (**AWRE**) bit of one indicates that the Logical Unit ***shall*** enable automatic reallocation to be performed during write operations. An **AWRE** bit of zero indicates that the Logical Unit ***shall not*** perform automatic reallocation of defective data blocks during write operations.

An automatic read reallocation enabled (**ARRE**) bit of one indicates that the Logical Unit ***shall*** enable automatic reallocation of defective data blocks during read operation. An **ARRE** bit of zero indicates that the Logical Unit ***shall not*** perform automatic reallocation of defective data blocks during read operation. When **ARRE** is enabled other error recovery modes ***shall not*** be used. The Disable Correction and Read Continuous ***shall not*** be enabled while **ARRE** is enabled.

A Transfer Block (**TB**) bit of one indicates that a data block that is not recovered within the recovery limits specified, ***shall*** be transferred to the Host before CHECK CONDITION status is returned. A **TB** bit of zero indicates that such a data block ***shall not*** be transferred to the Host. The **TB** bit does not affect the action taken for recovered data.

A Read Continuous (**RC**) bit of one indicates that the Logical Unit ***shall*** transfer the entire requested length of data without adding delays to perform error recovery procedures. This implies that the Logical Unit may send data that is erroneous or fabricated in order to maintain a continuous flow of data. A **RC** bit of zero indicates that error recovery operations that cause delays are acceptable during the data transfer.

A Post Error (**PER**) bit of one indicates that the Logical Unit ***shall*** report recovered errors. A **PER** bit of zero indicates that the Logical Unit ***shall not*** report recovered errors. Error recovery procedures ***shall*** be performed within the limits established by the error recovery parameters. This capability is very different for DVD media. To be able to recover the data from DVD media, error correction must be used. Thus it is not reasonable to report when ECC is used to recover the data. This bit for DVD media ***shall*** only be used to report when auto reallocation of a logical block has been performed. For CD media this capability is used to report when the Layered Error correction has been used to recover the data. Again as the CIRC is mandatory for recovery of data it ***shall not*** cause recovered errors to be reported.

A Disable Transfer on Error (**DTE**) bit of one indicates that the Logical Unit ***shall*** terminate the data transfer to the Host upon detection of a recovered error. A **DTE** bit of zero indicates that the Logical Unit ***shall not*** terminate the data transfer upon detection of a recovered error.

A Disable Correction (**DCR**) bit of one indicates that error correction codes ***shall not*** be used for data error recovery. A **DCR** bit of zero allows the use of error correction codes for data error recovery.

An example interpretation of the bits 5-0 in the Error Recovery Parameter byte for CD-ROM Logical Units is given in Table 181.

Table 181 - Error Recovery Descriptions (CD Media)

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 unrecovered error was detected. Recovered errors are not reported.
01h	Only retries of the read operation and CIRC are used (layered error correction is not used). Only CIRC unrecovered data errors are reported. If a CIRC unrecovered data error occurs, data transfer is terminated with CHECK CONDITION status. The block with the error is not transferred. The sense key is set to MEDIUM ERROR. The information bytes give the address of the block where the unrecovered error was detected. Recovered errors are not reported.
04h	The maximum error recovery procedures available are used. Recovered data errors are reported. If a recovered data error occurs, data transfer is not terminated. However, when the data transfer has completed CHECK CONDITION status is reported. The sense key is set to RECOVERED ERROR. The information bytes give the address of the last block where a recovered data error was detected. If a data error occurs that is uncorrectable with the ECC information available on the media, data transfer is terminated and CHECK CONDITION status is reported. The block with the error is not transferred. The sense key is set to MEDIUM ERROR. The information bytes give the address of the block where the uncorrectable error was detected.
05h	Only retries of the read operation and CIRC are used (layered error correction is not used). Recovered data errors are reported. If a recovered data error occurs, data transfer is not terminated. However, when the data transfer has completed CHECK CONDITION status is reported. The sense key is set to RECOVERED ERROR. The information bytes give the address of the last block where a CIRC recovered data error was detected. If an unrecovered data error occurs, data transfer is terminated and CHECK CONDITION status is reported. The block with the error is not transferred. The sense key is set to MEDIUM ERROR. The information bytes give the address of the block where the unrecovered error was detected.
06h	The maximum error recovery procedures are used. Recovered data errors are reported. If a recovered data error occurs data transfer is terminated and CHECK CONDITION status is reported. The block with the recovered error is not transferred. The sense key is set to RECOVERED ERROR. The information bytes give the address of the block where the recovered data error was detected. If a data error occurs that is uncorrectable with the ECC information on the medium, data transfer is terminated with CHECK CONDITION status. The block with the error is not transferred. The sense key is set to MEDIUM ERROR. The information bytes give the address of the block where the uncorrectable error was detected.
07h	Only retries of the read operation are used (layered error correction is not used) and 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 a CIRC unrecovered data error occurs, data transfer is terminated with CHECK CONDITION status. The block with the error is not transferred. The sense key is set to MEDIUM ERROR. The information bytes give the address of the block where the unrecovered error was detected.

Table 181 - Error Recovery Descriptions (CD Media) (Continued)

Code	Error Recovery Description
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.
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 uncorrectable error was detected. Reporting unrecovered errors takes precedence over reporting recovered errors.
20h	The maximum error recovery procedures available are used. If an error occurs which is uncorrectable with the error correction codes (ECC) on the media, data transfer is terminated with CHECK CONDITION status. The block with the error is transferred. The sense key is set to MEDIUM ERROR. The information bytes give the address of the block where the unrecovered error was detected. Recovered errors are not reported.
21h	Only retries of the read operation and CIRC are used (layered error correction is not used). Only CIRC unrecovered data errors are reported. If a CIRC unrecovered data error occurs data transfer is terminated with CHECK CONDITION status. The block with the error is transferred. The sense key is set to MEDIUM ERROR. The information bytes give the address of the block where the unrecovered error was detected. Recovered errors are not reported.
24h	The maximum error recovery procedures available are used. Recovered data errors are reported. If a recovered data error occurs data transfer is not terminated. However, when the data transfer has completed, CHECK CONDITION status is reported. The sense key is set to RECOVERED ERROR. The information bytes give the address of the last block where a recovered data error was detected. If a data error occurs that is uncorrectable with the ECC information available on the media data transfer is terminated and CHECK CONDITION status is reported. The block with the error is transferred. The sense key is set to MEDIUM ERROR. The information bytes give the address of the block where the uncorrectable error was detected.
25h	Only retries of the read operation and CIRC are used (layered error correction is not used). Recovered data errors are reported. If a recovered data error occurs, data transfer is not terminated. However, when the data transfer has completed, CHECK CONDITION status is reported. The sense key is set to RECOVERED ERROR. The information bytes give the address of the last block where a CIRC recovered data error was detected. If an unrecovered data error occurs, data transfer is terminated and CHECK CONDITION status is reported. The block with the error is transferred. The sense key is set to MEDIUM ERROR. The information bytes give the address of the block where the unrecovered error was detected.
26h	The maximum error recovery procedures are used. Recovered data errors are reported. If a recovered data error occurs, data transfer is terminated and CHECK CONDITION status is reported. The block with the recovered error is transferred. The sense key is set to RECOVERED ERROR. The information bytes give the address of the block where the recovered data error was detected. If a data error occurs that is uncorrectable with the ECC information on the 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 uncorrectable error was detected.
27h	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 transferred. The sense key is set to RECOVERED ERROR. The information bytes give the address of the block where the recovered data error was detected. If a CIRC unrecovered data error occurs, data transfer is terminated with CHECK CONDITION status. The block with the error is transferred. The sense key is set to MEDIUM ERROR. The information bytes give the address of the block where the unrecovered error was detected.

Table 182 - Error Recovery Descriptions (DVD media)

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 unrecovered error was detected. Recovered errors are not reported.
04h	The maximum error recovery procedures available are used. Recovered data errors are reported. If a recovered data error occurs, data transfer is not terminated. However, when the data transfer has completed CHECK CONDITION status is reported. The sense key is set to RECOVERED ERROR. The information bytes give the address of the last block where a recovered data error was detected. If a data error occurs that is uncorrectable with the ECC information available on the media, data transfer is terminated and CHECK CONDITION status is reported. The block with the error is not transferred. The sense key is set to MEDIUM ERROR. The information bytes give the address of the block where the uncorrectable error was detected. 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 which is uncorrectable with the error correction codes (ECC) on the media, data transfer is terminated with CHECK CONDITION status. The block with the error is transferred. The sense key is set to MEDIUM ERROR. The information bytes give the address of the block where the unrecovered error was detected. Recovered errors are not reported.
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 controller ***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 controller ***shall*** attempt its write recovery algorithm. This may not have any affect 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 Unrecovered Data Error is defined as a block for which the CIRC based error correction algorithm was unsuccessful on all read attempts up to the read retry count. Layered error correction was not used.

An L-EC Recovered Data Error is defined as a block for which the CIRC based error correction algorithm was unsuccessful, but the layered error correction was able to correct the block within the read retry count.

An L-EC Uncorrectable Data Error is defined as a block which could not be corrected by layered error correction within the read retry count.

11.12.3.2 Power Condition Page

The Power Condition Page provides the application client the means to control the length of time a Logical Unit will delay before changing its power requirements. There are notification events to the Host that a Logical Unit has entered into one of the power conditions.

Table 183 - Power Condition Page Format

Bit / Byte	7	6	5	4	3	2	1	0
0	PS	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)

On the receipt of a Command the Logical Unit ***shall*** adjust itself to the power condition which allows the Command to execute. The timer which maps to this power condition and any lower power condition timers ***shall*** be reset on receipt of the Command. On completion of the Command the timer associated with this power condition ***shall*** be restarted.

The Parameters Savable (**PS**) bit is only used with the MODE SENSE (10) Command. This bit is reserved with the MODE SELECT (10) Command. A **PS** bit of one indicates that the Logical Unit is capable of saving the Page in a non-volatile vendor-specific location.

An **Idle** bit of one indicates a Logical Unit ***shall*** use the Idle Timer to determine the length of inactivity time to wait before entering the Idle condition.

If the **Idle** bit is zero, or a value of zero in the Idle Timer field indicates the Logical Unit ***shall*** disable the Idle Timer.

The **Idle Timer** field indicates the inactivity time in 100 millisecond increments that the Logical Unit ***shall*** wait before entering the Idle condition. A value of zero disables 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 a value of zero in the Standby Timer field indicates the Logical Unit ***shall*** disable the Idle Timer.

The **Standby Timer** field indicates the inactivity time in 100 millisecond increments that the Logical Unit ***shall*** wait before entering the Standby condition. A value of zero disables the Standby Timer.

For more information on these timers see *7.1.2, "Timers"* on page 145.

11.12.3.3 CD Audio Control Page

The CD Audio Control Page sets the playback modes and output controls for subsequent PLAY AUDIO (10) Commands and any current audio playback operation.

Table 184 - 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 Always 1	SOTC Default 0	Reserved
3	Reserved							
4	Reserved							
5	Reserved							
6	Obsolete (75)							
7								
8	Reserved				CDDA Output Port 0 Channel Selection			
9	Output Port 0 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 Parameters Savable (**PS**) bit is only used with the MODE SENSE (10) Command. This bit is reserved with the MODE SELECT (10) Command. A **PS** bit of one indicates that the Logical Unit is capable of saving the Page in a non-volatile vendor-specific location.

The Immediate Bit (**Immed**) is used for information purposes only; the audio Commands will always send completion status as soon as the playback operation has been started. This bit ***shall*** always be set to 1.

A Stop On Track Crossing (**SOTC**) bit of zero indicates the 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. An **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 specifies the Red Book audio channels from the disc to which a specific output port ***shall*** be connected. More than one output port may be connected to an audio channel. More than one audio channel may be connected to an output port.

Table 185 - Example CDDA Output Port Channel Selection Codes

Code	Description
0000b	Output port muted
0001b	Connect audio channel 0 to this output port
0010b	Connect audio channel 1 to this output port
0011b	Connect audio channel 0 and audio channel 1 to this output port
0100b	Connect audio channel 2 to this output port
1000b	Connect audio channel 3 to this output port

The Output Port Volume Control indicates the relative volume level for this audio output port. The value used is specified as an attenuation of the normal volume level. A value of zero indicates the minimum volume level (Mute), and a value of FFh indicates maximum volume (No attenuation) level. It is recommended that the Mute and Volume functions should be supported on a per channel basis. The attenuation used ***shall*** be as specified in Table 186. 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 recommended 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 186 - Attenuation Levels for Audio

Binary Level	Attenuation
FFh	0db (On)
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)

11.12.3.4 Fault / Failure Reporting Page

The Fault / Failure Reporting Page defines the methods used by the target to control the reporting and the operations of specific informational exception conditions. This page ***shall*** only apply to informational exception that report CHECK CONDITION Status, 1/5D/00 FAILURE PREDICTION THRESHOLD EXCEEDED - Predicted Logical Unit Failure to the application client.

Informational exception conditions occur as result of vendor specific events within a target. An informational exception condition may occur asynchronously to any Commands issued by an application client.

Table 187 - Fault / Failure Reporting Page Format

Bit / Byte	7	6	5	4	3	2	1	0
0	PS	Reserved	Page Code (1Ch)					
1	Page Length (0Ah)							
2	Perf	Reserved		EWasc	DExcept	Test	Reserve	LogErr (0)
3	Reserved				MRIE			
4	(MSB)							
5	Interval Timer (10 Minutes, 6000)							
6								
7								(LSB)
8	(MSB)							
9	Reserved for Report Count (0)							
10								
11								(LSB)

The Parameters Savable (**PS**) bit is only used with the MODE SENSE (10) Command. This bit is reserved with the MODE SELECT (10) Command. A **PS** bit of one indicates that the Logical Unit is capable of saving the Page in a non-volatile vendor-specific location.

A log errors bit (**LogErr**) of zero indicates that the logging of informational exception conditions within a Logical Unit is vendor specific.

A disable exception control (**DExcpt**) bit of zero indicates informational 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 method of reporting Fault / Failure Reporting field is ignored when **DExcpt** is set to one. The Method of Reporting Informational Exceptions field is ignored when **DExcpt** is set to one and **EWasc** is set to zero.

An enable warning (**EWasc**) bit of zero indicates the Logical Unit ***shall*** disable reporting of the WARNING Sense Code. The **Method of Reporting Informational Exceptions** field is ignored when **DExcpt** is set to one and **EWasc** is set to zero. A **EWasc** bit of one indicates WARNING Sense Code reporting ***shall*** be enabled. The method for reporting the warning when the **EWasc** bit is set to one is determined from the **Method of Reporting Informational Exceptions** field (**MRIE**).

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 CHECK CONDITION Status, 1/5D/FF FAILURE PREDICTION THRESHOLD EXCEEDED (FALSE). If both the **Test** and the **DExcpt** bits are one, the Logical Unit ***shall*** terminate the MODE SELECT (10) Command with CHECK CONDITION Status, 5/26/00 INVALID FIELD IN PARAMETER LIST. A **Test** bit of zero ***shall*** instruct the Logical Unit not to generate any false Logical Unit failure notifications.

A Performance bit (**Perf**) of zero indicates that informational exception operations that are the cause of delays are acceptable. A **Perf** bit of one indicates the Logical Unit ***shall not*** cause delays while doing informational exception operations. A **Perf** bit set to one may cause the Logical Unit to disable some or all of the informational exception operations, thereby limiting the reporting of informational exception conditions.

The Method of Reporting Fault / Failure Reporting field (**MRIE**) indicates the methods that ***shall*** be used by the Logical Unit to report informational exception conditions (see Table 188). The priority of reporting multiple information exceptions is vendor specific.

Table 188 - Method of Reporting Fault / Failure Reporting field

MRIE	Description
0h	No reporting of informational exception condition: This method instructs the target to not report information exception conditions.
1h - 3h	Reserved
4h	Unconditionally generate recovered error: This method instructs the target to report informational exception conditions, regardless of the value of the per bit of the Read/Write Error Recovery Parameters Page, by returning CHECK CONDITION Status, 1/5D/00 FAILURE PREDICTION THRESHOLD EXCEEDED - Predicted Logical Unit Failure or CHECK CONDITION Status, 1/5D/01 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. This field ***shall*** be set to 6000 for a 10 minute time interval.

The **Report Count** field indicates the number of times to report an informational exception condition to the application client. A value of zero in the **Report Count** field indicates there is no limit on the number of times the Logical Unit ***shall*** report an informational exception condition. This field is currently reserved and ***shall*** be set to 0.

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.

11.12.3.5 Time-out & Protect Page

The Time-out & Protect Page specifies parameters that affect operation of many Commands.

Table 189 - Time-out & Protect Page Format

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 Parameters Savable (**PS**) bit is only used with the MODE SENSE (10) Command. This bit is reserved with the MODE SELECT (10) Command. A **PS** bit of one indicates that the Logical Unit is capable of saving the Page in a non-volatile vendor-specific location.

The Time-out Enable (**TMOE**) bit when set to 1 enables the Time-out capability. A TMOE bit of zero disables the Time-out reporting capability.

The **DISP** (DISable until Power cycle) bit when set to 1 ***shall*** make the Logical Unit unavailable until power has been removed and then reapplied. The Logical Unit ***shall*** report not ready for all media access after this bit has been set to 1. The default value of this bit ***shall*** be zero. Support for the **DISP** bit is optional.

The **SWPP** bit provides a Software Write Protect until Powerdown. 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. Support for the **SWPP** bit is optional.

See the Time-out model for more information on the Group 1 & 2 Minimum Time-out fields.

11.12.3.6 C/DVD Capabilities & Mechanical Status Page (obsolete)

The C/DVD Capabilities & Mechanical Status Page is read only and may not be set with MODE SELECT (10).

Note: This information is available via the GET CONFIGURATION Command.

Table 190 - C/DVD Capabilities and Mechanical Status Page Format (obsolete)

<table>
<tr><th colspan="2">Bit
Byte</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td colspan="2">0</td><td>PS</td><td>Reserved</td><td colspan="6">Page Code (2Ah)</td></tr>
<tr><td colspan="2">1</td><td colspan="8">Page Length (18h)</td></tr>
<tr><td colspan="2">2</td><td colspan="2">Reserved</td><td>DVD-RAM Read</td><td>DVD-R Read</td><td>DVD-ROM Read</td><td>Method 2</td><td>CD-RW Rd</td><td>CD-R Rd</td></tr>
<tr><td colspan="2">3</td><td colspan="2">Reserved</td><td>DVD-RAM Wr</td><td>DVD-R Write</td><td>Reserved</td><td>Test Write</td><td>CD-RW Wr</td><td>CD-R Wr</td></tr>
<tr><td>4</td><td rowspan="4">Media Function Capabilities</td><td>Reserved</td><td>Multi-session</td><td>Mode 2 Form 2</td><td>Mode 2 Form 1</td><td>Digital Port(2)</td><td>Digital Port(1)</td><td>Composite</td><td>Audio Play</td></tr>
<tr><td>5</td><td>Read Bar Code Capable</td><td>UPC</td><td>ISRC</td><td>C2 Pointers</td><td>R-W D&C</td><td>R-W Supported</td><td>CDDA Accurate</td><td>CD DA</td></tr>
<tr><td>6</td><td colspan="3">LMT</td><td>Reserved</td><td>Eject</td><td>Prevent Jumper</td><td>Lock State</td><td>Lock</td></tr>
<tr><td>7</td><td colspan="2">Reserved</td><td>R-W in Lead-in Readable</td><td>Side Change Capable</td><td>S/W Slot Selection (SSS)</td><td>Supports Disc Present (SDP)</td><td>Separate Channel Mute</td><td>Sep. vol.</td></tr>
<tr><td colspan="2">8</td><td colspan="8" rowspan="2">(MSB) Obsolete (LSB)</td></tr>
<tr><td colspan="2">9</td></tr>
<tr><td colspan="2">10</td><td colspan="8" rowspan="2">(MSB) Number of Volume Levels Supported (LSB)</td></tr>
<tr><td colspan="2">11</td></tr>
<tr><td colspan="2">12</td><td colspan="8" rowspan="2">(MSB) Buffer Size supported by Logical Unit (in KBytes) (LSB)</td></tr>
<tr><td colspan="2">13</td></tr>
<tr><td colspan="2">14</td><td colspan="8" rowspan="2">(MSB) Obsolete (LSB)</td></tr>
<tr><td colspan="2">15</td></tr>
<tr><td colspan="2">16</td><td colspan="8">Obsolete</td></tr>
<tr><td colspan="2">17</td><td colspan="2">Reserved</td><td colspan="2">Length</td><td>LSBF</td><td>RCK</td><td>BCK</td><td>Reserved</td></tr>
</table>

Table 190 - C/DVD Capabilities and Mechanical Status Page Format (obsolete) (Continued)

Bit Byte	7	6	5	4	3	2	1	0
18	(MSB)			Obsolete				
19								(LSB)
20	(MSB)			Obsolete				
21								(LSB)
22	(MSB)			Copy Management Revision Supported				
23								(LSB)
24				Reserved				
25				Reserved				

The Parameters Savable (**PS**) bit is only used with the MODE SENSE (10) Command. This bit is reserved with the MODE SELECT (10) Command. A **PS** bit of one indicates that the Logical Unit is capable of saving the Page in a non-volatile vendor-specific location.

Media Function Capabilities, when set to one, indicates support for the identified item. When set to zero, indicates no support:

If CD-R Read Field is set to one, the Logical Unit ***shall*** support the read function of CD-R disc (Orange Book Part II).

If CD-RW Read Field is set to one, the Logical Unit ***shall*** support the read function of CD-RW disc (Orange Book Part III).

If Method 2 is set to one, the Logical Unit ***shall*** support the read function of CD-R media written using fixed packet tracks using Addressing Method 2.

If DVD-ROM Read bit (read only field) is set to one, the Logical Unit ***shall*** support the read function of DVD-ROM disc.

If DVD-RAM Read bit (read only field) is set to one, the Logical Unit ***shall*** support the read function of DVD-RAM disc.

If DVD-R Read bit (read only field) is set to one, the Logical Unit ***shall*** support the read function of DVD-R disc.

If CD-R Write Field is set to one, the Logical Unit ***shall*** support the write function of CD-R disc (Orange Book Part II).

If CD-RW Write Field is set to one, the Logical Unit ***shall*** support the write function of CD-RW disc (Orange Book Part III).

If DVD-RAM Write bit (read only field) is set to one, the Logical Unit ***shall*** support the write function of DVD-RAM disc.

If DVD-R Write bit (read only field) is set to one, the Logical Unit ***shall*** support the write function of DVD-R disc.

If the Test Write bit is set to one, the Logical Unit ***shall*** only accept data from the Host and not write to the media.

The individual capabilities of the Logical Unit are specified by bytes 4 through 7. Each of the bits indicate if that specific capability is supported. A value of zero indicates that the capability is NOT supported; a value of one indicates the capability IS supported.

Bit 0, Sep. Vol.	Separate Volume Levels. The audio level for each channel can be controlled independently.
Bit 1, Separate Channel Mute	The mute capability for each channel can be controlled independently.
Bit 2, SDP	Supports Disc Present. This bit indicates that the Logical Unit contains an embedded changer, and that after a reset condition or if a cartridge is changed, it can report the exact contents of the slots. The response to the MECHANISM STATUS Command will contain valid Disc is Present status information for all slots.

Bit 3, SSS	Software Slot Selection. This bit controls the behavior of the LOAD/UNLOAD MEDIUM Command when trying to load a Slot with no Disc present (see Table 163 - *Load/Unload or Optional Selection Operations* on page 241).
Bit 4, Side Change Capable	This bit indicates that the Logical Unit is capable of selecting both sides of the Discs. This capability can be reported for Logical Units that have changer functions.
Bit 5, R-W in Lead-in Readable	This bit indcates that the Logical Unit is capable of reading R-W subcode in the Lead-in. This is used with CD+Text.
Bits 7-6, Reserved	Reserved.
Bit 8, Lock	The PREVENT/ALLOW MEDIUM REMOVAL Command is capable of actually locking the media into the Logical Unit.
Bit 9, Lock State	This indicates the current state of the Logical Unit. 0 The Logical Unit is currently in the allow (Unlocked) state. Media may be inserted or ejected. 1 The Logical Unit is currently in the prevent (Locked) state. Media loaded in the Logical Unit may not be removed via a soft or hard eject. If the Logical Unit is empty, media may not be inserted if the Prevent Jumper is not present. If the jumper is present, then media may be inserted.
Bit 10, Prevent Jumper	This indicates the state of the (Optional) Prevent/Allow Jumper. 0 Jumper is present. Logical Unit will power up to the allow state. Locking the Logical Unit with the PREVENT/ALLOW MEDIUM REMOVAL Command ***shall not*** prevent the insertion of media. 1 Jumper is not present. Logical Unit will power up to the Prevent State (Locked). The Logical Unit will not accept new media or allow the ejection of media already loaded until an allow Command is issued.
Bit 11, Eject Command	The Logical Unit can eject the disc via the normal START/STOP UNIT Command with the LoEj bit set. If the mechanism is a Changer that uses a Cartridge, then this bit indicates that the Cartridge can be ejected.
Bit 12, Reserved	Reserved
Bit 15-13, LMT	Loading Mechanism Type. This field specifies the type of disc loading the Logical Unit supports. See Table 191.

Table 191 - Loading Mechanism Type

Bit 15	Bit 14	Bit 13	Definition
0	0	0	Caddy type loading mechanism
0	0	1	Tray type loading mechanism
0	1	0	Pop-up type loading mechanism
0	1	1	Reserved
1	0	0	Changer with individually changeable discs
1	0	1	Changer using a Cartridge Mechanism
1	1	0	Reserved
1	1	1	Reserved

Bit 16, CD-DA	Red Book audio can be read using the READ CD Command.
Bit 17, CDDA Accurate	This bit indicates that the Logical Unit supports an advanced feature that allows it to return to an audio location without losing place to continue the READ CD Command.

	0:	The Logical Unit is incapable of accurately restarting the CD-DA read operation, and CHECK CONDITION Status, B/11/11 READ ERROR - LOSS OF STREAMING ***shall*** be reported whenever a loss of streaming occurs. This error will be fatal and the Command will have to be repeated from the beginning.
	1	The Logical Unit can continue from a loss of streaming condition and no error will be generated.

Bit 18, R-W Supported — The Commands that return Sub-channel data can return the combined R-W information.

Bit 19, R-W D&C — R-W De-interleaved & Corrected. This indicates that the R-W sub-channel data will be returned de-interleaved and error corrected.

Bit 20, C2 Pointers are Supported — This indicates that the Logical Unit supports the C2 Error Pointers. This also indicates that the Logical Unit is capable of returning the C2 Error Pointers and C2 Block Error flags in the READ CD Command.

Bit 21, ISRC — The Logical Unit can return the International Standard Recording Code Information.

Bit 22, UPC — The Logical Unit can return the Media Catalog Number (UPC)

Bit 23, Read Bar Code — The Logical Unit is capable of reading the disc bar code.

Bit 24, Audio Play — The Logical Unit is capable of Audio Play operation. This also indicates that the Logical Unit is capable of overlapping Play and other Commands such as reading of the Sub-channel information.

Bit 25, Composite — The Logical Unit is capable of delivering a composite Audio and Video data stream.

Bit 26, Digital Port(1) — The Logical Unit supports digital output (IEC958) on port 1

Bit 27, Digital Port(2) — The Logical Unit supports digital output(IEC958) on port 2

Bit 28, Mode 2 Form 1 — The Logical Unit is capable of reading sectors in Mode 2 Form 1 (XA) format.

Bit 29, Mode 2 Form 2 — The Logical Unit is capable of reading sectors in Mode 2 Form 2 format.

Bit 30, Multi Session — The Logical Unit is capable of reading multiple session or Photo-CD discs.

Bit 31, Reserved — Reserved.

The **Number of Volume Levels Supported** field returns the number of discrete levels. If the Logical Unit only supports turning audio on and off, the **Number of Volume Levels** field ***shall*** be set to 2.

The **Buffer Size Supported** field returns the number of bytes of buffer dedicated to the data stream returned to the Host. This value is returned in Kbytes (Size/1024). If the Logical Unit does not have a buffer cache, the value returned ***shall*** be zero.

Byte 17 is used to describe the format of the Logical Unit's digital output. See Table 192.

Table 192 - Digital Output Format

Bit	Name	Behavior
1	BCKF	Set if data valid on the falling edge of the BCK signal. Clear if data valid on the rising edge of the BCK signal
2	RCK	Set if HIGH on LRCK indicates left channel. Clear if HIGH on LRCK indicates right channel.
3	LSBF	Set if LSB first. Clear if MSB first.
4-5	Length	00 32 BCKs 01 16 BCKs 10 24 BCKs 11 24 BCKs (I^2S)

The **Copy Management Revision Supported** field indicates the version of the DVD Copy Protection scheme that is supported by the Logical Unit. This ***shall*** be 0001h if DVD CSS is supported or 0000h otherwise.

11.12.3.7 Write Parameters Page

The writing of a disc requires the Host read a set of parameters from the device, selecting the parameters to be used, setting those parameters in the write parameters of the device and then using the normal WRITE (10) Command. Once the write process has begun, data is streamed from the Host to the device.

The Write Parameters Page contains parameters needed for the correct execution of WRITE (10) Commands.

The values in this Page do not necessarily reflect the status on a given medium. They will be used as applicable when a write operation occurs. If any parameters have values incompatible with the current medium, the Logical Unit ***shall*** generate a CHECK CONDITION Status, 5/64/00 ILLEGAL MODE FOR THIS TRACK when a write is attempted.

Fields that are ignored for the current medium may contain 0 for the default mode parameter value.

Table 193 - 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	Multisession/Border		FP[a]	Copy	Track Mode[a]			
4	Reserved				Data Block Type[a]			
5	Link Size							
6	Reserved							
7	Reserved		Host Application Code[a]					
8	Session Format[a]							
9	Reserved							
10	(MSB)							
11	Packet Size							
12								
13								(LSB)
14	(MSB)							
15	Audio Pause Length[a]							(LSB)
16	(MSB)							
17								
:	Media Catalog Number[a]							
30								
31								(LSB)
32	(MSB)							
33								
:	International Standard Recording Code[a]							
46								
47								(LSB)
48	Sub-header Byte 0[a]							
49	Sub-header Byte 1[a]							
50	Sub-header Byte 2[a]							
51	Sub-header Byte 3[a]							

a. Ignored when DVD-R is present.

The Parameters Savable (**PS**) bit is only used with the MODE SENSE (10) Command. This bit is reserved with the MODE SELECT (10) Command. A **PS** bit of one indicates that the Logical Unit is capable of saving the Page in a non-volatile vendor-specific location.

The **BUFE** bit, when set to one, ***shall*** indicate that Buffer Under-run Free recording is enabled for sequential recording. The Logical Unit ***shall*** perform silent linking and continue the writing when the buffer becomes empty. The value zero ***shall*** indicate that Logical Unit ***shall*** terminate writing and perform linking. The following WRITE (10) Command is terminated with CHECK CONDITION Status, 5/21/02 INVALID ADDRESS FOR WRITE. This bit is valid when the DVD-R Write Feature is current.

The **LS_V** bit ***shall*** be set to one to indicate that the value in the Link Size field is valid. The value zero is for compatibility with legacy Logical Units that did not implement the Link Size field; such devices assume a Link Size of 7.

On CD-R or CD-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).

The validity of the **Test Write** bit is vendor specific for other media types.

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/RZone and disc information collected, during test write mode, ***shall*** be cleared. It should be noted that the number of Track/RZones reserved or written may be limited in test write mode.

Write type specifies the stream type to be used during writing. See Table 194.

Table 194 - Write Type Field

Value	Definition
00h	Packet/Incremental
01h	Track-at-once[a]
02h	Session-at-once/Disc-at-Once
03h	Raw[a]
04h-0Fh	Reserved

a. Invalid when DVD-R is present.

Packet/incremental - the device ***shall*** perform packet/incremental writing when WRITE (10) Commands are issued.

Track-at-once - the device ***shall*** perform track at once recording when WRITE (10) Commands are issued.

Session-at-once/Disc-at-once - For CD, the device ***shall*** perform session at once recording. This mode requires that a cue sheet be sent prior to sending WRITE (10) Commands.

For DVD, the device ***shall*** perform Disc at once recording. All data, includes Lead-in and Lead-out, is recorded on the media sequentially without interruption.

Raw - the device ***shall*** write data as received from the initiator. In this mode, the initiator sends the lead-in. As the initiator must provide Q sub-channel in this mode, the only valid Data Block Types are 1, 2, and 3. The Next Writable Address starts at the beginning of the lead-in (which ***shall*** be a negative LBA on a blank disc).

*Note: In RAW record mode the drive **shall not** generate run-in and run-out blocks (main and sub-channel 1 data) but **shall** generate and record the link block.*

The **Multisession/Border** field defines how a Session/Border closure affects the opening of the next Session/Border. See Table 195.

Table 195 - Multisession/Border Field Definition

Multisession/Border Field	Action Upon Session/Border Closure
00b	For CD, No B0 pointer. Next Session not allowed. For DVD, No next Border allowed. When current Border is closed, Lead-out ***shall*** be appended after last Border-out. In this case, the Next Border Marker in last Border-out ***shall*** be padded with 00h bytes and ***shall*** have the Lead-out attribute set.
01b	For CD, B0 pointer = FF:FF:FF. Next session not allowed. For DVD, Reserved
10b	Reserved
11b	For CD, Next session allowed. B0 pointer = next possible program area. For DVD, Next Border allowed.

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*** be set to one and ignored.

Track Mode is the Control nibble in all mode 1 Q sub-channel in the track. This field ***shall*** be ignored for DVD-R recording. The default value of this field for DVD-R Logical Units should be 5.

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 DVD-R, this field ***shall*** be ignored.

Data Block Type defines both the specific data fields in a user data block and its size. The **Data Block Type** is as defined in Table 196. This size is used for writing instead of the block size set in the Mode Select Header. For DVD-R, this field ***shall*** be ignored. The default value of this field for DVD-R Logical Units should be 8.

Table 196 - Data Block Type Codes

Value	Block Size	Definition	Requirement
0	2352	Raw data 2352 bytes of raw data (not valid for write type = packet)	Optional
1	2368	Raw data with P and Q sub-channel 2352 bytes of raw data, 16 bytes buffer for Q sub-channel: Bytes 0..9 are Q sub-channel data Bytes 10..11 are Q sub-channel EDC Bytes 12..14 are zero Byte 15, most significant bit has state of P sub-channel bit (not valid for write type = packet) (Q sub-channel data is in binary format.)	Optional
2	2448	Raw data with P-W sub-channel appended: 2352 bytes of raw data. 96 bytes of pack form R-W sub-channel in the low order 6 bits of each byte. Bit 7 of each byte contains the P sub-channel state and bit 6 of each byte contains the Q sub-channel bit. (not valid for write type = packet)	Optional
3	2448	Raw data with raw P-W sub-channel appended: 2352 bytes of raw data. 96 bytes of raw P-W sub-channel. (not valid for write type = packet)	Optional
4~6		Reserved values	-
7	NA	Vendor Specific	Optional
8	2048	Mode 1 (ISO/IEC 10149): 2048 bytes of user data	Mandatory
9	2336	Mode 2 (ISO/IEC 10149): 2336 bytes of user data	Optional
10	2048	Mode 2 (CD-ROM XA, form 1): 2048 bytes of user data, sub-header from write parameters	Mandatory
11	2056	Mode 2 (CD-ROM XA, form 1): 8 bytes of sub-header, 2048 bytes of user data	Optional
12	2324	Mode 2 (CD-ROM XA, form 2): 2324 bytes of user data, sub-header from write parameters	Optional
13	2332	Mode 2 (CD-ROM XA, form 1, form 2, or mixed form): 8 bytes of sub-header 2324 bytes of user data	Mandatory
14	-	Reserved	-
15	NA	Vendor Specific	Optional

General Writing Requirements

- When a track has been designated for packet writing, the device ***shall*** ensure that the TDB is written upon receipt of the WRITE (10) Command.
- 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.
- For data block types 8 through 13, the device ***shall*** generate all sync fields and all headers.
- For data blocks of mode 1 or of mode 2, form 1, the device ***shall*** generate EDC and L-EC parity.
- For data block types 0, 1, 2, and 3, the device ***shall*** perform no data scrambling per ISO/IEC 10149.
- For data block types 8 through 13, the device ***shall*** perform data scrambling per ISO/IEC 10149.

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, ILLEGAL REQUEST, ILLEGAL MODE FOR THIS TRACK/RZONE.

Table 197 - Link Size field Definition

Value	Description
00h	Linking Loss Area size is 0 bytes.
01h	Linking Loss Area size is 2048 bytes.
02h	Linking Loss Area size is 4096 bytes.
:	:
10h	Linking Loss Area size is 32768 bytes.
:	:
FFh	Linking Loss Area size is 522240 bytes.

The **Host Application Code** is typically zero. When the **Unrestricted Use Disc** bit in Disc Information Block is one, the **Host Application Code** ***shall*** be ignored by the device. If the **Unrestricted Use Disc** bit is zero, then the **Host Application Code** ***shall*** be set to the appropriate value for the medium in order that writing be allowed. A **Host Application Code** of zero is used for a Restricted Use - General Purpose Disc. The **Host Application Code** field is ignored for DVD-R recording.

The Session Format code is to be written in the TOC of the session containing this track. The Session Format code is the PSEC byte of the mode 1, point A0 TOC entry. See Table 198. The Session Format code is ignored for DVD-R recording.

Table 198 - Session Format Codes

Disc Type Code	Session Format
00h	CD-DA, CD-ROM, or other data disc
10h	CD-I Disc
20h	CD-ROM XA Disc
All Other Values	Reserved

The **Packet Size** field, if **FP** bit is set to 1, 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. The **Packet Size** ***shall*** be set to 16 to record to DVD-R media.

Audio Pause Length is the number of blocks from the beginning of the track for which the mode 1 Q sub-channel INDEX ***shall*** be zero. If this number is zero, then there is no period where the Mode 1 Q sub-channel INDEX ***shall*** be zero. The default value ***shall*** be 150. This field is valid only for audio tracks, otherwise it is ignored.

The **Media Catalog Number** (MCN). The MCN will be written in a mode 2 Q sub-channel in at least one out of every 100 blocks in the program area.

The **International Standard Recording Code** (ISRC) is valid only for audio tracks. Otherwise it is ignored. ISRC is formatted as in Table 199.

Table 199 - ISRC Format of Data Returned

Byte	Char	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0		TCVAL	Reserved						
1	I1	I1(Country Code)							
2	I2	I2							
3	I3	I3(Owner Code)							
4	I4	I4							
5	I5	I5							
6	I6	I6(Year of Recording)							
7	I7	I7							
8	I8	I8(Serial Number)							
9	I9	I9							
10	I10	I10							
11	I11	I11							
12	I12	I12							
13		Zero							
14		AFRAME							
15		Reserved							

All bytes are specified in ASCII. The following translation is specified for devices:

ASCII	Hex	MEDIA
‘0’ - ‘9’	30h - 39h	00 - 09h
‘@’ - ‘o’	40h - 6Fh	10h - 3Fh

Table 200 - ISRC value transformation

The following codes ***shall*** be valid for the above fields (Table 65):

a. Country Code: ‘A’ - ‘Z’ (41h - 5Ah)

b. Owner Code: ‘0’ - ‘9’ and ‘A’ - ‘Z’ (30h -39h, 41h - 5Ah)

c. Year of Recording: ‘0’ - ‘9’ (30h - 39h)

d. Serial Number: ‘0’ - ‘9’ (30h - 39h)

Zero field ***shall*** be set to 00h.

AFRAME may return the frame number in which the MCN was found. This ***shall*** be a value from 00h to 4Ah. All other values are reserved.

11.13 PAUSE/RESUME Command

The PAUSE/RESUME Command requests that the Logical Unit stop or start an audio play operation. This command is used with PLAY AUDIO (10) and PLAY CD Commands that are currently executing in immediate mode.

Table 201 - PAUSE/RESUME Command

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code (4Bh)							
1	LUN (Obsolete)			Reserved				
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	Reserved							
8	Reserved							Resume
9	Vendor-Specific		Reserved			NACA	Flag	Link
10	PAD							
11								

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 shall be terminated with CHECK CONDITION Status, 5/2C/00 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. See Figure 79 - *Stop Play/Play Audio/Audio Scan/Pause/Resume Sequencing* on page 422 for additional information.

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 202 describes errors that may occur during the operation of the Command or which may cause a CHECK CONDITION status to be reported.

Table 202 - PAUSE/RESUME Command Errors

Error Description
A-1.1, "Deferred Error Reporting" on page 437
Table 421 - *Basic Error Codes* on page 445
Table 422 - *Media Access Error Codes* on page 449

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11.14 PLAY AUDIO (10) Command

The PLAY AUDIO (10) Command requests that the CD Logical Unit begin an audio playback operation. The command function and the output of audio signals ***shall*** be as specified by the settings of the *CD Audio Control* Mode Page (0Eh), including the **SOTC** bit.

Table 203 - PLAY AUDIO (10) Command

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code (45h)							
1	LUN (Obsolete)			Reserved				
2	(MSB)							
3	Starting Logical Block Address							
4								
5								(LSB)
6	Reserved							
7	(MSB)							
8	Play Length							(LSB)
9	Vendor-Specific		Reserved			NACA	Flag	Link
10	PAD							
11								

This command responds with immediate status, allowing overlapped commands.

For ATAPI Logical Units this command ***shall*** set the DSC bit upon command completion. See also *B-9, "Immediate Command Processing Considerations"* on page 460.

If any commands related to audio operations are implemented then the PLAY AUDIO (10) Command ***shall*** be implemented to allow a method for the Host to determine if audio operations are supported. A CD Logical Unit responding to a PLAY AUDIO (10) Command that has a transfer length of zero with CHECK CONDITION Status, 5/20/00 INVALID COMMAND OPERATION CODE does not support audio play operations.

The **Starting Logical Block Address** field specifies the logical block at which the audio playback operation ***shall*** begin. PLAY AUDIO (10) Commands with a **Starting Logical Block Address** of FFFF FFFFh ***shall*** implement audio play from the current location of the pickup. PLAY AUDIO (10) Commands with a Starting LBA of 0000 0000h shall begin the audio play operation at 00/02/00.

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 Logical Block Address** is not found the command ***shall*** be terminated with CHECK CONDITION Status, 5/21/00 LOGICAL BLOCK ADDRESS OUT OF RANGE. If the address is not within an audio track the command ***shall*** be terminated with CHECK CONDITION Status, 5/64/00 ILLEGAL MODE FOR THIS TRACK. If a NOT READY Condition exists, the command ***shall*** be terminated with CHECK CONDITION Status with the Sense Key set to 2 unless the **Play Length** is set to 0.

If the CD information type (data vs. audio) changes within the Transfer Length, the command ***shall*** be terminated with a CHECK CONDITION Status, 5/63/00 END OF USER AREA ENCOUNTERED ON THIS TRACK at the time of encountering the transition.

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, 5/64/00 ILLEGAL MODE FOR THIS TRACK.

Table 204 describes errors that may occur during the operation of the Command or which may cause a CHECK CONDITION status to be reported.

Table 204 - PLAY AUDIO (10) Command Errors

Error Description
A-1.1, "Deferred Error Reporting" on page 437
Table 421 - *Basic Error Codes* on page 445
Table 422 - *Media Access Error Codes* on page 449

11.14.1 PLAY AUDIO (10) with Immediate Packet Commands

The PLAY AUDIO (10) and SCAN Commands will continue to play while other commands are processed by the Logical Unit. Some commands can be accepted without disrupting the audio operations, while others will cause the Play operation to stop. The following section describes the operation of other commands while playing audio.

The CD Logical Unit ***shall*** accept and perform the commands as specified in Table 205. If any other command than described in Table 205 is received, the Audio playback or Scan may be terminated.

See Figure 79 - *Stop Play/Play Audio/Audio Scan/Pause/Resume Sequencing* on page 422 for additional information.

For ATAPI Logical Units, the ATA commands other than A2 or A0 ***shall*** stop any play or scan.

When any command generates CHECK CONDITION Status, 5/24/00 INVALID FIELD IN CDB, it may terminate the Play operation.

Table 205 - Play or Scan Overlapped Command Operation

Opcode	Command Description	Action Taken
A1h	BLANK	Play operation ***shall*** be stopped.
5Bh	CLOSE TRACK/RZONE/SESSION/BORDER	Play operation ***shall*** be stopped.
35h	FLUSH CACHE	Play operation ***shall not*** be stopped
04h	FORMAT UNIT	Play operation ***shall*** be stopped
46h	GET CONFIGURATION	Play operation ***shall not*** be stopped
4Ah	GET EVENT/STATUS NOTIFICATION	Play operation ***shall not*** be stopped
ACh	GET PERFORMANCE	Play operation may be stopped
12h	INQUIRY	Play operation ***shall not*** be stopped
A6h	LOAD/UNLOAD MEDIUM	Play operation ***shall*** be stopped
BDh	MECHANISM STATUS	Play operation ***shall not*** be stopped
55h	MODE SELECT (10)	Play operation ***shall not*** be stopped
5Ah	MODE SENSE (10)	Play operation ***shall not*** be stopped
4Bh	PAUSE/RESUME	Play operation ***shall*** stop or continue based on command type
45h	PLAY AUDIO (10)	Play ***shall*** continue from the new address.
47h	PLAY AUDIO MSF	Play ***shall*** continue from the new address.
BCh	PLAY CD	Play ***shall*** continue from the new address.
1Eh	PREVENT/ALLOW MEDIUM REMOVAL	Play operation ***shall not*** be stopped
28h/A8h	READ (10), READ (12)	Play operation ***shall*** be stopped.
3Ch	READ BUFFER	Play operation may be stopped
25h	READ CAPACITY	Play operation ***shall not*** be stopped
BEh	READ CD	If the READ CD Command requests only the Q sub-channel data then the Play will continue and the Command will return the data from the current location. If any data other than the Q sub-channel is requested the Command ***shall*** be executed and the Play operation will be aborted.

Table 205 - Play or Scan Overlapped Command Operation (Continued)

Opcode	Command Description	Action Taken
B9h	READ CD MSF	If the READ CD Command requests only the Q sub-channel data then the Play will continue and the Command will return the data from the current location. If any data other than the Q sub-channel is requested the Command ***shall*** be executed and the Play operation will be aborted.
51h	READ DISC INFORMATION	Play operation may be stopped
ADh	READ DVD STRUCTURE	Play operation may be stopped
23h	READ FORMAT CAPACITIES	Play operation may be stopped
44h	READ HEADER	Play operation ***shall not*** be stopped
42h	READ SUBCHANNEL	Only the current position information (Format Code 01h) will be supported while the play is in progress. If any other type of information is requested the READ SUB-CHANNEL may not be executed and a CHECK CONDITION Status will be generated.
43h	READ TOC/PMA/ATIP	Only Logical Units that cache the TOC will be able to respond to this command while the play is in progress. If the Logical Unit does not support caching the TOC, the command may not be executed and a CHECK CONDITION will be generated.
52h	READ TRACK/RZONE INFORMATION	Play operation may be stopped
58h	REPAIR RZONE	Play operation ***shall*** be stopped
A4h	REPORT KEY	Play operation may be stopped
03h	REQUEST SENSE	Play operation ***shall not*** be stopped
53h	RESERVE TRACK/RZONE	Play operation may be stopped
BAh	SCAN	SCAN command will be executed and the PLAY command will resume at completion of the Scan.
2Bh	SEEK	Play operation ***shall*** be stopped
5Dh	SEND CUE SHEET	Play operation may be stopped
BFh	SEND DVD STRUCTURE	Play operation may be stopped
A2h	SEND EVENT	Play operation may be stopped
A3h	SEND KEY	Play operation may be stopped
54h	SEND OPC INFORMATION	Play operation may be stopped
A7h	SET READ AHEAD	Play operation ***shall not*** be stopped
B6h	SET STREAMING	Play operation may be stopped
1Bh	START/STOP UNIT	Play operation ***shall*** be stopped
4Eh	STOP PLAY/SCAN	Play operation ***shall*** be stopped
00h	TEST UNIT READY	Play operation ***shall not*** be stopped
2Fh	VERIFY (10)	Play operation ***shall*** be stopped
2Ah	WRITE (10)	Play operation ***shall*** be stopped
2Eh	WRITE and VERIFY (10)	Play operation ***shall*** be stopped
3Bh	WRITE BUFFER	Play operation may be stopped

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11.15 PLAY AUDIO MSF Command

The PLAY AUDIO MSF Command requests that the CD 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 in Table 184 - *CD Audio Control Page Format* on page 259.

Table 206 - PLAY AUDIO MSF Command

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code (47h)							
1	LUN (OBsolete)			Reserved				
2	Reserved							
3	Starting M							
4	Starting S							
5	Starting F							
6	Ending M							
7	Ending S							
8	Ending F							
9	Vendor-Specific		Reserved			NACA	Flag	Link
10	PAD							
11								

This command responds with immediate status, allowing overlapped commands.

For ATAPI Logical Units this command ***shall*** set the DSC bit upon command completion. See also *B-9, "Immediate Command Processing Considerations"* on page 460.

The **Starting M** field, the **Starting S** field, and the **Starting F** field specify the absolute MSF address at which 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 M**, **Starting S** and **Starting F** 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, 5/24/00 INVALID FIELD IN CDB.

If the starting address is not found the command ***shall*** be terminated with CHECK CONDITION Status, 5/21/00 LOGICAL BLOCK ADDRESS OUT OF RANGE. If the address is not within an audio track the command ***shall*** be terminated with CHECK CONDITION Status, 5/64/00 ILLEGAL MODE FOR THIS TRACK. If a NOT READY Condition exists, the command ***shall*** be terminated with CHECK CONDITION Status and the Sense Key set to 2, unless the Starting and Ending MSF fields are equal.

See *11.14.1, "PLAY AUDIO (10) with Immediate Packet Commands"* on page 276 for information on overlapped commands during an Audio Playback.

Table 207 describes errors that may occur during the operation of the Command or which may cause a CHECK CONDITION status to be reported.

Table 207 - PLAY AUDIO MSF Command Errors

Error Description
A-1.1, "Deferred Error Reporting" on page 437
Table 421 - *Basic Error Codes* on page 445
Table 422 - *Media Access Error Codes* on page 449

11.16 PLAY CD Command

The PLAY CD Command provides one standard, universal way of sending digital CD data to an external Logical Unit (e.g. an IEC958 or EBU port).

Table 208 - PLAY CD Command (LBA Form)

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code (BCh)							
1	LUN (Obsolete)			Expected Sector Type			CMSF (0)	Reserved
2	(MSB) Starting Logical Block Address							
3								
4								
5								(LSB)
6	(MSB) Play Length in Blocks							
7								
8								
9								(LSB)
10	Speed	Reserved			Port 2	Port 1	Composite	Audio
11	Vendor-Specific		Reserved			NACA	Flag	Link

Table 209 - PLAY CD Command (MSF Form)

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation code (BCh)							
1	LUN (Obsolete)			Expected Sector Type			CMSF (1)	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	Reserved							
10	SPEED	Reserved			Port 2	Port 1	Composite	Audio
11	Vendor-Specific		Reserved			NACA	Flag	Link

The Expected Sector Type field is used to check the sector type only. If the Requested Sector(s) do not match the specified type, the command will be terminated with CHECK CONDITION Status, 5/64/00 ILLEGAL MODE FOR THIS TRACK. The Sector that does not match will not be transferred to output port.

Note: The Expected Sector Type is used to generate an error and terminate the transfer when the sectors found on the media do not match the type desired. This field has NO control of the actual number of bytes transferred.

Table 210 - PLAY CD Expected Sector Type Field Definition

Expected Sector Type	Definition	Description
000b	Any Type (Mandatory)	No checking of the Sector Type will be performed. The Logical Unit ***shall*** always terminate a command, at the sector where a transition between CD-ROM and CD-DA occurs.
001b	CD DA (Mandatory)	Only Red Book (CD-DA) sectors ***shall*** be allowed. An attempt to read any other format ***shall*** result in the reporting of an error.
010b	Mode 1 (Mandatory)	Only Yellow Book sectors which have a “user” data field of 2048 bytes ***shall*** be allowed. An attempt to read any other format ***shall*** result in the reporting of an error.
011b	Mode 2 (Mandatory)	Only Yellow Book sectors which have a “user” data field of 2336 bytes ***shall*** be allowed. An attempt to read any other format ***shall*** result in the reporting of an error.
100b	Mode 2 Form 1 (Mandatory)	Only Green Book sectors which have a “user” data field of 2048 ***shall*** be allowed. An attempt to read any other format ***shall*** result in the reporting of an error.
101b	Mode 2 Form 2 (Mandatory)	Only Green Book sectors which have a “user” data field of 2324 ***shall*** be allowed. An attempt to read any other format ***shall*** result in the reporting of an error. Note that the spare data is included in the user data making the size 2324+4= 2328.
110b - 111b		Reserved

See also Figure 2 - *CD-ROM Sector Formats* on page 43.

Table 211 - PLAY CD Field Definition

Flag	Value	Description
Audio	0	Analog Audio Channel is Disabled
	1	Analog Audio Channel is Enabled
Composite	0	Composite Video port is Disabled
	1	Composite Video port is Enabled
Port 1	0	Digital Port 1 is Disabled
	1	Digital Port 1 is Enabled
Port 2	0	Digital Port 2 is Disabled
	1	Digital Port 2 is Enabled
SPEED	0	Speed will be set to x1 for the operation
	1	The Speed used will be the best possible

Table 212 describes errors that may occur during the operation of the Command or which may cause a CHECK CONDITION status to be reported.

Table 212 - PLAY CD Command Errors

Error Description
A-1.1, "Deferred Error Reporting" on page 437
Table 421 - *Basic Error Codes* on page 445
Table 422 - *Media Access Error Codes* on page 449

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11.17 PREVENT/ALLOW MEDIUM REMOVAL Command

The PREVENT/ALLOW MEDIUM REMOVAL Command requests that the Logical Unit enable or disable the removal of the medium in the Logical Unit. The prevention of media removal (when implemented) ***shall*** be accomplished through the use of a Locking Mechanism. The use of a physical locking mechanism is optional. If a non persistent prevent is issued and the Logical Unit does not support a physical locking mechanism, the Logical Unit shall return CHECK CONDITION Status, 5/24/00 INVALID FIELD IN CDB. If the operation is persistent then the Prevent will not be reset when media is removed or inserted. This will allow new media to become captive without Host interaction. The Persistent Prevent is to be used in conjunction with the GET EVENT/STATUS NOTIFICATION Command, to prevent media from being ejected with dirty file system buffers.

Table 213 - PREVENT/ALLOW MEDIUM REMOVAL Command

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code (1Eh)							
1	LUN (Obsolete)			Reserved				
2	Reserved							
3	Reserved							
4	Reserved						Persistent	Prevent
5	Vendor-Specific		Reserved			NACA	Flag	Link
6	PAD							
7								
8								
9								
10								
11								

The **Persistent** bit, when set, indicates that this will be a Persistent PREVENT/ALLOW MEDIUM REMOVAL Command. If the **Prevent** and **Persistent** bits are both 1, upon receiving this command, the target ***shall*** disable any eject mechanisms, and all media after initial drive spin up shall remain locked in the drive until the Host issues an eject request, or the Persistent Prevent status is reset and the hardware eject mechanism again becomes available.

The Persistent Prevent status ***shall*** be reset upon receipt of a PREVENT/ALLOW MEDIUM REMOVAL Command (from the same Host that originally set the Persistent Prevent state) with the **Persistent** bit set and the **Prevent** bit cleared, a bus reset, or a power reset condition.

Upon insertion of new media, under Persistent Prevent conditions, the target eject controls ***shall*** remain functional up until the drive generates or reports a New Media event as defined in the Media Status Events section. After this event has been generated or reported, the media ***shall*** remain locked as defined above. The Logical Unit is allowed to morph from the no medium present state to the medium present state without explicit direction from the Host.

The Logical Unit ***shall not*** report a New Media Event if the medium is removed between the generation of the Event and the next GET EVENT/STATUS NOTIFICATION Command issued.

The Persistent Prevent state shall not prevent an eject request from the Host from succeeding.

See *9.2, "Morphing Commands and functionality"* on page 155 for more information.

The behavior of the PREVENT/ALLOW MEDIUM REMOVAL Command with a Persistent bit of 0 is not affected by the Persistent Prevent state. The prevention of medium removal ***shall*** begin when the Host issues a PREVENT/ALLOW

MEDIUM REMOVAL command with a prevent bit of one and a Persistent bit of zero (medium removal prevented). The prevention of medium removal for the Logical Unit ***shall*** terminate:

1. after the Host has issued a PREVENT/ALLOW MEDIUM REMOVAL Command with a prevent bit of zero (Unlock), and the Logical Unit has successfully performed a Flush cache operation; or
2. upon a Hard Reset condition; or
3. upon a DEVICE RESET in an ATAPI environment; or
4. if the drive does not support a locking mechanism.

While a prevention of medium removal condition is in effect (Locked) the Logical Unit ***shall*** inhibit mechanisms that normally allow removal of the medium by an operator. This is also the case for changers.

The default state of the drive at power on is unlocked, unless the drive supports a prevent/allow jumper and the jumper is in the prevent state (See *11.12.3.6, "C/DVD Capabilities & Mechanical Status Page (obsolete)"* on page 263.)

This command will affect the actions of the START/STOP UNIT Command (See *11.44, "START/STOP UNIT Command"* on page 417) and other mechanisms external to this specification (manual ejection / media removal systems.)

Table 214 - Actions for Lock/Unlock/Eject (Persistent bit = 0)

Operation	Locked / Unlocked	If Drive Not Ready (No Media)	If Drive Ready (Media Present)
Unlock (Prevent = 0)	Unlocked	No Error	No Error
	Locked	No Error, Now media may be inserted	No Error, Now media may be removed
Lock (Prevent = 1)	Unlocked	No Error, Drive door locked and will not allow media to be inserted	No Error, Drive door locked and will not allow media to be removed
	Locked	No Error	No Error
Lock when the drive does not support a Locking Mechanism	Would always be Unlocked	CHECK CONDITION Status, 5/24/00 INVALID FIELD IN CDB	CHECK CONDITION Status, 5/24/00 INVALID FIELD IN CDB
Eject (START/STOP UNIT command with LoEj set)	Unlocked	No Error and Tray is opened if a tray exists.	No Error: Media Ejects
	Locked	CHECK CONDITION Status, 2/53/02 MEDIUM REMOVAL PREVENTED	CHECK CONDITION Status, 5/53/02 MEDIUM REMOVAL PREVENTED
Manual Eject	Unlocked	Tray opens (If tray exists)	Media is Ejected
	Locked	No operation occurs	No operation, Media stays locked in drive

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 - PREVENT/ALLOW MEDIUM REMOVAL Command Errors

Error Description
A-1.1, "Deferred Error Reporting" on page 437
Table 421 - *Basic Error Codes* on page 445
Table 422 - *Media Access Error Codes* on page 449

11.18 READ (10) Command

The READ (10) Command requests that the Logical Unit transfer data to the Host. The most recent data value written in the addressed logical block ***shall*** be returned. Any read by the Host 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, 5/6F/03 READ OF SCRAMBLED SECTOR WITHOUT AUTHENTICATION. For more information on the authentication process, see Figure 16 - *Device Key Exchange and Authentication State Diagram* on page 69. For more information on the Authentication Success Flag, see Figure 17 - *Authentication Flag Sequence* on page 69.

Table 216 - READ (10) Command

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code (28h)							
1	LUN (Obsolete)			DPO (0)	FUA	Reserved		RelAdr
2	(MSB)							
3	Logical Block Address							
4								
5								(LSB)
6	Reserved							
7	(MSB)							
8	Transfer Length							(LSB)
9	Vendor-Specific		Reserved			NACA	Flag	Link
10	PAD							
11								

The **RelAdr** bit is only used for SCSI Logical Units. For information on this bit see *C-3.1, "Use of the RelAdr bit"* on page 467.

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 priority shall be determined by the retention priority fields in the Cache Page if supported. All other aspects of the algorithm implementing the cache memory replacement strategy are vender specific.

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 Host 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.

Although the Logical Unit is capable of returning a variety of data, this command ***shall*** only return the “User Data” portion of the sector. Currently for DVD and CD media this length is 2048 bytes, and is specified according to the Feature that is currently active (e.g. the Random Readable Feature, see *11.5.2.5, "Feature 0010h: Random Readable"* on page 196).

For CD Media, Mode 1 and Mode 2 Form 1 sectors are the only sector types allowed for reading with the READ (10) or READ (12) Commands. For all other sector types, the Logical Unit ***shall*** set the ILI bit in the Request Sense Standard

Data and return CHECK CONDITION Status, 5/64/00 ILLEGAL MODE FOR THIS TRACK error if any read to them using this command is attempted.

For DVD media, all the sectors are of the same type, thus the user data portion of any sector in the user area of the media can be read with this command.

Table 217 describes errors that may occur during the operation of the Command or which may cause a CHECK CONDITION status to be reported.

Table 217 - READ (10) Command Errors

Error Description
A-1.1, "Deferred Error Reporting" on page 437
Table 421 - *Basic Error Codes* on page 445
Table 422 - *Media Access Error Codes* on page 449

11.19 READ (12) Command

The READ (12) Command requests that the Logical Unit transfer data to the Host. The most recent data value written in the addressed logical block ***shall*** be returned. Any read by the Host 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, 5/6F/03 READ OF SCRAMBLED SECTOR WITHOUT AUTHENTICATION. For more information on the authentication process, see Figure 16 - *Device Key Exchange and Authentication State Diagram* on page 69. For more information on the Authentication Success Flag, see Figure 17 - *Authentication Flag Sequence* on page 69.

Table 218 - READ (12) Command

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code (A8h)							
1	LUN (Obsolete)			DPO (0)	FUA	Reserved		RelAdr
2	MSB							
3	Logical Block Address							
4								
5								LSB
6	MSB							
7	Transfer Length							
8								
9								LSB
10	Reserved							
11	Vendor-Specific		Reserved			NACA	Flag	Link

See *11.18, "READ (10) Command"* on page 287 for a description of the parameters for this command.

See Table 217 - *READ (10) Command Errors* on page 288 for information on the error conditions.

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11.20 READ BUFFER Command

The READ BUFFER Command is used in conjunction with the WRITE BUFFER Command as a diagnostic function for testing Logical Unit memory in the target SCSI device and the integrity of the service delivery subsystem. This command shall not alter the medium.

Table 219 - READ BUFFER Command

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation code (3Ch)							
1	LUN (Obsolete)			Reserved		Mode		
2	Buffer ID							
3	(MSB)							
4	Buffer offset							
5								(LSB)
6	(MSB)							
7	Allocation length							
8								(LSB)
9	Vendor-Specific		Reserved			NACA	Flag	Link
10	PAD							
11								

If reservations are active, they shall affect the execution of the READ BUFFER Command as follows. A reservation conflict shall occur when a READ BUFFER Command is received from a Host other than the one holding a Logical Unit or element reservation.

The function of this command and the meaning of fields within the command descriptor block depend on the contents of the **Mode** field. The **Mode** field is defined in Table 220.

Table 220 - READ BUFFER Mode field

Mode	Description	Implementation requirements
000b	Combined header and data	Optional
001b	Vendor-specific	Vendor-specific
010b	Data	Optional
011b	Descriptor	Optional
100b	Reserved	Reserved
101b	Reserved	Reserved
110b	Reserved	Reserved
111b	Reserved	Reserved

11.20.1 Combined header and data mode (000b)

In this mode, a four-byte header followed by data bytes is returned to the application client in the Data-In Buffer. The buffer ID and the buffer offset fields are reserved.

The four-byte READ BUFFER header (see Table 221) is followed by data bytes from the buffer.

Table 221 - READ BUFFER header

bit / byte	7	6	5	4	3	2	1	0
0	Reserved							
1	(MSB)							
2	Buffer Capacity							
3								(LSB)

The buffer capacity field specifies the total number of data bytes available in the buffer. This number is not reduced to reflect the allocation length; nor is it reduced to reflect the actual number of bytes written using the WRITE BUFFER Command. Following the READ BUFFER header, the Logical Unit shall transfer data from the buffer. The Logical Unit shall terminate filling the Data-In Buffer when allocation length bytes of header plus data have been transferred or when all available header and buffer data have been transferred to the application client, whichever is less.

11.20.2 Vendor-specific mode (001b)

In this mode, the meaning of the buffer ID, buffer offset, and parameter list length fields are not specified by this standard.

11.20.3 Data mode (010b)

In this mode, the Data-In Buffer is filled only with Logical Unit buffer data. The buffer ID field identifies a specific buffer within the Logical Unit from which the data ***shall*** be transferred. The vendor assigns buffer ID codes to buffers within the Logical Unit. Buffer ID zero shall be supported. If more than one buffer is supported, additional buffer ID codes shall be assigned contiguously, beginning with one. Buffer ID code assignments for the READ BUFFER Command shall be the same as for the WRITE BUFFER Command. If an unsupported buffer ID code is selected, the Logical Unit shall return CHECK CONDITION Status, 5/24/00 INVALID FIELD IN CDB.

The device server shall terminate filling the Data-In Buffer when allocation length bytes have been transferred or when all the available data from the buffer has been transferred to the application client, whichever amount is less.

The buffer offset field contains the byte offset within the specified buffer from which data shall be transferred. The application client should conform to the offset boundary requirements returned in the READ BUFFER descriptor (see 7.14.4). If the device server is unable to accept the specified buffer offset, it shall return CHECK CONDITION Status, 5/24/00 INVALID FIELD IN CDB.

11.20.4 Descriptor mode (011b)

In this mode, a maximum of four bytes of READ BUFFER descriptor information is returned. The Logical Unit ***shall*** return the descriptor information for the buffer specified by the buffer ID (see the description of the buffer ID in 11.20.3). If there is no buffer associated with the specified buffer ID, the Logical Unit ***shall*** return all zeros in the READ BUFFER descriptor. The buffer offset field is reserved in this mode. The allocation length should be set to four or greater. The Logical Unit shall transfer the lesser of the allocation length or four bytes of READ BUFFER descriptor. The READ BUFFER descriptor is defined as shown in Table 222.

Table 222 - READ BUFFER descriptor

bit / byte	7	6	5	4	3	2	1	0
0	Offset Boundary							
1	(MSB)							
2	Buffer Capacity							
3								(LSB)

The offset boundary field returns the boundary alignment within the selected buffer for subsequent WRITE BUFFER and READ BUFFER Commands. The value contained in the offset boundary field shall be interpreted as a power of two.

The value contained in the buffer offset field of subsequent WRITE BUFFER and READ BUFFER Commands should be a multiple of $2^{\text{offset boundary}}$ as shown in Table 223.

Table 223 - Buffer offset boundary

Offset Boundary	$2^{\text{Offset Boundary}}$	Buffer Offsets
00h	20 = 1	Byte boundaries
01h	21 = 2	Even-byte boundaries
02h	22 = 4	Four-byte boundaries
03h	23 = 8	Eight-byte boundaries
04h	24 = 16	16-byte boundaries
...		
FFh	Not Applicable	0 is the only supported buffer offset

The buffer capacity field shall return the size of the selected buffer in bytes.

Note: In a system employing multiple application clients, a buffer may be altered between the WRITE BUFFER and READ BUFFER Commands by another application client. Buffer testing applications should insure that only a single application client is active. Use of reservations (to all Logical Units on the device) or linked commands may be helpful in avoiding buffer alteration between these two commands.

Table 224 describes errors that may occur during the operation of the Command or which may cause a CHECK CONDITION status to be reported.

Table 224 - READ BUFFER Command Errors

Error Description
A-1.1, "Deferred Error Reporting" on page 437
Table 421 - *Basic Error Codes* on page 445

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11.21 READ CAPACITY Command

The READ CAPACITY Command provides a means for the Host to request information regarding the capacity of the Logical Unit.

This command may not report the correct capacity of the recorded data for CD-R, CD-RW and DVD-R media that do not have a Lead-out in the last Session or Border out in the last bordered area.

Table 225 - READ CAPACITY Command

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation code (25h)							
1	LUN (Obsolete)			Reserved				Reladr (0)
2	Reserved							
3								
4								
5								
6	Reserved							
7	Reserved							
8	Reserved							PMI (0)
9	Vendor-Specific		Reserved			NACA	Flag	Link
10	PAD							
11								

The **Reladr** and the PMI bits ***shall*** be reserved for C/DVD Logical Units.

Eight bytes of READ CAPACITY data ***shall*** be returned to the Host. The returned logical block address and the block length in bytes are those of the last logical block on the Logical Unit.

Table 226 - READ CAPACITY DATA

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)							
1	Logical Block Address							
2								
3								(LSB)
4	(MSB)							
5	Block Length							
6								
7								LSB

The **Logical Block Address** field identifies the last addressable user data block. For CD media, the Logical Unit shall use the AAh point found in the last Table of Contents, convert to an LBA, and subtract one. If that block is a run-out block (found on incrementally recorded CD-R and CD-RW), the Logical Unit shall subtract two. If no complete session exists on the medium, this field ***shall*** be set to zero.

The **Block Length** specifies, in bytes, the length of each Logical Block. For CD or DVD media, this value shall be 2048.

Table 227 describes errors that may occur during the operation of the Command or which may cause a CHECK CONDITION status to be reported.

Table 227 - READ CAPACITY Command Errors

Error Description
A-1.1, "Deferred Error Reporting" on page 437
Table 421 - *Basic Error Codes* on page 445
Table 422 - *Media Access Error Codes* on page 449

11.22 READ CD Command

The READ CD Command (Family) provides one standard, universal way of accessing CD data. Rather than breaking the types of data into several related commands, this command is generic to all CD data types.

This Command returns any of the CD data streams, including the headers, EDC and ECC, ROM data and CD-DA data. Each type of data is enabled via the use of flags. These flags indicate which information from the CD is to be returned in the data stream. If a flag is cleared, then that particular information will not be returned. If all the flags are cleared, no data will be returned to the Host and this condition is not treated as an error.

Table 228 - READ CD Command

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code (BEh)							
1	LUN (Obsolete)			Expected Sector Type			Reserved	RelAdr
2	(MSB)							
3	Starting Logical Block Address							
4								
5								(LSB)
6	(MSB)							
7	Transfer Length in Blocks							
8								(LSB)
9	Sync Field	Header(s) Code		User Data	EDC & ECC	Error Flag(s)		Reserved
10	Reserved					Sub-Channel Data Selection Bits		
11	Vendor-Specific		Reserved			NACA	Flag	Link

The **RelAdr** bit is only used for SCSI Logical Units. For information on this bit see *C-3.1, "Use of the RelAdr bit"* on page 467.

The **Expected Sector Type** field is used to limit the amount of information returned to the Host. If the Requested Sector(s) do not match the specified type, the command will be terminated with CHECK CONDITION Status, 5/64/00 ILLEGAL MODE FOR THIS TRACK. The Sector that does not match will not be transferred to the Host.

Note: The Expected Sector Type is used to generate an error and terminate the transfer when the sectors found on the media, do not match the type desired. This field has NO control of the actual number of bytes transferred.

Table 229 - READ-CD, Expected Sector Type Field Definition

Expected Sector Type	Definition	Description
000b	Any Type (Mandatory)	No checking of the Sector Type will be performed. The Logical Unit ***shall*** always terminate a command, at the sector where a transition between CD-Rom and CD-DA occurs.
001b	CD DA (Optional)	Only Red Book (CD-DA) sectors ***shall*** be returned. An attempt to read any other format ***shall*** result in the reporting of an error.
010b	Mode 1 (Mandatory)	Only Yellow Book sectors which have a "user" data field of 2048 bytes ***shall*** be returned. An attempt to read any other format ***shall*** result in the reporting of an error.
011b	Mode 2 (Mandatory)	Only Yellow Book sectors which have a "user" data field of 2336 bytes ***shall*** be returned. An attempt to read any other format ***shall*** result in the reporting of an error.
100b	Mode 2 Form 1 (Mandatory)	Only Green Book sectors which have a "user" data field of 2048 ***shall*** be returned. An attempt to read any other format ***shall*** result in the reporting of an error.
101b	Mode 2 Form 2 (Mandatory)	Only Green Book sectors which have a "user" data field of 2324 ***shall*** be returned. An attempt to read any other format ***shall*** result in the reporting of an error. Note that the spare data is included in the user data making the size 2324+4= 2328.
110b - 111b		Reserved

See also Figure 2 - *CD-ROM Sector Formats* on page 43.

Byte 9 is collectively identified as Flag Bits.

The **Sync Field** Bit, when set to one indicates that the **Sync Field** from the sector will be included in the data stream. Note that the data fields that are requested to be included in the data stream ***shall*** be contiguous. The **Sync Field** information (if selected) will be the first information in the data stream; all other fields will follow.

The **Header(s) Code** is an encoded field that indicates the Header/Subheader information to be placed in the data stream. See Table 230.

Table 230 - READ CD, Header(s) Code Field Definition

Header(s) Code	Definition	Description
00b	None	None of the header data ***shall*** be returned.
01b	HdrOnly	Only the Mode 1 or Form 1 4-byte header will be returned in the data stream.
10b	SubheaderOnly	Only the Mode 2 Form 1 or 2 Subheader will be placed into the data stream.
11b	All Headers	Both the Header and Subheader will be placed in the data stream.

The **User Data** Flag, when set to one, indicates that the Data part of a CD Sector ***shall*** be returned in the data stream. When set to 1, the whole user data will be returned to the Host. Note that the setting of the Mode Select Block size and Density Code does not apply to this command, and the physical user data will be returned. If the current track is an Audio Track then the Audio Data will be returned, else the normal CD data will be returned.

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

Error Flag(s) is an encoded field that indicates which (if any) of the C2 and/or Block Error data will be included in the data stream. All the field types are mandatory. If the Logical Unit does not support the C2 pointers (as reported in the *C/DVD Capabilities & Mechanical Status* Mode Page (2Ah)) the data returned ***shall*** be zero filled. See Table 231.

Table 231 - READ CD, Error Flag(s) Field Definition

Error Flags	Definition	Description
00b	None	No Error information will be included in the data stream.
01b	C2 Error Flag data	The C2 Error Flag (Pointer) bits (2352 bits or 294 bytes) will be included in the data stream. When the C2 Error pointer bits are included in the data stream, there will be one bit for each byte in error in the sector (2352 total). The bit ordering is from the most significant bit to the least significant bit in each byte. The first bytes in the sector will be the first bits/bytes in the data stream.
10b	C2 & Block Error Flags	Both the C2 Error Flags (2352 bits or 294 bytes) and the Block Error Byte will be included in the data stream. The Block Error byte is the OR of all the C2 Error Flag bytes. So that the data stream will always be an even number of bytes, the Block Error byte will be padded with a byte (undefined). The Block Error byte will be first in the data stream followed by the pad byte.
11b	Reserved	Reserved for future enhancement.

The **Sub-Channel Data Selection** bits indicate which CD Sub-Channel information is to be included in the data stream, the Q information and/or the "Raw" Sub-channel information (All eight channels, one byte from each of the small frames.) If the bit is set, then that Sub-channel data will be included in the data stream to the Host. See Table 232.

Table 232 - READ CD, Sub-channel Data Selection Field Definition

Sub-channel Data Selection	Definition	Description	Type
000b	No Sub-channel Data	No Sub-channel data will be transferred	Mandatory
001b	RAW	Raw Sub-channel data will be transferred	Optional
010b	Q	Q data will be transferred	Optional
011b	Reserved		
100b	R - W	R-W data will be transferred	Optional
101b - 111b	Reserved		

Support of Sub-channel data is optional. In the case of R-W the Logical Unit may return the data de-interleaved and error-corrected, RAW or padded with zeros depending on the R-W Supported and R-W de-interleaved and error-corrected bits in the *C/DVD Capabilities & Mechanical Status* Mode Page (2Ah). Changing the **DCR** bit on the*Read/Write Error Recovery Parameters* Mode Page (01h) will affect error correction of subcode data. The inclusion of the sub-channel data will only be valid for Audio sectors. See Table 233 for a description of sub-channel data.

If the **Starting Logical Block Address** is set to FFFFFFFFh and the **only** information requested to be placed in the data stream is the Sub-channel data and there is currently a PLAY AUDIO command in process, the actual address used will be from the current location (of the Play). If the Logical Unit is not playing audio, the Logical Unit will respond with CHECK CONDITION Status, 5/2C/00 COMMAND SEQUENCE ERROR.

When the Starting Logical Block Address is set to F0000000h and P-W raw data is selected, the drive returns P-W raw data from the Lead-In area, and the current location ***shall*** be incremented by one. If there are no P-W data recorded in the Lead-in area, the command shall be terminated with CHECK CONDITION Status, 5/64/00 ILLEGAL MODE FOR

THIS TRACK. If the Starting Logical Block Address is set to FFFFFFFFh after the above command, the Sub-channel data ***shall*** be returned from the current location within the Lead-in area, and the current location ***shall*** be incremented by one. It is the responsibility of the device driver to convert this data to CD-Text format.

Table 233 - Formatted Q-subcode Data (A Total of 16 Bytes)

Byte	Description
0	Control (4 M.S. bits), ADR (4 L.S. bits)
1	Track number
2	Index number
3	Min
4	Sec
5	Frame
6	Reserved (00h)
7	AMin
8	Asec
9	AFrame
10	CRC[a] or 00h (hex)
11	CRC[a] or 00h (hex)
12	00h (pad)
13	00h (pad)
14	00h (pad)
15	Most Significant Bit is P for this sector (Optional) all other bits are zero.

a. CRC is optional

Table 234 - Number of Bytes Returned Based on Data Selection Field

Data to be transferred	Flag Bits	CD-DA	Mode 1	Mode 2 non XA	Mode 2 Form 1	Mode 2 Form 2
No Data	00h	0	0	0	0	0
User Data	10h	2352	2048	2336	2048	2328
User Data + EDC/ECC	18h	(10h)	2336	(10h)	2328	(10h)
Header Only	20h	(10h)	4	4	4	4
Header Only + EDC/ECC	28h	(10h)	Illegal	Illegal	Illegal	Illegal
Header & User Data	30h	(10h)	2052	2340	Illegal	Illegal
Header & User Data + EDC/ECC	38h	(10h)	2340	(30h)	Illegal	Illegal
Sub Header Only	40h	(10h)	0	0	8	8
Sub Header Only + EDC/ECC	48h	(10h)	Illegal	Illegal	Illegal	Illegal
Sub Header & User Data	50h	(10h)	(10h)	(10h)	2056	2336
Sub Header & User Data + EDC/ECC	58h	(10h)	(18h)	(10h)	2336	(50h)
All Headers Only	60h	(10h)	4	4	12	12
All Headers Only + EDC/ECC	68h	(10h)	Illegal	Illegal	Illegal	Illegal
All Headers & User Data	70h	(10h)	(30h)	(30h)	2060	2340
All Headers & User Data + EDC/ECC	78h	(10h)	(38h)	(30h)	2340	2340
Sync & User Data	90h	(10h)	Illegal	Illegal	Illegal	Illegal
Sync & User Data + EDC/ECC	98h	(10h)	Illegal	Illegal	Illegal	Illegal
Sync & Header Only	A0h	(10h)	16	16	16	16
Sync & Header Only + EDC/ECC	A8h	(10h)	Illegal	Illegal	Illegal	Illegal
Sync & Header & User Data	B0h	(10h)	2064	2352	Illegal	Illegal
Sync & Header & User Data + EDC/ECC	B8h	(10h)	2352	(B0h)	Illegal	Illegal
Sync & Sub Header Only	C0h	(10h)	Illegal	Illegal	Illegal	Illegal
Sync & Sub Header Only + EDC/ECC	C8h	(10h)	Illegal	Illegal	Illegal	Illegal
Sync & Sub Header & User Data	D0h	(10h)	Illegal	Illegal	Illegal	Illegal
Sync & Sub Header & User Data + EDC/ECC	D8h	(10h)	Illegal	Illegal	Illegal	Illegal
Sync & All Headers Only	E0h	(10h)	16	16	24	24
Sync & All Headers Only + EDC/ECC	E8h	(10h)	Illegal	Illegal	Illegal	Illegal
Sync & All Headers & User Data	F0h	(10h)	2064	2352	2072	2352
Sync & All Headers & User Data + EDC/ECC	F8h	(10h)	2352	(F0h)	2352	(F0h)
Repeat All Above and Add Error Flags	02h	+294	+294	+294	+294	+294
Repeat All Above and Add Block & Error Flags	04h	+296	+296	+296	+296	+296

The lengths of the data returned from the READ CD Command vary based on the type of sector that is being read and the requested fields to be returned to the Host. Many combinations are possible, but most are not very useful. Table 234 specifies how the Logical Unit responds to many of the requests possible. Requests for transfers not specified by this table ***shall*** not be supported and treated as Illegal. Illegal values will cause the command to be aborted with CHECK CONDITION Status, 5/24/00 INVALID FIELD IN CDB.

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

Values that are shaded are most useful to the Host and ***shall*** return the number of bytes specified if supported.

See Figure 2 - *CD-ROM Sector Formats* on page 43 for a description of the data available for each sector type.

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

Table 235 - CD-DA (Digital Audio) Data Block Format

Bit / Byte	7	6	5	4	3	2	1	0
Cell 1 (1st of 588)								
0	Left Channel (Lower Byte)							
	b7	b6	b5	b4	b3	b2	b1	b0
1	Left Channel (Upper Byte)							
	b15	b14	b13	b12	b11	b10	b9	b8
2	Right Channel (Lower Byte)							
	b7	b6	b5	b4	b3	b2	b1	b0
3	Right Channel (Upper Byte)							
	b15	b14	b13	b12	b11	b10	b9	b8
. . .	...							
2348	Left Channel (Lower Byte)							
	b7	b6	b5	b4	b3	b2	b1	b0
2349	Left Channel (Upper Byte)							
	b15	b14	b13	b12	b11	b10	b9	b8
2350	Right Channel (Lower Byte)							
	b7	b6	b5	b4	b3	b2	b1	b0
2351	Right Channel (Upper Byte)							
	b15	b14	b13	b12	b11	b10	b9	b8

If the CD-ROM Logical Unit does not support the CD-DA Stream-Is-Accurate capability (See *11.12.3.6, "C/DVD Capabilities & Mechanical Status Page (obsolete)"* on page 263) then the Digital Audio data must be read as a continuous stream. If while streaming the Logical Unit must stop, the Logical Unit shall generate CHECK CONDITION Status, B/11/11 READ ERROR - LOSS OF STREAMING. This is due to the 1 second uncertainty of the address (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, there will be no error, only some time delay for rotational latency.

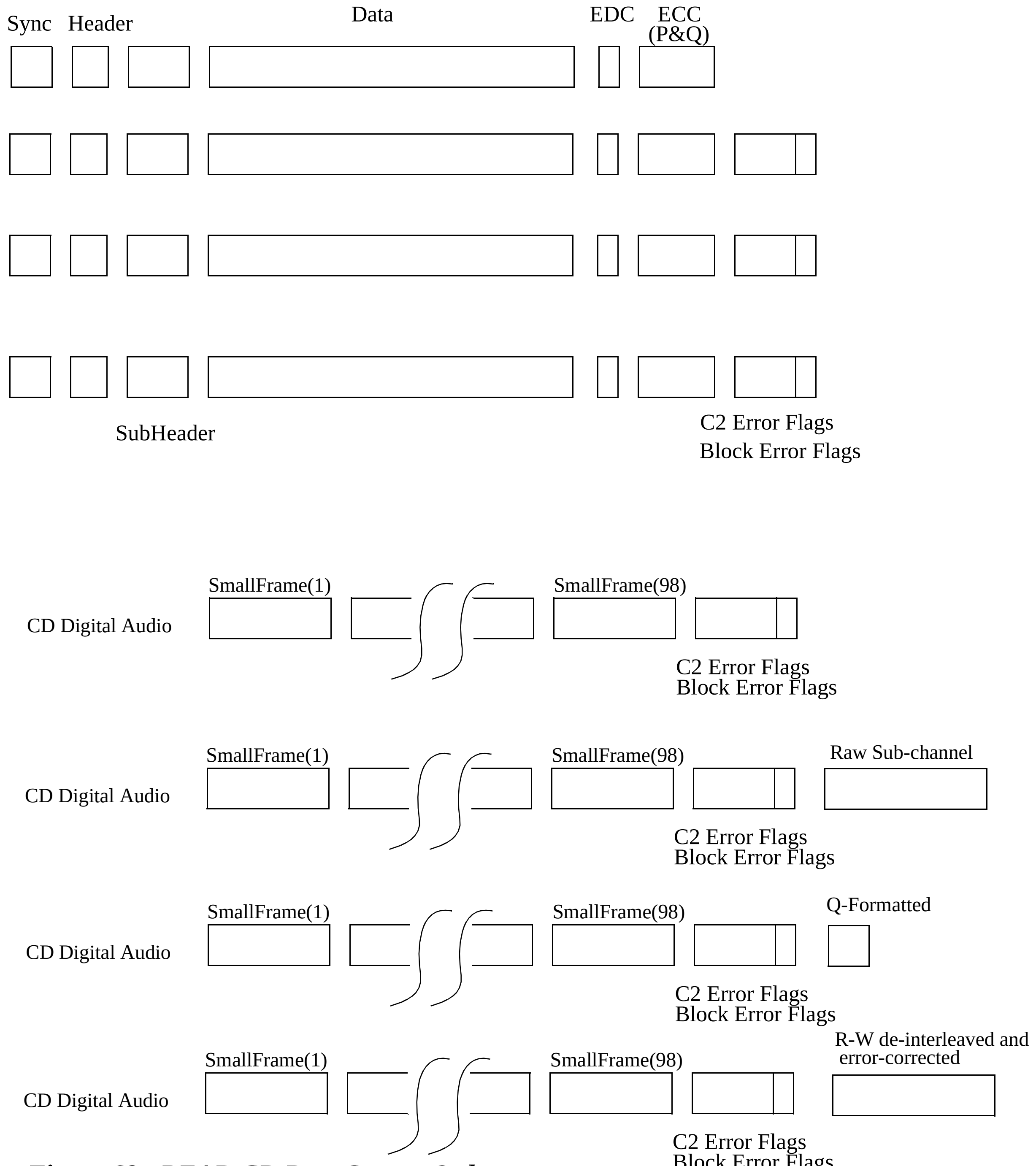

Figure 68 - READ CD Data Stream Order

11.22.0.1 Description of Sub-channels R-W

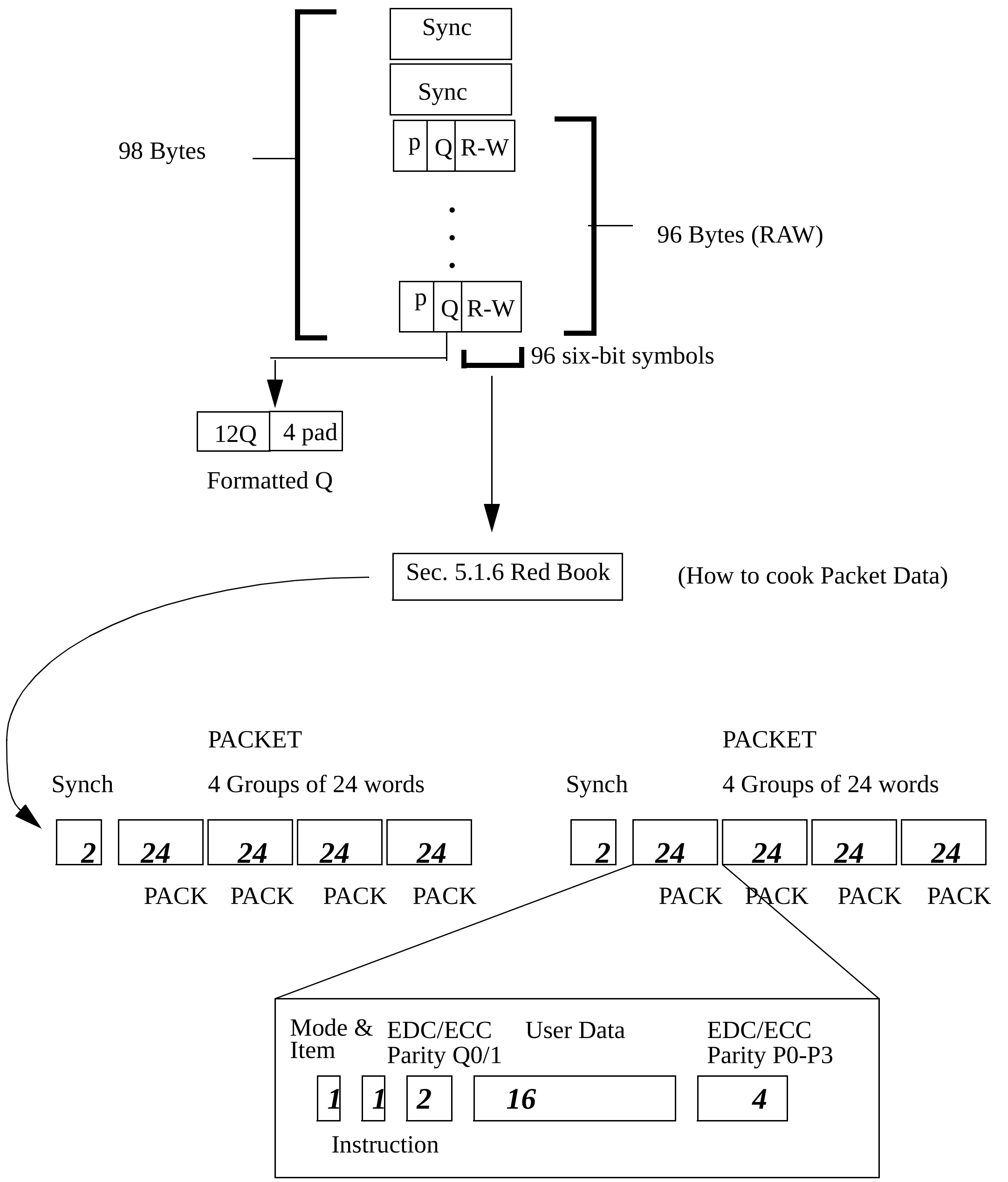

Figure 69 - Read CD Sub-channel, R-W (100b)

Note: the sizes shown are in 6 bit words.

Table 236 - P-W Raw

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

P-W Raw is returned in the format and order found on the media. It is the responsibility of the Host to deinterleave and perform error detection and correction on the RAW data to make it usable to higher level applications. The P and Q bits may be set to 0 or read from the medium.

Table 237 - R-W De-Interleaved & Error Corrected

Bit / Byte	7	6	5	4	3	2	1	0
0	P	Q	PACK1(0)					
1	P	Q	PACK1(1)					
...	...							
23	P	Q	PACK1(23)					
24	P	Q	PACK2(0)					
25	P	Q	PACK2(1)					
...	...							
47	P	Q	PACK2(23)					
48	P	Q	PACK3(0)					
49	P	Q	PACK3(1)					
...	...							
71	P	Q	PACK3(23)					
72	P	Q	PACK4(0)					
73	P	Q	PACK4(1)					
...	...							
95	P	Q	PACK4(23)					

Logical Units that can not return P or Q code with PACK data will return 0 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 69 - *Read CD Sub-channel, R-W (100b)* on page 304. The data is synchronized with the subcode synch patterns S0 and S1. Each group of 6 bits (R-W) is called a “symbol”. The symbol following the synchs S0 and S1 is the first symbol of the first pack in a packet. The packs following the sync bytes in R~W data must be from the same block and in chronological order.

To guard the data in the subcoding 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) Read-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 defined in the following table.

Table 238 - Sub-channel R-W, Allowed Mode/Item Combinations

Mode	Item	Description
000b (0d)	000b (0d)	The ZERO mode
001b (1d)	000b (0d)	The LINE GRAPHICS mode
	001b (1d)	The TV GRAPHICS mode
111b (7d)	000b (0d)	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 69 - *Read CD Sub-channel, R-W (100b)* on page 304. If the Q information needs to be taken from the raw data, then it ***shall*** be deinterleaved according the Red book formats.

Table 239 describes errors that may occur during the operation of the Command or which may cause a CHECK CONDITION status to be reported.

Table 239 - READ CD Command Errors

Error Description
A-1.1, "Deferred Error Reporting" on page 437
Table 421 - *Basic Error Codes* on page 445
Table 422 - *Media Access Error Codes* on page 449

11.23 READ CD MSF Command

The READ CD Command (Family) provides one standard, universal way of accessing CD data. Rather than breaking the types of data into several related commands, this command is generic to all CD data types.

This command returns any of the CD data streams, including the headers, EDC and ECC, ROM data and CD-DA data. Each type of data is enabled via the use of flags. These flags indicate which information from the CD is to be returned in the data stream. If a flag is cleared, then that particular information will not be returned. If all the flags are cleared, no data will be returned to the Host and this condition is not treated as an error.

Table 240 - READ CD MSF Command

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation code (B9h)							
1	LUN (Obsolete)			Expected 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 Field	Header(s) Code		User Data	EDC & ECC	Error flag(s)		Reserved
10	Reserved					Sub-Channel Data Selection Bits		
11	Vendor-Specific		Reserved			NACA	Flag	Link

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

A starting MSF address equal to an ending MSF address prevents a read operation. This ***shall*** not be considered an error. If the starting MSF address is greater than the ending MSF address, the command ***shall*** be terminated with CHECK CONDITION Status, 5/24/00 INVALID FIELD IN CDB.

If the starting address is not found, or if a NOT READY condition exists, the Command ***shall*** be terminated with CHECK CONDITION status.

See *11.22, "READ CD Command"* on page 297 for a description of **Expected Sector Type**, **Sync Field**, **Header(s) Code**, **User Data**, **EDC & ECC**, **Error flag(s)**, and **Sub-channel Data Selection** Fields.

Table 241 describes errors that may occur during the operation of the Command or which may cause a CHECK CONDITION status to be reported.

Table 241 - READ CD MSF Command Errors

Error Description
A-1.1, "Deferred Error Reporting" on page 437
Table 421 - *Basic Error Codes* on page 445
Table 422 - *Media Access Error Codes* on page 449

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11.24 READ DISC INFORMATION Command

The READ DISC INFORMATION Command requests that the Logical Unit transfer general information about the medium that is mounted to the Host. The parameters returned 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/Border. In the case of DVD-RAM, DVD+RW, or DVD-ROM, the number of RZones and Borders is considered one. If this command is required by an implemented Feature, this command shall always function, even if that Feature's Current bit becomes zero.

Table 242 - READ DISC INFORMATION Command

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code (51h)							
1	LUN (Obsolete)			Reserved				
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	(MSB)			Allocation Length				
8								(LSB)
9	Vendor-Specific		Reserved			NACA	Flag	Link
10	PAD							
11								

It is not possible to completely characterize some incomplete C/DVD-R, CD-RW discs with the information from the READ TOC/PMA/ATIP information or the READ DVD STRUCTURE information. The READ DISC INFORMATION Command provides information about all discs: Magnetic, MO, C/DVD-ROM, C/DVD-R, DVD-RAM, DVD+RW, and CD-RW, including all incomplete C/DVD-R, CD-RW discs.

The number of Disc Information Block bytes returned is limited by the **Allocation Length** parameter of the CDB. An **Allocation Length** of zero ***shall*** not be considered an error. If the **Allocation Length** is greater than the amount of available Disc Information Data, only the available data will be transferred.

Table 243 - Disc Information Returned

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			Disc Information length				
1								(LSB)
	Information Block							
2	Reserved			Erasable	Status of Last Session/Border		Disc Status	
3	Number of First Track/RZone on Disc							
4	Number of Sessions/Borders (LSB)							
5	First Track/RZone Number in Last Session/Border (LSB)							
6	Last Track/RZone Number in Last Session/Border (LSB)							
7	DID_V[a]	DBC_V[a]	URU	Reserved				
8	Disc Type[a]							

Table 243 - Disc Information Returned (Continued)

Bit / Byte	7	6	5	4	3	2	1	0
9	Number of Sessions/Borders (MSB)							
10	First Track/RZone Number in Last Session/Border (MSB)							
11	Last Track/RZone Number in Last Session/Border (MSB)							
12	(MSB)							
13	Disc Identification[a]							
14								
15								(LSB)
16	(MSB)							
17	Lead-in Start Time of Last Session[a]							
18	MSF							
19								(LSB)
20	(MSB)							
21	Last Possible Start Time for Start of Lead-out[a]							
22	MSF							
23								(LSB)
24	(MSB)							
:	Disc Bar Code[a]							
31								(LSB)
32	Reserved							
33	Number of OPC Table Entries							
34 : n	Entries OPC Table(s)							

a. Inapplicable field for non-CD media. Shall be set to zero.

The invalid field for corresponded media, will return 0.

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.

The **Erasable** flag, when set to 1, indicates that DVD-RAM, DVD+RW, or CD-RW medium is present. Otherwise, such a medium is not present.

Status of Last Session/Border is valid only for discs with either empty or incomplete status and given by the following table. For DVD-RAM, this field will return “Complete” (11b).

Table 244 shows the definition of the **Status of Last Session/Border**

Table 244 - Status of Last Session/Border

Status of Last Session/Border	Description
00b	Empty Session/Border
01b	Incomplete Session/Border
10b	Reserved
11b	Complete Session/Border (Only possible when Disc Status is Complete)

The **Disc Status** field indicates the status of the disc and is shown in Table 245. The device which does not have the ability to write for the inserted medium (ex. C/DVD-ROM device) will return “Complete”(10b) status.

Table 245 - Disc Status

Disc Status	Description
00b	Empty Disc
01b	Incomplete Disc (Appendable)
10b	Complete Disc (Not Appendable. C/DVD-ROM, complete CD-R, CD-RW, DVD-R, or write protected Random Writable media)
11b	Others (non-write protected Random Writable media)

The **Number of First Track/RZone** on the disc:

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

For CD media,

1. If Disc Status is set to 00 (Empty Disc), the **Number of First Track/RZone** field ***shall*** be 1.
2. If there are no entries in the PMA and the first track is an Incomplete Track, the **Number of First Track/RZone** field ***shall*** be equal to 1.
3. If the only session on the disc is an Incomplete Session, the **Number of First Track/RZone** field is from the PMA.
4. Otherwise, the **Number of First Track/RZone** field contains the track number for the first TOC entry in the first Session.

The **Number of Sessions/Borders** on the disc refers to all complete Sessions/Borders plus any incomplete or empty Sessions/Borders. A Blank Disc will always have a session/Border count equal to 1.

First Track/RZone Number in Last Session/Border and **Last Track/RZone Number in Last Session/Border**. In order that Tracks/RZones in a last Session/Border which is open may be scanned for READ TRACK/RZONE INFORMATION Command, both the **First Track/RZone Number in Last Session/Border** and the **Last Track/RZone Number in Last Session/Border** are identified. This is inclusive of the invisible track/RZone.

The **DID_V** (Disc Identification Valid) flag specifies the validity of the Disc Identification field. If it is set to 1, then the Disc Identification field is valid. Otherwise, it is invalid.

The **DBC_V** (Disc Bar Code Valid) flag specifies the validity of the Disc Bar Code field. If it is set to 1, then the Disc Bar Code field is valid. Otherwise, it is invalid.

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. 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 Host Application code shall be set through the *Write Parameters* Mode Page (05h). A Host Application Code of zero may be used to indicate a restricted use disc -general purpose. Logical Units that do not read CD-R or CD-RW ATIP should set this bit to one.

For CD, the **Disc Type** specifies the type of the data on whole disc. A disc has only one disc type. The disc type is recorded in the A0/PSEC field in the TOC of the session in which there is at least one data track, or is recorded together with disc ID in PMA. In the case of a session that contains no data tracks (only audio), A0/PSEC field in the TOC of the session is always 00h regardless of actual disc type. For CD disc, the Disc type ***shall*** be determined from the following sequence:

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 (not appendable).
4. The Disc type is NOT decided, the Disc Type field of Disc Information data ***shall*** contain FFh.

Table 246 - Disc Type Code

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

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

The **Lead-in Start Time of Last Session** field is valid only for CD medium. Otherwise, this field shall be set to 0. If the disc is Empty as specified in the **Disc Status** field or has no Complete Session, then the **Lead-in Start Time of Last Session** is set to the address encoded in the ATIP. If the last session, which is the second or greater, is an Empty or Incomplete Session, this field ***shall*** be set to the B0 pointer of the previous session - 60 seconds. If the Disc Status is Complete, the **Lead-in Start Time of Last Session** field ***shall*** be filled with FFh. The **Lead-in Start Time of Last Session** is given in the MSF format.

The **Last Possible Start Time for Start of Lead-out** field is valid only for CD media. Otherwise this field shall be set to 0. If the disc is a Complete disc, the Last Possible Start Time of Lead-out field is filled with FFh. The **Last Possible Start Time for Start of Lead-out** is returned as the address encoded in the ATIP and it is given in MSF format.

Disc Bar Code. If the Logical Unit has the ability to read Disc Bar Code and a bar code is present, then the Disc Bar Code field contains the 12 hex digits of the bar code.

Number of OPC Table Entries. An OPC (Optimum Power Calibration) Table is attached only if the values are known for the mounted 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 is used to compute the number of bytes that will follow. The number of bytes that follow will be the number of entries times 8. This number ***shall*** be the same for all values of Allocation Length.

Note: The Number of OPC Table Entries will always be zero for CD-ROM, DVD-ROM, DVD-RAM, and DVD+RW discs and for CD-R/RW discs for which OPC have not yet been determined. For DVD-R, the use of OPC table entries is vendor-specific.

Table 247 - OPC Table Entries

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			Speed				
1								(LSB)
2	(MSB)							
3								
4				OPC Value				
5								
6								
7								(LSB)

The **Speed** field indicates the speed for which this OPC value is valid. This value is the number of kilobytes per/second (Speed/1000) that the data is read from the Logical Unit.

Table 248 - Example Data Rates

Speed	CD(ROM/R/RW) Data Rate
X1	176 kBytes/second
X2	353 kBytes/second
X4	706 kBytes/second
X8	1.4 MBytes/second
X16	2.8 MBytes/second

The **OPC Value** field is associated with given speed and its contents are vendor specific.

Table 249 describes errors that may occur during the operation of the Command or which may cause a CHECK CONDITION status to be reported.

Table 249 - READ DISC INFORMATION Command Errors

Error Description
A-1.1, "Deferred Error Reporting" on page 437
Table 421 - *Basic Error Codes* on page 445
Table 422 - *Media Access Error Codes* on page 449

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11.25 READ DVD STRUCTURE Command

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

Table 250 - READ DVD STRUCTURE Command

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation code (ADh)							
1	LUN (Obsolete)			Reserved				
2	(MSB)							
3				Address				
4								
5								(LSB)
6	Layer Number							
7	Format							
8	(MSB)			Allocation Length				
9								(LSB)
10	AGID		Reserved					
11	Vendor-Specific		Reserved			NACA	Flag	Link

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

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

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

Requests for Format FFh ***shall*** always be fulfilled, even if no or incompatible media is installed.

When a READ DVD STRUCTURE Command is issued on non-DVD media for format codes 00h - FEh, this command ***shall*** be terminated with CHECK CONDITION Status, 5/30/02 CANNOT READ MEDIUM - INCOMPATIBLE FORMAT. When the device/media does not support specified format code, this command ***shall*** be terminated with CHECK CONDITION Status, 5/24/00 INVALID FIELD IN CDB.

In the case of DVD-R, the Logical Unit may have cache memory for the Lead-in Control Area data. If the disc has no Lead-in and there are no structures in the cache, the Logical Unit ***shall*** generate CHECK CONDITION Status, 5/24/00 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 structure.

The number of READ DVD STRUCTURE data bytes returned is limited by the **Allocation Length** field of the CDB. An **Allocation Length** of zero is not an error.

The **Address** field contains a value which depends on the value in the Format field.

For **Format** field = 05h (CGMS,CPM), the **Address** field contains an LBA (Logical Block Address).

For **Format** field = 0Ch (RMD in last Border-out), the **Address** field contains the Field number of RMD block which is recorded in the last Border-out. The Field number of RMD block are integers assigned in ascending order in the range 0 to 14.

For **Format** field = 0Dh (RMD in RMA), the **Address** field contains the sector number of RMA where the RMA read operation ***shall*** begin. The RMA sector size is 2KB. The RMA sector number is assigned to each sector of RMA, including RMD linking loss area. The RMA sector numbers are integers assigned in ascending order starting with zero. Each successive sector of RMA has a number increased by 1. When the Address field specifies an unrecorded RMA sector, this command ***shall*** be terminated with CHECK CONDITION status, Sense Key BLANK CHECK. Cached RMD information ***shall*** be returned by this command as if it had been committed to the medium.

For **Format** field = 30h (Disc Control Blocks), the **Address** field contains the Content Descriptor desired.

Other values - The **Address** field ***shall*** be reserved.

Table 251 - 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[a]
01h	Copyright	Layer Number	Reserved	Returns the Copyright information from DVD Lead-in
02h	Disc Key	Layer Number	Reserved	Returns the Disc Key obfuscated by using a Bus Key
03h	BCA	Reserved	Reserved	Returns the BCA information on DVD media
04h	Manufacturer’s	Layer Number	Reserved	Returns the Disc Manufacturing information from DVD Lead-in
05h	CGMS,CPM	Layer Number	LBA	Returns CGMS, CPM information from specified sector
06h - 07h	Reserved			
08h	DDS	Reserved	Reserved	Returns the DDS information on DVD-RAM media
09h - 0Bh	Reserved			
0Ch	RMD in last Border-out	Reserved	Start Field Number of RMD block	Returns the Field of RMD in last Border-out
0Dh	RMD	Reserved	Start RMA Sector Number	Returns RMD sectors which are recorded in RMA
0Eh	Pre-recorded information in Lead-in	Reserved	Reserved	Returns Pre-recorded information in Lead-in
0Fh	Unique Disc Identifier	Reserved	Reserved	Returns Unique Disc Identifier of the disc
10h-2Fh	Reserved			
30h	Disc Control Blocks	Reserved	Content Descriptor	Returns the Disc Control Block identified by the Content Descriptor
31h - FEh	Reserved			
FFh	Structure List	Layer Number	Reserved	Returns a list of DVD structures present in the specified Layer.

a. For DVD-R multi-border disc, returns information in the last Border-in.

11.25.1 Physical Format Information (Format 00h)

Physical Format Information is shown in Table 252.

Table 252 - READ DVD STRUCTURE Data Format (With 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 Structures							
	Layer Descriptor							

Table 253 - Layer Descriptor

Bit / Byte	7	6	5	4	3	2	1	0
0	Book Type				Book Version			
1	Disc Size				Minimum Rate			
2	Reserved	Number of Layers		Track Path	Layer Type			
3	Linear Density				Track Density			
4	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 Sector Number in Layer 0							
15								(LSB)
16	BCA Flag	Reserved						
17 - 2047	Media Specific							

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

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 non-existent layer is requested then the command ***shall*** be aborted with CHECK CONDITION Status, 5/24/00 INVALID FIELD IN CDB. If the media has more than one layer, but is recorded using the Opposite Track Path method, then the same information ***shall*** be returned for all layers.

The Book Type field specifies with which DVD Book this media complies. See Table 254.

Table 254 - Book Types

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

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

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

The **Minimum Rate** is used to specify to the Logical Unit the read rate to use for this media. See Table 255.

Table 255 - Minimum Rate Codes

Minimum Rate	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 specifies read/writability of the layer. See Table 256.

Table 256 - Layer Types

Layer Type Code	Layer Type
0001b	Read-only layer
0010b	Recordable layer
0100b	Rewritable layer
Others	Reserved

The **Linear Density** field indicates the minimum/maximum pit length used for this layer. See Table 257.

Table 257 - Linear Density Codes

Linear Density Code	Linear Density
0000b	0.267 µm/bit
0001b	0.293 µm/bit
0010b	0.409 to 0.435 µm/bit
1000b	0.176 µm/bit
Others	Reserved

The **Track Density** field indicates the track width used for this media. See Table 258.

Table 258 - Track Density

Track Density Code	Track Density
0000b	0.74 µm/track
0001b	0.80 µm/track
Others	Reserved

The **Starting Sector Number of Data Area** specifies the first block that contains user data. See Table 259.

Table 259 - Starting Physical Sector Number of Data Area

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

The **End Physical Sector Number of Data Area** specifies the last sector of the user data area 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. It should not be used for counting user capacity.

The **End Sector Number in Layer 0** field specifies the last sector of the user data in layer 0, if the media contains multiple layers with using the Opposite Track Path. In other cases, this value is set to 000000h.

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

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

11.25.2 DVD Copyright Information (Format 01h)

Table 260 - READ DVD STRUCTURE Data Format (With 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 Host. The **DVD STRUCTURE Data Length** value does not include the DVD STRUCTURE Data Length field itself.

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

The **Region Management Information** field describes the regions in which the disc can be played. Each bit represents one of eight regions. If a bit is Cleared 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.

There are currently 6 regions defined. See the DVD Book for more information.

11.25.3 DISC KEY (Format 02h)

Table 261 - READ DVD STRUCTURE Data Format (With 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							
Disk Key Structures								
0	(MSB)							
.				DISC KEY Data				
2047								(LSB)

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

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

When the DISC KEY does not exist on DVD media, this command with Format = 02h ***shall*** be terminated with CHECK CONDITION Status, 5/6F/01 COPY PROTECTION KEY EXCHANGE FAILURE - KEY NOT PRESENT.

When the DVD Logical Unit is not in the Bus Key state, this command with Format = 02h ***shall*** be terminated with CHECK CONDITION Status, 5/6F/02 COPY PROTECTION KEY EXCHANGE FAILURE - KEY NOT ESTABLISHED.

11.25.4 BCA (Format 03h)

Table 262 - READ DVD STRUCTURE Data Format (With 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 Structures								
0	(MSB)							
				BCA Information				
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 Host. The DVD STRUCTURE Data Length value does not include the DVD STRUCTURE Data Length field itself.

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

When a READ DVD STRUCTURE Command with a format field value of 03h is presented for a DVD media without BCA, the command ***shall*** be terminated with CHECK CONDITION Status, 5/24/00 INVALID FIELD IN CDB.

11.25.5 Disc Manufacturing Information (Format 04h)

Table 263 - READ DVD STRUCTURE Data Format (With 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 Lead-in Structures								
0								
				Disc Manufacturing Information Descriptor				
2047								

Table 264 - Disc Manufacturing Information Descriptor

Bit / Byte	7	6	5	4	3	2	1	0
0	Disc Manufacturing Information							
2047								

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

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

11.25.6 Copyright Management Information (Format 05h)

Table 265 - READ DVD STRUCTURE Data Format (With 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	CPM	Reserved	CGMS		Reserved			
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 Host. The **DVD STRUCTURE Data Length** value does not include the **DVD STRUCTURE Data Length** field itself.

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

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, indicates that copying is permitted without restriction, and if the **CGMS** field is set to 01b, 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.

11.25.7 DVD-RAM Disc Definition Structure (DDS) (Format 08h)

Table 266 - READ DVD STRUCTURE Data Format (With 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	(MSB)	DDS Information						
2047								(LSB)

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

The **DDS Information** is taken from the Defect Controls of the DVD-RAM media lead-in. The length of the **DDS Information** is currently 2048 bytes only.

When a READ DVD STRUCTURE Command with a format field value of 08h is presented for a DVD media without the DDS Information, the command ***shall*** be terminated with CHECK CONDITION Status, 5/30/02 CANNOT READ MEDIUM - INCOMPATIBLE FORMAT.

11.25.8 RMD in the last Border-out (Format 0Ch)

Table 267 - READ DVD STRUCTURE Data Format (With 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	(MSB)	RMD Bytes						
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 Host. The **DVD STRUCTURE Data Length** value does not include the DVD **STRUCTURE Data Length** field itself.

The **RMD Bytes** field returns the RMD which 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 30720 bytes (15 sectors).

11.25.9 Recording Management Area Data (Format 0Dh)

Table 268 - READ DVD STRUCTURE Data Format (With 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 Recording Management Data Structure								
0	(MSB)							
1				Last Recorded RMA Sector Number				
2								
3								(LSB)
4	(MSB)							
:				RMD Bytes				
N								(LSB)

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

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

Last Recorded RMA Sector Number field indicates the RMA sector number where the last RMD is recorded.

The **RMD Bytes** field returns the RMD which 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 Host. The returned RMD data ***shall*** end at the next ECC boundary. The maximum number of RMD bytes that can be returned is 32768.

11.25.10 Pre-recorded Information in Lead-in (Format 0Eh)

Table 269 - READ DVD STRUCTURE Data Format (With 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	Application code							
2	Disc Physical data							
3	(MSB)							
4				Last address of Data Recordable Area				
5								(LSB)
6	Reserved							

Table 269 - READ DVD STRUCTURE Data Format (With Format Field = 0Eh) (Continued)

Bit / Byte	7	6	5	4	3	2	1	0
7	Reserved							
8	Field ID (= 2)							
9	Recommended Write power							
10	Specified Wavelength for RWP							
11	Optimum Write Strategy							
12	Reserved							
13	Reserved							
14	Reserved							
15	Reserved							
16	Field ID (= 3)							
17	Manufacturer ID (17)							
18	Manufacturer ID (16)							
19	Manufacturer ID (15)							
20	Manufacturer ID (14)							
21	Manufacturer ID (13)							
22	Manufacturer ID (12)							
23	Reserved							
24	Field ID (= 4)							
25	Manufacturer ID (11)							
26	Manufacturer ID (10)							
27	Manufacturer ID (9)							
28	Manufacturer ID (8)							
29	Manufacturer ID (7)							
30	Manufacturer ID (6)							
31	Reserved							
32	Field ID (= 5)							
33	Manufacturer ID (5)							
34	Manufacturer ID (4)							
35	Manufacturer ID (3)							
36	Manufacturer ID (2)							
37	Manufacturer ID (1)							
38	Manufacturer ID (0)							
39	Reserved							
40 - 63	Reserved							

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

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

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

11.25.11 Unique Disc Identifier (Format 0Fh)

Table 270 - READ DVD STRUCTURE Data Format (With 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 Unique Disc Identifier								
0	Reserved							
1	Reserved							
2	(MSB)	Random Number						
3								(LSB)
4	(MSB)	Year						
5								
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)

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

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

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

11.25.12 Disc Control Blocks (Format 30h)

The Address field of the READ DVD STRUCTURE command ***shall*** contain a Content Descriptor to identify the DCB requested. Valid values are as shown in Table 271.

Table 271 - Content Descriptors

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 result data is shown in Table 252.

Table 272 - READ DVD STRUCTURE Data Format (With 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				
0				Disc Control Block				
32767								

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. See Table 273.

Table 273 - 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 - 32767				Disc Control Block 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 Host. 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 - 32767.

The **Unknown Content Descriptor Actions** contains a bit mask. This mask ***shall*** describe actions the drive is allowed to perform if the **Content Descriptor** is not known by the drive. Each bit, when set to one, ***shall*** prohibit the corresponding action. When set to zero, the corresponding action is allowed. See Table 274.

Table 274 - Unknown Content Descriptor Actions

Bit	Action
0	Recording within the user data area
1	Reading within the user data area
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 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 Host. If the Logical Unit records DCBs that are generated internally, and those DCBs cannot be sent from the Host, the Logical Unit ***shall not*** report those DCBs as recordable.

Table 275 - Disc Control Block (FFFFFFFFh)

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)							
1	Content Descriptor = FFFFFFFFh							
2								
3								(LSB)
4	(MSB)							
5	Reserved							
6								
7								(LSB)
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 275 - Disc Control Block (FFFFFFFFh) (Continued)

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 Host. 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.

11.25.13 DVD Structure List (Format FFh)

Table 276 - READ DVD STRUCTURE Data Format (With 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	Structure List							
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 Host. 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 277.

Note: This DVD Structure is generated by the Logical Unit rather than read from the medium.

Table 277 - 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 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 - READ DVD STRUCTURE Command Errors

Error Description
A-1.1, "Deferred Error Reporting" on page 437
Table 421 - *Basic Error Codes* on page 445
Table 422 - *Media Access Error Codes* on page 449

11.26 READ FORMAT CAPACITIES Command

The READ FORMAT CAPACITIES Command allows the Host 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 this command is required by an implemented Feature, this command ***shall*** function independently of the state of that Feature’s current bit.

Table 279 - READ FORMAT CAPACITIES Command

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code (23h)							
1	LUN (Obsolete)			Reserved				
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	(MSB) Allocation Length							
8								(LSB)
9	Vendor-Specific		Reserved			NACA	Flag	Link
10	PAD							
11								

The **Allocation Length** field specifies the maximum number of bytes that a Host 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 drive ***shall*** terminate the data transfer when **Allocation Length** bytes have been transferred or when all available data have been transferred to the Host, whichever is less.

Table 280 - 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	Formattable Capacity Descriptor 0							
7								
...								
n * 8	Formattable Capacity Descriptor n							
n * 8 + 7								

Table 281 - Capacity List Header

Bit / Byte	7	6	5	4	3	2	1	0
0	Reserved							
1								
2								
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 282 - 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 indicates the type of information the descriptor contains. The values are shown in Table 283.

Table 283 - Descriptor Types

Descriptor Type	Description
00b	Reserved
01b	Unformatted Media. The reported value is for the Maximum formattable capacity for this media
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 user data blocks between the first Lead-in and the last Lead-out or Border zone. When the media has no closed session or Border, 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 284 - 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 indicates the type of information for formatting.

Table 285 - 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-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 descriptor

Table 285 - Format Types (Continued)

Format Type	Description	Type Dependent Parameter
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-RW media. The packet size and number of addressable blocks may be adjusted downward by the Host before sending this descriptor back via the FORMAT UNIT Command.	Fixed Packet Size in sectors
11h	The descriptor ***shall*** contain the maximum number of addressable blocks and the packet size which can be used to expand (grow) the last complete session of CD-RW media. The number of addressable blocks may be adjusted downward by the Host before sending this descriptor back via the FORMAT UNIT Command.	Fixed Packet Size in sectors
12h	The descriptor ***shall*** contain the maximum number of addressable blocks and the maximum packet size which can be used to add a new session to a CD-RW media. The packet size and number of addressable blocks may be adjusted downward by the Host before sending this descriptor back via the FORMAT UNIT Command.	Fixed Packet Size in sectors
13h - 1Fh	Reserved	
20h	The descriptor ***shall*** contain the maximum number of addressable blocks and the sparing parameters to be used.	M and N (sparing parameters)
21h-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 285. In the case of Format Type 20h, M specifies SL where $SL = 2^M$, $4 \le M \le 15$ or SL = 0 if M = 0 and N identifies SI where $SI = 2^N$, $4 \le N \le 24$. The Type Dependent Parameter ***shall*** be set to M * 10000h + N, effectively placing M in byte offset 5 and N in byte offset 7, and making byte 8 reserved. The device ***shall*** supply its default values for M and N.

The Logical Unit ***shall*** only return Formattable Capacity Descriptors that apply to the installed media. If there is no medium installed, the Logical Unit ***shall*** return only the Current/Maximum Capacity Descriptor, with the maximum capacity of a medium that the Logical Unit is capable of reading.

A Formattable Capacity Descriptor of **Format Type** 00h ***shall*** be reported if any other Formattable Capacity Descriptor is reported.

The descriptors ***shall*** be returned in ascending order of Format Type. For Format Types other than 04h and 05h, if multiple format descriptors exist, they ***shall*** be returned in Logical Unit preferred order. For Format Types 04h and 05h, the format descriptors ***shall*** be returned in ascending order of Zone number.

Formattable Capacity Descriptors for media that can be read, but cannot be formatted by the Logical Unit ***shall not*** be reported.

Table 286 - Returned Current/Maximum Descriptor for Combination of drive and media

		Media			
		No Media	**ROM Media**	**Sequential Writable Media**	**Random Writable Media**
Drive	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)

Note: This command is not mandatory for all drive types shown in Table 286; the table indicates the values returned if the command is implemented.

Table 287 describes errors that may occur during the operation of the Command or which may cause a CHECK CONDITION status to be reported.

Table 287 - READ FORMAT CAPACITIES Command Errors

Error Description
A-1.1, "Deferred Error Reporting" on page 437
Table 421 - *Basic Error Codes* on page 445
Table 422 - *Media Access Error Codes* on page 449

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11.27 READ HEADER Command

The READ HEADER Command requests that the Logical Unit return the CD-ROM Data Block Address Header of the requested logical block.

Table 288 - READ HEADER Command

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation code (44h)							
1	LUN (Obsolete)			Reserved			MSF	Reserved
2	(MSB)							
3	Logical Block Address							
4								
5								(LSB)
6	Reserved							
7	(MSB) Allocation Length							
8								(LSB)
9	Vendor-Specific		Reserved			NACA	Flag	Link
10	PAD							
11								

See *3.5, "CD Address Reporting Formats (MSF bit)"* on page 47 for a description of the **MSF** bit.

The **Logical Block Address** field specifies the logical block at which the read header operation ***shall*** begin.

The **Allocation Length** field specifies the maximum number of bytes that a Host 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 drive ***shall*** terminate the data transfer when **Allocation Length** bytes have been transferred or when all available data have been transferred to the Host, whichever is less.

See the READ (10) Command for exception handling.

The READ HEADER data format in Table 289 and Table 290 defines the format for the returned CD-ROM data block address header of the requested logical block.

Table 289 - READ HEADER LBA Data Format

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

Table 290 - READ HEADER MSF Data Format

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

The **CD-ROM Data Mode** field specifies the CD-ROM data mode of the logical blocks in this sector of data. The values in this field are defined in Table 291.

Table 291 - CD Data, Mode Codes

CD-ROM Data Mode	User Data Field Contents (2048 Bytes)
00h	Mode 0 or Audio
01h	Mode 1
02h	Mode 2
03h - FFh	Reserved

If the **MSF** bit is zero, the Absolute Address field gives the logical block address of the first logical block in the physical sector where the data for the requested logical block address is found. If the MSF bit is one, the Absolute Address field gives the **MSF** address of the sector where the data for the requested logical block address is found.

Table 292 describes errors that may occur during the operation of the Command or which may cause a CHECK CONDITION status to be reported.

Table 292 - READ HEADER Command Errors

Error Description
A-1.1, "Deferred Error Reporting" on page 437
Table 421 - *Basic Error Codes* on page 445
Table 422 - *Media Access Error Codes* on page 449

11.28 READ SUBCHANNEL Command

The READ SUBCHANNEL Command requests that the CD Logical Unit return the requested sub-channel data plus the state of play operations.

Table 293 - READ SUBCHANNEL Command

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation code (42h)							
1	LUN (Obsolete)			Reserved			MSF	Reserved
2	Reserved	SubQ	Reserved					
3	Sub-channel Data Format							
4	Reserved							
5	Reserved							
6	Track Number							
7	(MSB) Allocation Length							
8	Allocation Length (LSB)							
9	Vendor-Specific		Reserved			NACA	Flag	Link
10	PAD							
11	PAD							

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 play operation, the CD Logical Unit may access the media to read the sub-channel data. The CD Logical Unit is responsible for ensuring that the data returned are current and consistent.

See *3.5, "CD Address Reporting Formats (MSF bit)"* on page 47 for a description of the **MSF** bit. Support for the **MSF** bit is mandatory.

The **SubQ** bit set to one requests that the CD Logical Unit return the Q sub-channel data. The sub Q bit set to zero requests that no sub-channel data be returned. This ***shall*** not be considered an error. Support for the SubQ bit is mandatory. When the sub Q bit is Zero, only the Sub-Channel data header is returned. See Table 295.

The **Sub-Channel Data Format** field specifies the returned sub channel data. If this field is 01h, 02h or 03h, the requested sub-Q data item is returned.

Table 294 - Sub-channel Data Format Codes

Format Code	Returned data	Support Requirement
00h	Reserved	Reserved
01h	CD current position	Mandatory
02h	Media catalogue number (UPC/bar code)	Mandatory
03h	Track international standard recording code (ISRC)	Mandatory
04h - EFh	Reserved	
F0h - FFh	Vendor-specific	Optional

The **Track Number** field specifies the track number from which the ISRC code is transferred. This field ***shall*** have a value from 01h to 63h (99d), and is valid only when the sub-channel data format is 03h. If this field is nonzero for any Sub-Channel Data Formats other than 03h, the drive will terminate the command with a check condition (INVALID REQUEST / INVALID FIELD IN COMMAND PACKET).

The result data format is a Sub-Channel Data Header followed by data specified by the **Format Code**.

The **Allocation Length** field shall indicate the maximum number of bytes the drive shall return to the host. An **Allocation Length** field of zero shall not be considered an error.

Table 295 - Sub-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)

11.28.1 CD Current Position Data Format

Table 296 describes the result data format if Format Code 01h is requested.

Table 296 - CD Current Position Data Format (Format Code 01h)

Bit / Byte	7	6	5	4	3	2	1	0
Sub Channel Data Header								
0	Reserved							
1	Audio Status							
2	(MSB) Sub-channel Data Length							
3								(LSB)
CD Current Position Data Block								
4	Sub Channel Data Format Code (01h)							
5	ADR				Control			
6	Track Number							
7	Index Number							
8	(MSB) Absolute CD Address							
9	See Table 3 - *MSF Address Format* on page 47							
10								
11								(LSB)
12	(MSB) Track Relative CD Address							
13	See Table 3 - *MSF Address Format* on page 47							
14								
15								(LSB)

The **Audio Status** field indicates the status of play operations. The audio status values are defined inTable 297 - *Audio Status Codes* on page 341. **Audio Status** values 13h and 14h return information on previous audio operations; they are returned only once after the condition has occurred. If another play operation is not requested, the **Audio Status** returned for subsequent READ SUB-CHANNEL commands is 15h.

Table 297 - Audio Status Codes

Status	Description
00h	Audio status byte not supported or not valid
11h	Play operation in progress
12h	Play operation paused
13h	Play operation successfully completed
14h	Play operation stopped due to error
15h	No current audio status to return

The **Sub-channel Data Length** 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.

The Sub-Q Channel Data Block consists of control data (bytes 4 - 5), current position data (bytes 6 - 15) and identification data (bytes 16 - 47). 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.

1. If an play operation is proceeding in the background, position data for the last sector played ***shall*** be reported.
2. In other cases, for instance after a READ command, the CD 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.

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

Table 298 - ADR Sub-channel Q Field

ADR code	Description
0h	Sub-channel Q mode information not supplied
1h	Sub-channel Q encodes current position data (i.e. track, index, absolute address, relative address)
2h	Sub-channel Q encodes media catalogue number
3h	Sub-channel Q encodes ISRC
4h - Fh	Reserved

For a description of the Sub-Q channel Control bits, see Table 318 - *Bit Definitions for the Control Field in Sub-channel Q* on page 357.

The **Track Number** field shall indicate the Track number of the current track.

The **Index Number** specifies the index number in the current track.

The **Absolute CD Address** field gives the current location relative to the logical beginning of the media. If the MSF bit is zero, this field is a logical block address. If the MSF bit is one, this field is an absolute MSF address.

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 logical block address. (If the current block is in the pre-gap area of a track, this will be a negative value, expressed as a twos-complement number.) If the MSF bit is one, this field is the relative MSF address from the Q sub-channel.

11.28.2 Media Catalogue Number Data Format

The Media Catalogue Number Data Format is shown in Table 299.

Table 299 - Media Catalogue Number Data Format (Format Code 02h)

Bit / Byte	7	6	5	4	3	2	1	0
Sub Channel Data Header								
0	Reserved							
1	Audio Status							
2	MSB	Sub-channel Data Length						
3								LSB
Media Catalogue Number Data Block								
0	Sub Channel Data Format Code (02h)							
1	Reserved							
2	Reserved							
3	Reserved							
4	Media Catalogue Number (UPC/Bar Code)							
19	(See Table 300 - *UPC Format* on page 342)							

A Media Catalogue Valid (**MCVal**) bit of one indicates that the media catalogue number field is valid. A MCVal bit of zero indicates that the media catalogue number field is not valid.

The **Media Catalogue Number** field contains the identifying number of this media according to the uniform product code values (UPC/EAN bar coding) expressed in ASCII. Non-zero values in this field are controlled by the Uniform Product Code Council[1]) and the European Article Number Council[2]. A value in this field of all ASCII zeros indicates that the media catalog number is not supplied.

If media catalogue number data is found, the **MCVal** bit is set to one. If MCN data is not detected, the **MCVal** bit is set to zero to indicate the Media Catalogue Number field is invalid.

The **Media Catalogue Number** data returned by this command with sub-channel data format field code 02h may be from any block that has UPC bar code Q sub-channel data. (This code is constant anywhere in every applicable disc.)

The CD Drive may either return the UPC information that it has previously read (Cached data) or may scan for the information. As the UPC is only guaranteed to be contained in 1 out of 100 sectors and errors may be encountered, the time required to return the UPC data could be several seconds.

Table 300 - UPC Format

Bit / Byte	7	6	5	4	3	2	1	0
0	MCVal	Reserved						
1	N1 (Most significant)							
2	N2							
3	N3							
4	N4							
5	N5							
6	N6							
7	N7							

1. The Uniform Product Code Council is located at 8163 Old Yankee Road, Suite J, Dayton, Ohio 45459.
2. The European Article Number Council is located at Rue des Colonies, 54-BTE8, 1000 Brussels, Belgium.

Table 300 - UPC Format

Bit / Byte	7	6	5	4	3	2	1	0
8	N8							
9	N9							
10	N10							
11	N11							
12	N12							
13	N13							
14	Zero							
15	AFrame (Binary)							

N1 through **N13** ***shall*** be retrieved from the Q channel in mode 2. The data ***shall*** be encoded as ASCII characters (i.e. if N1 of the UPC is 01bcd, then N1 of the above field ***shall*** be 49d or 31h).

11.28.3 Track International Standard Recording Code Data Format

The Track ISRC field contains the identifying number of this media according to the ISRC standards (DIN-31-621). The result data format is described in Table 301.

Table 301 - Track International Standard Recording Code Data Format

Bit / Byte	7	6	5	4	3	2	1	0
Sub Channel Data Header								
0	Reserved							
1	Audio Status							
2	(MSB) Sub-channel Data Length							
3								(LSB)
Track ISRC Data Block								
0	Sub Channel Data Format Code (03h)							
1	ADR (03)				Control			
2	Track Number							
3	Reserved							
4	Track International Standard Recording Code (ISRC)							
19	See Table 303 - *ISRC Format of Data Returned to Host* on page 344.							

If ISRC data is detected, the **TCVal** bit is set to one. If ISRC data is not detected, the **TCVal** bit is set to zero to indicate the ISRC field is invalid.

Track ISRC data returned by this command with sub-channel data format field 03h may be from any block in the specified track that has ISRC data. When **ADR** field is 3 (0011), it is used to assign a unique number to an audio track. This is done by means of the ISRC which is 12 characters long (represented by I1 to I12.) The ISRC can only change immediately after the TNO has been changed.

Table 302 - Raw ISRC Format on the CD Disc

S0, S1	Control	ADR	I1 I2	I3 I4 I5	00	I6 I7 I8 I9 I10 I11 I12	zero	A Frame	CRC
		3	ISRC 60 bits						

00: These 2 bits are zero.

zero: These 4 bits are zero.

I1, I2 are the country code; I3, I4, I5 are the owner code; I6, I7 are the year of recording; I8, I9, I10, I11, I12 are the serial number of the recording. AFrame is the absolute frame number.

The information returned for the ISRC ***shall*** be converted to ASCII. The translation used will translate media codes from 00h - 09h to ASCII ‘0’ - ‘9’ and media codes from 10h - 3Fh to ASCII ‘@’ - ‘0’.

Table 303 - ISRC Format of Data Returned to Host

Bit / Byte	7	6	5	4	3	2	1	0
0	TCVal	Reserved						
1	I1 (Country Code) Valid codes are ASCII ‘A’ - ‘Z’							
2	I2							
3	I3 (Owner Code) Valid codes are ASCII ‘0’ - ‘9’ & ‘A’ - ‘Z’							
4	I4							
5	I5							
6	I6 (Year of Recording) Valid codes are ASCII ‘0’ - ‘9’							
7	I7							
8	I8 (Serial Number) Valid codes are ASCII ‘0’ - ‘9’							
9	I9							
10	I10							
11	I11							
12	I12							
13	Zero							
14	AFrame							
15	Reserved							

Table 304 describes errors that may occur during the operation of the Command or which may cause a CHECK CONDITION status to be reported.

Table 304 - READ SUBCHANNEL Command Errors

Error Description
A-1.1, "Deferred Error Reporting" on page 437
Table 421 - *Basic Error Codes* on page 445
Table 422 - *Media Access Error Codes* on page 449

11.28.4 Caching of Sub-Channel Data

Sub-channel Q data ***shall*** be cached by the drive while playing audio. This is necessary so that the Read Sub-channel or Read CD commands can access the Sub-Channel Q data while executing an immediate command. The device ***shall*** generate an error if the data is not in the cache.

Read Sub-channel will return the “Current” data, while Read CD will return the specified data and remove any previous (older) data from the cache.

Using “FFFFFFFFh” on Read CD will work just like Read Sub-channel.

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11.29 READ TOC/PMA/ATIP Command

The READ TOC/PMA/ATIP Command requests that the CD Logical Unit transfer data from the Table of Contents, the Program Memory Area (PMA), or the Absolute Time in Pre-Grove (ATIP) from CD media.

For DVD media, as there is no TOC, this command will return fabricated information that is similar to that of CD media for some formats. This fabrication is required for some legacy Host environments.

Table 305 - READ TOC/PMA/ATIP Command

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation code (43h)							
1	LUN (Obsolete)			Reserved			MSF	Reserved
2	Reserved				Format			
3	Reserved							
4	Reserved							
5	Reserved							
6	Track / Session Number							
7	(MSB) Allocation Length							
8								(LSB)
9	Vendor-Specific		Reserved			NACA	Flag	Link
10	PAD							
11								

See *3.5, "CD Address Reporting Formats (MSF bit)"* on page 47 for a description of the MSF bit. The **Format** field is defined in Table 306.

The **Track/Session Number** field specifies the starting track number for which the data shall be returned. The data is returned in contiguous ascending track number order. A value of AAh requests that the starting address of the lead-out area be returned. If this value is zero, the Table of Contents data shall begin with the first track or session on the medium.

If the **Track/Session Number** field is not valid for the currently installed medium, the command shall be terminated with CHECK CONDITION Status, 5/24/00 INVALID FIELD IN CDB.

When a READ TOC/PMA/ATIP command is presented for a CD-R/RW media, where the first TOC has not been recorded (no complete session) and the Format codes 0000b, 0001b, or 0010b are specified, this command shall be rejected with CHECK CONDITION Status, 5/24/00 INVALID FIELD IN CDB. Logical Units that are not capable of reading an incomplete session on CD-R/RW media **shall** report CHECK CONDITION Status, 2/30/02 CANNOT READ MEDIUM - INCOMPATIBLE FORMAT.

Table 306 - Format Code definitions for READ TOC/PMA/ATIP command

Format field	Returned Data	Usage	Description	Use of Track/Session Field
0h	TOC	CD Read Feature and Fabricated data for DVD Media	The Track/Session Number field specifies starting track number for which the data will be returned. For multi-session discs, this command will return the TOC data for all sessions and for Track number AAh only the lead-out area of the last complete session. See Table 307 - *READ TOC/PMA/ATIP Data Format (With Format Field = 0h)* on page 349	Contains the Track number
1h	Session Information	CD Read Feature and Fabricated data for DVD Media	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 308 - *READ TOC/PMA/ATIP Data Format (With Format Field = 1h)* on page 350	Reserved
2h	Full TOC	CD Read Feature	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 format, the drive will support Q Sub-channel Point field value of A0h, A1h, A2h, Track numbers, B0h, B1h, B2h, B3h, B4h, C0h, and C1h. See Table 309 - *READ TOC/PMA/ATIP Data Format (With Format Field = 2h)* on page 351	Contains the Session number
3h	PMA	Incremental Streaming Write Feature	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 311 - *READ TOC/PMA/ATIP Data Format (With Format Field = 3h)* on page 352	Reserved
4h	ATIP	Incremental Streaming Write Feature	This format returns ATIP data. In this format, the Track/Session Number field is reserved and ***shall*** be set to 00h. See Table 312 - *READ TOC/PMA/ATIP Data Format (With Format Field = 4h)* on page 353	Reserved
5h	CD-Text	CD-Text	This format returns CD-Text information from the Lead-in	Contains the Session number
6h - 0Fh	Reserved			

11.29.1 READ TOC/PMA/ATIP Format 0h

Table 307 - READ TOC/PMA/ATIP Data Format (With Format Field = 0h)

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			TOC Data Length				
1								(LSB)
2				First Track Number				
3				Last Track Number				
TOC Track Descriptors								
0				Reserved				
1		ADR				Control		
2				Track Number				
3				Reserved				
4	MSB							
5				Track Start Address				
6								
7								LSB

The READ TOC/PMA/ATIP data consist of four header bytes and zero or more track descriptors. The READ TOC/PMA/ATIP data is dependent upon the format specified in the format field of the COMMAND PACKET.

The **TOC Data Length** specifies the length in bytes of the following TOC data. The TOC data length value does not include the TOC data length field itself. This value is not modified when the allocation length is insufficient to return all of the TOC data available.

The **First Track Number** field indicates the first track number in the first complete session Table of Contents.

The **Last Track Number** field indicates the last track number in the last complete session Table of Contents before the lead-out.

The **ADR** field gives the type of information encoded in the Q sub-channel of the block where this TOC entry was found. The possible ADR values are defined in Table 298 - *ADR Sub-channel Q Field* on page 341.

The **Control** field indicates the attributes of the track. The possible control field values are defined in Table 318 - *Bit Definitions for the Control Field in Sub-channel Q* on page 357

The **Track Number** field indicates the track number for which the data in the TOC track descriptor is valid. A track number of AAh indicates that the track descriptor is for the start of the lead-out area.

The **Track Start Address** contains the address of the first block with user information for that track number as read from the Table of Contents. An MSF bit of zero indicates that the **Track Start Address** field contains a Logical Block Address. An MSF bit of one indicates the **Track Start Address** field contains an MSF address.

11.29.2 READ TOC/PMA/ATIP Format 1h

Table 308 - READ TOC/PMA/ATIP Data Format (With Format Field = 1h)

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)	TOC Data Length (0Ah)						
1								(LSB)
2	First Complete Session Number (Hex)							
3	Last Complete Session Number (Hex)							
TOC Track Descriptors								
0	Reserved							
1	ADR				Control			
2	First Track Number in Last Complete Session							
3	Reserved							
4	(MSB)							
5	Start Address of First Track in Last Session							
6								
7								(LSB)

The **TOC Data Length** specifies the length in bytes of the available session data. The **TOC Data Length** value does not include the **TOC Data Length** field itself. This value is not modified when the allocation length is insufficient to return all of the session data available.

The **First Complete Session Number** is set to one.

The **Last Complete Session Number** indicates the number of the last complete session on the disc. The **Last Complete Session Number** shall be set to one for a single session disc or if the Logical Unit does not support multi-session discs.

The **ADR** field gives the type of information encoded in the Q sub-channel of the block where this TOC entry was found. The possible ADR values are defined in Table 298 - *ADR Sub-channel Q Field* on page 341.

The **Control** field indicates the attributes of the track. The possible control field values are defined in Table 318 - *Bit Definitions for the Control Field in Sub-channel Q* on page 357.

First Track Number In Last Complete Session returns the first track number in the last complete session.

The **Start Address of First Track in Last Session** contains the address of the first block with user information for the first track of the last session, as read from the Table of Contents. An MSF bit of zero indicates that the **Start Address of First Track in Last Session** field contains a Logical Block Address. An MSF bit of one indicates the **Start Address of First Track in Last Session** field contains an MSF address.

11.29.3 READ TOC/PMA/ATIP Format 2h

None of the fields in the result data of Format 2h are affected by the MSF bit in the CDB.

Table 309 - READ TOC/PMA/ATIP Data Format (With Format Field = 2h)

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			TOC Data Length				
1								(LSB)
2	First Complete Session Number							
3	Last Complete Session Number							
TOC Track Descriptors								
0	Session Number							
1	ADR				Control			
2	Byte 1 or TNO							
3	Byte 2 or Point							
4	Byte 3 or Min							
5	Byte 4 or Sec							
6	Byte 5 or Frame							
7	Byte 6 or Zero							
8	Byte 7 or PMin							
9	Byte 8 or PSec							
10	Byte 9 or PFrame							

Multiple entries are recorded in the TOC area, but only one of each entry is reported.

For a **Format** field of 2h, the Logical Unit should 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** 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** is set to one for a single session disc or if the Logical Unit does not support multi-session discs.

The **ADR** field gives the type of information encoded in the Q sub-channel of the block where this TOC entry was found. The possible ADR values are defined in Table 298 - *ADR Sub-channel Q Field* on page 341.

The **Control** field indicates the attributes of the track. The possible control field values are defined in Table 318 - *Bit Definitions for the Control Field in Sub-channel Q* on page 357.

Entries in bytes 2 through 10 of the descriptors shall be converted to hex by the Logical Unit if the media contains a value between 0 and 99bcd.

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, C0h-FFh. Only recorded Points ***shall*** be returned.

Q sub-channel formats in the lead-in area of the TOC is described in Table 317 - *Lead in Area, Sub-channel Q formats* on page 356.

Table 310 - READ TOC/PMA/ATIP Track Descriptors

Byte	Point	Action	Description
Byte 0	-	Return a hex value	Session Number
Byte 1	-	No conversion, return as is	ADR / Control
Byte 2	-	0	Track (CD STRUCTURE = 0)
Byte 3	-	If 0-99bcd, then convert to hex	Point
Bytes 4 - 6 (MSF field)	00 - 99	Value should be 00h	
	A0h - AFh	Value should be 00h	
	B0h	Convert to hex	NRA
	B1h - BFh	Convert to hex	Skip Values
	C0	No Conversion	ORP / App Code
	C1	No Conversion	Copy of ATIP additional info 1
	C2 - FFh	No Conversion	Reserved
Byte 7	00h - AFh	Value should be 00h	
	B0h - BFh	Convert to Hex	# Pntrs / Skip
	C0h	No Conversion	Reserved
	C1h	Value should be 00h	
	C2h - FFh	No Conversion	Reserved
Bytes 8 - 10 (MSF field)	00 - 99	Convert to hex	Track Start
	A0h	Convert PMIN to hex, PSEC is returned as is	1st / Last / Start LO
	A1h - AFh	Convert to hex	1st / Last / Start LO
	B0h	Convert to hex	Lead Out Max
	B1h - BFh	Convert to hex	Skip Values
	C0h	Convert to hex	ORP / App Code
	C1h	Convert to hex	1st / Last / Start LO from ATIP
	C2h - FFh	No conversion	Reserved

11.29.4 READ TOC/PMA/ATIP Format 3h

None of the fields in the result data of Format 3h are affected by the MSF bit in the CDB.

Table 311 - READ TOC/PMA/ATIP Data Format (With Format Field = 3h)

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			PMA Data Length				
1								(LSB)
2				Reserved				
3				Reserved				
				PMA Descriptors				
0				Reserved				
1		ADR				Control		
2				Byte 1 or TNO				

Table 311 - READ TOC/PMA/ATIP Data Format (With Format Field = 3h) (Continued)

Bit / Byte	7	6	5	4	3	2	1	0
3	Byte 2 or Point							
4	Byte 3 or Min							
5	Byte 4 or Sec							
6	Byte 5 or Frame							
7	Byte 6 or Zero							
8	Byte 7 or PMin							
9	Byte 8 or PSec							
10	Byte 9 or PFrame							

Multiple entries are recorded in the PMA area.

The **PMA Data Length** specifies 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 returned PMA descriptors are arranged in the order found in the PMA, with duplicates removed.

Entries in bytes 2 through 10 of the descriptors shall be converted to hex by the Logical Unit if the media contains a value between 0 and 99bcd.

11.29.5 READ TOC/PMA/ATIP Format 4h

None of the fields in the result data of Format 4h are affected by the MSF bit in the CDB.

Table 312 - READ TOC/PMA/ATIP Data Format (With Format Field = 4h)

Bit / Byte	7	6	5	4	3	2	1	0
0	MSB	ATIP Data Length						
1								LSB
2	Reserved							
3	Reserved							
ATIP Descriptors								
4	1	Indicative Device Writing Power			Reserved	Reference Speed		
5	0	URU	Reserved					
6	1	Disc Type	Disc Sub-Type			A1	A2	A3
7	Reserved							
8	ATIP Start Time of lead-in (Mn)							
9	ATIP Start Time of lead-in (Sec)							
10	ATIP Start Time of lead-in (Frame)							
11	Reserved							
12	ATIP Last Possible Start Time of lead-out (Min)							
13	ATIP Last Possible Start Time of lead-out (Sec)							
14	ATIP Last Possible Start Time of lead-out (Frame)							
15	Reserved							

Table 312 - READ TOC/PMA/ATIP Data Format (With Format Field = 4h) (Continued)

Bit / Byte	7	6	5	4	3	2	1	0
16	0	Lowest Usable CLV Recording Speed			Highest Usable CLV Recording Speed			
17	0	Power Multiplication Factor p			Device y value of the Modulation/Power function			Reserved
18	1	Recommended Erase/Write Power Ratio (Pe_0/We_0)			Reserved			
19	Reserved							
20 - 22	A2 Values							
23	Reserved							
24 - 26	A3 Values							
27	Reserved							

ATIP Data Length specifies the number of bytes to be transferred in response to the command. The **ATIP Data Length** value does not include the data length field itself. This value is not modified when the allocation length is insufficient to return all of the ATIP data available.

Indicative Device Writing Power - encoded information indicating the media's recommended initial laser power setting. The meaning of these bits varies between CD-R and CD-RW media.

Reference Speed - encoded information indicating the recommended write speed for the media. 00h = reserved. 01h -2X recording. Valid only for CD-RW media.

The **URU** (Unrestricted Use Disc) flag, when set to one, indicates that the mounted CD-R/RW disc is defined for unrestricted use. When the Unrestricted Use Disc 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 Page. A Host Application Code of zero may be used to indicate a restricted use disc - general purpose.

Disc Type - zero indicates CD-R media; one indicates CD-RW media.

Disc Sub-Type - ***shall*** be set to zero.

A1 - when set to one, indicates that bytes 16-18 are valid.

A2 - when set to one, indicates that bytes 20-22 are valid.

A3 - when set to one, indicates that bytes 24-26 are valid.

ATIP Start time of Lead-in - 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.

Lowest Usable CLV Recording Speed - valid only when A1 = 1. See Table 313.

Table 313 - Lowest Usable CLV Recording Speed

Value	Recording Speed
000b	Reserved
001b	2X
010b - 111b	Refer to Orange Book

Highest Usable CLV Recording Speed - valid only when A1. See Table 314.

Table 314 - Highest Usable CLV Recording Speed

Value	Recording Speed
000b	Reserved
001b	2X
010b	4X
011b	6X
100b	8X
101b - 111b	Refer to Orange Book

Power Multiplication Factor p - reported as recorded in ATIP.

Device y value of the Modulation/Power Ratio (Pe0 / We0) - reported as recorded in ATIP.

A2 Values - Reserved

A3 Values - Reserved

11.29.6 READ TOC/PMA/ATIP Format 5h

None of the fields in the result data of Format 5h are affected by the MSF bit in the CDB.

Table 315 - READ TOC/PMA/ATIP Data Format (With Format Field = 5h)

Bit / Byte	7	6	5	4	3	2	1	0
0	MSB			CD-Text Data Length				
1								LSB
2	Reserved							
3	Reserved							
CD-Text Descriptor								
4-21	CD-Text Descriptor							

CD-Text Data Length specifies the number of bytes available to be transferred in response to the command. The CD-Text 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, and depends on the number of recorded Pack Data.

The CD-Text Descriptor field provides Pack Data available in the Lead-in area of the medium. Each Pack Data consists of 18 bytes of CD-Text information. If Pack Data is recorded repeatedly on the medium, the Logical Unit should return it only once. CD-Text Pack Data is described in *Appendix G - "CD-Text Format in the Lead-In Area (Informative)"* on page 487.

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 - READ TOC/PMA/ATIP Command Errors

Error Description
A-1.1, "Deferred Error Reporting" on page 437
Table 421 - *Basic Error Codes* on page 445
Table 422 - *Media Access Error Codes* on page 449

11.29.7 Sub-channel Q information

Table 317 - Lead in Area, Sub-channel Q formats

S0, S1	Control / ADR		TNO	Point	Min	Sec	Frame	Zero	Pmin	PSec	PFrame	CRC
	4/6	1	00	A0	00 (Absolute time is allowed)			00	First Track num	Disc Type	00	
	4/6	1	00	A1	00 (Absolute time is allowed)			00	Last Track num	00	00	
	4/6	1	00	A2	00 (Absolute time is allowed)			00	Start position of the Lead-out area			
	4/6	1	00	01-99	00 (Absolute time is allowed)			00	Start position of track			
	4/6	5	00	B0	Start time of next possible program in the Recordable Area of the Hybrid Disc			# of pointers in Mode 5	Maximum start time of the outermost Lead Out area in the Recordable Area of the Hybrid Disc			
	4/6	5	00	B1	00	00	00	00	# of Skip Interval Pointers (N<=40)	# of Skip Track Pointers (N<=21)	00	$x^{16} + x^{12} + x^5 + 1$
	4/6	5	00	B2-B4	Skip #	Skip #	Skip #	Skip #	Skip #	Skip #	Skip #	
	4/6	5	00	01-40	Ending time for the interval that should be skipped			Reserved	Start time for interval that should be skipped on playback			
	4/6	5	00	C0	Optimum recording power	Application Code	Reserved	Reserved	Start time of the first Lead In Area of the Hybrid Disc			
	4/6	5	00	C1	Copy of information from A1 point in ATIP							

Point

The Point field defines various types of information:

01-99 Track number references
A0 First Track number in the program area
A1 Last Track number in the program area
A2 Start location of the Lead-out area
B0 Used to identify a Hybrid Disc (Photo CD)
Contains start time of next possible program area
B1 Number of Skip Interval Pointers & Skip Track assignments
B2-B4 Skip Track Assignment Pointers
C0 Start time of first Lead In area of Hybrid Disc

		This only exists in the first Lead In area
	C1	Copy of information from additional area in ATIP
Disc Type Byte	This byte contains a definition of the type of disc	
	00h	CD-DA or CD-ROM with first track in Mode 1
	10h	CD-I disc
	20h	CD-ROM XA disc with first track in Mode 2

The Control field is defined in Table 318.

Table 318 - Bit Definitions for the Control Field in Sub-channel Q

Control Field	Definition
00x0b	2 Audio without Pre-emphasis
00x1b	2 Audio with Pre-emphasis of 50/15µs
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

11.29.8 Example READ TOC/PMA/ATIP Operations

The following example is based on a 4-session, 12-track Photo CD disc. Data structure is shown as the data to Host.

Command Packet: 43h 00 02h 00 00 00 00 10h 00 00 00 00

Table 319 - Example READ TOC/PMA/ATIP Operations

Ses	A/C	TNO	Pnt	Min Sec Frame	Zero	PMin PSec PFrame	Comments
01	14	00	A0	00 00 00	00	01 20 00	First track is 1. XA disc
01	14	00	A1	00 00 00	00	03 00 00	Last track is 3
01	14	00	A2	00 00 00	00	02 08 3F	Lead Out Area on 1st session
01	14	00	01	00 00 00	00	00 02 00	Start address of track 1
01	14	00	02	00 00 00	00	00 08 02	Start address of track 2
01	14	00	03	00 00 00	00	00 15 32	Start address of track 3
01	54	00	B0	04 26 3F	02	40 02 00	Next recordable area address
01	54	00	C0	C0 00 00	00	61 2C 00	Hybrid disc
02	14	00	A0	00 00 00	00	04 20 00	1st track on 2nd session is 4
02	14	00	A1	00 00 00	00	06 00 00	Last track on 2nd session is 6
02	14	00	A2	00 00 0	00	08 20 08	Lead Out Area on 2nd session
02	14	00	04	00 00 00	00	04 28 3F	Start address of track 4
02	14	00	05	00 00 00	00	04 2E 41	Start address of track 5
02	14	00	06	00 00 00	00	06 27 36	Start address of track 6
02	54	00	B0	09 2C 08	01	40 02 00	Next recordable area address
03	14	00	A0	00 00 00	00	07 20 00	1st track on 3rd session is 7
03	14	00	A1	00 00 00	00	09 00 00	Last track on 3rd session is 9
03	14	00	A2	00 00 00	00	0C 27 32	Lead Out Area on 3rd session

Table 319 - Example READ TOC/PMA/ATIP Operations (Continued)

Ses	A/C	TNO	Pnt	Min Sec Frame	Zero	PMin PSec PFrame	Comments
03	14	00	07	00 00 00	00	09 2E 08	Start address of track 7
03	14	00	08	00 00 00	00	09 34 10	Start address of track 8
03	14	00	09	00 00 00	00	0B 04 24	Start address of track 9
03	54	00	B0	20 09 32	01	40 02 00	Next recordable area address
04	14	00	A0	00 00 00	00	0A 20 00	1st track on 4th session is 10
04	14	00	A1	00 00 00	00	0C 00 00	Last track on 4th session is12
04	14	00	A2	00 00 00	00	12 1B 1A	Lead Out Area on 4th session
04	14	00	0A	00 00 00	00	0E 0B 32	Start address of track 10
04	14	00	0B	00 00 0	00	0E 11 34	Start address of track 11
04	14	00	0C	00 00 00	00	11 08 22	Start address of track 12
04	54	00	B0	13 39 1A	01	40 02 00	Next recordable area address

Ses: session number

A/C: ADR/Control

TNO: 00 for Lead In area

Pnt: Point

If you use the following command on this disc:

Command Packet: 43h 00 01h 00 00 00 00h 10h 00 00 00 00, return data would be as shown in Table 320.

Table 320 - Values for Control Field in READ TOC/PMA/ATIP

Control Field value	Description
01h	First Session Number
04h	Last Session Number
00h	Reserved
14h	ADR/Control
0Ah (10d)	First Track Number in Last session
00h	Reserved
00h,00h,F8h,EDh (In LBA format, 63725)	Absolute CD-ROM address of first track in last session -> 14M 9S 50F -> add 2 sec: 14M 11S 50F

11.29.9 Fabrication of TOC information for DVD media

When the READ TOC/PMA/ATIP Command is used with DVD media the basic CD information required by some legacy Host environments should be fabricated from the DVD Lead-in information. Although there are commands that report the needed information about DVD media to the Host, these commands are not used by some BIOS and Legacy OS systems. Thus the need to report some basic information to the Host using the READ TOC/PMA/ATIP command is allowed.

This section will give some guidelines to the developer that would like to fabricate information about DVD media to be reported to the READ TOC/PMA/ATIP Command.

There are many types of structures that exist in CD media that have no corresponding DVD structure. For example CD media have multiple tracks but DVD data is contained in only one track. As CD media provides Audio and Host Data as different types of information and DVD has only Host Data, reporting of Host data types only can be performed for DVD media.

When reporting the CD media ADR/Control fields for DVD media, the ADR field should contain 1h and the Control field should contain 4h.

11.29.9.1 Conversion of addresses on DVD media to CD MSF addressing

For some forms of the READ TOC/PMA/ATIP command the information that is reported to the Host is formatted in a special address form called MSF. The largest address that can be reported using MSF addressing is only 1151849 blocks or about 2.35 Gigabytes. Thus addresses larger than this will be truncated. For LBA addressing the full four byte field may be used for the address and thus should not create any truncation.

11.29.9.2 Conversion of DVD track to CD track information

DVD media is different from CD media in that there is only one track and there is no logical track information as used for CD Audio tracks. Thus in providing information to the Host using the READ TOC/PMA/ATIP Command, there will be only two or three tracks reported to the Host: the data tracks and the Lead-out track. If the media is DVD-ROM, DVD-RAM, or DVD+RW, there will only be two tracks reported that should cover the full recorded capacity. When DVD-R media that has been recorded using multiple borders is reported, all the border areas except the last one are reported as the first track and the last border is reported as the second track.

For reporting of the starting address for the lead-out track, the address reported will be one more than the ending address of the last data track reported and less than MSF of 255/59/75.

11.29.9.3 Example Fabricated Data for DVD Media

In the following example, the size of the recorded media is larger than the maximum that can be reported using MSF addressing, so the addresses have been truncated.

11.29.9.3.1 Sample 1

The following sample Command Packet requests Format 1 in LBA format.

Command Packet: 43h 00h 01h 00 00 00 00 00 30h 00 00 00

Table 321 - Example READ TOC/PMA/ATIP Operations for DVD Media - Format 1

F_Ses	L_Ses	A/C	TNO	Address	Comments
01	01	14	01	0	As if one session exists

F_Ses: First session number

L_Ses: Last session number

A/C: ADR/Control

TNO: First Track in Last Session

Address: Address of First Track in Last Session

11.29.9.3.2 Sample 2

In the following example, the sample Command Packet requests Format 0 in LBA format.

Command Packet: 43h 00 00 00 00 00 00 00 30h 00 00 00

Table 322 - Example READ TOC/PMA/ATIP Operations for DVD Media - Format 0

A/C	TNO	Track Start Address	Comments
14	01	00000000h	Track 1
14	AA	00230000h	Lead Out Area

A/C: ADR/Control

TNO: Track Number

11.30 READ TRACK/RZONE INFORMATION Command

The READ TRACK/RZONE INFORMATION Command provides information about a Track/RZone, regardless of its status. In case of DVD-RAM, ROM, the number of RZone and Border is considered one. If this command is required by an implemented Feature, this command shall function if any media is present.

For CD, if the PMA/TOC is unreadable. the command ***shall*** be terminated with CHECK CONDITION Status, 3/57/00 UNABLE TO RECOVER TABLE-OF-CONTENTS.

For DVD, if the RMA/RMD in Border-out is unreadable. the command ***shall*** be terminated with CHECK CONDITION Status, 3/11/05 L-EC UNCORRECTABLE ERROR.

Table 323 - READ TRACK/RZONE INFORMATION Command

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code (52h)							
1	LUN (Obsolete)			Reserved			Address/Number Type	
2	(MSB)							
3	Address/Number							
4								
5								(LSB)
6	Reserved							
7	(MSB)			Allocation Length				
8								(LSB)
9	Vendor-Specific		Reserved			NACA	Flag	Link
10	PAD							
11								

The **Address/Number Type** field in byte 1 is used to specify the contents of the Address/Number field. See Table 324.

The **Address/Number** field is defined in Table 324.

Table 324 - Address/Number Field definition

Address/Number Type Value	Address/Number field	Description
0	Logical Block Address	T_{LBA}, where T_{LBA} is the number of the Track/RZone which contains the block associated with Logical Block Address.
1	00h	T_{TOC}, where T_{TOC} is the Lead-in area of the disc
1	Valid Track/RZone Number	T_{CDB}
1	FFh	T_{INV}, where T_{INV} is the Track number of the invisible or incomplete Track
2	Border Number	R_{BORDER}, where R_{BORDER} is the number of the first RZone which is in the Border Number.
3	Reserved	

Note: The Address/Number Type 2 is easy way to recognize UDF-Bridge file system that specified by DVD-ROM Book Part2.

The number of Track/RZone 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 loaded media shall return 0.

The format and content of the Track/RZone Information Block is shown in Table 325.

Table 325 - Track/RZone Information Returned

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			Track/RZone Information Length				
1								(LSB)
2				Track/RZone Number (LSB)				
3				Session/Border Number (LSB)				
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/RZone Start Address				
10								
11								(LSB)
12	(MSB)							
13				Next Writable Address				
14								
15								(LSB)
16	(MSB)							
17				Free Blocks				
18								
19								(LSB)
20	(MSB)							
21				Fixed Packet Size /				
22				Blocking Factor				
23								(LSB)
24	(MSB)							
25				Track/RZone Size				
26								
27								(LSB)
28	(MSB)							
29				Last Recorded Address				
30								
31								(LSB)
32				Track/RZone Number (MSB)				
33				Session/Border Number (MSB)				
34				Reserved				
35				Reserved				

The **Track/RZone Information Length** field specifies the length, in bytes, of the data available to be transferred given a sufficient **Allocation Length**. The **Track/RZone Information Length** value does not include the **Track/RZone Information Length** field itself. If the **Allocation Length** specified is less than the Track/RZone information length, the response ***shall*** be truncated at the Allocation Length specified. This truncation ***shall*** not cause a CHECK CONDITION status. The **Track/RZone Information Length** is not modified when the **Allocation Length** is insufficient to return all of the response data available.

Track/RZone Number is the Track number on CD media, the RZone number on DVD-R media, or 1 for media not containing logical tracks.

Session/Border Number is the Session number on CD media, the Border number on DVD media, or 1 for media not containing Sessions or Borders, that contains this Track/RZone.

The **Copy** bit indicates that this track is a second or higher generation copy. (CD) For all other media, this bit shall be set to zero.

The **Damage** bit, when set to one, and the NWA_V is set to zero, the Track/RZone shall be considered "not closed due to an incomplete write." An automatic repair may be attempted by the device when the CLOSE TRACK/RZONE/SESSION/BORDER Command is issued. Further incremental writing in this Track/RZone is not possible.

The **Damage** bit, when set to one, and the NWA_V is set to one, indicates a Track/RZone that may be recorded further in an incremental manner. An automatic repair shall be attempted by the device when the next command that requires writing to the Track/RZone 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.

On CD media, the **Track Mode** is the control nibble as defined for mode 1 Q sub-channel for this track. For all other media, this field shall be set to 4.

If the **RT** bit is zero, then the Track/RZone is not reserved, otherwise the Track/RZone is reserved. For CD, RT indicates that a PMA entry indicating the track's start and end addresses exists. If the Logical Unit is not capable of reading the PMA or RMA, this field ***shall*** be set to zero.

For CD, 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 track's start and end addresses exists.

For DVD, the **RT** bit of zero indicates that the RZone is Complete, Invisible, or Incomplete status. The **RT** bit of one indicates that the RZone is Empty Reserved or Partially Recorded Reserved status.

The **Blank** bit, when set to one, indicates that the Track/RZone contains no written data and Last Recorded Address field is invalid. For CD, tracks with the Track Descriptor Block recorded shall not be considered blank. For other media, this bit ***shall*** be set to zero.

The **Packet/Inc** bit, when set to one, indicates that this Track/RZone is to be written only with packets (CD) or incremental recording (DVD). For CD, the **Packet/Inc** bit is valid only when the **RT** bit is set to one or the track indicated is the incomplete track.

For CD media, 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. 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. For other media this field should be zero.

When writing, certain parameters may be set via the Write Parameters Mode Page. The state of the Track/RZone determines what parameters must be set and which parameters in the mode page must match. Required Write Parameters are defined in Table 326.

Table 326 - Write Parameter Restrictions due to Track/RZone State

RT	Blank	Packet/ Inc	DVD Write Parameter Restrictions	CD Write Parameter Restrictions
0	0	0	Can't write to stamped disc, or writing disc-at-once mode; can not write to complete disc	Can't write to stamped disc, or during track at once on invisible track, or writing session at once mode
0	0	1	Write type set to incremental; Complete RZone or Incomplete RZone. All parameters common to READ TRACK/RZONE INFORMATION and the Write Parameters Mode Page must match.	Write type set to packet; all parameters common to READ TRACK/RZONE INFORMATION and the Write Parameters Mode Page must match.
0	1	0	Write type set to disc-at-once; Invisible RZone of disc-at-once, empty disc. Can't start disc-at-once recording in this state. A RZone shall be reserved prior to start disc-at-once recording. All parameters common to READ TRACK/RZONE INFORMATION and the Write Parameters Mode Page must match.	Write type may be set to packet or TAO. All other parameters shall be changeable. If this track is the first track of a Session, then Session at Once is allowed.
0	1	1	Write type set to incremental; Invisible RZone for incremental recording, the RZone is writable. All parameters common to READ TRACK/RZONE INFORMATION and the Write Parameters Mode Page must match.	Invalid State
1	0	0	Can't write to disc during disc-at-once on reserved RZone	Can't write to recorded track or during track at once on reserved track.
1	0	1	Write type set to incremental; Partially recorded reserved RZone, the RZone is writable. All parameters common to READ TRACK/RZONE INFORMATION and the Write Parameters Mode Page must match.	Write type set to packet; all parameters common to READ TRACK/RZONE INFORMATION and the Write Parameters Mode Page must match.
1	1	0	Write type set to disc-at-once; Empty reserved RZone for disc-at-once. All parameters common to READ TRACK/RZONE INFORMATION and the Write Parameters Mode Page must match.	Write type set to TAO. Track mode set to same as READ TRACK/RZONE INFORMATION. Copy bit may be set only if copyright bit in track mode is clear. All other common parameters must match.
1	1	1	Write type set to incremental. Empty Reserved RZone, the RZone is writable. All parameters common to READ TRACK/RZONE INFORMATION and the Write Parameters Mode Page must match.	Write type set to Packet. Track mode set to same as READ TRACK/RZONE INFORMATION. Copy bit may be set only if copyright bit in track mode is clear. FP and packet size are changeable. All other common parameters must match. *Note: It is not possible to create such a track using Commands described in this standard.*

For CD, when RT, Blank and Packet bits are set to one, FP bit of a Read Track Information result data is set to zero.

For CD, **Data Mode** defines the track content. Data Mode is defined in Table 328. For other media, this field should report 1.

Table 327 - Track/RZone Status Indications

RT	Blank	Packet /Inc	FP	DVD		CD	
				Write Method	RZone Status	Write Method	Track Status
0	0	0	-	-	(invalid)	Uninterrupted/ TAO/SAO	Complete/ During TAO/SAO
0	0	1	0	Incremental	Incomplete	Variable	Incomplete
0	0	1	1	-	(invalid)	Fixed	Incomplete
0	1	0	-	DAO/ Incremental	Invisible	TAO/ Variable/Fixed(*)	Invisible
0	1	1	0	Incremental	Invisible	-	(invalid)
0	1	1	1	-	(invalid)	-	(invalid)
1	0	0	-	DAO	Complete/ during DAO	TAO	Complete/ During TAO
1	0	1	0	Incremental	Complete/ Partially Recorded Reserved	Variable	Complete/ Partially Recorded Reserved
1	0	1	1	-	(invalid)	Fixed	Complete/ Partially Recorded Reserved
1	1	0	-	DAO	before start writing	TAO	Empty Reserved
1	1	1	0	Incremental	Empty Reserved	Variable/Fixed	Empty Reserved
1	1	1	1	-	(invalid)	-	(invalid)

* In case last session is empty, SAO is also valid.

Table 328 - Data Mode (CD)

Value	Definition
1	Mode 1 (ISO/IEC 10149)
2	Mode 2 (ISO/IEC 10149 or CD-ROM XA)
Fh	Data Block Type unknown (no track descriptor block)
0,3 - Eh	Reserved

The Next Writable Address Valid (**NWA_V**) bit validates the next writable address. If **NWA_V** is zero, then the next writable address field is not valid. Otherwise, the next writable address field is valid. The **NWA_V** bit shall be set to zero if the Track/RZone is not writable for any reason.

The Last Recorded Address Valid (**LRA_V**) bit validates the last recorded address. 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/RZone has damage for any reason and is repaired automatically.

The **Track/RZone Start Address** is the starting address for the specified Track/RZone.

The **Next Writable Address**, if valid, is the LBA of the next writable user block in the Track/RZone specified by the LBA/Track/RZone Number field in the CDB. For CD media, the **Next Writable Address** shall be associated with the **RT**, **Blank**, and **Packet/Inc** bits as defined in Table 329. 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 device expects to receive if no under-run occurs.

Table 329 - Next Writable Address Definition (CD)

RT	Blank	Packet/ Inc	FP	NWA_V	Definition
0	0	0	x	1[a]	LBA that shall be specified by next write command[b]
0	0	1	0	1[c]	LBA that shall be specified by next write command[b]
0	0	1	1	1[c]	LBA that shall be specified by next write command[b,d]
0	1	0	0	1	LBA of the first data block after pre-gap[e]
0	1	1	0	x	Not Valid
0	1	1	1	x	Not Valid
1	0	0	x	0[a]	LBA that shall be specified by next write command[b]
1	0	1	0	1[c]	LBA that shall be specified by next write command[b]
1	0	1	1	1[c]	LBA that shall be specified by next write command[b,d]
1	1	0	x	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	-	-

a. During TAO (SAO), NWA_V is 1.
b. 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.
c. When "Free Blocks" becomes 0 (data full), NWA_V becomes 0.
d. NWA shall follow the Addressing Method-2 if Method-2 bit in Mode CD Capabilities and Mechanical Status Page is set to one.
e. *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/RZone.

For CD media, this field shall be computed as follows: First, the Available Track Space (ATS) shall be computed. For the invisible track, *ATS = (StartTimeofLastPossibleLeadout) - NWA + 5.*

For a reserved track, *ATS = (PMAStopTime) - NWA + 5.*

If the track is reserved for, or written with, fixed packets, or is the invisible track and the Write Parameters page specifies fixed packets:

$FreeBlocks = IP\left(\frac{ATS}{PacketSize + 7}\right) \bullet PacketSize$. Otherwise, *FreeBlocks = ATS -7*

Note: The StartTimeofLastPossibleLead-out is the last possible location of the link block at the start of the lead-out.

Note: If a disc is fully recorded, the PMA entry for the last track will be equal to the StartTimeofLastPossibleLead-out.

Addressing within fixed packet written tracks is translated by the Logical Unit for reading and writing. The NWA shall also

reflect this translation: $NWA_{Method2} = NWA_{Method1} - 7 \bullet IP\left(\frac{NWA_{Method1} - TrackStartAddress}{PacketSize + 7}\right)$

Method 1 is the physical address. Method 2 is used on fixed packet written tracks to hide the link areas from the initiator. The *TrackStartAddress* is always a physical address, even if prior tracks are recorded with Method 2. *IP( )* is the integer part of the value.

For CD, the **Fixed Packet Size/Blocking Factor** field is valid only when the Packet/Inc and the FP bits are both set to one.

For DVD-R, if the FP bit is set to 0, the **Fixed Packet Size/Blocking Factor** field specifies the number of sectors that is actual disc access unit. In case of DVD, this field is 16. FP bit 1 is undefined yet.

If the disc is stamped, then **Damage** = 0, **Blank** = 0, **RT** = 0, and **NWA_V** = 0.

The **Track/RZone Size** reports the length in blocks of the user data in the specified Track/RZone.

For CD, The track size shall be computed as follows: First, compute the Complete Track Size (CTS).

For an incomplete track, *CTS = (StartTimeofLastPossibleLeadout) - PMATrackStart* + 5.

For a reserved track, *CTS = (PMAStopTime) - PMAStartTime* + 5.

If the track is reserved for, or written with, fixed packets, or is the invisible track and the Write Parameters page specifies fixed packets:

$TrackSize = IP\left(\frac{CTS}{PacketSize + 7}\right) \bullet PacketSize$. Otherwise, *TrackSize =CTS - 7*

The **Last Recorded Address** is the address of last written user data sector of the specified RZone.

Note: READ TRACK/RZONE INFORMATION shall provide certain valid fields for a disc with Unrecordable status: Track/RZone Number, Session/Border Number, Track Mode, Data Mode, Track/RZone 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:

TrackSizeofTrack_n = (StartofTrack_n+1) - (StartofTrack_n)

n+1 is the Lead Out if n is the last track recorded in the TOC.

The Track Size from this calculation may include blocks from the following track and these blocks may not be readable.

Table 330 describes errors that may occur during the operation of the Command or which may cause a CHECK CONDITION status to be reported.

Table 330 - READ TRACK/RZONE INFORMATION Command Errors

Error Description
A-1.1, "Deferred Error Reporting" on page 437
Table 421 - *Basic Error Codes* on page 445
Table 422 - *Media Access Error Codes* on page 449

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11.31 REPAIR RZONE Command

A Track/RZone which has been defined for incremental/packet writing may be damaged due to an incomplete ECC block/packet block at the end of written data. This may be caused by a RESET or a power-fail condition during a incremental/packet write.

For CD, the REPAIR RZONE Command will fill a fixed length packet to its correct user data length and add run-outs. Variable length packets will simply be completed with run-outs. The user data in the repaired packet must be rewritten as the repaired packet is not readable.

For DVD, the REPAIR RZONE Command will fill multiple of ECC block length data from beginning of damaged sector of the ECC block and ended with linking.

The recovery indicated here only allows the Track/RZone to become writable again.

Table 331 - REPAIR RZONE Command

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation code (58h)							
1	Reserved							Immed
2	Reserved							
3	Reserved							
4	(MSB)			RZone Number				
5								(LSB)
6	Reserved							
7	Reserved							
8	Reserved							
9	Vendor-Specific		Reserved			NACA	Flag	Link
10	PAD							
11								

The **Immed** bit allows execution of the REPAIR RZONE 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 **RZone Number** specifies the RZone which requires repair.

Behavior of this command is the same as automatic repair. This command causes repair action without an explicit write of data.

For DVD-R, if the **RZone Number** field is set to 0, the RMA may be repaired.

Table 332 describes errors that may occur during the operation of the Command or which may cause a CHECK CONDITION status to be reported.

Table 332 - REPAIR RZONE Command Errors

Error Description
A-1.1, "Deferred Error Reporting" on page 437
Table 421 - *Basic Error Codes* on page 445
Table 422 - *Media Access Error Codes* on page 449
Table 423 - *Write Error Codes* on page 452

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11.32 REPORT KEY Command

The REPORT KEY Command requests the start of the authentication process and provides data necessary for authentication and for generating a Bus Key for the DVD Logical Unit. This command, in conjunction with SEND KEY Command, is intended to perform authentication for Logical Units which conform to DVD Copy Protection scheme and to generate a Bus Key as the result of authentication.

The REPORT KEY Command also requests the DVD Logical Unit to transfer TITLE KEY data, obfuscated by a Bus Key, to the Host.

Table 333 - REPORT KEY Command

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation code (A4h)							
1	LUN (Obsolete)			Reserved				
2	(MSB)							
3	Reserved or Logical Block Address							
4								
5								(LSB)
6	Reserved							
7	Key Class							
8	(MSB)			Allocation Length				
9								(LSB)
10	AGID		KEY Format					
11	Vendor-Specific		Reserved			NACA	Flag	Link

The **KEY Format** field indicates the type of information that is requested to be sent to the Host.

The REPORT KEY Command with **KEY Format** field of 000000b begins the authentication process. The Logical Unit, when ready to begin the authentication process, ***shall*** grant the request by returning an Authentication Grant ID (AGID). If there is no available Authentication Grant ID, the command shall be terminated with CHECK CONDITION Status, 5/55/00 SYSTEM RESOURCE FAILURE.

The **AGID** field is used to control simultaneous key exchange sequences. The **AGID** specified in subsequent Key Exchange commands shall match a currently active **AGID**. An **AGID** becomes active by requesting one with KEY Format 0. The **AGID** remains active until the authentication sequence completes or is invalidated. The **AGID** field ***shall*** be reserved when the KEY Format Field contains either 0h or 5h.

In case of **KEY Format** = 000100b, the **Reserved / Logical Block Address** field specifies the logical block address which contains the TITLE KEY to be sent to the Host obfuscated by a Bus Key. In all other cases, this field ***shall*** be reserved.

The **Key Class** field ***shall*** identify the type of authentication conversation according to Table 334.

Table 334 - Key Class Definitions

Key Class	Authentication Type
00h	DVD CSS
01h	Rewritable Security Services-A
02h-FFh	Reserved

Table 335 - Key Format Code definitions for REPORT KEY Command (Key Class 0)

Key Format	Returned Data	Description	AGID Use
000000b	AGID	Returns an AUTHENTICATION GRANT ID	Reserved & N/A
000001b	Challenge KEY	Returns a Challenge KEY	Valid AGID required
000010b	KEY1	Returns a KEY1	
000100b	TITLE KEY	Returns a TITLE KEY obfuscated by a Bus Key	
000101b	ASF	Returns the current state of the Authentication Success Flag	Reserved & Ignored
001000b	RPC State	Report drive region settings	
111111b	None	Invalidate Specified AGID. Invalidating an invalid AGID ***shall*** not be considered an error. An AGID that has not been granted ***shall*** be considered invalid.	Valid AGID required
All other values	Reserved		

Table 336 through Table 342 show the data returned to the Host for this command. With Key Format Code of 3Fh, no data ***shall*** be returned to the Host.

Table 336 - 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								
0	Reserved							
1	Reserved							
2	Reserved							
3	AGID		Reserved					

Table 337 - 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)

Table 337 - REPORT KEY Data Format (With KEY Format = 000001b, Key Class = 0)

Bit / Byte	7	6	5	4	3	2	1	0
2	Reserved							
3	Reserved							
Challenge Key								
0	(MSB)							
.	Challenge Key Value							
9								(LSB)
10	Reserved							
11	Reserved							

The **Challenge Key Value** field returns a value to be used to interrogate an external device to determine conformance with the DVD CSS scheme. The external device then generates the corresponding KEY2.

Table 338 - REPORT KEY Data Format (With KEY Format = 000010b, Key Class = 0)

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)							
1	REPORT KEY Data Length (0Ah)							(LSB)
2	Reserved							
3	Reserved							
KEY1								
0	(MSB)							
.	KEY1 Value							
4								(LSB)
5	Reserved							
6	Reserved							
7	Reserved							

KEY1 Value field returns a value used to determine the Logical Unit's conformity with DVD Copy Protection scheme by an external device. The **KEY1 Value** will also be used as a parameter to generate a Bus Key in the Logical Unit.

When the Logical Unit is unable to produce a **KEY1 Value**, this command with KEY Format = 000010b shall be terminated with CHECK CONDITION Status, 5/6F/01 COPY PROTECTION KEY EXCHANGE FAILURE - KEY NOT PRESENT.

Table 339 - 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 Information								
0	CPM	CP_SEC	CGMS		Reserved			
TITLE KEY								
1	(MSB)							
2								
3	Title Key Value							
4								
5								(LSB)
6	Reserved							
7	Reserved							

The **CPM** field identifies the presence of copyrighted material in this sector. A value of 0 shall indicate material not copyrighted. A value of 1 shall indicate copyrighted material.

The **CP_SEC** field indicates that the specified sector has a specific data structure for copyright protection system. A value of 0 shall indicate that no such data structure exists in this sector. A value of 1 shall indicate a specific data structure exists in this sector.

The **CGMS** field indicates the restrictions on copying, as shown in

Table 340 - CGMS field definition

CGMS Value	Definition
00b	Copying is permitted without restriction
01b	Reserved
10b	One generation of copies may be made
11b	No copying is allowed

TITLE KEY Value field returns the TITLE KEY which is obfuscated by a Bus Key. The length of **TITLE KEY Value** is currently 5 bytes only.

When the TITLE KEY does not exist on DVD media, this command with KEY Format = 000100b shall be terminated with CHECK CONDITION Status, 5/6F/01 COPY PROTECTION KEY EXCHANGE FAILURE - KEY NOT PRESENT.

When the Logical Unit is not in the Bus Key Established state, this command with KEY Format = 000100b shall be terminated with CHECK CONDITION Status, 5/6F/02 COPY PROTECTION KEY EXCHANGE FAILURE - KEY NOT ESTABLISHED.

Table 341 - 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						
1								(LSB)
2	Reserved							
3	Reserved							
AUTHENTICATION SUCCESS FLAG								
0	Reserved							
1	Reserved							
2	Reserved							
3	Reserved							Success Flag

For more information on the contents of the Success Flag, see Figure 17 - *Authentication Flag Sequence* on page 69.

Table 342 - REPORT KEY Parameter List (With KEY Format = 001000b, Key Class = 0)

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)	REPORT KEY Parameter List 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 **Type Code** field specifies the current state of the Regionalization Process. See Table 343.

Table 343 - Type Code field definition

Type Code	Name	Definition
00b	NONE	No drive region setting
01b	SET	Drive region is set
10b	LAST CHANCE	Drive region is set, with additional restrictions required to make a change.
11b	PERM	Drive 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. This value is set to 4 by the drive manufacturer and decremented each time the vendor clears the drive's region. When this value is zero, the vendor can no longer clear the drive'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 indicates the Logical Unit's specified region. Once the drive region has been set, exactly one bit ***shall*** be set to zero to indicate the region. Each bit represents one of eight regions. If a bit is set to zero in this field, the disc can be played in the corresponding region. If a bit is set to one 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 344.

Table 344 - RPC Scheme

RPC Scheme	RPC Name	Definition
00h	Unknown	The Logical Unit does not enforce Region Playback Controls (RPC).
01h	RPC Phase II	The Logical Unit ***shall*** adhere to this specification and all requirements of the CSS license agreement concerning RPC.
02h-FFh	Reserved	

Table 345 describes errors that may occur during the operation of the Command or which may cause a CHECK CONDITION status to be reported.

Table 345 - REPORT KEY Command Errors

Error Description
A-1.1, "Deferred Error Reporting" on page 437
Table 421 - *Basic Error Codes* on page 445
Table 422 - *Media Access Error Codes* on page 449
Table 425 - *Authentication Error Codes* on page 453

11.33 REQUEST SENSE Command

The REQUEST SENSE Command requests that the Logical Unit transfer sense data to the Host.

Table 346 - REQUEST SENSE Command

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation code (03h)							
1	LUN (Obsolete)			Reserved				
2	Reserved							
3	Reserved							
4	Allocation Length							
5	Vendor-Specific		Reserved				Flag	Link
6	PAD							
7								
8								
9								
10								
11								

The sense data:

1. ***shall*** be available if an error condition (CHECK CONDITION) had previously been reported to the Host;
2. ***shall*** be available if other information (e.g. medium position) is available in any field.

If the Logical Unit has no other sense data available to return, it ***shall*** return a sense key of NO SENSE and an additional sense code of NO ADDITIONAL SENSE INFORMATION. No further CHECK CONDITION status shall be generated.

The sense data ***shall*** be preserved by the Logical Unit until retrieved by a REQUEST SENSE Command or until the receipt of any other I/O Command.

The Logical Unit ***shall*** return CHECK CONDITION status for a REQUEST SENSE Command only to report exception conditions specific to the command itself. For example:

1. A Logical Unit malfunction prevents return of the sense data.

If a recovered error occurs during the execution of the REQUEST SENSE Command, the Logical Unit ***shall*** return the sense data with GOOD status. If a Logical Unit returns CHECK CONDITION status for a REQUEST SENSE Command, the sense data may be invalid.

Logical Units ***shall*** be capable of returning at least 18 bytes of data in response to a REQUEST SENSE Command. If the allocation length is 18 or greater, and a Logical Unit returns less than 18 bytes of data, the Host should assume that the bytes not transferred would have been zeros had the Logical Unit returned those bytes. Hosts can determine how much sense data has been returned by examining the allocation length parameter in the Command Packet and the additional sense length in the sense data. Logical Units ***shall*** not adjust the additional sense length to reflect truncation if the allocation length is less than the sense data available.

The sense data format for error codes 70h (current errors) and 71h (deferred errors) are defined in Table 347. Error code values of 72h to 7Eh are reserved. Error code 7Fh is for a vendor-specific sense data format. Logical Units ***shall*** implement error code 70h; implementation of error code 71h is optional. Error code values of 00h to 6Fh are not defined by this Specification and their use is not recommended.

Table 347 - Request Sense Standard Data

Bit / Byte	7	6	5	4	3	2	1	0
0	Valid	Error Code (70h or 71h)						
1	Segment Number (Reserved)							
2	Reserved		ILI	Reserved	Sense Key			
3	Information							
6								
7	Additional Sense Length (n - 7)							
8	Command Specific Information							
9								
10								
11								
12	Additional Sense Code							
13	Additional Sense Code Qualifier (Optional)							
14	Field Replaceable Unit Code (Optional)							
15	SKSV	Sense Key Specific						
16	Sense Key Specific							
17								
18	Additional Sense Bytes							
n								

A **Valid** bit of zero indicates that the information field is not as defined in this Specification. A Valid bit of one indicates the information field contains valid information as defined in this Specification. Logical Units ***shall*** implement the Valid bit.

The **Segment Number** field is Reserved.

An Incorrect Length Indicator (**ILI**) bit of one indicates that the requested allocation length did not match the logical block length of the data on the medium.

The **Sense Key**, **Additional Sense Code** and **Additional Sense Code Qualifier** provide a hierarchy of information. The intention of the hierarchy is to provide a top-down approach for a Host to determine information relating to the error and exception conditions. The Sense Key provides generic categories in which error and exception conditions can be reported. Hosts would typically use sense keys for high-level error recovery procedures. Additional Sense Codes provide further detail describing the sense key. Additional Sense Code Qualifiers add further detail to the additional sense code. The Additional Sense Code and Additional Sense Code Qualifier can be used by Hosts where sophisticated error recovery procedures require detailed information describing the error and exception conditions.

The **Sense Key** field is mandatory and indicates generic information describing an error or exception condition. The sense keys are defined in Table 352 - *Sense Key Descriptions* on page 381.

The contents of the **Information** field is command-specific and is defined within the appropriate section for the command of interest. Logical Units ***shall*** implement the **Information** field. Unless specified otherwise, this field contains the unsigned logical block address associated with the sense key.

The **Additional Sense Length** field indicates the number of additional sense bytes to follow. If the allocation length of the Command Packet is too small to transfer all of the additional sense bytes, the **Additional Sense Length** is not adjusted to reflect the truncation.

The **Command-specific Information** field contains information that depends on the command that was executed. Further meaning for this field is defined within the command description. When this field is used to report a logical block address the data contained in this field ***shall*** always be a logical address. Commands that make use of MSF addressing ***shall*** report the error location in LBA format.

The Additional Sense Code (**ASC**) field indicates further information related to the error or exception condition reported in the Sense Key field. Logical Units ***shall*** support the Additional Sense Code field. Support of the additional sense codes not explicitly required by this Specification is optional. A list of additional sense codes is in Table 420 - *All Error Codes* on page 438. If the Logical Unit does not have further information related to the error or exception condition, the Additional Sense Code is set to NO ADDITIONAL SENSE INFORMATION.

The Additional Sense Code Qualifier (**ASCQ**) indicates detailed information related to the Additional Sense Code. The ASCQ is optional. If the error or exception condition is reportable by the Logical Unit, the value returned ***shall*** be as specified in Table 420 - *All Error Codes* on page 438. If the Logical Unit does not have detailed information related to the error or exception condition, the ASCQ is set to zero.

Non-zero values in the **Field Replaceable Unit Code** field are used to define a Logical Unit-specific mechanism or unit that has failed. A value of zero in this field ***shall*** indicate that no specific mechanism or unit has been identified to have failed or that the data is not available. The Field Replaceable Unit Code field is optional. The format of this information is not specified by this Specification. Additional information about the field replaceable unit may be available in the ASCII information page, if supported by the Logical Unit.

The **Additional Sense Bytes** field may contain command specific data, peripheral device specific data, or vendor-specific data that further defines the nature of the CHECK CONDITION status.

11.33.1 Sense-key Specific

The **Sense-key Specific** field is defined by this Specification when the value of the Sense-key Specific Valid (**SKSV**) bit is one. The **Sense-key Specific Valid** bit and **Sense-key Specific** field are optional. The definition of this field is determined by the value of the sense key field. This field is reserved for sense keys not described below. An **SKSV** value of zero indicates that this field is not as defined by this Specification.

If the Sense Key field is set to ILLEGAL REQUEST and the SKSV bit is set to one, the Sense-key Specific field indicates which illegal parameters in the Command Packet or the data parameters are in error.

Table 348 - Field Pointer Bytes

Bit / Byte	7	6	5	4	3	2	1	0
15	SKSV	C/D	Reserved	Reserved	BPV	Bit Pointer		
16	(MSB) Field Pointer							
17								(LSB)

A Command Data (**C/D**) bit of one indicates that the illegal parameter is in the Command Packet. A **C/D** bit of zero indicates that the illegal parameter is in the data parameters sent by the Host.

A Bit Pointer Valid (**BPV**) bit of zero indicates that the value in the Bit Pointer field is not valid. A **BPV** bit of one indicates that the Bit Pointer field specifies which bit of the byte designated by the field pointer field is in error. When a multiple-bit field is in error, the Bit Pointer field ***shall*** point to the most-significant (left-most) bit of the field.

The **Field** Pointer field indicates which byte of the Command Packet or of the parameter data was in error. Bytes are numbered starting from zero, as shown in the tables describing the commands and parameters. When a multiple-byte field is in error, the pointer ***shall*** point to the most significant (left-most) byte of the field.

If the sense key is RECOVERED ERROR, HARDWARE ERROR or MEDIUM ERROR and if the SKSV bit is one, the sense-key specific field ***shall*** be as shown in Table 349.

Table 349 - Actual Retry Count Bytes

Bit / Byte	7	6	5	4	3	2	1	0
15	SKSV	Reserved						
16	(MSB)	Actual Retry Count						
17								(LSB)

The **Actual Retry Count** field returns implementation-specific information on the actual number of retries of the recovery algorithm used in attempting to recover an error or exception condition. This field should relate to the retry count fields within the Error Recovery Page of the MODE SELECT command.

If the sense key is MEDIUM ERROR and the additional sense code & qualifier set to ZONED FORMATTING FAILED DUE TO SPARE LINKING and if the SKSV bit is one, the sense-key specific field ***shall*** be as shown in Table 350.

Table 350 - Zone Number Bytes

Bit / Byte	7	6	5	4	3	2	1	0
15	SKSV	Reserved						
16	(MSB)	Zone Number						
17								(LSB)

The **Zone Number** field returns the zone number of the first zone which has a spare linking into the zone designated by a FORMAT UNIT command.

If the Sense Key field is set to NOT READY or NO SENSE and the SKSV bit is set to one, the Sense-key Specific field ***shall*** be as shown in Table 351.

Table 351 - Progress Indication

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 based upon the total operation time including any certification or initialization operations.

11.33.2 Deferred Errors

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

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

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

If an I/O Command terminates with CHECK CONDITION status and the subsequent sense data returns a deferred error, that I/O command ***shall not*** have been executed. After the 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 unrecovered or required to be reported by the mode parameters, a deferred error indication ***shall*** be returned to the Host.

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

11.33.3 Sense-key and Sense Code Definitions

Table 352 - Sense Key Descriptions

Sense key	Description
0h	NO SENSE. Indicates that there is no specific sense key information to be reported for the designated Logical Unit. This would be the case for a successful command.
1h	RECOVERED ERROR. Indicates that the last command completed successfully with some recovery action performed by the Logical Unit. Details may be determinable by examining the additional sense bytes and the information field. When multiple recovered errors occur during one command, the choice of which error to report (first, last, most severe, etc.) is Logical Unit specific.
2h	NOT READY. Indicates that the Logical Unit cannot be accessed. Operator intervention may be required to correct this condition.
3h	MEDIUM ERROR. Indicates that the command terminated with a non-recovered error condition that was probably caused by a flaw in the medium or an error in the recorded data. This sense key may also be returned if the Logical Unit is unable to distinguish between a flaw in the medium and a specific hardware failure (sense key 4h).
4h	HARDWARE ERROR. Indicates that the Logical Unit detected a non-recoverable hardware failure (for example, controller failure, Logical Unit failure, parity error, etc.) while performing the command or during a self test.
5h	ILLEGAL REQUEST. Indicates that there was an illegal parameter in the Command Packet or in the additional parameters supplied as data for some commands. If the Logical Unit detects an invalid parameter in the Command Packet, then it ***shall*** terminate the command without altering the medium. If the Logical Unit detects an invalid parameter in the additional parameters supplied as data, then the Logical Unit may have already altered the medium.

Table 352 - Sense Key Descriptions

Sense key	Description
6h	UNIT ATTENTION. Indicates that the removable medium may have been changed or the Logical Unit has been reset.
7h	DATA PROTECT. Indicates that a command that reads the medium was attempted on a block that is protected from this operation. The read operation is not performed.
8h	BLANK CHECK. Indicates that a write-once device or a sequential-access device encountered blank medium or format-defined end-of-data indication while reading or a write-once device encountered a non-blank medium while writing.
9h - Ah	Reserved
Bh	ABORTED COMMAND. Indicates that the Logical Unit has aborted the command. The Host may be able to recover by trying the command again. This error is reported for conditions such as an overrun etc.
0Ch - 0Dh	Reserved
Eh	MISCOMPARE. Indicates that the source data did not match the data read from the medium.
Fh	Reserved

11.33.4 Using the REQUEST SENSE Command

Whenever an Error is reported, the Host should issue a REQUEST SENSE Command to receive the sense data describing what caused the Error condition. If the Host issues some other command, the sense data is lost.

This command may be issued even if CHECK CONDITION status has not been reported to the Host.

See *Appendix A - "Error Reporting and Sense Codes (Normative)"* on page 437 for a list of Sense Key, ASC, and ASCQ code values that may be reported to this command.

Table 353 - REQUEST SENSE Command Errors

Error Description	
5/24/00	INVALID FIELD IN CDB

11.34 RESERVE TRACK/RZONE Command

The RESERVE TRACK/RZONE Command allows reservation of disc space for a Track/RZone. A PMA/RMA entry for the Track/RZone shall be either written or cached for writing prior to disc removal.

Table 354 - RESERVE TRACK/RZONE Command

Byte \ Bit	7	6	5	4	3	2	1	0
0	Operation code (53h)							
1	Reserved							
2	Reserved							
3	Reserved							
4	Reserved							
5	(MSB)							
6	Reservation Size							
7								
8								(LSB)
9	Vendor-Specific		Reserved			NACA	Flag	Link
10	PAD							
11								

The **Reservation Size** field contains the number of user blocks desired for the Track/RZone reservation. The actual number of blocks allocated shall be according to the Write Parameters Mode Page.

For CD, the PMA start time shall reflect the appropriate pre-gap, as determined by the previous track's mode and the settings of the Write Parameters Mode Page.

For DVD, when the Write Type field of Write Parameters Mode Page is "Disc-at-once," the Reservation Size field is used to specify the actual size of user data to be transferred from Host to the Logical Unit. When the Write Type field specifies "Incremental," the tail of reserved RZone is rounded up to ECC block unit and one ECC block length is added to the reserved RZone as a BSGLL. Table 355 specifies the RZone reservation sizing.

Table 355 - RZone reservation sizing (DVD)

Write Parameters Mode Page Write Type Value	Reserved RZone Size
Disc-at-once	Reserves the number of user blocks specified. The Reserved RZone Size shall be $ReservedRZoneSize = ReservationSize$ where *ReservationSize* is the value specified in the CDB.
Incremental	Reserves the number of user blocks specified. The Reserved RZone Size shall be $ReservedRZoneSize = 16 \bullet Ceil\left(\frac{ReservationSize + (NWA \wedge 0Fh)}{16}\right) - (NWA \wedge 0Fh) + 16$ [a] where *ReservationSize* is the value specified in the CDB. NWA is the Next Writable Address of the Invisible RZone, ^ means mathematical AND, *+16* means BSGLL. Ceil (x) returns the least integer value greater than or equal to x.

a. If the reservation size is equal to the remaining disc capacity, the BSGLL ***shall not*** be added to the reserved RZone size.

Table 356 specifies the PMA stop time.

Table 356 - Track reservation sizing (CD)

Write Parameters Mode Page Write Type Value	PMA Stop Time
Session-at-once	Return CHECK CONDITION Status, 5/2C/00 COMMAND SEQUENCE ERROR.
Track-at-once	Reserves the number of user blocks specified. The PMA stop time shall be $PMAStart + ReservationSize + 2$
Variable Packet	Reserve behaves as in track-at-once.
Fixed Packet	Set $p = \frac{ReservationSize}{PacketSize}$ packets, where packet size is taken from the Write Parameters Mode Page. If p is an integer, then the reservation is performed and the PMA stop time shall be $PMAStart + (PacketSize + 7) \bullet p - 5$. Otherwise, the reservation is not performed and the Logical Unit returns CHECK CONDITION Status, 5/24/00 INVALID FIELD IN CDB. Enough space for reservation size user data packets shall be reserved.

The Invisible Track/RZone is known to have Track/RZone number N+1 only because the Track/RZone number of the Track/RZone immediately preceding it has Track/RZone number N. Tracks/RZones shall only be reserved from the beginning of the invisible Track/RZone. Each Track/RZone prior to the invisible Track/RZone has a Track/RZone number defined in the RMA/PMA. After the reservation is done, the Track/RZone number given to the new Track/RZone is the current Track/RZone number of the invisible Track/RZone. The number of the invisible Track/RZone is increased by one following a reservation.

For CD, if the **Reservation Size** is smaller than 298, excluding pre-gap length, the drive shall return CHECK CONDITION Status, 5/24/00 INVALID FIELD IN CDB.

For DVD, if the Reservation Size field is set to 0, no reservation is done by device and shall not be considered an error.

Reserving shall be allowed when the last Track/RZone is Invisible. When the last Track/RZone is not Invisible, the Logical Unit shall generate CHECK CONDITION Status, 5/2C/00 COMMAND SEQUENCE ERROR.

For CD, reserving a Track when the Write Type is set to Packet Writing shall cause the TDB (Track Descriptor Block) to be written.

For DVD, the maximum number of partially recorded reserved RZones is two. Attempting to reserve RZone when two RZones are already reserved but not fully recorded, the command ***shall*** be terminated with CHECK CONDITION Status, 5/72/05 NO MORE RZONE RESERVATIONS ARE ALLOWED.

Because three RMD blocks are required for reservation, RZone closure and Border closure, attempting to reserve RZone when remaining ECC blocks in the RMA are less than three, the command ***shall*** be terminated with CHECK CONDITION Status, 3/73/05 PROGRAM MEMORY AREA/RMA IS FULL.

Table 357 - RESERVE TRACK/RZONE Command Errors

Error Description
A-1.1, "Deferred Error Reporting" on page 437
Table 421 - *Basic Error Codes* on page 445
Table 422 - *Media Access Error Codes* on page 449
Table 423 - *Write Error Codes* on page 452

11.35 SCAN Command

The SCAN Command requests a fast-forward or fast-reverse scan operation starting from the Scan Starting Address. The command ***shall*** scan all the way to the end of the media (last audio track).

This command responds with immediate status, allowing overlapped commands. See also *B-9, "Immediate Command Processing Considerations"* on page 460.

For ATAPI Logical Units, this command ***shall*** set the DSC bit upon command completion.

Table 358 - SCAN Command

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation code (BAh)							
1	LUN (Obsolete)			DIRECT	Reserved			RelAdr
2	(MSB)							
3	Scan Starting Address							
4								
5								(LSB)
6	Reserved							
7	Reserved							
8	Reserved							
9	Type		Reserved					
10	Reserved							
11	Vendor-Specific		Reserved			NACA	Flag	Link

A Direction (**DIRECT**) bit of zero indicates a fast-forward. A DIRECT bit of one indicates a fast-reversed operation.

The **Scan Starting Address** specifies the address at which the Audio Fast Scan ***shall*** begin. The Type Field determines the interpretation of the address.

Like the Audio Play Commands, the SCAN Command ***shall*** terminate the scan at the last audio track or upon receipt of the STOP PLAY/SCAN Command. Upon receipt of the STOP PLAY/SCAN Command the Logical Unit ***shall*** set the current address to the last address output during the SCAN Command. Subsequent Audio Play Commands ***shall*** cause the Logical Unit to begin playing at the location last output by the SCAN Command. If the drive receives a PAUSE/RESUME Command with the resume bit clear, the drive shall pause. After that, if the drive receives a PAUSE/RESUME Command with the resume bit set, the drive shall resume audio play (note: not scan) from the address where the audio pause occurred. See Figure 79 - *Stop Play/Play Audio/Audio Scan/Pause/Resume Sequencing* on page 422 for additional information.

If the drive receives a SCAN Command during play or pause, the drive shall stop play or pause and perform Scan.

Upon receipt of a READ SUBCHANNEL Command during scan, the drive shall return an Audio Status of 11h (Audio Play operation in Progress).

If the drive receives a SCAN Command during play or pause for which a valid stop address was specified, the drive will remember the stop address but ignore it during the scan command. The stop address becomes valid again when audio play resumes. Thus, upon resumption of audio play, if the current address is greater than the former stop address, the drive shall stop playing and return good status. After this, if the drive receives a READ SUBCHANNEL Command, the drive shall return an Audio Status of 13h (Audio Play operation successfully completed).

If the drive reaches a data track, it shall stop scan.

Request to the implementer: *The following implementation of forward and reverse scan speed will provide good quality sound: 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.*
*This can be some fixed number between 150 and 200.

The Type field is defined in Table 359. This field specifies the “Type” of address contained in the Scan Starting Address Field.

Table 359 - Type field

Type field	Definition
00b	Logical Block Address format
01b	AMIN, ASEC and AFRAME format
10b	Track Number (TNO) format
11b	Reserved

See *11.14.1, "PLAY AUDIO (10) with Immediate Packet Commands"* on page 276 for information on overlapped commands during a SCAN operation.

Table 360 - Scan Starting Address in Logical Block Format

Bit / Byte	7	6	5	4	3	2	1	0
2	(MSB)							
3	Scan Starting Address							
4								
5								(LSB)

Table 361 - Scan Starting Address in AMIN, ASEC and AFRAME Format

Bit / Byte	7	6	5	4	3	2	1	0
2	Reserved							
3	CD-absolute time (AMIN)							
4	CD-absolute time (ASEC)							
5	CD-absolute time (AFRAME)							

The **AMIN**, **ASEC** and **AFRAME** fields specifies the relative running time from the beginning of the disc. The **AMIN** field has a range of 00 to 99d (63h). The **ASEC** ranges from 00 to 59d (3Bh). The **AFRAME** field has a range of 00 to 74d (4Ah). All MSF fields ***shall*** be Binary.

Table 362 - Scan Starting Address in Track Number (TNO) Format

Bit / Byte	7	6	5	4	3	2	1	0
2	Reserved							
3	Reserved							
4	Reserved							
5	Track Number (TNO)							

The Track Number field specifies the track in binary notation at which the scan operation will begin. This field has a range of 01h to 63h.

Table 363 - SCAN Command Errors

Error Description
A-1.1, "Deferred Error Reporting" on page 437
Table 421 - *Basic Error Codes* on page 445
Table 422 - *Media Access Error Codes* on page 449

When a PLAY CD Command is actively using one of the Digital Output ports a SCAN Command shall be aborted with CHECK CONDITION Status, 5/64/00 ILLEGAL MODE FOR THIS TRACK.

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11.36 SEEK Command

The SEEK Command request that the Logical Unit seek to the specified logical block address. All Logical Block Addresses are valid targets for a seek operation, including a CD-DA audio sector. The content of the Sector at the specified LBA ***shall not*** affect the seek operation nor cause an error to be generated.

The SEEK Command should be executed as an immediate command. The command should return completion status as soon as the seek operation has been started.

Table 364 - SEEK Command

Byte \ Bit	7	6	5	4	3	2	1	0
0	Operation code (2Bh)							
1	LUN (Obsolete)			Reserved				
2	(MSB) Logical Block Address							
3								
4								
5								(LSB)
6	Reserved							
7	Reserved							
8	Reserved							
9	Vendor-Specific		Reserved			NACA	Flag	Link
10	PAD							
11								

The **Logical Block Address** field specifies the destination of the SEEK command.

Table 365 - SEEK Command Errors

Error Description
A-1.1, "Deferred Error Reporting" on page 437
Table 421 - *Basic Error Codes* on page 445
Table 422 - *Media Access Error Codes* on page 449

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11.37 SEND CUE SHEET Command

A Session-at-once recording is written beginning with the lead-in and continuing through the lead-out. Only user data will be sent with the write commands, so a guide structure is required by the CD-R/RW device 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 device.

Table 366 - SEND CUE SHEET Command

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation code (5Dh)							
1	LUN (Obsolete)			Reserved				
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	(MSB)							
7	Cue Sheet Size							
8								(LSB)
9	Vendor-Specific		Reserved			NACA	Flag	Link
10	PAD							
11								

The **Cue Sheet Size** parameter is the number of bytes in the cue sheet to be sent to the device. The entire cue sheet must be received by the device prior to beginning the write process. If the device cannot accept and buffer the entire cue sheet, then the Logical Unit shall return CHECK CONDITION Status, 5/24/00 INVALID FIELD IN CDB.

If the Write Parameters Mode Page does not have Write Type set to Session-at-once, then the Logical Unit shall return CHECK CONDITION Status, 5/2C/00 COMMAND SEQUENCE ERROR.

If the Write Mode in the Write Parameter Mode page is changed from session at once, the cue sheet may be lost.

11.37.1 CUE SHEET FORMAT

The Cue Sheet contains information required to specify the layout of a disc to be written, and must be sent to the Logical Unit via the SEND CUE SHEET Command before writing data to the disc.

Table 367 - Cue Sheet Format

Byte Number	Cue Sheet Data
0	Mixture of Information of absolute disc location, catalogue code and ISRC (Total M lines)
...	
(M-1) * 8	

If the Catalogue Code is to be recorded, it shall be described at the beginning of the Cue sheet.

If the ISRC is to be recorded, it shall be described immediately preceding each Track’s information in the Cue Sheet.

For the Cue sheet, the lead-out start time shall be the last entry.

11.37.2 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 (10) Command

Table 368 - Sample Cue Sheet

Byte Number (hex)	Ctl/Adr (hex)	TNO (hex)	Index (hex)	Data Form (hex)	SCMS (hex)	Absolute Time Min	Sec	Frame
00 (lead-in)	01[a]	00	00[b]	01[a]	00	00[b]	00[b]	00[b]
08 (TNO:01)[c]	01	01	00	01	00	00	02	00
18 (TNO:02)	01	02	00	C0	00	07	29	71
20 (TNO:02)	01	02	01	C0	00	07	31	71
28 (TNO:03)	01	03	01	C0	00	14	18	03
30 (TNO:04)[d]	41	04	00	10	00	19	06	62
38 (TNO:04)	41	04	01	10	00	19	09	62
40 (TNO:05)[d]	41	05	00	11	00	27	37	10
48 (TNO:05)	41	05	01	10	00	27	40	10
50 (TNO:06)	01	06	00	01	80[e]	38	53	23
58 (TNO:06)	01	06	01	00	80[e]	38	55	23
60 (lead-out)	01[a]	AA	01[f]	01[a]	00	56	37	46

a. For the lead-in and lead-out area the DATA FORM shall be one. For lead-in, data form and control mode of the first track is specified. For lead-out, data form and control mode of last track is specified automatically. All data for both lead-in and lead-out shall be generated by the Logical Unit.
b. Always zero for lead-in.
c. 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).
d. Pre-gap
e. Copy
f. Always 01h for lead-out

This information is composed of data units of 8 bytes (1 line). The information consists of three parts:

1. The lead-in area, which contains exactly one data unit.
2. The Program area, which contains one or more data units.
3. The lead-out area, which contains exactly one data unit.

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 369 - CUE Sheet Data

Ctl/Adr (hex)	TNO (hex)	Index (hex)	Data Form (hex)	SCMS (hex)	Absolute Time Min	Sec	Frame
01	02	01	C0	00	07	31	71
01	03	01	C0	00	14	18	03

The above data unit indicates that the value of TNO changes from 02 to 03 when ABSOLUTE TIME is 14/18/03 MSF.

11.37.2.1 Control/Address Field

The CTL/ADR byte contains the Control field in the upper 4 bits and the ADR in the lower 4 bits.

Table 370 - CTL/ADR Byte

7	6	5	4	3	2	1	0
CTL Field				ADR Field			

11.37.2.2 CTL Field (upper 4 bits)

The CTL (Control) field contains 4 bits that define the kind of information in a track. See Table 371.

Table 371 - 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.

11.37.2.3 ADR Field(lower 4 bits)

Table 372 defines the codes found in the ADR Field.

Table 372 - ADR Field

Bit 3	Bit 2	Bit 1	Bit 0	Definition
0	0	0	1	start time at TNO/IDX
0	0	1	0	CATALOG CODE
0	0	1	1	ISRC CODE

All other codes are reserved for future use.

Control must be the same for each entry associated with a particular track except for first part of pre-gap.

11.37.2.4 TNO

The TNO field indicates track number expressed in HEX. Each track has a minimum length of 4 seconds, not including the pause length preceding the track.

11.37.2.5 INDEX Field

The index number expressed in HEX. The Logical Unit supports only 00h - 63h.

11.37.2.6 DATA FORM

The following table defines the data form byte.

Figure 70 - Data Form Byte

7	6	5	4	3	2	1	0
Data Form of Sub-channel		Data Form of Main Data					

11.37.2.7 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 161). The other 7 bits (Reserved) are zero. This bit is effective if Copy bit of the Control Code is zero.

Figure 71 - SCMS Byte

7	6	5	4	3	2	1	0
Alternate Copy bit	Reserved						

11.37.2.8 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.

11.37.2.9 CD-DA Data Form

The following figure defines a CD-DA Data Form for one frame.

Figure 72 - CD-DA Data Form

Data Form	Data of One Frame	Data Size
00h	2352	2352
01h	2352	0

The CD-DA data format, is as follows:

Figure 73 - 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)

11.37.2.10 CD-ROM mode 1 Form

The following defines the form for CD-ROM mode 1.

Figure 74 - CD-ROM Mode 1

Data Form	Sync/ Header	Data of One Frame	EDC/ECC Area	Data Size
10h	16 *2	2048 *1	288 *2	2048
11h	16 *3	2048 *1	288 *3	2352
12h	16 *2	2048 *3	288 *2	2048
13h	16 *3	2048 *3	288 *3	2352
14h	16 *2	2048 *2	288 *2	0

11.37.2.11 CD-ROM XA, CD-I Form

The following figure defines the form for CD-ROM XA, CD-I.

Figure 75 - CD-ROM XA, CD-I

Data Form		Sync/ Header	Sub Header	Data of One Frame	EDC/ECC Area	Data Size
20h	Form 1	16 *2	8 *1	2048 *1	280 *3	2336
	Form 2	16 *2	8 *1	2324 *1	4 *3	2336
21h	Form 1	16 *3	8 *1	2048 *1	280 *3	2352
	Form 2	16 *3	8 *1	2324 *1	4 *3	2352
22h	Form 1	16 *2	8 *1	2048 *3	280 *3	2336
	Form 2	16 *2	8 *1	2324 *3	4 *3	2336
23h	Form 1	16 *3	8 *1	2048 *3	280 *3	2352
	Form 2	16 *3	8 *1	2324 *3	4 *3	2352
24h	Form 1	NA	NA	NA	NA	NA
	Form 2	16 *2	8 *2	2324 *2	4 *2	0

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.

11.37.2.12 CD-ROM mode 2

The following figure defines the form for CD-ROM mode 2.

Figure 76 - CD-ROM Mode 2

Data Form	Sync/ Header	Data of One Frame	Data Size
30h	16 *2	2336 *1	2336
31h	16 *3	2336 *1	2352
32h	16 *2	2336 *3	2336
33h	16 *3	2336 *3	2352
34h	16 *2	2336 *2	0

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 (10) Command. However, the Logical Unit ignores the data and generates data for this area.

11.37.3 Data Form of Sub-Channel

The DATA FORM OF SUB-CHANNEL (Table 163) field specifies the format of the sub-channel data stored in the inner buffer by WRITE (10) Command to write on the disc.

Figure 77 - Data Form of Sub-channel

Data Form		Data of One Frame				Data Size
Bit 7	Bit 6					
0	0	96[a]				0
0	1	96[b]				96
1	0	Reserved				
1	1	24 Pack[c]	24 Pack[c]	24 Pack[c]	24 Pack[c]	96

a. Generate zero data
b. RAW Data
c. 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.

The Sub-channel data is placed at the end of each Frame of main data. Figure 78 shows the relationship of Main Data and sub-channel data.

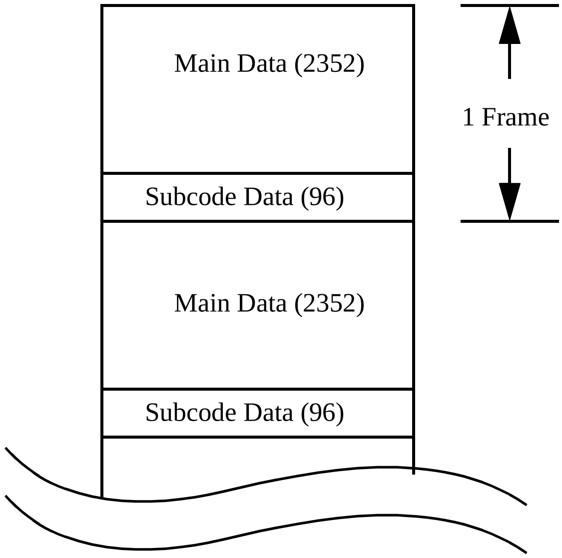

Figure 78 - Location of Sub-channel Data

The P and Q sub-channel information contained within the Subcode 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.

11.37.4 Absolute Time

The time shown at Min, Sec, and Frame gives the changing point of the CONTROL, TNO, X, DATA FORM or SCMS field. These values are given in absolute time scale.

11.37.5 Session Format

The Session Format is used for the identification of the type of disc. Refer to Table 112 - Session Format Codes.

11.37.6 Pre-gap

If a Data track is preceded by a different mode of track (such as an audio track) or if the mode number of CD-ROM changes, this Data track starts with an extended pre-gap. A pre-gap is placed at the head of a Data track, also is belonging to the Data track. A pre-gap does not contain actual user data. The pre-gap is encoded as “pause.”

An extended pre-gap is divided into two parts. The first part of the extended pre-gap has a minimum 1 second of data, and it is encoded according to the data structure of previous track. The second part has a minimum 2 seconds data, and this data track is encoded according to the same data structure as the other parts.

11.37.7 Post-gap

If a Data track is followed by another kind of track (such as an audio track), this Data track ends with a post-gap. A post-gap is placed at the end of a Data track, and is part of the Data Track. A post-gap does not contain actual user data. The minimum length of post-gap is 2 seconds. The Logical Unit does not perform any action for a Post-gap.

11.37.8 Catalog Number

The 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 373 - Catalog Number (N1..N13)

CTL/ ADR	**Catalog Number**						
Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
02h	N1	N2	N3	N4	N5	N6	N7
02h	N8	N9	N10	N11	N12	N13	00h

N1-N13: Catalog Number

CTL: 4 bits are zero.

ADR: 0010b

Catalog Number: ASCII 13 BYTES

11.37.9 ISRC

Table 165, 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 374 - ISRC (I1..I12)

CTL/ ADR	**ISRC(International Standard Recording Code)**						
byte 0	byte 1	byte 2	byte 3	byte 4	byte 5	byte 6	byte 7
x3h	TNO	I1	I2	I3	I4	I5	I6
x3h	TNO	I7	I8	I9	I10	I11	I12

CTL: 4 bits of Control code are the same as that of disc location of the specified track

ADR: 0011b

TNO: Track number in HEX.

12 letters ISRC (On the Cue Sheet, I1-I12 must be described by valid ASCII characters. See Table 303 - *ISRC Format of Data Returned to Host* on page 344 for valid codes.
I1-I2: Country Code
I3-I5 Owner Code
I6-I7 Year of recording
I8-I12 Serial Number

Table 375 - SEND CUE SHEET Command Errors

Error Description
A-1.1, "Deferred Error Reporting" on page 437
Table 421 - *Basic Error Codes* on page 445
Table 422 - *Media Access Error Codes* on page 449
Table 423 - *Write Error Codes* on page 452

11.38 SEND DVD STRUCTURE Command

The SEND DVD STRUCTURE Command provides a means for the Host to transfer DVD Structure data to the DVD Logical Unit.

Table 376 - SEND DVD STRUCTURE Command

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation code (BFh)							
1	LUN			Reserved				
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	Format							
8	(MSB) Parameter List Length							
9								(LSB)
10	Reserved							
11	Vendor-Specific		Reserved			NACA	Flag	Link

The **Format** field indicates the type of information that is requested be sent to the Logical Unit. When the Logical Unit and medium combination does not support specified format code, this command ***shall*** be terminated with CHECK CONDITION Status, 5/24/00 INVALID FIELD IN CDB.

Table 377 - Format Code definitions for SEND DVD STRUCTURE Command

Format Code	Data	Description
00h - 03h	Reserved	
04h	User Specific Data	Send User Specific Data to the RMD cache
05h	CPM, CGMS	Send data to CPR_MAI in data area cache. (CPM, CGMS)
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-FFh	Reserved	

A DVD-R Logical Unit ***shall*** implement cache memory for DVD Structure data.

The cached RMD can be read by using the READ DVD STRUCTURE Command.

The **Parameter List Length** field specifies the length in bytes of the DVD STRUCTURE data that ***shall*** be transferred from the Host to the DVD Logical Unit after the Command Packet is transferred. A Parameter List Length field of zero indicates that no data ***shall*** be transferred. This condition ***shall*** not be considered an error.

11.38.1 User Specific Data (Format 04h)

Table 378 - SEND DVD STRUCTURE Data Format (With Format Field = 04h)

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			Structure Data Length				
1								(LSB)
2				Reserved				
3				Reserved				
DVD-R User Specific Data								
0	(MSB)			User Specific Data				
...								
N								(LSB)

The **Structure Data Length** field specifies the number of bytes that follow the **Structure Data Length** field.

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 or Border-in, the contents of this field ***shall*** also be written in Disc manufacturing information field of Lead-in or Border-in.

11.38.2 Copyright Management Information (Format 05h)

Table 379 - SEND DVD STRUCTURE Data Format (With Format Field = 05h)

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			Structure Data Length				
1								(LSB)
2				Reserved				
3				Reserved				
Copyright Management Information in data area								
0	CPM	Reserved	CGMS		Reserved			
1				Reserved				
2				Reserved				
3				Reserved				

The **Structure Data Length** field specifies the number of bytes that follow the **Structure Data Length** field.

The sector written in the data area ***shall*** reflect the values in Table 379 for the copyright management information field of the sector.

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 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 380.

Table 380 - 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 must much with this format following write operation.

11.38.3 Timestamp (Format 0Fh)

Table 381 - SEND DVD STRUCTURE Data Format (With Format Field = 0Fh)

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			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 **Structure Data Length** field specifies the number of bytes that follow the **Structure Data Length** field.

The Timestamp data ***shall*** be used to specify the **Unique Disc Identifier** field of the RMD Field 0.

The Timestamp data ***may*** also be used in the OPC related field in the RMD Field 1 and ***may*** help the judgement to do OPC.

The time value of the Timestamp data should be current UTC (Universal Coordinated Time) 24 hour clock.

The **Year** field ***shall*** specify the year which coded as ASCII in the range “0001” to “9999”.

The **Month** field ***shall*** specify the month of the year which coded as ASCII in the range “01” to “12”.

The **Day** field ***shall*** specify the day of the month which coded as ASCII in the range “01” to “31”.

The **Hour** field ***shall*** specify the hour of the day which coded as ASCII in the range “00” to “23”.

The **Minute** field ***shall*** specify the minute of the hour which coded as ASCII in the range “00” to “59”.

The **Second** field ***shall*** specify the second of the minute which coded as ASCII in the range “00” to “59”.

11.38.4 Disc Control Block (Format 30h)

Table 382 - SEND DVD STRUCTURE Data Format (With Format Field = 30h)

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB) Structure Data Length							
1								(LSB)
2	Reserved							Erase
3	Reserved							
Disc Control Block								
0	(MSB) Disc Control Block							
...								
N								(LSB)

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, ***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 Table 273 - *Generic Disc Control Block* on page 327. If a DCB with fewer than 32768 bytes is sent, the Logical Unit ***shall*** pad the DCB with 00h bytes.

Table 383 describes errors that may occur during the operation of the Command or which may cause a CHECK CONDITION status to be reported.

Table 383 - SEND DVD STRUCTURE Command Errors

Error Description
A-1.1, "Deferred Error Reporting" on page 437
Table 421 - *Basic Error Codes* on page 445
Table 422 - *Media Access Error Codes* on page 449
Table 423 - *Write Error Codes* on page 452

11.39 SEND EVENT Command

The SEND EVENT Command requests the Logical Unit to process an event for the Host. The Event should be one that the Host had received from an earlier GET EVENT/STATUS NOTIFICATION Command but not handled by the Host.

If a Logical Unit has received a persistent prevent, it will 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 Host by a GET EVENT/STATUS NOTIFICATION Command. Such events may include front panel button presses, etc. When such a request is received by the Host, 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 Host ***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 384 - SEND EVENT Command

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation code (A2h)							
1	LUN (Obsolete)			Reserved				Immed
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	Reserved							
8	(MSB) Parameter List Length							
9								(LSB)
10	Reserved							
11	Vendor-Specific		Reserved			NACA	Flag	Link

An immediate bit of zero ***shall*** indicate that the Command ***shall not*** complete until the requested operation is complete. 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 Host. The **Immed** bit ***shall*** be set to 1 for ATAPI devices.

The **Parameter List Length** field specifies the length in bytes of the Event parameter list that ***shall*** be transferred from the Host to the Logical Unit after the Command Packet is transferred. A parameter list length of zero indicates that no data ***shall*** be transferred. This condition ***shall not*** be considered as an error.

If the Event parameter list length results in the truncation of Event parameter data, the Logical Unit ***shall*** terminate the command with CHECK CONDITION Status, 5/1A/00 PARAMETER LIST LENGTH ERROR.

The Logical Unit ***shall*** terminate the command with CHECK CONDITION Status, 5/26/00 INVALID FIELD IN PARAMETER LIST, and ***shall not*** take any action directed by the event specified for the following conditions:

1. If the Host sets any unreserved field in the Event parameter header to an unsupported value.
2. If an Host 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 Host sends an invalid value for any Event parameter.

The Parameter List shall consist of an Event Parameter Header followed by an External Request Event Descriptor. Please see Table 125 - *Notification Status List* on page 220 for the Parameter List layout, Table 126 - *Event Status Header* on page 221 for the Event Status Header format, and *11.6.3, "External Request Class Events"* on page 223 for a description of the External Request Class Descriptor.

No more than one External Request Event Descriptor ***shall*** be sent by the Host.

Table 385 - SEND EVENT Command Errors

Error Description
A-1.1, "Deferred Error Reporting" on page 437
Table 421 - *Basic Error Codes* on page 445

11.40 SEND KEY Command

The SEND KEY Command provides data necessary for authentication and for generating a Bus Key for the DVD Logical Unit.

This command, in conjunction with REPORT KEY Command, is intended to perform authentication for Logical Units which conform to DVD Copy Protection scheme and to generate a Bus Key as the result of authentication.

Table 386 - SEND KEY Command

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation code (A3h)							
1	LUN (Obsolete)			Reserved				
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	Key Class							
8	(MSB) Parameter List Length							
9								(LSB)
10	AGID		KEY Format					
11	Vendor-Specific		Reserved			NACA	Flag	Link

The **KEY Format** field indicates the type of information that is requested to be sent to the Host.

The **AGID** field is used to control simultaneous key exchange sequences. The **AGID** specified in subsequent Key Exchange commands shall match a currently active **AGID**. The **AGID** field is further described in the REPORT KEY Command. See *11.32*, on page 371.

The **Key Class** field ***shall*** identify the type of authentication conversation according to

Table 387 - Key Class Definitions

Key Class	Authentication Type
00h	DVD CSS
01h	Rewritable Security Services-A
02h-FFh	Reserved

Table 388 - Key Format Code definitions for SEND KEY Command (Key Class = 0)

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		

Table 389 - SEND KEY Parameter List (With KEY Format = 000001b, Key Class = 0)

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								
0	(MSB)	Challenge Key Value						
.								
9								(LSB)
10	Reserved							
11	Reserved							

The **Challenge Key** is sent to the DVD Logical Unit to get corresponding KEY1 from the DVD Logical Unit to interrogate conformity with DVD Copy Protection scheme.

Table 390 - SEND KEY Parameter List (With KEY Format = 000011b, Key Class = 0)

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)	SEND KEY Parameter List Length (0Ah)						
1								(LSB)
2	Reserved							

Table 390 - SEND KEY Parameter List (With KEY Format = 000011b, Key Class = 0)

Bit / Byte	7	6	5	4	3	2	1	0
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 **KEY2** value will be used for the second input to generate a Bus Key in the DVD Logical Unit.

When the **KEY2** value sent does not conform with the DVD Copy Protection scheme, this command shall be terminated with CHECK CONDITION Status, 5/6F/00 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 391 - SEND KEY Parameter List (With KEY Format = 000110b, Key Class = 0)

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)							
1	SEND KEY Parameter List Length (06h)							(LSB)
2	Reserved							
3	Reserved							
RPC Structure								
0	Preferred Drive Region Code							
1	Reserved							
2	Reserved							
3	Reserved							

Preferred Drive Regional Code is sent to the DVD Logical Unit to make the Logical Unit regionalized. The Preferred Drive 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 Drive 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, 5/6F/05 DRIVE REGION MUST BE PERMANENT/REGION RESET COUNT ERROR.

Table 392 describes errors that may occur during the operation of the Command or which may cause a CHECK CONDITION status to be reported.

Table 392 - SEND KEY Command Errors

Error Description
A-1.1, "Deferred Error Reporting" on page 437
Table 421 - *Basic Error Codes* on page 445
Table 422 - *Media Access Error Codes* on page 449
Table 425 - *Authentication Error Codes* on page 453

11.41 SEND OPC INFORMATION Command

This command is used to restore the Optimum Power Calibration (OPC) values to the device for a specific disc.

For CD, it is used in combination with the READ DISC INFORMATION Command.

Table 393 - SEND OPC INFORMATION Command

<table>
<tr><th>Bit
Byte</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>0</td><td colspan="8">Operation code (54h)</td></tr>
<tr><td>1</td><td colspan="3">Reserved</td><td colspan="4">Reserved</td><td>DoOpc</td></tr>
<tr><td>2</td><td colspan="8">Reserved</td></tr>
<tr><td>3</td><td colspan="8">Reserved</td></tr>
<tr><td>4</td><td colspan="8">Reserved</td></tr>
<tr><td>5</td><td colspan="8">Reserved</td></tr>
<tr><td>6</td><td colspan="8">Reserved</td></tr>
<tr><td>7</td><td colspan="8" rowspan="2">(MSB)
Parameter List Length
(LSB)</td></tr>
<tr><td>8</td></tr>
<tr><td>9</td><td colspan="2">Vendor-Specific</td><td colspan="3">Reserved</td><td>NACA</td><td>Flag</td><td>Link</td></tr>
<tr><td>10</td><td colspan="8" rowspan="2">PAD</td></tr>
<tr><td>11</td></tr>
</table>

The **Parameter List Length** must be set to reflect the number of the parameter bytes to be transferred. This value ***shall*** be an integral multiple of 8.

The **DoOpc** bit, when is set to one, indicates the drive ***shall*** perform an OPC operation to set the OPC values for the current speed. These OPC values ***shall*** become current. A Parameter List may be sent to indicate an initial value of OPC. When the bit is set to zero, the device 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 Host ***shall*** transfer zero or more OPC table entries. The transfer length ***shall*** be 8X (the number of OPC table entries). The Host ***shall not*** send more than one OPC table entry with the same value in the OPC Speed field. If an illegal OPC entry is detected, the Logical Unit shall report CHECK CONDITION Status, 5/26/00 INVALID FIELD IN PARAMETER LIST.

If PCA is almost full, and the **DoOPC** bit is set to one, the Command ***shall*** be executed normally and report CHECK CONDITION Status, 1/73/01 POWER CALIBRATION AREA ALMOST FULL.

If PCA is full, and the **DoOPC** bit is set to one, the Command is not executed, and the Logical Unit ***shall*** report CHECK CONDITION Status, 3/73/02 POWER CALIBRATION AREA IS FULL.

The format of the OPC Response Data to be transferred is shown in Table 394.

Table 394 - SEND OPC INFORMATION Parameter List

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			OPC Speed in KBytes per Second				
1								(LSB)
2	(MSB)							
3								
4				OPC Value				
5								
6								
7								(LSB)

Table 395 describes errors that may occur during the operation of the Command or which may cause a CHECK CONDITION status to be reported.

Table 395 - SEND OPC INFORMATION Command Errors

Error Description
A-1.1, "Deferred Error Reporting" on page 437
Table 421 - *Basic Error Codes* on page 445
Table 422 - *Media Access Error Codes* on page 449
Table 423 - *Write Error Codes* on page 452

11.42 SET READ AHEAD Command

The SET READ AHEAD Command requests that the Logical Unit perform Read Ahead Caching operations from the **Read-Ahead Logical Block Address** when the drive encounters the **Trigger Logical Block Address** during its internal Read Ahead Caching operation.

If this command is received by the Logical Unit when data after the **Trigger Logical Block Address** and before the **Read Ahead Logical Block Address** is contained in its cache, that data should be discarded and Read Ahead Caching restarted from the specified Read Ahead Logical Block Address.

Sectors after the **Trigger LBA** (Not including the Trigger LBA) should be skipped. The data for both the Trigger and Read Ahead LBAs will normally be read by the host. The sectors between these addresses (exclusive) are normally not read by the host.

Note: The Host should expect seek delays if these sectors are read.

The Read-Ahead operation ***shall*** be performed in background, i.e. the Logical Unit shall accept a command during the Read-Ahead operation.

Table 396 - SET READ AHEAD Command

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation code (A7h)							
1	LUN (Obsolete)			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	Vendor-Specific		Reserved			NACA	Flag	Link

Table 397 describes errors that may occur during the operation of the Command or which may cause a CHECK CONDITION status to be reported.

Table 397 - SET READ AHEAD Command Errors

Error Description
A-1.1, "Deferred Error Reporting" on page 437
Table 421 - *Basic Error Codes* on page 445
Table 422 - *Media Access Error Codes* on page 449

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11.43 SET STREAMING Command

The SET STREAMING Command provides a way for the Host to indicate to the Logical Unit that the application has specific request or requirements for drive performance. The Logical Unit may utilize the Host 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.

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 398 - SET STREAMING Command

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation code (B6h)							
1	LUN (Obsolete)			Reserved				
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	Reserved							
8	Reserved							
9	(MSB) Parameter List Length							
10								(LSB)
11	Vendor-Specific		Reserved			NACA	Flag	Link

The Host shall send a performance descriptor during the data phase of this command. The Performance Descriptor shall be sent in the format shown in Table 399.

Table 399 - Performance Descriptor

Bit / Byte	7	6	5	4	3	2	1	0
0	Reserved					RDD	Exact	MRW
1	Reserved							
2	Reserved							
3	Reserved							
4	(MSB)							
5	Start LBA							
6								
7								(LSB)
8	(MSB)							
9	End LBA							
10								
11								(LSB)

Table 399 - Performance Descriptor (Continued)

Bit / Byte	7	6	5	4	3	2	1	0
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 **RDD** (Restore Drive Defaults) bit, when set to zero, means that the remaining fields are valid. When set to one, ***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 operation specified by the Read/Write Error Recovery page.

The **Exact** bit, when set to zero, ***shall*** indicate that the Logical Unit set its internal configuration to match the parameters as best as possible. No errors ***shall*** occur. When set to one, shall indicate that the Logical Unit set its internal configuration to support the requested parameters. If the Logical Unit cannot perform as requested, it ***shall*** generate CHECK CONDITION Status, 5/26/00 INVALID FIELD IN PARAMETER LIST, and the Sense Key Specific bytes ***shall*** identify the Size or Time parameter that is not valid.

The **MRW** (Mixed Read/Write) bit, when set to zero, allows the Logical Unit to independently set the read and write speeds. When set to one, shall indicate to the Logical Unit that its performance settings should be optimized for random changes between reading and writing by the Host. For example, a CD recorder that can record at 2X and read at 6X may choose to limit reading to 2X if the **MRW** 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 $\frac{ReadSize}{ReadTime}$.

The **Read Size** field shall indicate the number of kilobytes the Host expects to be delivered per period of **Read Time** when the Host's requests for data occur sufficiently fast.

The **Read Time** field shall indicate the amount of time, in milliseconds, over which the Read Size is expected to be read.

The Host 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 which 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 Host 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 400 describes errors that may occur during the operation of the Command or which may cause a CHECK CONDITION status to be reported.

Table 400 - SET STREAMING Command Errors

Error Description
A-1.1, "Deferred Error Reporting" on page 437
Table 421 - *Basic Error Codes* on page 445
Table 422 - *Media Access Error Codes* on page 449
Table 423 - *Write Error Codes* on page 452

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11.44 START/STOP UNIT Command

The START/STOP UNIT Command requests that the Logical Unit enable or disable media access operations.

Table 401 - START/STOP UNIT Command

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation code (1Bh)							
1	LUN (Obsolete)			Reserved				Immed
2	Reserved							
3	Reserved							
4	Power Condition				Reserved		LoEj	Start
5	Vendor-Specific		Reserved			NACA	Flag	Link
6	PAD							
7								
8								
9								
10								
11								

An immediate (**Immed**) bit of one indicates that status ***shall*** be returned as soon as the Command Packet has been validated. An **Immed** bit of zero indicates that status ***shall*** be returned after the operation is completed.

A **Start** bit of one requests the Logical Unit be made ready for use. The Idle and Standby timers are reloaded. A **Start** bit of zero requests that the Logical Unit be stopped (media cannot be accessed by the Host). See Table 402.

Table 402 - Start/Stop and Eject Operations

LoEj	Start	Power Condition	Operation to be Performed
0	0	0	Stop the Disc
0	1	0	Start the Disc and read the TOC
1	0	0	Eject the Disc if possible (See Table 214 - *Actions for Lock/Unlock/Eject (Persistent bit = 0)* on page 286)
1	1	0	Load the Disc (Close Tray)
x	x	1h - Fh	Power Condition Change (Table 404)

Any attempt to Eject or Load a Disc when the Logical Unit does not support that capability ***shall*** result in CHECK CONDITION Status, 5/24/00 INVALID FIELD IN CDB

A load eject (**LoEj**) bit of zero requests that no action be taken regarding loading or ejecting the medium. A **LoEj** bit of one requests that the medium be unloaded if the start bit is zero. A **LoEj** bit of one requests that the medium be loaded if the start bit is one.

When the Loading Mechanism Type is a Changer utilizing individual disc change capability (4h), the Eject operation ***shall*** only eject the disc that is currently in the Play Position. If the Loading Mechanism is a changer utilizing a Cartridge (5h), then the Cartridge ***shall*** only be ejected when no media is in the play position.

Table 403 - Actions for Eject/Load Disc

Operation	Locked / Unlocked	If Logical Unit Not Ready (No Media)	If Logical Unit Ready (Media Present)
Eject	Unlocked	No Error and Tray is opened	No Error: Media Ejects
	Locked	CHECK CONDITION Status, 2/53/02 MEDIUM REMOVAL PREVENTED	CHECK CONDITION Status, 5/53/02 MEDIUM REMOVAL PREVENTED
	Changer using Cartridge with Disc in Play Position	CHECK CONDITION Status, 2/53/02 MEDIUM REMOVAL PREVENTED	CHECK CONDITION Status, 5/53/02 MEDIUM REMOVAL PREVENTED
	Changer using Individual disc changeability with no Disc in the Play Position	CHECK CONDITION Status, 2/53/02 MEDIUM REMOVAL PREVENTED	CHECK CONDITION Status, 5/53/02 MEDIUM REMOVAL PREVENTED
Manual Eject	Unlocked	Tray opens (If tray exists)	Media is Ejected
	Locked	No operation occurs	No operation, Media stays locked in Logical Unit

The **Power Condition** field requests the Logical Unit be placed into the power state defined in Table 404. If any bit is set in this field then the Start and the LoEj bits ***shall*** be ignored.

When the Logical Unit enters the sleep state, any queued GET EVENT/STATUS NOTIFICATION Commands ***shall*** be removed from the command queue without command completion.

If any commands other then event status are in the queue upon receipt of the sleep command then the sleep command ***shall*** terminate with CHECK CONDITION Status, 5/2C/00 COMMAND SEQUENCE ERROR.

An immediate (**Immed**) bit of one indicates that status shall be returned as soon as the command packet has been validated. An **Immed** bit of zero indicates that status ***shall*** be returned after the operation is completed.

The **Immed** bit ***shall*** be ignored if the Power Condition field contains 5h (Place Logical Unit into Sleep State).

Requests to enter the current power state ***shall*** complete without error.

If a request to go to a power state fails, the Logical Unit ***shall*** remain in the current power state and ***shall*** generate power management class event with the Power Event Field set to PwrChg-Fail.

All power state change requests, except sleep, that complete successfully ***shall*** generate power management class event with the Power Event Field set to PwrChg-Succ.

Notification of power states ***shall*** occur upon entering a new power state.

Table 404 - Power Conditions

Code	Description
0h	No change in power conditions or in which Logical Unit is controlling power conditions
1h	Reserved
2h	Place Logical Unit into the Idle State, Standby Timer is reloaded
3h	Place Logical Unit into the Standby State
4h	Reserved
5h	Place Logical Unit into Sleep State. Before entering the sleep state, all buffers must be successfully flushed by the Logical Unit. If the sleep command is successful, the host shall not issue new commands after receiving the successful completion status. The Device shall de-power and disable the interface only after all Logical Units have successful complete sleep commands.
6h - Fh	Reserved

In the Sleep condition the device ***shall*** only respond to a reset condition. When a device has multiple Logical Units attached it shall enter the Sleep condition only after all the Logical Units have been placed into a Sleep condition.

Table 405 describes errors that may occur during the operation of the Command or which may cause a CHECK CONDITION status to be reported.

Table 405 - START/STOP UNIT Command Errors

Error Description
A-1.1, "Deferred Error Reporting" on page 437
Table 421 - *Basic Error Codes* on page 445
Table 422 - *Media Access Error Codes* on page 449

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11.45 STOP PLAY/SCAN Command

The STOP PLAY/SCAN Command stops playback of audio or scan commands.

Table 406 - STOP PLAY/SCAN Command

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation code (4Eh)							
1	LUN (Obsolete)			Reserved				
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	Reserved							
8	Reserved							
9	Vendor-Specific		Reserved			NACA	Flag	Link
10	PAD							
11								

Table 407 - STOP PLAY/SCAN Command Errors

Error Description
A-1.1, "Deferred Error Reporting" on page 437
Table 421 - *Basic Error Codes* on page 445
Table 422 - *Media Access Error Codes* on page 449

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.

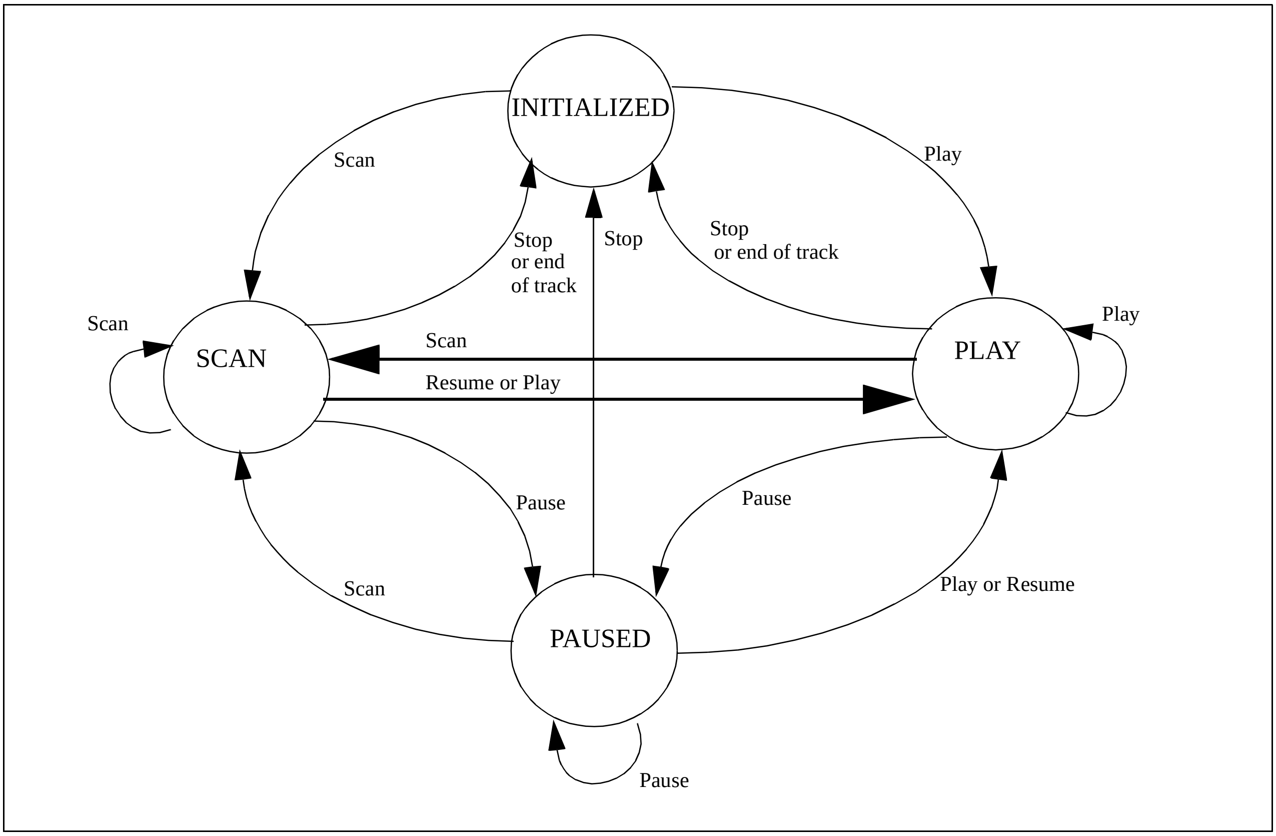

Figure 79 - Stop Play/Play Audio/Audio Scan/Pause/Resume Sequencing

11.46 TEST UNIT READY Command

The TEST UNIT READY Command provides a means to check if the Logical Unit is ready. This is not a request for a self-test. If the Logical Unit would accept an appropriate medium-access command without returning CHECK CONDITION status, this command ***shall*** return a GOOD status. For unformatted media, the FORMAT UNIT Command shall be considered an appropriate medium access command. If the Logical Unit cannot become operational or is in a state such that a Host action (e.g. START/STOP UNIT Command with Start = 1) is required to make the unit ready, the Logical Unit ***shall*** return CHECK CONDITION Status with a Sense Key of NOT READY.

Table 408 - TEST UNIT READY Command

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation code (00h)							
1	LUN (Obsolete)			Reserved				
2	Reserved							
3	Reserved							
4	Reserved							
5	Vendor-Specific		Reserved			NACA	Flag	Link
6	PAD							
7								
8								
9								
10								
11								

11.46.1 Using the TEST UNIT READY Command

The TEST UNIT READY Command is useful in that it allows a Host to poll a Logical Unit until it is ready without the need to allocate space for returned data. It is especially useful to check cartridge status. Logical Units are expected to respond promptly to indicate the current status of the Logical Unit. See Figure 80.

Table 409 - TEST UNIT READY Command Errors

Error Description
A-1.1, "Deferred Error Reporting" on page 437
Table 421 - *Basic Error Codes* on page 445
Table 422 - *Media Access Error Codes* on page 449

Note: Some Logical Units return ASC/ASCQ with Audio Status and Sense Key 0 when there is no error condition.

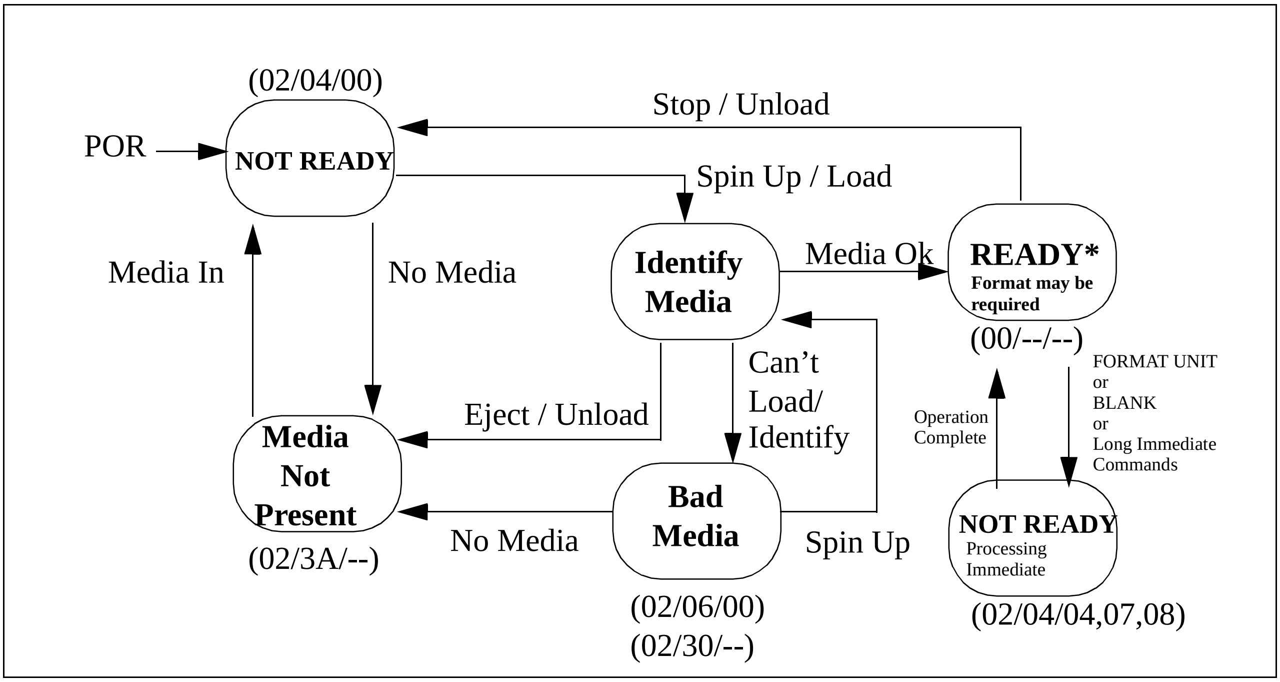

Figure 80 - TEST UNIT READY State Diagram

11.47 VERIFY (10) Command

The VERIFY (10) Command requests that the Logical Unit verify the data on the medium.

Table 410 - VERIFY (10) Command

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation code (2Fh)							
1	LUN (Obsolete)			DPO (0)	Reserved	BlkVfy	BytChk (0)	RelAdr
2	(MSB)							
3	Logical Block Address							
4								
5								(LSB)
6	Reserved							
7	(MSB)							
8	Verification Length							(LSB)
9	Vendor-Specific		Reserved			NACA	Flag	Link
10	PAD							
11								

The VERIFY (10) Command shall use stricter criteria for data recoverability than Read Commands. The criteria is derived from the relevant media standard, with additional vendor specific criteria allowed. Automatic reallocation shall be controlled by the **ARRE** bit (see *11.12.3.1, "Read/Write Error Recovery Parameters Page"* on page 253). The VERIFY (10) Command may return an error for a sector that a Read command may not.

Verify Error Recovery Page parameters are not supported.

The **RelAdr** bit is only used for SCSI Logical Units. For information on this bit *C-3.1, "Use of the RelAdr bit"* on page 467

The byte check (**BytChk**) bit is not used and ***shall*** be set to zero, which causes a medium verification to be performed with no data comparison.

A blank verify (**BlkVfy**) bit of one causes a verification that the blocks are blank.

The Disable Page Out (**DPO**) bit is not used and ***shall*** be set to zero. A **DPO** bit of zero indicates the priority shall be determined by the retention priority fields in the cache page if supported. All other aspects of the algorithm implementing the cache memory replacement strategy are vender specific.

The **Verification Length** specifies the number of contiguous logical blocks of data or blanks that shall be verified. A **Verification 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.

Table 411 - VERIFY (10) Command Errors

Error Description
A-1.1, "Deferred Error Reporting" on page 437
Table 421 - *Basic Error Codes* on page 445
Table 422 - *Media Access Error Codes* on page 449

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11.48 WRITE (10) Command

The WRITE (10) Command requests that the Logical Unit write the data transferred from the Host to the medium.

If used with the Incremental Streaming Write Feature, the WRITE (10) Command ***shall*** use the Write Parameters Mode Page to determine its operating behavior.

Table 412 - WRITE (10) Command

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation code (2Ah)							
1	LUN (Obsolete)			DPO (0)	FUA	EBP (0)	Reserved	RelAdr
2	(MSB)							
3	Logical Block Address							
4								
5								(LSB)
6	Reserved							
7	(MSB)							
8	Transfer Length							(LSB)
9	Vendor-Specific		Reserved			NACA	Flag	Link
10	PAD							
11								

The **RelAdr** bit is only used for SCSI Logical Units. For information on this bit see *C-3.1, "Use of the RelAdr bit"* on page 467.

The Erase By-pass (**EBP**) bit is not used by C/DVD Logical Units and ***shall*** be set to zero. An **EBP** bit of zero indicates that the Logical Unit will default to the normal write operation which does not by-pass the erase operation prior to writing the data.

The Disable Page Out (**DPO**) bit is not used by C/DVD Logical Units and ***shall*** be set to zero. A **DPO** bit of zero indicates the priority ***shall*** be determined by the retention priority fields in the cache page if supported. All other aspects of the algorithm implementing the cache memory replacement strategy are vender specific.

A Force Unit Access (**FUA**) bit of one indicates that the C/DVD Logical Unit ***shall*** access the media in performing the command. Write commands ***shall*** access the specified logical blocks on the media In the case where the cache contains a more recent version of a logical block than the media, the logical block ***shall*** first be written to the media. A **FUA** bit of zero indicates that the C/DVD Logical Unit may satisfy the command by writing to the cache memory.

The **Transfer Length** specifies the number of contiguous logical blocks of data that ***shall*** be transferred. A **Transfer Length** of zero indicates that no data ***shall*** be transferred. This condition ***shall not*** be considered an error and no data ***shall*** be written. Any other value indicates the number of logical blocks that ***shall*** be transferred.

The **Logical Block Address** field specifies the logical block where the write operation ***shall*** begin. For CD-R or DVD-R, and FUA=0 with incremental writing, and if the LBA is equal to the Next Writable Address in the same RZone as a previous Write, then writing should continue without interruption of streaming. If the LBA is equal to the NWA in another Track/RZone, a FLUSH CACHE may be performed before executing the write command. If the LBA is not any Next Writable Address, the Logical Unit ***shall*** return CHECK CONDITION Status, 5/21/02 INVALID ADDRESS FOR WRITE.

For CD, LBA in the range of -45150 (FFFF4FA2h) to -1 (FFFFFFFFh) ***shall*** be encoded as a two's complement negative number. Values in the range 0 through ffff4fa1h ***shall*** be considered positive values. Values -45150 through 404849 are valid for CD media. Table 413 shows the MSF to LBA mapping.

Table 413 - LBA to MSF translation (CD)

Condition	Formulae
$-150 \le LBA \le 404849$	$M = IP\left(\frac{LBA + 150}{60 \cdot 75}\right)$ $S = IP\left(\frac{LBA + 150 - (M \cdot 60 \cdot 75)}{75}\right)$ $F = IP(LBA + 150 - (M \cdot 60 \cdot 75) - (S \cdot 75))$
$-45150 \le LBA \le -151$	$M = IP\left(\frac{LBA + 450150}{60 \cdot 75}\right)$ $S = IP\left(\frac{LBA + 450150 - (M \cdot 60 \cdot 75)}{75}\right)$ $F = IP(LBA + 450150 - (M \cdot 60 \cdot 75) - (S \cdot 75))$
$00/00/00 \le MSF \le 89/59/74$	$LBA = (M \cdot 60 + S) \cdot 75 + F - 150$
$90/00/00 \le MSF \le 99/59/74$	$LBA = (M \cdot 60 + S) \cdot 75 + F - 450150$

For CD-R or DVD-R, once actual writing to the media has started, the data stream must be uninterrupted until the recording is done. Interruptions of data are called “underruns.” The underrun condition may also be forced with the FLUSH CACHE Command. The CD-R or DVD-R Logical Unit ***shall*** behave as follows in an underrun condition.

1) Disc-at-Once: (DVD)
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 RMA.

2) Session at Once mode: (CD)
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 to match the data actually recorded.

3) Track at Once mode: (CD)
The Logical Unit ***shall*** pad the track with all 00h main data if reserved or not minimum length and update the PMA.

4-1) Incremental mode: (DVD)
The Logical Unit ***shall*** perform linking.

4-2) Variable Packet: (CD)
If insufficient space exists for another variable packet within a reserved track, the Logical Unit ***shall*** pad the packet with all 00h data such that it fills the track. Otherwise, the Logical Unit ***shall*** write run-out and link blocks.

4-3) Fixed Packet: (CD)
The Logical Unit ***shall*** pad the packet with all 00h main data to the fixed packet size.

5) Raw mode: (CD)
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.

Note: In Raw mode, it is possible for the Host to send a TOC that is not valid, thus making a disc that cannot be read.

Note: “Update the RMA/PMA” means to update the RMA/PMA on the disc or to update the RMA/PMA Cache, which ***shall*** *be written to the RMA/PMA on the disc prior to removing the disc from the Logical Unit. PMA Caching is vendor specific.*

For CD, if the block number specified by the LBA field is already written on CD-R media, the Logical Unit ***shall*** return CHECK CONDITION Status, 5/21/02 INVALID ADDRESS FOR WRITE. This error will indicate that an underrun may have occurred, as the run-out and link blocks occupy logical addresses. On CD-RW media, the LBA ***shall*** specify an address that is an appendable point (according to CD-R rules) or is the first user data block of an existing packet or track.

While writing is occurring, the Logical Unit may not be able to process all SCSI/ATAPI commands. The following is a list of commands that ***shall*** function during writing without causing a flush cache.

1. TEST UNIT READY
2. REQUEST SENSE
3. INQUIRY
4. READ TRACK/RZONE INFORMATION (for current track). If the LBA or track number specified is not within the current track, the Logical Unit may return CHECK CONDITION Status, 5/24/00 INVALID FIELD IN CDB.
5. READ BUFFER CAPACITY
6. GET CONFIGURATION
7. GET EVENT/STATUS NOTIFICATION

All other commands ***shall*** execute normally, but may force a FLUSH 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. CHECK CONDITION Status, 2/04/08 LOGICAL UNIT NOT READY, LONG WRITE IN PROGRESS may exist when the Logical Unit is padding a reserved track or writing Lead-in and Lead-out.

Table 414 describes errors that may occur during the operation of the Command or which may cause a CHECK CONDITION status to be reported.

Table 414 - WRITE (10) Command Errors

Error Description
A-1.1, "Deferred Error Reporting" on page 437
Table 421 - *Basic Error Codes* on page 445
Table 422 - *Media Access Error Codes* on page 449
Table 423 - *Write Error Codes* on page 452

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11.49 WRITE and VERIFY (10) Command

The WRITE and VERIFY (10) Command requests that the Logical Unit write the data transferred from the Host to the medium and then verify that the data is correctly written.

Table 415 - WRITE and VERIFY (10) Command

Byte \ Bit	7	6	5	4	3	2	1	0
0	Operation code (2Eh)							
1	LUN (Obsolete)			DPO (0)	Reserved		BytChk (0)	RelAdr
2	(MSB) Logical Block Address							
3								
4								
5								(LSB)
6	Reserved							
7	(MSB) Transfer Length							(LSB)
8								
9	Vendor-Specific		Reserved			NACA	Flag	Link
10	PAD							
11								

The Verify operation of this command shall use stricter criteria for data recoverability than Read commands. The criteria is derived from the appropriate media standard, with additional vendor specific criteria allowed. Automatic reallocation shall be controlled by the **ARRE** bit (see *11.12.3.1, "Read/Write Error Recovery Parameters Page"* on page 253). The VERIFY command may return an error for a sector that a READ command may not.

The **RelAdr** bit is only used for SCSI Logical Units. For information on this bit *C-3.1, "Use of the RelAdr bit"* on page 467.

The byte check (**BytChk**) bit is not used and ***shall*** be set to zero, which causes a medium verification to be performed with no data comparison.

The Disable Page Out (**DPO**) bit is not used by C/DVD Logical Units and ***shall*** be set to zero. A **DPO** bit of zero indicates the priority shall be determined by the retention priority fields in the cache page if supported. All other aspects of the algorithm implementing the cache memory replacement strategy are vender specific.

The **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.

Table 416 - WRITE and VERIFY (10) Command Errors

Error Description
A-1.1, "Deferred Error Reporting" on page 437
Table 421 - *Basic Error Codes* on page 445
Table 422 - *Media Access Error Codes* on page 449
Table 423 - *Write Error Codes* on page 452

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11.50 WRITE BUFFER Command

The WRITE BUFFER Command is used in conjunction with the READ BUFFER Command as a diagnostic function for testing Logical Unit memory in the target SCSI device and the integrity of the service delivery subsystem. Additional modes are provided for downloading microcode and for downloading and saving microcode.

Table 417 - WRITE BUFFER Command

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation code (3Bh)							
1	LUN (Obsolete)			Reserved		Mode		
2	Buffer ID							
3	(MSB)							
4	Buffer offset							
5								(LSB)
6	(MSB)							
7	Parameter list length							
8								(LSB)
9	Vendor-Specific		Reserved			NACA	Flag	Link
10	PAD							
11								

If reservations are active, they shall affect the execution of the WRITE BUFFER Command as follows. A reservation conflict shall occur when a WRITE BUFFER Command is received from a Host other than the one holding a Logical Unit or element reservation.

This command shall not alter any medium of the Logical Unit when the data mode or the combined header and data mode is specified.

The function of this command and the meaning of fields within the command descriptor block depend on the contents of the **Mode** field. The **Mode** field is defined in Table 418.

Table 418 - WRITE BUFFER Mode field

Mode	Description	Implementation requirements
000b[a]	Write combined header and data	Optional
001b[a]	Vendor-specific	Vendor-specific
010b	Write data	Optional
011b	Reserved	Reserved
100b	Download microcode	Optional
101b	Download microcode and save	Optional
110b[b]	Download microcode with offsets	Optional
111b[b]	Download microcode with offsets and save	Optional

a. Implementing this Mode is not recommended.
b. These are the only Modes recommended when buffer offsets are used.

11.50.1 Combined header and data mode (000b)

In this mode, data to be transferred is preceded by a four-byte header. The four-byte header consists of all reserved bytes. The buffer ID and the buffer offset fields shall be zero. The parameter list length field specifies the maximum number of bytes that shall be transferred from the Data-Out Buffer. This number includes four bytes of header, so the data length to be stored in the Logical Unit's buffer is parameter list length minus four. The application client should attempt to ensure that the parameter list length is not greater than four plus the buffer capacity (see *11.20.4*, on page 292) that is returned in the header of the READ BUFFER Command (Mode 00b). If the parameter list length exceeds the buffer capacity the Logical Unit shall return CHECK CONDITION status and shall set the sense key to ILLEGAL REQUEST.

11.50.2 Vendor-specific mode (001b)

In this mode, the meaning of the buffer ID, buffer offset, and parameter list length fields are not specified by this standard.

11.50.3 Data mode (010b)

In this mode, the Data-Out Buffer contains buffer data destined for the Logical Unit. The buffer ID field identifies a specific buffer within the Logical Unit. The vendor assigns buffer ID codes to buffers within the Logical Unit. Buffer ID zero shall be supported. If more than one buffer is supported, additional buffer ID codes shall be assigned contiguously, beginning with one. If an unsupported buffer ID code is selected, the Logical Unit shall return CHECK CONDITION Status, 5/24/00 INVALID FIELD IN CDB. Data are written to the Logical Unit buffer starting at the location specified by the buffer offset. The application client should conform to the offset boundary requirements returned in the READ BUFFER descriptor. If the Logical Unit is unable to accept the specified buffer offset, it shall return CHECK CONDITION Status, 5/24/00 INVALID FIELD IN CDB.

The parameter list length specifies the maximum number of bytes that shall be transferred from the Data-Out Buffer to be stored in the specified buffer beginning at the buffer offset. The application client should attempt to ensure that the parameter list length plus the buffer offset does not exceed the capacity of the specified buffer. (The capacity of the buffer may be determined by the buffer capacity field in the READ BUFFER descriptor.) If the buffer offset and parameter list length fields specify a transfer in excess of the buffer capacity, the Logical Unit shall return CHECK CONDITION Status, 5/24/00 INVALID FIELD IN CDB.

11.50.4 Download microcode mode (100b)

If the Logical Unit cannot accept this command because of some device condition, the Logical Unit shall terminate each WRITE BUFFER Command with this mode (100b) with CHECK CONDITION Status, 5/2C/00 COMMAND SEQUENCE ERROR.

In this mode, vendor-specific microcode or control information shall be transferred to the control memory space of the Logical Unit. After a power-cycle or reset, the device operation shall revert to a vendor-specific condition. The meanings of the buffer ID, buffer offset, and parameter list length fields are not specified by this standard and are not required to be zero-filled. When the microcode download has completed successfully the Logical Unit shall generate a unit attention condition for all Hosts except the one that issued the WRITE BUFFER Command. The additional sense code shall be set to MICROCODE HAS BEEN CHANGED.

11.50.5 Download microcode and save mode (101b)

If the Logical Unit cannot accept this command because of some device condition, the Logical Unit shall terminate each WRITE BUFFER Command with this mode (101b) with CHECK CONDITION Status, 5/2C/00 COMMAND SEQUENCE ERROR.

In this mode, vendor-specific microcode or control information shall be transferred to the Logical Unit and, if the WRITE BUFFER Command is completed successfully, also shall be saved in a non-volatile memory space (semiconductor, disk, or other). The downloaded code shall then be effective after each power-cycle and reset until it is supplanted in another download microcode and save operation. The meanings of the buffer ID, buffer offset, and parameter list length fields are not specified by this standard and are not required to be zero-filled. When the download microcode and save command has completed successfully the Logical Unit shall generate a unit attention condition for all Hosts except the one that issued the WRITE BUFFER Command. When reporting the unit attention condition, the Logical Unit shall set the additional sense code to MICROCODE HAS BEEN CHANGED.

11.50.6 Download microcode with offsets (110b)

In this mode, the application client may split the transfer of the vendor-specific microcode or control information over two or more WRITE BUFFER Commands. If the Logical Unit cannot accept this command because of some device condition, the Logical Unit shall terminate each WRITE BUFFER Command with this mode (110b) with CHECK CONDITION Status, 5/2C/00 COMMAND SEQUENCE ERROR.

If the last WRITE BUFFER Command of a set of one or more commands completes successfully, the microcode or control information shall be transferred to the control memory space of the Logical Unit. After a power-cycle or reset, the device shall revert to a vendor-specific condition. In this mode, the Data-Out Buffer contains vendor-specific, self-describing microcode or control information.

Since the downloaded microcode or control information may be sent using several commands, when the Logical Unit detects the last download microcode with offsets and save mode WRITE BUFFER Command has been received, the Logical Unit shall perform any Logical Unit required verification of the complete set of downloaded microcode or control information prior to returning GOOD status for the last command. After the last command completes successfully the Logical Unit shall generate a unit attention condition for all Hosts except the one that issued the set of WRITE BUFFER Commands. When reporting the unit attention condition, the Logical Unit shall set the additional sense code to MICROCODE HAS BEEN CHANGED.

If the complete set of WRITE BUFFER Commands required to effect a microcode or control information change (one or more commands) are not received before a reset or power-on cycle occurs, the change shall not be effective and the new microcode or control information shall be discarded.

The buffer ID field identifies a specific buffer within the Logical Unit. The vendor assigns buffer ID codes to buffers within the Logical Unit. A Buffer ID value of zero shall be supported. If more than one buffer is supported, additional buffer ID codes shall be assigned contiguously, beginning with one. If an unsupported buffer ID code is identified, the Logical Unit shall return CHECK CONDITION Status, 5/24/00 INVALID FIELD IN CDB.

The microcode or control information are written to the Logical Unit buffer starting at the location specified by the buffer offset. The application client shall send commands that conform to the offset boundary requirements (see *11.20.4,* on page 292). If the Logical Unit is unable to accept the specified buffer offset, it shall return CHECK CONDITION Status, 5/24/00 INVALID FIELD IN CDB.

The parameter list length specifies the maximum number of bytes that shall be present in the Data-Out Buffer to be stored in the specified buffer beginning at the buffer offset. The application client should attempt to ensure that the parameter list length plus the buffer offset does not exceed the capacity of the specified buffer. (The capacity of the buffer may be determined by the buffer capacity field in the READ BUFFER descriptor.) If the buffer offset and parameter list length fields specify a transfer in excess of the buffer capacity, the Logical Unit shall return CHECK CONDITION Status, 5/24/00 INVALID FIELD IN CDB.

11.50.7 Download microcode with offsets and save mode (111b)

In this mode, the Host may split the transfer of the vendor-specific microcode or control information over two or more WRITE BUFFER Commands. If the Logical Unit cannot accept this command because of some device condition, the Logical Unit shall terminate each mode 111b WRITE BUFFER Command with CHECK CONDITION Status, 5/2C/00 COMMAND SEQUENCE ERROR.

If the last WRITE BUFFER Command of a set of one or more commands completes successfully, the microcode or control information shall be saved in a non-volatile memory space (semiconductor, disk, or other). The saved downloaded microcode or control information shall then be effective after each power-cycle and reset until it is supplanted by another download microcode with save operation or download microcode with offsets and save operation. In this mode, the Data-Out Buffer contains vendor-specific, self-describing microcode or control information.

Since the downloaded microcode or control information may be sent using several commands, when the Logical Unit detects the last download microcode with offsets and save mode WRITE BUFFER Command has been received, the

Logical Unit shall perform any Logical Unit required verification of the complete set of downloaded microcode or control information prior to returning GOOD status for the last command. After the last command completes successfully the Logical Unit shall generate a unit attention condition for all Hosts except the one that issued the set of WRITE BUFFER Commands. When reporting the unit attention condition, the Logical Unit shall set the additional sense code to MICROCODE HAS BEEN CHANGED.

If the complete set of WRITE BUFFER Commands required to effect a microcode or control information change (one or more commands) are not received before a reset or power-on cycle occurs, the change shall not be effective and the new microcode or control information shall be discarded. The buffer ID field identifies a specific buffer within the Logical Unit. The vendor assigns buffer ID codes to buffers within the Logical Unit. A Buffer ID value of zero shall be supported. If more than one buffer is supported, additional buffer ID codes shall be assigned contiguously, beginning with one. If an unsupported buffer ID code is identified, the Logical Unit shall return CHECK CONDITION Status, 5/24/00 INVALID FIELD IN CDB.

The microcode or control information are written to the Logical Unit buffer starting at the location specified by the buffer offset. The application client shall conform to the offset boundary requirements. If the Logical Unit is unable to accept the specified buffer offset, it shall return CHECK CONDITION Status, 5/24/00 INVALID FIELD IN CDB.

The parameter list length specifies the maximum number of bytes that shall be present in the Data-Out Buffer to be stored in the specified buffer beginning at the buffer offset. The application client should attempt to ensure that the parameter list length plus the buffer offset does not exceed the capacity of the specified buffer. (The capacity of the buffer may be determined by the buffer capacity field in the READ BUFFER descriptor.) If the buffer offset and parameter list length fields specify a transfer in excess of the buffer capacity, the Logical Unit shall return CHECK CONDITION Status, 5/24/00 INVALID FIELD IN CDB.

Table 419 describes errors that may occur during the operation of the Command or which may cause a CHECK CONDITION status to be reported.

Table 419 - WRITE BUFFER Command Errors

Error Description
A-1.1, "Deferred Error Reporting" on page 437
Table 421 - *Basic Error Codes* on page 445

Appendix A - Error Reporting and Sense Codes (Normative)

A-1 Error Reporting

This annex lists error codes that may be generated by 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. Although a particular command lists a set of errors, some of those errors may be typically reported to a subsequent command due to deferred error reporting.

A-1.1 Deferred Error Reporting

Any error may be reported in response to any command due to the occurrence of a deferred error. For example, a write error may occur due to data cached from a WRITE (10) Command and that error shall be reported in response to the next Command (with some exceptions). Errors listed in Table 421 are not caused by any specific commands but by actions outside the control of the Initiator.

A-1.2 Error Tables

Table 420 lists all errors that may be generated by Logical Units. Not all errors are applicable to all devices.

Table 421 lists errors that may occur at any time, typically in response to a protocol or hardware error or user intervention.

Table 422 lists errors that may occur when accessing the medium. The access may be implicit or explicit, and may be a read or write.

Table 423 lists errors that may occur when writing to the medium. The write may be to the user data area or to a control area on the medium.

Table 424 lists errors that may occur when operating on Sessions or Borders.

Table 425 lists errors that may occur when performing a key exchange operation.

Table 420 - All Error Codes (Sheet 1 of 8)

Sense Key	ASC	ASC Q	Description	Type
8	--	--	BLANK CHECK	Write Once, Incremental Streaming Write
0	00	00	NO ADDITIONAL SENSE INFORMATION	General
0	00	01	FILEMARK DETECTED	N/A
0	00	02	END-OF-PARTITION/MEDIUM DETECTED	N/A
0	00	03	SETMARK DETECTED	N/A
0	00	04	BEGINNING-OF-PARTITION/MEDIUM DETECTED	N/A
0	00	05	END-OF-DATA DETECTED	N/A
B	00	06	I/O PROCESS TERMINATED, PLAY OPERATION ABORTED	General
0	00	11	AUDIO PLAY OPERATION IN PROGRESS	Audio Play
0	00	12	AUDIO PLAY OPERATION PAUSED	Audio Play
0	00	13	AUDIO PLAY OPERATION SUCCESSFULLY COMPLETED	Audio Play
0	00	14	AUDIO PLAY OPERATION STOPPED DUE TO ERROR	Audio Play
0	00	15	NO CURRENT AUDIO STATUS TO RETURN	Audio Play
0	00	16	OPERATION IN PROGRESS	Sequential Write
4	00	17	CLEANING REQUESTED	Read
4	01	00	NO INDEX/SECTOR SIGNAL	Read
3	02	00	NO SEEK COMPLETE	Read
3	03	00	PERIPHERAL DEVICE WRITE FAULT	Random Write
3	03	01	NO WRITE CURRENT	N/A
3	03	02	EXCESSIVE WRITE ERRORS	N/A
2	04	00	LOGICAL UNIT NOT READY, CAUSE NOT REPORTABLE	General
2	04	01	LOGICAL UNIT IS IN PROCESS OF BECOMING READY	Read
2	04	02	LOGICAL UNIT NOT READY, INITIALIZING CMD. REQUIRED	Read
2	04	03	LOGICAL UNIT NOT READY, MANUAL INTERVENTION REQUIRED	General
2	04	04	LOGICAL UNIT NOT READY, FORMAT IN PROGRESS	Random Write
2	04	05	LOGICAL UNIT NOT READY, REBUILD IN PROGRESS	N/A
2	04	06	LOGICAL UNIT NOT READY, RECALCULATION IN PROGRESS	N/A
2	04	07	LOGICAL UNIT NOT READY, OPERATION IN PROGRESS	Read
2	04	08	LOGICAL UNIT NOT READY, LONG WRITE IN PROGRESS	Write
2	05	00	LOGICAL UNIT DOES NOT RESPOND TO SELECTION	General
2	06	00	NO REFERENCE POSITION FOUND (medium may be upside down)	Read
5	07	00	MULTIPLE PERIPHERAL DEVICES SELECTED	N/A
4	08	00	LOGICAL UNIT COMMUNICATION FAILURE	General
4	08	01	LOGICAL UNIT COMMUNICATION TIME-OUT	General
4	08	02	LOGICAL UNIT COMMUNICATION PARITY ERROR	General
4	08	03	LOGICAL UNIT COMMUNICATION CRC ERROR (ULTRA-DMA/32)	General
4	09	00	TRACK FOLLOWING ERROR	Read
4	09	01	TRACKING SERVO FAILURE	Read
4	09	02	FOCUS SERVO FAILURE	Read
4	09	03	SPINDLE SERVO FAILURE	Read
4	09	04	HEAD SELECT FAULT	N/A
6	0A	00	ERROR LOG OVERFLOW	General

Table 420 - All Error Codes (Sheet 2 of 8)

Sense Key	ASC	ASC Q	Description	Type
1	0B	00	WARNING	General
1	0B	01	WARNING - SPECIFIED TEMPERATURE EXCEEDED	General
1	0B	02	WARNING - ENCLOSURE DEGRADED	General
3	0C	00	WRITE ERROR	Write
3	0C	01	WRITE ERROR - RECOVERED WITH AUTO REALLOCATION	N/A
3	0C	02	WRITE ERROR - AUTO REALLOCATION FAILED	Random Write
3	0C	03	WRITE ERROR - RECOMMEND REASSIGNMENT	Random Write
3	0C	04	COMPRESSION CHECK MISCOMPARE ERROR	N/A
3	0C	05	DATA EXPANSION OCCURRED DURING COMPRESSION	N/A
3	0C	06	BLOCK NOT COMPRESSIBLE	N/A
3	0C	07	WRITE ERROR - RECOVERY NEEDED	Write
3	0C	08	WRITE ERROR - RECOVERY FAILED	Write
3	0C	09	WRITE ERROR - LOSS OF STREAMING	Sequential Write
1	0C	0A	WRITE ERROR - PADDING BLOCKS ADDED	Sequential Write
	0D	00	Reserved	
	0E	00	Reserved	
	0F	00	Reserved	
3	10	00	ID CRC OR ECC ERROR	Read
3	11	00	UNRECOVERED READ ERROR	Read
3	11	01	READ RETRIES EXHAUSTED	Read
3	11	02	ERROR TOO LONG TO CORRECT	Read
3	11	03	MULTIPLE READ ERRORS	N/A
3	11	04	UNRECOVERED READ ERROR - AUTO REALLOCATE FAILED	N/A
3	11	05	L-EC UNCORRECTABLE ERROR	Read
3	11	06	CIRC UNRECOVERED ERROR	CD Read
3	11	07	RE-SYNCHRONIZATION ERROR	N/A
3	11	08	INCOMPLETE BLOCK READ	N/A
3	11	09	NO GAP FOUND	N/A
3	11	0A	MISCORRECTED ERROR	N/A
3	11	0B	UNRECOVERED READ ERROR - RECOMMEND REASSIGNMENT	N/A
3	11	0C	UNRECOVERED READ ERROR - RECOMMEND REWRITE THE DATA	N/A
3	11	0D	DE-COMPRESSION CRC ERROR	N/A
3	11	0E	CANNOT DECOMPRESS USING DECLARED ALGORITHM	N/A
3	11	0F	ERROR READING UPC/EAN NUMBER	CD Read
3	11	10	ERROR READING ISRC NUMBER	CD Read
B	11	11	READ ERROR - LOSS OF STREAMING	Read
3	12	00	ADDRESS MARK NOT FOUND FOR ID FIELD	Read
3	13	00	ADDRESS MARK NOT FOUND FOR DATA FIELD	Read
3	14	00	RECORDED ENTITY NOT FOUND	Write
3	14	01	RECORD NOT FOUND	Read
3	14	02	FILEMARK OR SETMARK NOT FOUND	N/A
3	14	03	END-OF-DATA NOT FOUND	N/A
3	14	04	BLOCK SEQUENCE ERROR	N/A
3	14	05	RECORD NOT FOUND - RECOMMEND REASSIGNMENT	Read
3	14	06	RECORD NOT FOUND - DATA AUTO-REALLOCATED	Read

Table 420 - All Error Codes (Sheet 3 of 8)

Sense Key	ASC	ASC Q	Description	Type
4	15	00	RANDOM POSITIONING ERROR	Read
4	15	01	MECHANICAL POSITIONING ERROR	Read
3	15	02	POSITIONING ERROR DETECTED BY READ OF MEDIUM	Read
3	16	00	DATA SYNCHRONIZATION MARK ERROR	Random Write
3	16	01	DATA SYNC ERROR - DATA REWRITTEN	Random Write
3	16	02	DATA SYNC ERROR - RECOMMEND REWRITE	Random Write
3	16	03	DATA SYNC ERROR - DATA AUTO-REALLOCATED	Random Write
3	16	04	DATA SYNC ERROR - RECOMMEND REASSIGNMENT	Random Write
1	17	00	RECOVERED DATA WITH NO ERROR CORRECTION APPLIED	Read
1	17	01	RECOVERED DATA WITH RETRIES	Read
1	17	02	RECOVERED DATA WITH POSITIVE HEAD OFFSET	Read
1	17	03	RECOVERED DATA WITH NEGATIVE HEAD OFFSET	Read
1	17	04	RECOVERED DATA WITH RETRIES AND/OR CIRC APPLIED	Read
1	17	05	RECOVERED DATA USING PREVIOUS SECTOR ID	Read
1	17	06	RECOVERED DATA WITHOUT ECC - DATA AUTO-REALLOCATED	Random Write
1	17	07	RECOVERED DATA WITHOUT ECC - RECOMMEND REASSIGN-MENT	Random Write
1	17	08	RECOVERED DATA WITHOUT ECC - RECOMMEND REWRITE	Random Write
1	17	09	RECOVERED DATA WITHOUT ECC - DATA REWRITTEN	Random Write
1	18	00	RECOVERED DATA WITH ERROR CORRECTION APPLIED	Read
1	18	01	RECOVERED DATA WITH ERROR CORR. & RETRIES APPLIED	Read
1	18	02	RECOVERED DATA - DATA AUTO-REALLOCATED	Random Write
1	18	03	RECOVERED DATA WITH CIRC	CD Read
1	18	04	RECOVERED DATA WITH L-EC	Read
1	18	05	RECOVERED DATA - RECOMMEND REASSIGNMENT	Random Write
1	18	06	RECOVERED DATA - RECOMMEND REWRITE	Random Write
1	18	07	RECOVERED DATA WITH ECC - DATA REWRITTEN	Random Write
1	18	08	RECOVERED DATA WITH LINKING	N/A
3	19	00	DEFECT LIST ERROR	Random Write
3	19	01	DEFECT LIST NOT AVAILABLE	Random Write
3	19	02	DEFECT LIST ERROR IN PRIMARY LIST	Random Write
3	19	03	DEFECT LIST ERROR IN GROWN LIST	Random Write
5	1A	00	PARAMETER LIST LENGTH ERROR	General
4	1B	00	SYNCHRONOUS DATA TRANSFER ERROR	General
4	1C	00	DEFECT LIST NOT FOUND	Random Write
4	1C	01	PRIMARY DEFECT LIST NOT FOUND	Random Write
4	1C	02	GROWN DEFECT LIST NOT FOUND	Random Write
E	1D	00	MISCOMPARE DURING VERIFY OPERATION	Write
1	1E	00	RECOVERED ID WITH ECC CORRECTION	Read
3	1F	00	PARTIAL DEFECT LIST TRANSFER	N/A
5	20	00	INVALID COMMAND OPERATION CODE	General
5	21	00	LOGICAL BLOCK ADDRESS OUT OF RANGE	Read
5	21	01	INVALID ELEMENT ADDRESS	N/A
5	21	02	INVALID ADDRESS FOR WRITE	Incremental Streaming Write
5	22	00	ILLEGAL FUNCTION (USE 20 00, 24 00, OR 26 00)	N/A

Table 420 - All Error Codes (Sheet 4 of 8)

Sense Key	ASC	ASC Q	Description	Type
	23	00	Reserved	
5	24	00	INVALID FIELD IN CDB	General
5	25	00	LOGICAL UNIT NOT SUPPORTED	General
5	26	00	INVALID FIELD IN PARAMETER LIST	General
5	26	01	PARAMETER NOT SUPPORTED	General
5	26	02	PARAMETER VALUE INVALID	General
5	26	03	THRESHOLD PARAMETERS NOT SUPPORTED	General
5	26	04	INVALID RELEASE OF ACTIVE PERSISTENT RESERVATION	General
7	27	00	WRITE PROTECTED	Write
7	27	01	HARDWARE WRITE PROTECTED	Write
7	27	02	LOGICAL UNIT SOFTWARE WRITE PROTECTED	Write
7	27	03	ASSOCIATED WRITE PROTECT	Write
7	27	04	PERSISTENT WRITE PROTECT	Write
7	27	05	PERMANENT WRITE PROTECT	Write
6	28	00	NOT READY TO READY CHANGE, MEDIUM MAY HAVE CHANGED	General
6	28	01	IMPORT OR EXPORT ELEMENT ACCESSED	N/A
6	29	00	POWER ON, RESET, OR BUS DEVICE RESET OCCURRED	General
6	29	01	POWER ON OCCURRED	General
6	29	02	SCSI BUS RESET OCCURRED	General
6	29	03	BUS DEVICE RESET FUNCTION OCCURRED	General
6	29	04	DEVICE INTERNAL RESET	General
6	2A	00	PARAMETERS CHANGED	General
6	2A	01	MODE PARAMETERS CHANGED	General
6	2A	02	LOG PARAMETERS CHANGED	General
6	2A	03	RESERVATIONS PREEMPTED	General
5	2B	00	COPY CANNOT EXECUTE SINCE HOST CANNOT DISCONNECT	General
5	2C	00	COMMAND SEQUENCE ERROR	General
5	2C	01	TOO MANY WINDOWS SPECIFIED	N/A
5	2C	02	INVALID COMBINATION OF WINDOWS SPECIFIED	N/A
5	2C	03	CURRENT PROGRAM AREA IS NOT EMPTY	CD Write
5	2C	04	CURRENT PROGRAM AREA IS EMPTY	CD Write
5	2C	05	PERSISTENT PREVENT CONFLICT	Morphing
3	2D	00	OVERWRITE ERROR ON UPDATE IN PLACE	N/A
6	2E	00	INSUFFICIENT TIME FOR OPERATION	Timeout
6	2F	00	COMMANDS CLEARED BY ANOTHER INITIATOR	General
2	30	00	INCOMPATIBLE MEDIUM INSTALLED	Read
2	30	01	CANNOT READ MEDIUM - UNKNOWN FORMAT	Read
2	30	02	CANNOT READ MEDIUM - INCOMPATIBLE FORMAT	Read
5	30	02	CANNOT READ MEDIUM - INCOMPATIBLE FORMAT	Read
2	30	03	CLEANING CARTRIDGE INSTALLED	Read
5	30	04	CANNOT WRITE MEDIUM - UNKNOWN FORMAT	Write
5	30	05	CANNOT WRITE MEDIUM - INCOMPATIBLE FORMAT	Write
5	30	06	CANNOT FORMAT MEDIUM - INCOMPATIBLE MEDIUM	Random Write
2	30	07	CLEANING FAILURE	N/A
5	30	08	CANNOT WRITE - APPLICATION CODE MISMATCH	Sequential Write
5	30	09	CURRENT SESSION NOT FIXATED FOR APPEND	Sequential Write

Table 420 - All Error Codes (Sheet 5 of 8)

Sense Key	ASC	ASC Q	Description	Type
3	31	00	MEDIUM FORMAT CORRUPTED	Random Write
3	31	01	FORMAT COMMAND FAILED	Formattable
3	31	02	ZONED FORMATTING FAILED DUE TO SPARE LINKING	Formattable
3	32	00	NO DEFECT SPARE LOCATION AVAILABLE	Random Write
3	32	01	DEFECT LIST UPDATE FAILURE	Random Write
3	33	00	TAPE LENGTH ERROR	N/A
4	34	00	ENCLOSURE FAILURE	General
4	35	00	ENCLOSURE SERVICES FAILURE	General
5	35	01	UNSUPPORTED ENCLOSURE FUNCTION	General
2	35	02	ENCLOSURE SERVICES UNAVAILABLE	General
4	35	03	ENCLOSURE SERVICES TRANSFER FAILURE	General
5	35	04	ENCLOSURE SERVICES TRANSFER REFUSED	General
3	36	00	RIBBON, INK, OR TONER FAILURE	N/A
1	37	00	ROUNDED PARAMETER	N/A
5	38	00	Reserved	Sequential Write
5	39	00	SAVING PARAMETERS NOT SUPPORTED	General
2	3A	00	MEDIUM NOT PRESENT	General
2	3A	01	MEDIUM NOT PRESENT - TRAY CLOSED	General
2	3A	02	MEDIUM NOT PRESENT - TRAY OPEN	General
3	3B	00	SEQUENTIAL POSITIONING ERROR	N/A
3	3B	01	TAPE POSITION ERROR AT BEGINNING-OF-MEDIUM	N/A
3	3B	02	TAPE POSITION ERROR AT END-OF-MEDIUM	N/A
3	3B	03	TAPE OR ELECTRONIC VERTICAL FORMS UNIT NOT READY	N/A
4	3B	04	SLEW FAILURE	N/A
4	3B	05	PAPER JAM	N/A
3	3B	06	FAILED TO SENSE TOP-OF-FORM	N/A
3	3B	07	FAILED TO SENSE BOTTOM-OF-FORM	N/A
3	3B	08	REPOSITION ERROR	N/A
3	3B	09	READ PAST END OF MEDIUM	N/A
3	3B	0A	READ PAST BEGINNING OF MEDIUM	N/A
3	3B	0B	POSITION PAST END OF MEDIUM	N/A
3	3B	0C	POSITION PAST BEGINNING OF MEDIUM	N/A
5	3B	0D	MEDIUM DESTINATION ELEMENT FULL	N/A
5	3B	0E	MEDIUM SOURCE ELEMENT EMPTY	N/A
6	3B	0F	END OF MEDIUM REACHED	Read
2	3B	11	MEDIUM MAGAZINE NOT ACCESSIBLE	Load
6	3B	12	MEDIUM MAGAZINE REMOVED	Load
6	3B	13	MEDIUM MAGAZINE INSERTED	Load
6	3B	14	MEDIUM MAGAZINE LOCKED	Load
6	3B	15	MEDIUM MAGAZINE UNLOCKED	Load
4	3B	16	MECHANICAL POSITIONING OR CHANGER ERROR	Load
	3C	00	Reserved	N/A
5	3D	00	INVALID BITS IN IDENTIFY MESSAGE	General
2	3E	00	LOGICAL UNIT HAS NOT SELF-CONFIGURED YET	General
4	3E	01	LOGICAL UNIT FAILURE	General
4	3E	02	TIMEOUT ON LOGICAL UNIT	General

Table 420 - All Error Codes (Sheet 6 of 8)

Sense Key	ASC	ASC Q	Description	Type
6	3F	00	TARGET OPERATING CONDITIONS HAVE CHANGED	General
6	3F	01	MICROCODE HAS BEEN CHANGED	General
6	3F	02	CHANGED OPERATING DEFINITION	General
6	3F	03	INQUIRY DATA HAS CHANGED	General
4	40	00	RAM FAILURE (SHOULD USE 40 NN)	N/A
4	40	NN	DIAGNOSTIC FAILURE ON COMPONENT NN (80H-FFH)	General
4	41	00	DATA PATH FAILURE (SHOULD USE 40 NN)	N/A
4	42	00	POWER-ON OR SELF-TEST FAILURE (SHOULD USE 40 NN)	N/A
5	43	00	MESSAGE ERROR	General
4	44	00	INTERNAL TARGET FAILURE	General
b	45	00	SELECT OR RESELECT FAILURE	General
4	46	00	UNSUCCESSFUL SOFT RESET	General
4	47	00	SCSI PARITY ERROR	General
b	48	00	INITIATOR DETECTED ERROR MESSAGE RECEIVED	General
b	49	00	INVALID MESSAGE ERROR	General
4	4A	00	COMMAND PHASE ERROR	General
4	4B	00	DATA PHASE ERROR	General
4	4C	00	LOGICAL UNIT FAILED SELF-CONFIGURATION	General
b	4D	NN	TAGGED OVERLAPPED COMMANDS (NN = QUEUE TAG)	General
B	4E	00	OVERLAPPED COMMANDS ATTEMPTED	General
	4F	00	Reserved	N/A
	50	00	WRITE APPEND ERROR	N/A
	50	01	WRITE APPEND POSITION ERROR	N/A
	50	02	POSITION ERROR RELATED TO TIMING	N/A
3	51	00	ERASE FAILURE	Random Write
3	52	00	CARTRIDGE FAULT	N/A
4	53	00	MEDIA LOAD OR EJECT FAILED	Load
	53	01	UNLOAD TAPE FAILURE	N/A
2	53	02	MEDIUM REMOVAL PREVENTED	General
5	53	02	MEDIUM REMOVAL PREVENTED	General
	54	00	SCSI TO HOST SYSTEM INTERFACE FAILURE	N/A
5	55	00	SYSTEM RESOURCE FAILURE	General
	55	01	SYSTEM BUFFER FULL	N/A
	56	00	Reserved	N/A
3	57	00	UNABLE TO RECOVER TABLE-OF-CONTENTS	Read
	58	00	GENERATION DOES NOT EXIST	N/A
	59	00	UPDATED BLOCK READ	N/A
6	5A	00	OPERATOR REQUEST OR STATE CHANGE INPUT	General
6	5A	01	OPERATOR MEDIUM REMOVAL REQUEST	General
6	5A	02	OPERATOR SELECTED WRITE PROTECT	Write
6	5A	03	OPERATOR SELECTED WRITE PERMIT	Write
6	5B	00	LOG EXCEPTION	General
6	5B	01	THRESHOLD CONDITION MET	General
6	5B	02	LOG COUNTER AT MAXIMUM	General
6	5B	03	LOG LIST CODES EXHAUSTED	General
6	5C	00	RPL STATUS CHANGE	N/A

Table 420 - All Error Codes (Sheet 7 of 8)

Sense Key	ASC	ASC Q	Description	Type
6	5C	01	SPINDLES SYNCHRONIZED	N/A
3	5C	02	SPINDLES NOT SYNCHRONIZED	N/A
1	5D	00	FAILURE PREDICTION THRESHOLD EXCEEDED - Predicted Logical Unit Failure	General
1	5D	01	FAILURE PREDICTION THRESHOLD EXCEEDED - Predicted Media Failure	General
1	5D	FF	FAILURE PREDICTION THRESHOLD EXCEEDED (FALSE)	General
6	5E	00	LOW POWER CONDITION ON	General
6	5E	01	IDLE CONDITION ACTIVATED BY TIMER	General
6	5E	02	STANDBY CONDITION ACTIVATED BY TIMER	General
6	5E	03	IDLE CONDITION ACTIVATED BY COMMAND	General
6	5E	04	STANDBY CONDITION ACTIVATED BY COMMAND	General
	5F	00	Reserved	N/A
4	60	00	LAMP FAILURE	N/A
3	61	00	VIDEO ACQUISITION ERROR	N/A
3	61	01	UNABLE TO ACQUIRE VIDEO	N/A
3	61	02	OUT OF FOCUS	N/A
4	62	00	SCAN HEAD POSITIONING ERROR	N/A
5	63	00	END OF USER AREA ENCOUNTERED ON THIS TRACK	CD Read
5	63	01	PACKET DOES NOT FIT IN AVAILABLE SPACE	CD Read
5	64	00	ILLEGAL MODE FOR THIS TRACK	CD Read
5	64	01	INVALID PACKET SIZE	CD Write
4	65	00	VOLTAGE FAULT	General
4	66	00	AUTOMATIC DOCUMENT FEEDER COVER UP	N/A
4	66	01	AUTOMATIC DOCUMENT FEEDER LIFT UP	N/A
4	66	02	DOCUMENT JAM IN AUTOMATIC DOCUMENT FEEDER	N/A
4	66	03	DOCUMENT MISS FEED AUTOMATIC IN DOCUMENT FEEDER	N/A
4	67	00	CONFIGURATION FAILURE	N/A
4	67	01	CONFIGURATION OF INCAPABLE LOGICAL UNITS FAILED	N/A
4	67	02	ADD LOGICAL UNIT FAILED	N/A
4	67	03	MODIFICATION OF LOGICAL UNIT FAILED	N/A
4	67	04	EXCHANGE OF LOGICAL UNIT FAILED	N/A
4	67	05	REMOVE OF LOGICAL UNIT FAILED	N/A
4	67	06	ATTACHMENT OF LOGICAL UNIT FAILED	N/A
4	67	07	CREATION OF LOGICAL UNIT FAILED	N/A
2	68	00	LOGICAL UNIT NOT CONFIGURED	N/A
4	69	00	DATA LOSS ON LOGICAL UNIT	N/A
4	69	01	MULTIPLE LOGICAL UNIT FAILURES	N/A
4	69	02	A PARITY/DATA MISMATCH	N/A
1	6A	00	INFORMATIONAL, REFER TO LOG	N/A
6	6B	00	STATE CHANGE HAS OCCURRED	N/A
6	6B	01	REDUNDANCY LEVEL GOT BETTER	N/A
6	6B	02	REDUNDANCY LEVEL GOT WORSE	N/A
3	6C	00	REBUILD FAILURE OCCURRED	N/A
3	6D	00	RECALCULATE FAILURE OCCURRED	N/A
4	6E	00	COMMAND TO LOGICAL UNIT FAILED	N/A

Table 420 - All Error Codes (Sheet 8 of 8)

Sense Key	ASC	ASC Q	Description	Type
5	6F	00	COPY PROTECTION KEY EXCHANGE FAILURE - AUTHENTICATION FAILURE	CPP
5	6F	01	COPY PROTECTION KEY EXCHANGE FAILURE - KEY NOT PRESENT	CPP
5	6F	02	COPY PROTECTION KEY EXCHANGE FAILURE - KEY NOT ESTABLISHED	CPP
5	6F	03	READ OF SCRAMBLED SECTOR WITHOUT AUTHENTICATION	CPP
5	6F	04	MEDIA REGION CODE IS MISMATCHED TO LOGICAL UNIT REGION	CPP
5	6F	05	DRIVE REGION MUST BE PERMANENT/REGION RESET COUNT ERROR	CPP
3	70	NN	DECOMPRESSION EXCEPTION SHORT ALGORITHM ID OF NN	N/A
3	71	00	DECOMPRESSION EXCEPTION LONG ALGORITHM ID	N/A
3	72	00	SESSION FIXATION ERROR	Sequential Write
3	72	01	SESSION FIXATION ERROR WRITING LEAD-IN	Sequential Write
3	72	02	SESSION FIXATION ERROR WRITING LEAD-OUT	Sequential Write
5	72	03	SESSION FIXATION ERROR - INCOMPLETE TRACK IN SESSION	Sequential Write
5	72	04	EMPTY OR PARTIALLY WRITTEN RESERVED TRACK	Sequential Write
5	72	05	NO MORE RZONE RESERVATIONS ARE ALLOWED	Sequential Write
3	73	00	CD CONTROL ERROR	CD Read
1	73	01	POWER CALIBRATION AREA ALMOST FULL	Sequential Write
3	73	02	POWER CALIBRATION AREA IS FULL	Sequential Write
3	73	03	POWER CALIBRATION AREA ERROR	Sequential Write
3	73	04	PROGRAM MEMORY AREA/RMA UPDATE FAILURE	Sequential Write
3	73	05	PROGRAM MEMORY AREA/RMA IS FULL	Sequential Write
1	73	06	PROGRAM MEMORY AREA/RMA IS (almost) FULL	Sequential Write
	80 through FF	xx through xx	VENDOR SPECIFIC	

ALL CODES NOT SHOWN ARE RESERVED.

Table 421 - Basic Error Codes (Sheet 1 of 4)

Sense Key	ASC	ASC Q	Description
0	00	00	NO ADDITIONAL SENSE INFORMATION
B	00	06	I/O PROCESS TERMINATED, PLAY OPERATION ABORTED
2	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
4	08	03	LOGICAL UNIT COMMUNICATION CRC ERROR (ULTRA-DMA/32)
6	0A	00	ERROR LOG OVERFLOW
1	0B	00	WARNING

Table 421 - Basic Error Codes (Sheet 2 of 4)

Sense Key	ASC	ASC Q	Description
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
5	26	03	THRESHOLD PARAMETERS NOT SUPPORTED
5	26	04	INVALID RELEASE OF ACTIVE PERSISTENT RESERVATION
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	2C	00	COMMAND SEQUENCE ERROR
6	2F	00	COMMANDS CLEARED BY ANOTHER INITIATOR
4	34	00	ENCLOSURE FAILURE
4	35	00	ENCLOSURE SERVICES FAILURE
5	35	01	UNSUPPORTED ENCLOSURE FUNCTION
2	35	02	ENCLOSURE SERVICES UNAVAILABLE
4	35	03	ENCLOSURE SERVICES TRANSFER FAILURE
5	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	00	RAM FAILURE (SHOULD USE 40 NN)
4	40	NN	DIAGNOSTIC FAILURE ON COMPONENT NN (80H-FFH)
4	41	00	DATA PATH FAILURE (SHOULD USE 40 NN)
4	42	00	POWER-ON OR SELF-TEST FAILURE (SHOULD USE 40 NN)
5	43	00	MESSAGE ERROR
4	44	00	INTERNAL TARGET FAILURE
b	45	00	SELECT OR RESELECT FAILURE

Table 421 - Basic Error Codes (Sheet 3 of 4)

Sense Key	ASC	ASC Q	Description
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
4	54	00	SCSI TO HOST SYSTEM INTERFACE FAILURE
5	55	00	SYSTEM RESOURCE FAILURE
6	55	01	SYSTEM BUFFER FULL
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	00	FAILURE PREDICTION THRESHOLD EXCEEDED - Predicted Logical Unit Failure
1	5D	01	FAILURE PREDICTION THRESHOLD EXCEEDED - Predicted Media Failure
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
4	65	00	VOLTAGE FAULT
4	67	00	CONFIGURATION FAILURE
4	67	01	CONFIGURATION OF INCAPABLE LOGICAL UNITS FAILED
4	67	02	ADD LOGICAL UNIT FAILED
4	67	03	MODIFICATION OF LOGICAL UNIT FAILED
4	67	04	EXCHANGE OF LOGICAL UNIT FAILED
4	67	05	REMOVE OF LOGICAL UNIT FAILED
4	67	06	ATTACHMENT OF LOGICAL UNIT FAILED
4	67	07	CREATION OF LOGICAL UNIT FAILED
2	68	00	LOGICAL UNIT NOT CONFIGURED
6	6A	00	INFORMATIONAL, REFER TO LOG
6	6B	00	STATE CHANGE HAS OCCURRED

Table 421 - Basic Error Codes (Sheet 4 of 4)

Sense Key	ASC	ASC Q	Description
6	6B	01	REDUNDANCY LEVEL GOT BETTER
6	6B	02	REDUNDANCY LEVEL GOT WORSE
3	6C	00	REBUILD FAILURE OCCURRED
3	6D	00	RECALCULATE FAILURE OCCURRED
4	6E	00	COMMAND TO LOGICAL UNIT FAILED
	80	xx	VENDOR SPECIFIC
	through		
	FF	xx	

Table 422 - Media Access Error Codes (Sheet 1 of 3)

Sense Key	ASC	ASC Q	Description
4	00	17	CLEANING REQUESTED
4	01	00	NO INDEX/SECTOR SIGNAL
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	05	LOGICAL UNIT NOT READY, REBUILD IN PROGRESS
2	04	06	LOGICAL UNIT NOT READY, RECALCULATION IN PROGRESS
2	04	07	LOGICAL UNIT NOT READY, OPERATION IN PROGRESS
2	04	08	LOGICAL UNIT NOT READY, LONG WRITE IN PROGRESS
2	06	00	NO REFERENCE POSITION FOUND (medium may be upside down)
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	10	00	ID CRC OR ECC ERROR
3	11	00	UNRECOVERED READ ERROR
3	11	01	READ RETRIES EXHAUSTED
3	11	02	ERROR TOO LONG TO CORRECT
3	11	03	MULTIPLE READ ERRORS
3	11	04	UNRECOVERED READ ERROR - AUTO REALLOCATE FAILED
3	11	05	L-EC UNCORRECTABLE ERROR
3	11	06	CIRC UNRECOVERED ERROR
3	11	07	RE-SYNCHRONIZATION ERROR
3	11	08	INCOMPLETE BLOCK READ
3	11	09	NO GAP FOUND
3	11	0A	MISCORRECTED ERROR
3	11	0B	UNRECOVERED READ ERROR - RECOMMEND REASSIGNMENT
3	11	0C	UNRECOVERED READ ERROR - RECOMMEND REWRITE THE DATA
3	11	0D	DE-COMPRESSION CRC ERROR
3	11	0E	CANNOT DECOMPRESS USING DECLARED ALGORITHM
3	11	0F	ERROR READING UPC/EAN NUMBER
3	11	10	ERROR READING ISRC NUMBER
B	11	11	READ ERROR - LOSS OF STREAMING
3	12	00	ADDRESS MARK NOT FOUND FOR ID FIELD
3	13	00	ADDRESS MARK NOT FOUND FOR DATA FIELD
4	15	00	RANDOM POSITIONING ERROR
4	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

Table 422 - Media Access Error Codes (Sheet 2 of 3)

Sense Key	ASC	ASC Q	Description
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	06	RECOVERED DATA WITHOUT ECC - DATA AUTO-REALLOCATED
1	17	07	RECOVERED DATA WITHOUT ECC - RECOMMEND REASSIGN-MENT
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	07	RECOVERED DATA WITH ECC - DATA REWRITTEN
1	18	08	RECOVERED DATA WITH LINKING
3	19	00	DEFECT LIST ERROR
3	19	01	DEFECT LIST NOT AVAILABLE
3	19	02	DEFECT LIST ERROR IN PRIMARY LIST
3	19	03	DEFECT LIST ERROR IN GROWN LIST
4	1C	00	DEFECT LIST NOT FOUND
4	1C	01	PRIMARY DEFECT LIST NOT FOUND
4	1C	02	GROWN DEFECT LIST NOT FOUND
1	1E	00	RECOVERED ID WITH ECC CORRECTION
3	1F	00	PARTIAL DEFECT LIST TRANSFER
5	21	00	LOGICAL BLOCK ADDRESS OUT OF RANGE
5	21	01	INVALID ELEMENT ADDRESS
2	30	00	INCOMPATIBLE MEDIUM INSTALLED
2	30	01	CANNOT READ MEDIUM - UNKNOWN FORMAT
2	30	02	CANNOT READ MEDIUM - INCOMPATIBLE FORMAT
5	30	02	CANNOT READ MEDIUM - INCOMPATIBLE FORMAT
2	30	03	CLEANING CARTRIDGE INSTALLED
5	30	04	CANNOT WRITE MEDIUM - UNKNOWN FORMAT
5	30	05	CANNOT WRITE MEDIUM - INCOMPATIBLE FORMAT
5	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
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	59	00	UPDATED BLOCK READ

Table 422 - Media Access Error Codes (Sheet 3 of 3)

Sense Key	ASC	ASC Q	Description
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	6F	03	READ OF SCRAMBLED SECTOR WITHOUT AUTHENTICATION
3	73	00	CD CONTROL ERROR
	80	xx	VENDOR SPECIFIC
	through		
	FF	xx	

Table 423 - Write Error Codes (Sheet 1 of 2)

Sense Key	ASC	ASC Q	Description
8	--	--	BLANK CHECK
3	03	00	PERIPHERAL DEVICE WRITE FAULT
3	03	01	NO WRITE CURRENT
3	03	02	EXCESSIVE WRITE ERRORS
3	0C	00	WRITE ERROR
3	0C	01	WRITE ERROR - RECOVERED WITH AUTO REALLOCATION
3	0C	02	WRITE ERROR - AUTO REALLOCATION FAILED
3	0C	03	WRITE ERROR - RECOMMEND REASSIGNMENT
3	0C	04	COMPRESSION CHECK MISCOMPARE ERROR
3	0C	05	DATA EXPANSION OCCURRED DURING COMPRESSION
3	0C	06	BLOCK NOT COMPRESSIBLE
3	0C	07	WRITE ERROR - RECOVERY NEEDED
3	0C	08	WRITE ERROR - RECOVERY FAILED
3	0C	09	WRITE ERROR - LOSS OF STREAMING
1	0C	0A	WRITE ERROR - PADDING BLOCKS ADDED
E	1D	00	MISCOMPARE DURING VERIFY OPERATION
5	21	02	INVALID ADDRESS FOR WRITE
7	27	00	WRITE PROTECTED
7	27	01	HARDWARE WRITE PROTECTED
7	27	02	LOGICAL UNIT SOFTWARE WRITE PROTECTED
7	27	03	ASSOCIATED WRITE PROTECT
7	27	04	PERSISTENT WRITE PROTECT
7	27	05	PERMANENT WRITE PROTECT
5	30	04	CANNOT WRITE MEDIUM - UNKNOWN FORMAT
5	30	05	CANNOT WRITE MEDIUM - INCOMPATIBLE FORMAT
5	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
3	32	00	NO DEFECT SPARE LOCATION AVAILABLE
3	32	01	DEFECT LIST UPDATE FAILURE
5	38	00	Reserved
4	50	00	WRITE APPEND ERROR
4	50	01	WRITE APPEND POSITION ERROR
4	50	02	POSITION ERROR RELATED TO TIMING
3	51	00	ERASE FAILURE
5	64	01	INVALID PACKET SIZE
3	73	00	CD CONTROL ERROR
1	73	01	POWER CALIBRATION AREA ALMOST FULL

Table 423 - Write Error Codes (Sheet 2 of 2)

Sense Key	ASC	ASCQ	Description
3	73	02	POWER CALIBRATION AREA IS FULL
3	73	03	POWER CALIBRATION AREA ERROR
3	73	04	PROGRAM MEMORY AREA/RMA UPDATE FAILURE
3	73	05	PROGRAM MEMORY AREA/RMA IS FULL
1	73	06	PROGRAM MEMORY AREA/RMA IS (almost) FULL
	80 through FF	xx xx	VENDOR SPECIFIC

Table 424 - Session/Border Error Codes

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
5	72	05	NO MORE RZONE RESERVATIONS ARE ALLOWED
	80 through FF	xx xx	VENDOR SPECIFIC

Table 425 - Authentication Error Codes

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	04	MEDIA REGION CODE IS MISMATCHED TO LOGICAL UNIT REGION
5	6F	05	DRIVE REGION MUST BE PERMANENT/REGION RESET COUNT ERROR

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Appendix B - ATAPI Implementation Notes (Normative)

B-1 Introduction

See the X3T13 ATA/ATAPI-4 Specification for information on the connection and protocol to be use for ATAPI C/DVD device.

The ATA/IDE interface has become a de facto industry standard for connection of disk drives in PC's. In the interest of simplicity and cost, the ATA/IDE interface was originally designed to support only a small subset of computer peripherals. The expanding use of multimedia, inexpensive program distribution on CD & DVD, and faster and more powerful systems has created the need for enhancements to ATA. This specification is one of those enhancements and provides a simple and inexpensive C/DVD interface through a superset of ATA.

B-2 ATA Signal Utilization

ATAPI Devices will utilize the same signals and timing from the ATA Standard and Extensions.

B-3 ATA Command Utilization

The ATA Task File concept does not contain enough bytes to support some of the command structures, so a command called "ATAPI Packet Command" has been added to allow a Packet to be sent to the Device. The Packet will be transferred by writing multiple times to the Data Register. No random access to the register file in the Peripheral can be done. This technique reduces the number of register addresses needed, but not the actual space needed. Although all the commands for the CD-ROM Device could be sent via this packet mode, some of the existing ATA commands and the full ATA command protocol must be provided for the existing drivers to operate correctly. The C/DVD Device will therefore support some existing ATA commands in addition to the new "ATAPI Packet command," so that there will be minimal changes to the existing drivers. This minimal set of ATA commands is different than the minimum as defined in the ATA standard, but should be sufficient for normal operation.

B-4 ATA Compatibility

There are several legacy issues with the existing ATA commands, and therefore the Device will respond to the existing ATA Reset Master/Slave Diagnostic Sequence, but not the Identify Drive or Read commands. This will allow the BIOS and older drivers to ignore the Device and not confuse ATAPI data with normal ATA Drive format data. All unsupported ATA commands ***shall*** be Aborted, and not executed. As with aborted commands in ATA, an interrupt will be generated to signal the completion with an "aborted" error status.

B-5 Packet Types

To allow for generic packet transfer and the connection of SCSI like peripherals, there ***shall*** exist a minimum set of information that is exchanged. This information ***shall*** generically support the following:

- Command Packet (Always padded to number of bytes identified in byte 0 of the identify drive data. 00 = 12 bytes, 01 = 16 bytes)
- Command Parameter Data (e.g. Write Data etc.)
- Command Response Data (e.g. Read Data etc.)
- Status. The Status will not take the form of a packet of information. The status will be presented using the ATAPI Status Register (redefinitions of the ATA Status Register).

B-6 How SCSI is Used by ATAPI

Although the ATAPI Device will utilize many of the actual packet definitions from the SCSI standard, it will NOT use most other features of the normal SCSI Protocol. Thus there are no Phases, no Messages, no sharable bus, (only one Host Computer) and no SCSI Hardware. For those who are familiar with the current SCSI-3 effort, this specification will not conform with that Packetized Standard.

B-6.1 Differences from the SCSI Standard

Some of the major differences from the SCSI Standard:

- Status will use the ATAPI description, rather than a Data Byte passed at the end of the command.
- ATAPI Device is slave during operation rather than the master view of a SCSI Peripheral.
- No messages are supported.
- No disconnect/reconnect or any of the SCSI Pointers.
- No linking.
- All CD Command Packets (CP) are 12 bytes in length, rather than the 6, 8, 10 or 12-byte packets of the SCSI Standard; however, 16-byte ATAPI Command Packets are defined for SAM compatibility for future Devices. The size of the Command Packet required by a Device is defined in word 0 of the ATAPI Identify Device command, allowing Host System Device Drivers to determine the size of the Command Packets before issuing an ATAPI Command Packet.
- No allegiance conditions are used.

This standard will make use of many of the Standard SCSI Command Block definitions and Commands, but some of the commands that would normally be supported by a SCSI Device will not be supported for various reasons. These commands are:

- Reserve and release; as there is only one Host allowed, this is not needed.
- Send and receive diagnostics; the ATA EXECUTE DRIVE DIAGS command replaces these commands.
- Change definitions; as there is no SCSI, this command is nonsensical.
- Copy / Copy and Verify; no shared bus so this command can’t be implemented.
- Compare; no shared bus, so this command can’t be implemented.
- Read and Write Buffer; simplification.
- Log Sense and Select; simplification.
- Search Data; simplification.
- Verify; simplification.

B-6.2 Reset Usage

This section describes the three types of resets and how they are used in an ATAPI environment.

Table 426 - Reset Function Mapping

Reset Type	ATAPI
Power-On Reset	Same as Power-On Reset in the proposed ATA/ATAPI-4 X3T13/1153D Standard
Hard Reset	Hard Reset, RESET- bus signal
	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 proposed ATA/ATAPI-4 X3T13/1153D Standard
	ATAPI Soft Reset in SFF8020i

B-6.3 Power On Reset

The Power On Reset ***shall*** operate as specified in the proposed ATA/ATAPI-4 X3T13/1153D Standard.

B-6.4 Hard Reset

The Hard Reset corresponds to the Hard Reset (RESET- signal line) and the SRST (ATA/ATAPI Software Reset).

The ATAPI Hard Reset, being different from SCSI, can not reset just one device. In ATAPI all the devices on the same cable are reset.

The effect of these two resets are the same, but usage of the SRST will be restricted.

B-6.4.1 SRST

The SRST was defined for use in an ATA environment and **should not be used in an ATAPI environment**. However there are some specific requirements of the SRST that are specified in the ATA/ATAPI-4 X3T13/1153D Proposed Standard. These ***shall*** be followed. These are requirements caused because the SRST is a Channel Reset and not a specific device reset.

B-6.5 Device Reset

The Device Reset corresponds to the DEVICE RESET command in the proposed ATA/ATAPI-4 X3T13/1153D Standard. In an earlier standard (SFF8020) the Device Reset was called ATAPI SOFT RESET. The functions of DEVICE RESET and ATAPI SOFT RESET are the same.

The Device Reset is capable of resetting an individual device.

The Device Reset should keep the media-based information such as disc TOC. It it expected that the Device Reset will operate quickly. Host drivers expect that the device will be ready to perform other commands quickly after the Device Reset. It is recommended that all information about a previously installed media be maintained across a Device Reset.

The ATAPI version of Device Reset is different from SCSI. Known differences include:

- Device Reset will immediately reset ATAPI logical protocol sequence. SCSI protocols are not affected by the Device Reset.
- Time constraints on the processing of the reset exist in ATAPI but not the SCSI environments.

B-6.6 Function Comparison Table

Table 427 - Reset Function Comparison

Function	Power-On / Hard Reset	ATA/ATAPI-4 Device Reset	SRST
Initialization sequence required	Yes	No	No
Immediate Bus Release	Yes	Yes	Yes
Mode parameters	Reset to default or saved parameters	No change allowed	No change allowed
Cached Lead-in information	Discarded	Should not re-read lead-in	Should not re-read lead-in
Persistent Prevent Flag	Unlocked	No change allowed	No change allowed
Key Management	Reset to Default state	Reset to Default state	No change allowed

B-6.7 Redundant Command Functionality (Task File vs. Packet)

The SCSI Standard has provided some commands that the ATA Standard also provides. It is the intent of this standard to allow all the functionality to exist, by utilizing only Command Packets. This will allow existing SCSI like drivers to continue to issue packets for all operation, and have some lower level driver convert them to the ATAPI protocol. Unfortunately there are existing low level drivers that would like to continue to use some non data transfer ATA Task File commands. As such both these “Task File” and “Packet” commands will be supported.

B-6.7.1 Door Lock and Door Unlock vs. Prevent / Allow Medium Removal

There exists both an ATA and a Packet method to control the insertion and removal of media. Both of these methods do not provide necessary functionality for the Host operating system. It is therefor recommended that both the ATA Lock/Unlock and the Packet Prevent/Allow functions not be implemented by a C/DVD device. There now exist a new set of commands, both for ATA and for Packet Commands. These commands control a capability called Media Status Notification. As the functionality for the packet and the register based commands are similar, only the Packet versions of the MSN commands ***shall*** be implemented by C/DVD devices.

B-6.7.2 ATAPI Identify Drive vs. Inquiry

The ATAPI IDENTIFY DRIVE command has information that the low level drivers use to perform ATA interface hardware configuration. Information in the Identify Drive ***shall*** continue to look exactly as the ATA Identify Drive does for compatibility reasons. As the information in the Inquiry Command cannot be returned by the ATAPI Identify Drive Command, the Inquiry Command will be supported for use by higher level drivers.

B-6.7.3 Initialize Drive Parameters & Set Features vs. Mode Sense and Mode Select

The INITIALIZE DRIVE PARAMETERS command does not contain a method to provide non ATA device configuration information, and will not be used. As such the Mode Select and Mode Sense from the SCSI standard ***shall*** be supported. The combination of Mode Select and Set Features commands contain all the necessary functionality and is most compatible with the existing BIOSes and OS Drivers.

B-6.8 ATAPI Device Reset

Note: For performance reasons, a Device reset may not force reading of TOC.

B-6.9 Execute Drive Diagnostics

This command ***shall*** perform the internal diagnostic tests implemented by the drive. The DRV bit is ignored. Both drives, if present, ***shall*** execute this command. See the ATA Standard (X3T9.2/791D) for more information.

Note: ATAPI device drivers issuing the Execute Diagnostics command will cause all ATA and ATAPI devices to execute a diagnostic command resulting in a device reset. To prevent unwanted resets and or driver compatibility issues, ATAPI drivers should not issue the Execute Diagnostics command. The command is implemented by ATAPI devices for ATA compatibility only.

B-6.10 ATAPI Identify Device

The ATAPI IDENTIFY DEVICE command enables the host to receive parameter information from the drive. For more information see ATA/ATAPI-4 Standard.

B-7 Command Packet Description

An ATAPI command is communicated by sending a Command Packet to the Device. For several commands, the Command Packet is accompanied by a list of parameters sent upon receiving an interrupt following the Command Packet being sent. See the specific commands for detailed information.

The Command Packet always has an operation code as its first byte.

For all commands, if there is an invalid parameter in the Command Packet, then the ATAPI Device ***shall*** abort the command without altering the medium.

Table 428 - Typical Command Packet for Most Commands

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code							
1	Reserved			Reserved				
2	(MSB)							
3	Logical Block Address (if required)							
4								
5								(LSB)
6	Reserved							
7	(MSB)	Transfer Length (if required) or Parameter List Length (if required) or						
8	Allocation Length (if required)							(LSB)
9	Reserved							
10	Pad							
11								

Table 429 - Typical Command Packet for Some Extended Commands

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code							
1	Reserved			Reserved				
2	(MSB)							
3	Logical Block Address (if required)							
4								
5								(LSB)
6	(MSB)							
7	Transfer Length (if required) or							
8	Parameter List Length (if required) or							
9	Allocation Length (if required)							(LSB)
10	Reserved							
11	Reserved							

B-7.1 Operation Code

The operation code of the Command Packet has a group code field and a command code field. The three-bit group code field provides for eight groups of command codes. The five-bit command code field provides for thirty-two command codes in each group. Thus, a total of 256 possible operation codes exist. Operation codes are defined in the subsequent sections.

Table 430 - Operation Code

Bit	7	6	5	4	3	2	1	0
	Group Code			Command Code				

Note: The Group / Command code fields have been kept for backward compatibility and are not used by ATAPI.

B-7.2 Logical Block Address

The logical block address ***shall*** begin with block zero and be contiguous up to the last logical block.

B-7.3 Transfer Length

The Transfer Length Field specifies the amount of data to be transferred, usually the number of blocks. For several commands the transfer length indicates the requested number of bytes to be sent as defined in the command description. For these commands the Transfer Length Field may be identified by a different name. See the following descriptions and the individual command descriptions for further information.

In commands that use multiple bytes for the transfer length, a transfer length of zero indicates that no data transfer ***shall*** take place. A value of one or greater indicates the number of blocks that ***shall*** be transferred.

B-7.4 Parameter List Length

The Parameter List Length is used to specify the number of bytes to be sent to the Drive. This field is typically used in Command Packets for parameters that are sent to a Drive (e.g. mode parameters, diagnostic parameters, etc.). A parameter length of zero indicates that no data ***shall*** be transferred.

B-7.5 Allocation Length

The Allocation Length Field specifies the maximum number of bytes that a Host Computer has allocated for returned data. An allocation length of zero indicates that no data ***shall*** be transferred. The Drive ***shall*** terminate the data transfer when allocation length bytes have been transferred or when all available data have been transferred to the Host Computer, whichever is less. The allocation length is used to limit the maximum amount of data (e.g. sense data, mode data, etc.) returned to a Host Computer. When data is truncated, no error is generated, except for the Mechanism Status Command that ***shall*** generate a Parameter List Length Error.

B-8 Status

A Status byte ***shall*** be sent from the Drive to the Host Computer at the completion of each command unless the command is terminated by one of the following events:

1. A hard reset condition.
2. An unexpected event.

Status is normally presented at the end of a command, but in some cases may occur prior to transferring the Command Packet.

For a description of the Status Byte see ATA/ATAPI-4.

B-9 Immediate Command Processing Considerations

Immediate commands are a class of commands which return completion status to the host system before they are finished executing the command. The purpose of immediate commands is to allow the host to execute more than one command at a time on the same IDE cable.

ATAPI devices use the DSC bit to indicate the completion status of the seek operation of immediate commands. No INTRQ is issued by these device when the DSC bit is set, so it the responsibility of the ATAPI driver to poll this bit to determine the completion status of the immediate command.

Some Commands that make use of this immediate capability are.

- Play Audio
- Play Audio MSF
- Play CD
- Seek
- Scan

B-10 Command Processing Considerations and Exception Conditions

The following sections describe some exception conditions and errors associated with command processing and the sequencing of commands.

B-10.1 Selection of an invalid logical unit

The CD-ROM Drive's response to selection of a logical unit that is not valid is described in the following paragraphs. The logical unit may not be valid because:

1. The ATAPI CD-ROM Drive does not support the logical unit. In response to an INQUIRY command, the ATAPI CD-ROM Drive shall return the INQUIRY data with the peripheral qualifier set to the value required in *11.8.1, "Standard INQUIRY Data"* on page 235 In response to any other command except REQUEST SENSE, the ATAPI CD-ROM Drive shall terminate the command with CHECK CONDITION status. In response to a REQUEST SENSE command, the ATAPI CD-ROM Drive shall return sense data. The sense key shall be set to ILLEGAL REQUEST and the additional sense code shall be set to LOGICAL UNIT NOT SUPPORTED.
2. The ATAPI CD-ROM Drive supports the logical unit, but the peripheral device is not currently attached to the ATAPI CD-ROM Drive. In response to an INQUIRY command, the ATAPI CD-ROM Drive shall return the INQUIRY data with the peripheral qualifier set to the value required in *11.8.1, "Standard INQUIRY Data"* on page 235. In response to any other command except REQUEST SENSE, the ATAPI CD-ROM Drive shall terminate the command with CHECK CONDITION status. In response to a REQUEST SENSE command, the ATAPI CD-ROM Drive shall return sense data. The sense key shall be set to ILLEGAL REQUEST and the additional sense code shall be set to LOGICAL UNIT NOT SUPPORTED.
3. The ATAPI CD-ROM Drive supports the logical unit and the peripheral device is attached, but not operational. In response to an INQUIRY command, the ATAPI CD-ROM Drive shall return the INQUIRY data with the peripheral qualifier set to the value required in *11.8.1, "Standard INQUIRY Data"* on page 235. The ATAPI CD-ROM Drive's response to any command other than INQUIRY and REQUEST SENSE is vendor-specific.

B-10.2 Parameter Rounding

Certain parameters sent to an ATAPI Device with various commands contain a range of values. ATAPI devices may choose to implement only selected values from this range. When the ATAPI Device receives a value that it does not support, it either rejects the command (CHECK CONDITION status with ILLEGAL REQUEST sense key) or it rounds the value received to a supported value. The ATAPI device ***shall*** reject unsupported values unless rounding is permitted in the description of the parameter.

Rounding of parameter values, when permitted[1], ***shall*** be performed as follows - An ATAPI device that receives a parameter value that is not an exact supported value ***shall*** adjust the value to one that it supports and ***shall*** return CHECK CONDITION status with a sense key of RECOVERED ERROR. The additional sense code ***shall*** be set to

1. Generally, the ATAPI device should adjust maximum-value fields down to the next lower supported value than the one specified by the Host Computer. Minimum-value fields should be rounded up to the next higher supported value than the one specified by the Host Computer. In some cases, the type of rounding (up or down) is explicitly specified in the description of the parameter.

ROUNDED PARAMETER. The Host Computer is responsible for issuing an appropriate command to learn what value the ATAPI device has selected.

B-11 Unit Attention Condition

The ATAPI device ***shall*** generate a unit attention on each valid logical unit whenever the ATAPI device has been reset by a hard reset condition, or by a power-on reset. The ATAPI device ***shall*** also generate a unit attention condition on the affected logical unit(s) whenever one of the following events occurs:

1. A removable Disc or Cartridge may have been changed.
2. The version or level of microcode has been changed.
3. INQUIRY or Packet Identify Drive Data has been changed.
4. The mode parameters in effect for the Host Computer have been restored from non-volatile memory.
5. Any other event occurs that requires the attention of the Host Computer.
6. Any Disc or Cartridge has been manually moved within a Changer.

The ATAPI device may queue unit attention conditions on logical units. After the first unit attention condition is cleared, another unit attention condition may exist (e.g. a power on condition followed by a microcode change condition).

The unit attention condition ***shall*** persist on the logical unit, until the Host Computer clears the condition as described in the following paragraphs.

If an INQUIRY command is received from an Host Computer to a logical unit with a pending unit attention condition, the ATAPI device ***shall*** perform the INQUIRY command and ***shall not*** clear the unit attention condition.

If a REQUEST SENSE command is received from a Host Computer with a pending unit attention condition, then the ATAPI device ***shall*** either:

1. report any pending sense data and preserve the unit attention condition on the logical unit, or,
2. report the unit attention condition, may discard any pending sense data, and clear the unit attention condition on the logical unit.

If an Host Computer issues a Command other than GET EVENT/STATUS NOTIFICATION, INQUIRY or REQUEST SENSE while a unit attention condition exists for that Host, the ATAPI device ***shall not*** perform the command and ***shall*** report CHECK CONDITION status unless a higher priority status as defined by the ATAPI device is also pending (e.g. BUSY).

B-12 Commands and Parameters

The ATAPI commands were derived from the SCSI command set.

With the exception of the CD-ROM MSF addressing technique, the interface uses logical rather than physical addressing for all data blocks. Each Device may be interrogated to determine how many blocks it contains. A logical unit may coincide with all or part of a peripheral device.

B-12.1 Operation Code Types

Table 431 - Operation Code Types

Operation Code Type	Description
M	Mandatory - Commands so designated ***shall*** be implemented in order to meet the minimum requirement of this Specification.
O	Optional - Commands so designated, if implemented, ***shall*** be implemented as defined in this Specification.
R	Reserved - Operation codes so designated ***shall not*** be used. They are reserved for future extensions to this Specification.

Commands are classified as mandatory, optional, or vendor-specific. ATAPI devices are required to implement all mandatory commands and may implement other commands as well. ATAPI devices contain commands that facilitate the writing of self-configuring software drivers that can discover all necessary attributes without prior knowledge of specific peripheral characteristics (such as storage capacity).

Table 432 - Packet Commands for ATAPI C/DVD Devices

Command Description	Opcode	Reference
BLANK	A1h	*11.1*, on page 169
CLOSE TRACK/RZONE/SESSION/BORDER	5Bh	*11.2*, on page 173
FLUSH CACHE	35h	*11.3*, on page 177
FORMAT UNIT	04h	*11.4*, on page 179
GET CONFIGURATION	46h	*11.5*, on page 185
GET EVENT/STATUS NOTIFICATION	4Ah	*11.6*, on page 219
GET PERFORMANCE	ACh	*11.7*, on page 231
INQUIRY	12h	*11.8*, on page 235
LOAD/UNLOAD MEDIUM	A6h	*11.9*, on page 241
MECHANISM STATUS	BDh	*11.10*, on page 243
MODE SELECT (10)	55h	*11.11*, on page 247
MODE SENSE (10)	5Ah	*11.12*, on page 249
PAUSE/RESUME	4Bh	*11.13*, on page 273
PLAY AUDIO (10)	45h	*11.14*, on page 275
PLAY AUDIO MSF	47h	*11.15*, on page 279
PLAY CD	BCh	*11.16*, on page 281
PREVENT/ALLOW MEDIUM REMOVAL	1Eh	*11.17*, on page 285
READ (10)	28h	*11.18*, on page 287
READ (12)	A8h	*11.19*, on page 289
READ CAPACITY	25h	*11.21*, on page 295
READ CD	BEh	*11.22*, on page 297
READ CD MSF	B9h	*11.23*, on page 307
READ DISC INFORMATION	51h	*11.24*, on page 309
READ DVD STRUCTURE	ADh	*11.25*, on page 315
READ FORMAT CAPACITIES	23h	*11.26*, on page 331
READ HEADER	44h	*11.27*, on page 337
READ SUBCHANNEL	42h	*11.28*, on page 339
READ TOC/PMA/ATIP	43h	*11.29*, on page 347
READ TRACK/RZONE INFORMATION	52h	*11.30*, on page 361
REPAIR RZONE	58h	*11.31*, on page 369
REPORT KEY	A4h	*11.32*, on page 371
REQUEST SENSE	03h	*11.33*, on page 377
RESERVE TRACK/RZONE	53h	*11.34*, on page 383
SCAN	BAh	*11.35*, on page 385
SEEK	2Bh	*11.36*, on page 389
SEND CUE SHEET	5Dh	*11.37*, on page 391
SEND DVD STRUCTURE	BFh	*11.38*, on page 399
SEND EVENT	A2h	*11.39*, on page 403
SEND KEY	A3h	*11.40*, on page 405
SEND OPC INFORMATION	54h	*11.41*, on page 409

Table 432 - Packet Commands for ATAPI C/DVD Devices (Continued)

Command Description	Opcode	Reference
SET READ AHEAD	A7h	*11.42*, on page 411
SET STREAMING	B6h	*11.43*, on page 413
START/STOP UNIT	1Bh	*11.44*, on page 417
STOP PLAY/SCAN	4Eh	*11.45*, on page 421
TEST UNIT READY	00h	*11.46*, on page 423
VERIFY (10)	2Fh	*11.47*, on page 425
WRITE (10)	2Ah	*11.48*, on page 427
WRITE and VERIFY (10)	2Eh	*11.49*, on page 431

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Appendix C - SCSI Implementation Notes (Normative)

C-1 Introduction

This section will describe where possible the use of the contents for SCSI C/DVD devices. This specification is intended to be used in conjunction with the SCSI-3 Architecture Model (SAM) the SCSI-3 Primary Command Set (SPC-2) standard and the SCSI-3 Block Command Set (SBC).

See the X3T10 SCSI-3 Specifications for information on the connection and protocol to be use for a SCSI C/DVD device.

C-2 SCSI Signal Utilization

C/DVD Devices will utilize the same signals and timing from the SCSI Standard and Extensions.

C-3 SCSI Compatibility

C-3.1 Use of the RelAdr bit

A relative address (RelAdr) bit of one indicates that the logical block address field is a two's complement displacement. This negative or positive displacement shall be added to the logical block address last accessed on the Logical Unit to form the logical block address for this command. This feature is only available when linking commands. The feature requires that a previous command in the linked group have accessed a block of data on the Logical Unit.

A RelAdr bit of zero indicates that the logical block address field specifies the first logical block of the range of logical blocks to be operated on by this command. This bit is only supported for Logical Units that make use of a SCSI interface. The command field shows that this bit exists, but is only applicable to SCSI.

C-3.2 Differences from the SCSI Standard

Some of the major differences from the SCSI Standard:

- LUN field of command packets (CDB) is used by this specification.
- SYNCHRONIZE CACHE Command is called FLUSH CACHE. This command also does not make use of the Logical Block or Number of Blocks fields.
- EVENT STATUS NOTIFICATION replaces the AEN capability in SCSI.
- CHANGE DEFINITION is not used.
- INQUIRY Command does not use EVPD or CmdDt CDB bits.
- Unit Attention with INQUIRY DATA HAS CHANGED is not used.
- Peripheral qualifier in the INQUIRY data is not used.
- The AERC, TrmTsk and NormACA are in conflict with the current definition of the INQUIRY data. This specification specifies the ATAPI Transport version in place of these bits.
- EncServ, MultiP, MChngr, ACKREQQ, Addr32, Addr16, RelAdr, WBus32, WBus16, Sync, Linked, TranDis, CmdQue bits in the INQUIRY data is defined as Reserved in this specification.
- Byte 56 and 57 of the INQUIRY data are used to specify the Major and Minor version the Logical Unit is compliant with.
- 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 PF bit in the MODE SELECT command is specified as always set to 1.
- The DBD bit in the MODE SENSE is specified as being set to one. This bit is allowed to be set to zero only when the Logical Unit is a legacy SCSI device.
- EER bit of the Read-Write recovery page is not supported by this specification.
- Correction Span, Head offset count, Data strobe offset count, Recovery Time Limit fields of the Read-Write recovery page are not supported by this specification.
- 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 specification.
- LogErr bit in the Information Exceptions mode page is not supported.
- Disconnect/Reconnect, Write Parameter, Verify Error Recovery, Caching, Peripheral Device, Control Mode and Medium Types pages are not supported by this specification.
- DPO bit in the READ Command is not supported by this specification.
- Only the READ(12) is supported by this specification.
- The PMI bit of the READ CAPACITY command is not supported by this specification.
- READ CAPACITY command is recommended not to be used by this specification.

C-4 Reset Functionality

This section describes the functionality of the various resets in SCSI.

C-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).

C-4.2 Hard Reset

In SCSI, Hard Reset is mapped as Hard Reset in the SCSI Architecture Model. See “Hard Reset” in SAM.

Devices that comply with this specification follow a simple model and the initiator is mapped to the Host and a target is mapped to the device. Hard Reset for a SCSI Device will:

- 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.

C-4.2.1 TARGET RESET task management function

A response to a TARGET RESET task management request, issued by an initiator.

Different from ATA/ATAPI, in SCSI, the TARGET RESET can reset a devices individually. When a SCSI initiator is wishes to reset all the devices connected on one cable with TARGET RESET request, the initiator must issue the TARGET RESET task management request to every device.

Note: The TARGET RESET task management function was called a “Bus Device Reset” in SCSI-2.

Note: The LOGICAL UNIT RESET function is gone from SCSI-3 SAM revision 18. If this function is issued by the Host to this a C/DVD device, the reaction of the device ***shall*** *be same as the TARGET RSET task management function.*

C-4.2.2 Reset Events.

A protocol specific event which may trigger a Hard Reset response from a SCSI device.

For example, SIP SCSI-3 Parallel Interface, there's a Reset Service generated by assertion of the RST- (reset) bus signal. This is one of the reset events and is a kind of Task Management Service defined in SIP SCSI-3 Interlocked Protocol specification, as a ULP, upper layer protocol.

SIP : SCSI Interlocked Protocol specification (X3T10/856D)

SPI : SCSI Parallel Interface specification (X3T10/855D)

Table 433 - Example Hard Reset Implementation

Mt Fuji	Generic SCSI-3 SAM	Example SCSI-3 SIP,SPI
Hard Reset	TARGET RESET task management function	TARGET RESET message
	Reset events	RST bus signal activated

C-4.3 Device Reset

In SCSI, Device Reset is not equivalent with the ATA/ATAPI Device Reset. For SCSI devices there are two possible Device Reset alternatives, ABORT TASK SET or CLEAR TASK SET. The ABORT TASK SET is mandatory for all SCSI devices, but the function is a little different from the ATA/ATAPI Device Reset. The CLEAR TASK SET is not always supported by the SCSI devices that don’t support tagged tasks. CLEAR TASK SET is different from ABORT TASK SET in that CLEAR TASK SET clears all the queued tasks for all initiators. If the device is in a single initiator SCSI environment, ABORT and CLEAR TASK SET are the same.

As in ATAPI Device Reset, these “resets” in SCSI don’t set to defaults the Mode Parameters, or SCAM functions and does not flush the contents of any cached lead-in data.

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

Although the Host may use the ABORT/CLEAR TASK SET functions to provide a Device Reset, when something is wrong with the SCSI communications it may be necessary for the Host to use stronger means, such as Hard Reset (a TARGET RESET or a Reset Event).

Table 434 - Reset Function Comparison

Function	Power-On / Hard Reset	SCSI-3 ABORT/CLEAR TASK SET
Initialization sequence required	Yes	No
Immediate Bus Release	Yes	No
Mode parameters	Reset to default or saved parameters	No change allowed
Cached Lead-in information	Discarded	Not Specified
Persistent Prevent Flag	Unlocked	No change allowed
Key Management	Reset to Default state	Reset to Default state

C-4.3.1 Device Reset Issues for SCSI Devices

The Host may generate a Device Reset to bring the hung-up (something wrong or the communication is broken) device back to operation. For this purpose, this will work well in ATAPI. But in SCSI, this may not work well. Even the Hard Reset (a TARGET RESET or a Reset Event) may not work well in SCSI system because these Hard Resets are not always HARDWARE based resets, and it depends on the device design. Thus the application should consider the differences between ATAPI and SCSI environment.

Note: In the SCSI-3 standard, the term "Soft Reset" is no longer defined.

C-4.4 Power management and Device Reset in SCSI

When a SCSI Device is in the Power Managed Sleep state, the SCSI Target Reset ***shall*** be used to wake the device.

C-5 Command Utilization for a SCSI Logical Unit

Commands often implemented on CD/DVD Logical Units are listed in Table 435.

Table 435 - Packet Commands for SCSI C/DVD Devices

Command Description	Opcode	Reference
BLANK	A1h	*11.1*, on page 169
CLOSE TRACK/RZONE/SESSION/BORDER	5Bh	*11.2*, on page 173
FLUSH CACHE	35h	*11.3*, on page 177
FORMAT UNIT	04h	*11.4*, on page 179
GET CONFIGURATION	46h	*11.5*, on page 185
GET EVENT/STATUS NOTIFICATION	4Ah	*11.6*, on page 219
GET PERFORMANCE	ACh	*11.7*, on page 231
INQUIRY	12h	*11.8*, on page 235
LOAD/UNLOAD MEDIUM	A6h	*11.9*, on page 241
MECHANISM STATUS	BDh	*11.10*, on page 243
MODE SELECT (10)	55h	*11.11*, on page 247
MODE SELECT (6)		SPC
MODE SENSE (10)	5Ah	*11.12*, on page 249
MODE SENSE (6)		SPC
PAUSE/RESUME	4Bh	*11.13*, on page 273
PLAY AUDIO (10)	45h	*11.14*, on page 275
PLAY AUDIO (12)		MMC
PLAY AUDIO MSF	47h	*11.15*, on page 279
PLAY CD	BCh	*11.16*, on page 281
PREVENT/ALLOW MEDIUM REMOVAL	1Eh	*11.17*, on page 285
READ (10)	28h	*11.18*, on page 287
READ (12)	A8h	*11.19*, on page 289
READ (6)	08h	SBC
READ CAPACITY	25h	*11.21*, on page 295
READ CD	BEh	*11.22*, on page 297
READ CD MSF	B9h	*11.23*, on page 307
READ DISC INFORMATION	51h	*11.24*, on page 309
READ DVD STRUCTURE	ADh	*11.25*, on page 315
READ FORMAT CAPACITIES	23h	*11.26*, on page 331
READ HEADER	44h	*11.27*, on page 337
READ SUBCHANNEL	42h	*11.28*, on page 339
READ TOC/PMA/ATIP	43h	*11.29*, on page 347
READ TRACK/RZONE INFORMATION	52h	*11.30*, on page 361
RELEASE		SPC
REPAIR RZONE	58h	*11.31*, on page 369
REPORT KEY	A4h	*11.32*, on page 371
REQUEST SENSE	03h	*11.33*, on page 377
RESERVE		SPC
RESERVE TRACK/RZONE	53h	*11.34*, on page 383
SCAN	BAh	*11.35*, on page 385
SEEK	2Bh	*11.36*, on page 389
SEND CUE SHEET	5Dh	*11.37*, on page 391
SEND DIAGNOSTIC		SPC
SEND DVD STRUCTURE	BFh	*11.38*, on page 399
SEND EVENT	A2h	*11.39*, on page 403

Table 435 - Packet Commands for SCSI C/DVD Devices (Continued)

Command Description	Opcode	Reference
SEND KEY	A3h	*11.40*, on page 405
SEND OPC INFORMATION	54h	*11.41*, on page 409
SET READ AHEAD	A7h	*11.42*, on page 411
SET STREAMING	B6h	*11.43*, on page 413
START/STOP UNIT	1Bh	*11.44*, on page 417
STOP PLAY/SCAN	4Eh	*11.45*, on page 421
TEST UNIT READY	00h	*11.46*, on page 423
VERIFY (10)	2Fh	*11.47*, on page 425
WRITE (10)	2Ah	*11.48*, on page 427
WRITE and VERIFY (10)	2Eh	*11.49*, on page 431

Appendix D - IEEE 1394 Implementation Notes (Normative)

D-1 Introduction

This section will describe where possible the use of the contents for IEEE 1394 devices. This specification is intended to be used in conjunction with IEEE 1394, the SCSI-3 Architecture Model (SAM), the Serial Bus Protocol (SBP-2), the SCSI-3 Primary Command Set (SPC) standard and the SCSI-3 Block Command Set.

See the X3T10 SCSI-3 Specifications for information on the connection and protocol to be use for a SCSI C/DVD device.

D-2 IEEE 1394 Signal Utilization

Logical Units shall utilize the signals and timing defined in IEEE 1394.

D-3 Compatibility

D-3.1 Use of the RelAdr bit

A relative address (RelAdr) bit of one indicates that the logical block address field is a two's complement displacement. This negative or positive displacement shall be added to the logical block address last accessed on the Logical Unit to form the logical block address for this command. This feature is only available when linking commands. The feature requires that a previous command in the linked group have accessed a block of data on the Logical Unit.

A RelAdr bit of zero indicates that the logical block address field specifies the first logical block of the range of logical blocks to be operated on by this command. This bit is supported for Logical Units that make use of a IEEE 1394 interface.

D-3.2 Comparison of SBP-2 and MMC-2

Some of the major differences between MMC-2 and SCSI or SBC-2:

- EVENT STATUS NOTIFICATION replaces unsolicited status.
- CHANGE DEFINITION is not used.
- INQUIRY Command does not use EVPD or CmdDt CDB bits.
- Unit Attention with INQUIRY DATA HAS CHANGED is not used.
- Peripheral qualifier in the INQUIRY data is not used.
- The PF bit in the MODE SELECT command is specified as always set to 1.
- The power model for this specification is different from that described for IEEE 1394.

D-4 Reset Functionality

This section describes the functionality of the various resets in IEEE 1394.

D-4.1 Power On Reset

The Power On Reset is an event that causes the Power On condition in IEEE 1394. See “Task and Command Lifetimes” in the SCSI Architecture Model standard (SAM).

D-4.2 Hard Reset

In IEEE 1394, Hard Reset is mapped as Hard Reset in the SCSI Architecture Model. See “Hard Reset” in SAM.

Devices that comply with this specification follow a simple model and the initiator is mapped to the Host and a target is mapped to the Logical Unit. Hard Reset for a IEEE 1394 Logical Unit will:

- Abort all tasks in all task sets;
- Clear all auto contingent allegiance conditions;
- Release all 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 (10) conditions shall be restored to their last saved values if saved values have been established. MODE SELECT (10) conditions for which no saved values have been established shall be returned to their default values;
- Unit Attention condition shall be set.

D-4.2.1 TARGET RESET task management function

A response to a TARGET RESET task management request, issued by an initiator.

Different from ATA/ATAPI, in IEEE 1394, the TARGET RESET can reset a devices individually. When a Host wishes to reset all the devices connected on one cable with TARGET RESET request, the Host must issue the TARGET RESET task management request to every device.

Note: The TARGET RESET task management function was called a "Bus Device Reset" in SCSI-2.

Note: The LOGICAL UNIT RESET function is gone from SCSI-3 SAM revision 18. If this function is issued by the Host to this a C/DVD device, the reaction of the device ***shall*** *be same as the TARGET RSET task management function.*

D-4.3 Device Reset

In IEEE 1394, Device Reset is not equivalent with the ATA/ATAPI Device Reset. For IEEE 1394 devices there are two possible Device Reset alternatives, ABORT TASK SET or CLEAR TASK SET. The ABORT TASK SET is mandatory for all IEEE 1394 devices, but the function is a little different from the ATA/ATAPI Device Reset. The CLEAR TASK SET is not always supported by the IEEE 1394 devices that don't support tagged tasks. CLEAR TASK SET is different from ABORT TASK SET in that CLEAR TASK SET clears all the queued tasks for all initiators. If the device is in a single initiator IEEE 1394 environment, ABORT and CLEAR TASK SET are the same.

As in ATAPI Device Reset, these "resets" in IEEE 1394 don't set to defaults the Mode Parameters and does not flush the contents of any cached lead-in data.

The ABORT/CLEAR TASK SET:

- Does not immediately reset IEEE 1394 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

Although the Host may use the ABORT/CLEAR TASK SET functions to provide a Device Reset, when something is wrong with the IEEE 1394 communications it may be necessary for the Host to use stronger means, such as Hard Reset (a TARGET RESET or a Reset Event).

Table 436 - Reset Function Comparison

Function	Power-On / Hard Reset	IEEE 1394 ABORT/CLEAR TASK SET
Initialization sequence required	Yes	No
Immediate Bus Release	Yes	No
Mode parameters	Reset to default or saved parameters	No change allowed
Cached Lead-in information	Discarded	Not Specified
Persistent Prevent Flag	Unlocked	No change allowed
Key Management	Reset to Default state	Reset to Default state

D-4.3.1 Device Reset Issues for IEEE 1394 Devices

The Host may generate a Device Reset to bring the hung-up (something wrong or the communication is broken) device back to operation. For this purpose, this will work well in ATAPI. But in IEEE 1394, this may not work well. Even the Hard Reset (a TARGET RESET or a Reset Event) may not work well in IEEE 1394 system because these Hard Resets are not always HARDWARE based resets, and it depends on the device design. Thus the application should consider the differences between ATAPI and IEEE 1394 environment.

Note: In the SCSI-3 standard, the term "Soft Reset" is no longer defined.

D-4.4 Power management and Device Reset in IEEE 1394

When a IEEE 1394 Device is in the Power Managed Sleep state, a Target Reset ***shall*** be used to wake the device.

D-5 Command Utilization for a IEEE 1394 Logical Unit

Table 437 - Packet Commands for IEEE 1394 C/DVD Devices

Command Description	Opcode	Reference
BLANK	A1h	*11.1*, on page 169
CLOSE TRACK/RZONE/SESSION/BORDER	5Bh	*11.2*, on page 173
FLUSH CACHE	35h	*11.3*, on page 177
FORMAT UNIT	04h	*11.4*, on page 179
GET CONFIGURATION	46h	*11.5*, on page 185
GET EVENT/STATUS NOTIFICATION	4Ah	*11.6*, on page 219
GET PERFORMANCE	ACh	*11.7*, on page 231
INQUIRY	12h	*11.8*, on page 235
LOAD/UNLOAD MEDIUM	A6h	*11.9*, on page 241
MECHANISM STATUS	BDh	*11.10*, on page 243
MODE SELECT (10)	55h	*11.11*, on page 247
MODE SELECT (6)		SPC
MODE SENSE (10)	5Ah	*11.12*, on page 249
MODE SENSE (6)		SPC
PAUSE/RESUME	4Bh	*11.13*, on page 273
PLAY AUDIO (10)	45h	*11.14*, on page 275
PLAY AUDIO (12)		MMC

Table 437 - Packet Commands for IEEE 1394 C/DVD Devices

Command Description	Opcode	Reference
PLAY AUDIO MSF	47h	*11.15*, on page 279
PLAY CD	BCh	*11.16*, on page 281
PREVENT/ALLOW MEDIUM REMOVAL	1Eh	*11.17*, on page 285
READ (10)	28h	*11.18*, on page 287
READ (12)	A8h	*11.19*, on page 289
READ (6)	08h	SBC
READ CAPACITY	25h	*11.21*, on page 295
READ CD	BEh	*11.22*, on page 297
READ CD MSF	B9h	*11.23*, on page 307
READ DISC INFORMATION	51h	*11.24*, on page 309
READ DVD STRUCTURE	ADh	*11.25*, on page 315
READ FORMAT CAPACITIES	23h	*11.26*, on page 331
READ HEADER	44h	*11.27*, on page 337
READ SUBCHANNEL	42h	*11.28*, on page 339
READ TOC/PMA/ATIP	43h	*11.29*, on page 347
READ TRACK/RZONE INFORMATION	52h	*11.30*, on page 361
RELEASE		SPC
REPAIR RZONE	58h	*11.31*, on page 369
REPORT KEY	A4h	*11.32*, on page 371
REQUEST SENSE	03h	*11.33*, on page 377
RESERVE		SPC
RESERVE TRACK/RZONE	53h	*11.34*, on page 383
SCAN	BAh	*11.35*, on page 385
SEEK	2Bh	*11.36*, on page 389
SEND CUE SHEET	5Dh	*11.37*, on page 391
SEND DIAGNOSTIC		SPC
SEND DVD STRUCTURE	BFh	*11.38*, on page 399
SEND EVENT	A2h	*11.39*, on page 403
SEND KEY	A3h	*11.40*, on page 405
SEND OPC INFORMATION	54h	*11.41*, on page 409
SET READ AHEAD	A7h	*11.42*, on page 411
SET STREAMING	B6h	*11.43*, on page 413
START/STOP UNIT	1Bh	*11.44*, on page 417
STOP PLAY/SCAN	4Eh	*11.45*, on page 421
TEST UNIT READY	00h	*11.46*, on page 423
VERIFY (10)	2Fh	*11.47*, on page 425
WRITE (10)	2Ah	*11.48*, on page 427
WRITE and VERIFY (10)	2Eh	*11.49*, on page 431

Appendix E - Example Event Implementation Notes (Informative)

E-1 Design Intent

E-1.1 Goals

The set of commands used with Morphing was designed to eliminate the use of errors for the communication of errors and normal device events to the host. The use of event reporting allows errors to be used to communicate true errors - i.e. illegal usage or medium defects. The use of events may help reduce the amount of error handling code in host software.

The implementation described here replaces the Asynchronous Event Notification defined in SCSI. AEN was not widely supported, as it would require a change in architecture of most OS to allow unsolicited messages from the peripheral. In particular, the OS would have to decide to which process an unsolicited message belonged. There were other inhibiting factors also. For example, there is no low level protocol for a peripheral to send an unsolicited message.

E-1.2 Command Use

The GET EVENT/STATUS NOTIFICATION Command has two modes of operation. The first is the non-immediate mode. This is the preferred method of operation. Non-immediate mode means that the command will complete as soon as an event occurs. Effectively, a message can be sent at any time to the host because it has been solicited. However, this method of operation is not feasible if command queuing and overlap are not possible. Current ATAPI implementations do not support queuing nor overlap, so the immediate mode must be used.

The Immediate mode allows the host to periodically poll the device to find events and examine status. This technique should be used only in environments where queuing is not possible.

E-1.3 Implementation Hints

Events are not required to be queued, nor is generation of events blocked due to the occurrence of a new event. What this means is that an implementation can set aside an event variable and a status variable for each event class it supports. Each section of code that needs to generate an event can simply overwrite any event that exists in the same class.

E-1.4 Interactions with Unit Attention

The GET EVENT/STATUS NOTIFICATION Command specifies that any associated UNIT ATTENTION not be cleared when an Event is reported to the host. Therefore, no changes to sense generation or reporting are required.

E-1.5 Sample Implementation of Events

The following code shows how events might be implemented in C.

```
typedef struct _sEventData {
      UInt8       Event;
      UInt8       Status;
      Uint16      EventData;
} sEventData;

sEventData EventData[8];                  /* One per event class */

Set_Event(EventClass, Event, Status, EventData)
{
      EventData[EventClass].Event = Event
      EventData[EventClass].Status = Status;
      EventData[EventClass].EventData = EventData;
      Do_Synchronous_Event_Notification(EventClass);        /*This completes any
            pending GET EVENT/STATUS NOTIFICATION Commands in the queue    */
}
```

Note that none of these routines checks for existing Events. Any old Event is simply replaced with the new one.

The GET EVENT/STATUS NOTIFICATION Command would report the EventData structure for the highest priority (lowest number) requested event and then clear that Event.

Appendix F - Command Implementation Notes (Informative)

F-1 Overview

This section explains what information shall return when READ DISC INFORMATION or READ TRACK/RZONE INFORMATION command are issued for C/DVD media to a Read Only Logical Unit.

The READ DISC INFORMATION and READ TRACK/RZONE INFORMATION Commands are originally designed for writable logical unit. A Read Only Logical Unit shall also return the information of C/DVD media appropriately when READ DISC INFORMATION and READ TRACK/RZONE INFORMATION Command is issued.

F-1.1 Returned data for CD media

For Read Only Logical Unit, the interpretation of the status of CD media which has one or more complete session is based on followings:

- Disc Status is always treated as “Complete” even if there is incomplete session on the disc.
- Last Session is considered to be the Complete Session closed at the end even if there is an incomplete session exists following the complete session. The incomplete session which has not been closed by writable Logical Unit is not considered to return disc/track status. Only the information on Complete Session(s) on the disc shall be returned.
- Number of Session is the total of closed Complete Sessions.
- All the values of PMA are invalid because Read Only Logical Unit does not have capability to read PMA.

If the disc of which 1st session is not complete is inserted into Read Only Logical Unit, appropriate error shall be returned. And media access commands shall report BLANK CHECK when a Blank disc is loaded.

The Figure 81 shows an example of CD recorded/stamped media. (Session 1 and session 2 are both completed. Session 3 is incomplete status. Each session has some tracks.)

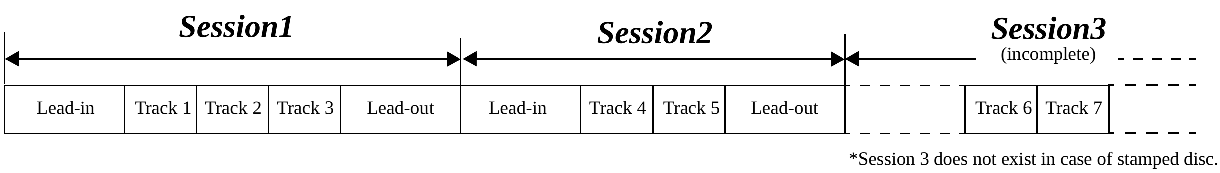

Figure 81 - Example of CD Multisession recorded/stamped disc*

Table 438 shows the example of data returned, when the READ DISC INFORMATION command is issued for the above media.

Table 438 - Example of READ DISC Information returned for CD media

Inserted media Disc Information field	CD-ROM/R/RW disc
Erasable	0 or 1[a]
Status of Last Session	11b (Complete Session)
Disc Status	10b (Complete Disc)
Number of First track on Disc	1[b]
Number of Sessions	2[b]
First Track Number in Last Session	4[b]
Last Track Number in Last Session	5[b]
DID_V	0
DBC_V	0
URU	invalid
Disc Type	from A0/PSEC field in the TOC of the first Session in which there is at least one data track
Disc Identification	invalid
Lead-in Start Time for Last Session (MSF)	FF:FF:FF
Last Possible Start Time for Start of Lead-out (MSF)	FF:FF:FF
Disc Bar Code	invalid

a. If Logical Unit can detect the Erasable media, this field may be set to 1, otherwise the field is set to 0.
b. In the case of *"Figure 81 - Example of CD Multisession recorded/stamped* disc"* on page 479.

There are some kinds of writing method of recording data in CD media. Disc At Once, Session At Once, Track At Once, and Packet Writing are used as the method of recording CD media. The Packet Writing can be classified into Variable Packet Writing and Fixed Packet Writing.

The Packet layout for CD media is shown in *"Figure 82* - Packet Layout". Each packet starts with Link block followed by four Run-in blocks. The User data blocks are placed directly after the Run-in blocks. Finally two Run-out blocks are located following the User data blocks. In the case of Fixed packet writing, the size of User Data blocks is always constant in length.

.

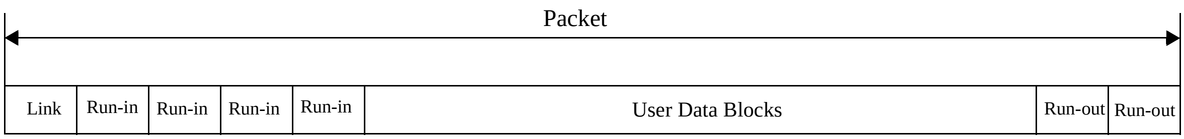

Figure 82 - Packet Layout

For CD media, there are two kinds of addressing method. Except for the space within a Fixed Packet written track, the logical block number has a one-to-one relationship to the physical block number. Such kind of addressing method is called “Method 1 Addressing” and logical block numbers are also assigned to Link, Run-in, and Run-out blocks. On the other hand, in the Fixed Packet written track, the logical block number has a linear relationship to the physical block number using the special addressing method called “Method 2 Addressing”. In this case, Logical Block numbers are not assigned to Link, Run-in, and Run-out blocks.

When the READ TRACK/RZONE INFORMATION command is issued for CD media, *"Table 439* - Example of READ TRACK/RZONE Information returned for CD media" shows the example of data returned for the command.

Table 439 - Example of READ TRACK/RZONE Information returned for CD media

Track type Track Information field	Stamped track/ DAO[a] written track/ Audio track	TAO[b] written data track	Variable Packet written data track	Fixed Packet written data track
Damage	0	0	0	0
Copy	0	0	0	0
Track Mode	from Q sub-channel of this track			
RT	0 or 1[c]	0 or 1	0 or 1	0 or 1
Blank	0	0	0	0
Packet	0	0	1	1
FP	0	0	0	1
Data Mode	Fh	1h or 2h	1h or 2h	1h or 2h
NWA_V	0	0	0	0
Track Start Address	from TOC	from TOC	from TOC	from TOC
Next Writable Address	0	0	0	0
Free Blocks	0	0	0	0
Fixed Packet Size	0	0	0	from TDB[d]
Track Size	See below			

a. DAO: Disc At Once recording
b. TAO: Track At Once recording
c. If it can be considered the disc as stamped disc, this field is set to 0.
d. TDB: Track Descriptor Block

Note: In order to distinguish if the medium is Disc At Once recorded/Stamped, the Logical Unit should read the pre-gap of the first data track. If a TDB is written, the media is Track At Once or Packet written media. If no TDB is written, the media is Disc At Once recorded or Stamped media.

The track size is different according to the difference of the writing method. The Track Size shall be computed as follows:

First, compute the Complete Track Size (*CTS*). For Read Only Logical Unit, *CTS* for the track which has a track number *n* is computed as follows.

$$CTS(n) = TrackStartAddress(n+1) - TrackStartAddress(n)$$

Where *TrackStartAddress(n)* means Track Start address of the track which has a track number *n*. The value is encoded in the TOC. If the track number *n* is the last track number of the session, *TrackStartAddress(n+1)* means the Lead-out start address.

For Disc At Once written media, $TrackSize(n) = CTS(n)$

Where *TrackSize(n)* means track size of the track which has a track number *n*.

For Track At Once written track or Variable packet written track, $TrackSize(n) = CTS(n) - PreGapLength(n+1) - 2$

Where *PreGapLength(n)* means the Pre-gap length of the track which has track number *n*. When the Pre-gap has no TDB or the Logical Unit does not read the TDB, *PreGapLength(n)* is treated as always 150 even if the actual *PreGapLength(n)* is not 150[1]. If the track number *n* is the last track, *PreGapLength(n+1)* is 0.

For Fixed Packet written track, $TrackSize(n) = \frac{CTS(n) - PreGapLength(n+1) + 5}{PacketSize(n) + 7} \bullet PacketSize(n)$

1. This may cause an incorrectly computed result.

If *TrackStartAddress(n)* is the last track start address of the session, then *TrackStartAddress(n+1)* is start address of the Lead-out and *PreGapLength(n+1)* is zero. *PacketSize(n)* is the number of User Data Blocks in the fixed packet and is encoded in the Pre-gap as required by the Orange Book Part-II & Part-III[1]. *Figure 83* - on page 482 shows example of the layout of packet written track.

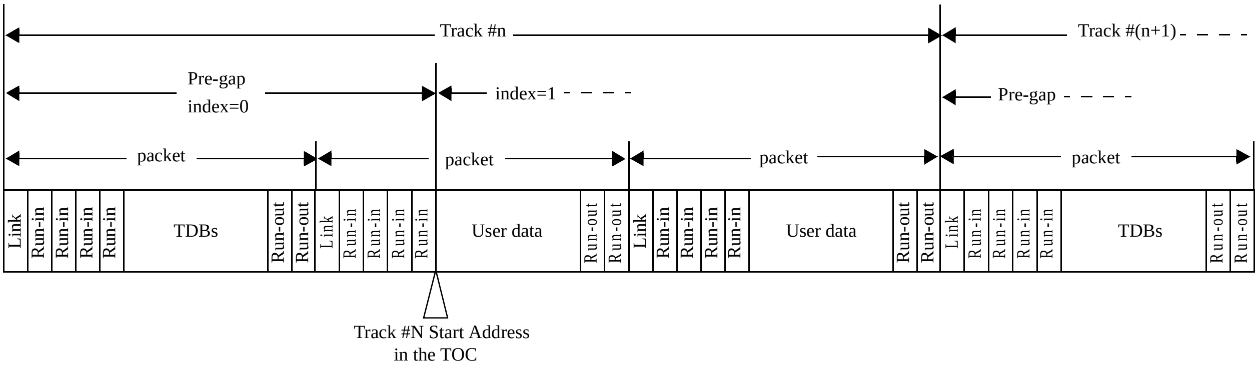

Figure 83 - Example of Packet written track layout

F-1.1.1 Track Descriptor Block

Information about current track attributes is encoded in the Pre-gap as Track Descriptor Block (TDB). Optionally all preceding track attributes are included in the TDB. One or more TDBs are recorded as one packet in the Pre-gap. The TDB consists of track descriptor table and track descriptor unit(s). The track descriptor unit gives the information such as writing method of the track and packet size. The track descriptor unit shall be used by the Logical Unit to determine Packet type and Packet size for a Packet recorded track. If the disc is recorded by Disc At Once, the TDB may not be present.

Table 440 - Track Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0 - 7	Track Descriptor Table							
0 - N	Track Descriptor Unit(s)							

Track Descriptor Table consists of 8 bytes and is structured as shown below.

1. Specifications developed by Philips & Sony Corp.

Table 441 - Track Descriptor Table

Bit / Byte	7	6	5	4	3	2	1	0
0	Track Descriptor Identification (54h)							
1	Track Descriptor Identification (44h)							
2	Track Descriptor Identification (49h)							
3	Pre-Gap Length							
4								
5	Type of Track Descriptor Unit							
6	Lowest Track Number							
7	Highest Track Number							

The **Track Descriptor Identification** field contain the Hexadecimal code: '54 44 49' (ASCII "TDI").

The **Pre Gap length** field contain the number of blocks of the second part of this Pre Gap, encoded in BCD.

The **Type of Track Descriptor Unit field** indicates which Track Descriptor Units are present. When this field set to 00h, indicates that Track Descriptor Units of previous tracks are present in this Track Descriptor Block. When this field set to 01h, indicates that only the Track Descriptor Units of the current track is present in this Track Descriptor Block. In other case, this field shall be reserved.

The **Lowest Track number** field indicates that the lowest track number described in this Track Descriptor Block, encoded in BCD.

The **Highest Track number** field indicates that the highest track number described in this Track Descriptor Block, encoded in BCD.

Track Descriptor Unit describes the data attributes of the track and consists of 16 bytes. The contents of these 16 bytes are shown in "*Table 442* - Track Descriptor Unit".

Table 442 - Track Descriptor Unit

Bit / Byte	7	6	5	4	3	2	1	0
0	Track Number							
1	(MSB)			Write Method of the Track				(LSB)
2	Packet Size							
3								
4								
5	Reserved							
:								
15								

The **Track Number** field contains that the number of the Track to which this Track Descriptor Unit belongs, BCD encoded.

The **Write Method of the Track** field when Bit 7 through Bit 4 set to 1000b, indicates that the track is uninterrupted written data track and consists of only one packet. In this case, Bit 3 through Bit 0 shall be reserved and set to 0000b.

When the Bit 7 through Bit 4 set to 1001b, indicates that the track is incrementally written data track and consists of more than one packet. In this condition, when Bit 3 through Bit 0 set to 0000b, indicates that the packet size is variable length. And if Bit 3 through Bit 0 set to 0001b, indicates that the packet size is fixed length. All other values for Bit 3 through Bit 0 are reserved.

When the Bit 7 through Bit 4 set to 0000b, indicates that the track is uninterrupted written audio track. In this condition, Bit 3 through Bit 0 shall be reserved and set to 0000b.

All other values for Bit 7 through Bit 4 are reserved. And any corresponded values for Bit 3 through Bit 4 are also reserved.

The **Packet Size** field shall be interpreted as follows:

For Incremental written Tracks with fixed Packet Size (Byte 1 = 91h), these bytes contains the BCD encoded Packet Size in blocks (MSBytes first). For Incremental written Tracks with variable Packet Size (Byte 1='90' hex), and Uninterrupted written Data Tracks (Byte 1 = 80h), these three bytes contain the code FFFFFFh.

The **Reserved** field shall be reserved and set to zero.

F-1.2 Returned data for DVD media

The READ DISC INFORMATION and READ TRACK/RZONE INFORMATION returned data includes the RZone/Border information for DVD media. However, there is no concept of RZone/Border in DVD-ROM/RAM media. For DVD-ROM or formatted DVD-RAM media, to respond to this command appropriately, the Data Area is considered to be one RZone which has RZone number one and the number of Border is considered to be one.

For Read Only Logical Unit, the interpretation of the status of DVD media which has one or more complete Border is based on followings:

- Disc Status is always treated as "Complete" even if there is incomplete Border on the disc.
- Last Border is considered to be the Complete Border closed at the end even if there is an incomplete Border exists following the complete Border. The incomplete Border which has not been closed by writable Logical Unit is not considered to return disc/RZone status. Only the information on Complete Border(s) on the disc shall be returned.
- The RZone number of the first RZone is one.
- Number of Border is the total of closed Complete Borders.

If the blank disc or the disc which has no complete Border is inserted into Read Only Logical Unit, appropriate error shall be returned. And media access commands shall report BLANK CHECK when a Blank disc is loaded.

The Figure 84 shows one example of DVD-R recorded media. (Border 1 and Border 2 are both completed. Border 3 is incomplete status. Each Border has some RZones.)

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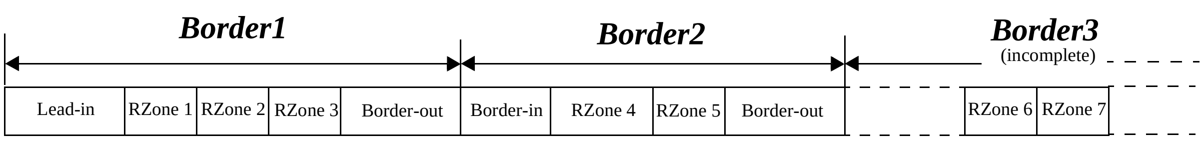

Figure 84 - Example of DVD-R Multi-Border disc

"Table 443 - Example of READ DISC Information returned for DVD media" on page 485 shows the example of data returned, when the READ DISC INFORMATION Command is issued for the above media. The Returned data for DVD-ROM/RAM disc are also shown in same figure.

Table 443 - Example of READ DISC Information returned for DVD media

Media Type Disc Information field	DVD-R disc	DVD-ROM disc	DVD-RAM disc
Erasable	0	0	1
Status of Last Session/Border	11b (Complete)	11b (Complete)	11b (Complete)
Disc Status	10b (Complete Disc)	10b (Complete Disc)	10b (Complete Disc)
Number of First RZone on Disc	1	1	1
Number of Borders	2[a]	1	1
First RZone Number in Last Border	4[a]	1	1
Last RZone Number in Last Border	5[a]	1	1
DID_V	0	0	0
DBC_V	0	0	0
URU	invalid	invalid	invalid
Disc Type	invalid	invalid	invalid
Disc Identification	invalid	invalid	invalid
Lead-in Start Time for Last Session (MSF)	invalid	invalid	invalid
Last Possible Start Time for Start of Lead-out (MSF)	invalid	invalid	invalid
Disc Bar Code	invalid	invalid	invalid

a. In the case of *"Figure 84 - Example of DVD-R Multi-Border disc"* on page 484.

To get the RZone status of DVD media, the READ TRACK/RZONE INFORMATION Command shall be used. There are two kinds of writing method of recording data in DVD-R media. Disc At Once and Incremental recording are used as the method of recording DVD media.

For Read Only Logical Unit, the interpretation of the RZone status is shown in *"Table 444 - Example of READ TRACK/RZONE Information returned for DVD media"* on page 485.

Table 444 - Example of READ TRACK/RZONE Information returned for DVD media

RZone type Track Information Field	DVD-ROM/DVD-RAM/ DAO written RZone	Incremental written RZone
Damage	0	0
Copy	invalid	invalid
Track Mode	invalid	invalid
RT	0 or 1[a]	1
Blank	0	0
Packet/Inc	0	1
FP	invalid	invalid
Data Mode	invalid	invalid
NWA_V	0	0
RZone Start Address	0	from RMD in Border-out
Next Writable Address	invalid	invalid
Free Blocks	0	0
Blocking Factor	16	16
RZone Size	from Lead-in	from RMD in Border-out

a. If it can be considered the disc as ROM or RAM disc, this field is set to 0.

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Appendix G - CD-Text Format in the Lead-In Area (Informative)

This annex explains the CD-Text information that is stored in the Lead-In Area as raw R-W Sub-channel data. The information here is stored in a memory and can be retrieved to the Initiator immediately.

G-1 General

The CD-Text information in the Lead-In area is retrieved from raw R-W Sub-Channel data. The data format of RAW Sub-channel is explained in Table 236 - *P-W Raw* on page 305. 6 bits of each byte are R-W Raw data and are converted from 6 bits to 8 bits from the 1^{st} bytes, thus making 4 chunks of 18 bytes of data each. Each 18 byte data block is called CD-Text Pack Data as shown in Table 445. CD-Text information is recorded repeatedly in the Lead-In area and this one repeated data is called the Text Group. Each Text Group consists of up to 8 types of language Blocks. Each Block represents one language and consists of a maximum of 255 sets of Pack Data. Table 445 shows the contents of one Pack Data.

Table 445 - CD-Text Pack Data format for the Lead-In area

Bit / Byte	7	6	5	4	3	2	1	0
0	Pack Type Indicator							
1	EF	Track Number Indicator						
2	Sequence Number Indicator							
3	DBCC	Block Number			Character Position			
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							

Each Data Pack consists of a four byte Header Field, twelve bytes of Text Data and a CRC Field.

The Pack Type Indicator has the value and descriptions defined in Table 446. Packs shall be encoded in the order of the items listed in the Table.

Table 446 - Pack Type Indicator Definitions

Pack Type	Description
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 **EF** (Extension Flag) bit is normally set to 0b. If it is set to 1b, the Pack is used for an extended application.

The **Track Number** field contains the Track Number or Pack Element Number. A Track Number is used when the Text Data fields belongs to a track. If the Pack is independent of Tracks, this field indicates Pack Element Number which depends on the type of the Pack.

The **Sequence Number** Indicator is the number incrementally increased from the first Pack to the end in each Block. It starts from 00h to FFh.

The DBCC (Double Byte Character Code) bit, when set to one, indicates that the Text Data Field contains a Double Byte Character Code. When set to 0b, the Single Byte Character Code is used.

The Block Number field indicates 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. Up to 8 can be used at the same time.

The Character Position field is the number of characters in the strings that belong to the Text Data Field in the previous Pack. The Character Position starts from 0 to 15, and 15 indicates that the first character belongs to the one before the previous Pack. When the character code is double byte code, a set of 2 bytes in the Text Data Field is counted at one.

A null code is also counted as a character, which indicates termination of each string.

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 Pack Types 88h, 89h and 8Fh shall contain character strings in the Text Data Field. If Packs with Pack Type 80h to 85h, and 8Eh are used, a character string 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 codes for double byte)

The size of a character string is recommended to be less than 160 bytes. If a character string does not fit in a Text Data Field of a Pack, it is continued onto the succeeding Packs. The succeeding character string will be encoded starting at the next byte in the Text Data Field after the terminator of the current string. Unused bytes in the Text Data Field shall be filled with null codes.

In case the same character stings is used for consecutive tracks, the Tab Indicator may be used to indicate the same as previous track. It is a single tab code (09h) for single byte codes, and two tab codes for double bytes character codes. It shall not used for the first track.

Packs with ID1=86h, 87h, 88h, 89h and 8Fh contains binary information in the Text Data Field.

The CRC Field consists of 2 bytes. The Host may use these bytes to check for errors in the Pack. The polynomial is $X^{16} + X^{12} + X^5 + 1$. All bits shall be inverted before recording. This field is not mandatory for supporting CD-Text data. This field shall be valid or set to 0000h.

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Appendix H - Mt. Fuji revision history (Informative)

H-1 Changes from Mt. Fuji 1 to Mt. Fuji 2

1. Added support for DVD-RAM devices.
2. Numerous spelling, grammatical, and convention errors fixed. (Changed most occurrences of CD-E to CD-RW, Used “Logical Unit” in place of “C/DVD Logical Unit,” “drive,” “target,”, and “device.”)
3. Added Feature Descriptors.
4. Added Profiles.
5. Added Regional Playback Control model and Command support.
6. Added a DVD-RAM model section.
7. Added a DVD-R model section.
8. Added the FLUSH CACHE Command.
9. Added the FORMAT UNIT Command.
10. Added the GET CONFIGURATION Command.
11. Removed the Feature Set Support & Version Page.
12. The GET EVENT/STATUS NOTIFICATION Command ***shall not*** clear the Unit Attention condition.
13. Changed the definition of the NEA bit from “No Event available in the requested Class(es)” to “None of the requested Event Classes is supported.”
14. The “MediaChange” Event was added.
15. Added the GET PERFORMANCE Command.
16. Allowed use of the EVPD bit in the INQUIRY Command.
17. Updated the Audio Attenuation Levels in the CD Audio Control Page.
18. Added the READ (10) Command.
19. Added the READ BUFFER Command.
20. Added READ DVD STRUCTURE Format 8h.
21. Added the READ FORMAT CAPACITIES Command.
22. Added fabrication of data for DVD media to the READ TOC/PMA/ATIP Command.
23. Added the Last Recorded Address, Track/RZone Number (MSB), Session/Border Number (MSB), and two reserved bytes to the READ TRACK/RZONE INFORMATION Command result data.
24. Added REPORT KEY Format 1000b for RPC state.
25. Added SEND KEY Format 110b for RPC.
26. Added the SET STREAMING Command.
27. Added the VERIFY (10) Command.
28. Added the WRITE (10) Command.
29. Added the WRITE and VERIFY (10) Command.
30. Added the WRITE BUFFER Command.

H-2 Changes from Mt. Fuji 2 to Mt. Fuji 3

1. Added support for CD-R, CD-RW, DVD-R, DVD+RW, and AS-MO devices.
2. Added terms to *2.2, "Definitions"* on page 29 for the added device support.
3. Added parameters for new devices to Table 8 - *General Parameters of DVD Discs* on page 54.
4. Added parameters for the Physical Information descriptor (Table 11 - *Common Part of Physical Format Information* on page 64) for the new devices.
5. Added *4.15, "Recording/Reading for DVD+RW Media"* on page 89.
6. Added material to *4.16, "Recording for DVD-R media"* on page 95 to describe writing to DVD-R.
7. Added *5.0, "AS-MO model"* on page 129.
8. Obsoleted the *C/DVD Capabilities & Mechanical Status* Mode Page (2Ah) and adjusted references to it to point to the appropriate Feature Descriptor instead.
9. Added Profiles for Non-removable disk, MO Erasable, MO Write Once, AS-MO, CD-R, CD-RW, and DVD-R to *Section 10.0, "Profiles"* on page 161.
10. Modified the DVD-RAM or DVD+RW Feature (0012h) to include DVD+RW (description only).
11. Added the BLANK Command.
12. Added the COMPARE Command.
13. Added the ERASE (10) Command.
14. Added the CLOSE TRACK/RZONE/SESSION/BORDER Command.
15. Added descriptors 10h, 11h, 12h, and 20h to the FORMAT UNIT Command for CD-RW and DVD+RW.
16. Added Incremental Streaming Writable, Sector erasable, Write Once, Restricted Overwrite, CD Track at Once, CD Mastering, DVD-R Write, Logical Unit serial number, and Disc Control Blocks Features.
17. Modified the Morphing Feature to describe the case of Class 3 Events.
18. Modified the Random Writable Feature to remove dependency on the Random Readable Feature (added bytes 8-15).
19. Added the Operational Change Request/Notification, External Request, and Multi-Initiator Event Classes to the GET EVENT/STATUS NOTIFICATION Command.
20. Added the *Write Parameters* Mode Page (05h).
21. Added the Address field to the READ DVD STRUCTURE Command.
22. Added structures 05h, 0Ch-0Fh, 30h, and FFh to the READ DVD STRUCTURE Command.
23. Added result codes to the READ DVD STRUCTURE Command for some fields for new media support.
24. Added format codes 10h-12h and 20h to the READ FORMAT CAPACITIES Command.
25. Added format 5h for CD-Text to the READ TOC/PMA/ATIP Command.
26. Added the REPAIR RZONE Command.
27. Added the Key Class field to the REPORT KEY and SEND KEY Commands.
28. Added the BLANK CHECK Sense Key to the REQUEST SENSE Command.
29. Added the RESERVE TRACK/RZONE Command.
30. Added the SEND CUE SHEET Command.
31. Added the SEND DVD STRUCTURE Command.

32. Added the SEND EVENT Command.
33. Added the SEND OPC INFORMATION Command.
34. Obsoleted the SET C/DVD SPEED Command.
35. Added use of the BlkVfy bit in the VERIFY (10) Command.
36. Added descriptions on the use of the WRITE (10) Command with sequentially written media.
37. Added *Appendix D - "IEEE 1394 Implementation Notes (Normative)"* on page 473.
38. Added *Appendix E - "Example Event Implementation Notes (Informative)"* on page 477
39. Added *Appendix F - "Command Implementation Notes (Informative)"* on page 479 for a description of using the READ DISC INFORMATION and READ TRACK/RZONE INFORMATION Commands.
40. Added *Appendix G - "CD-Text Format in the Lead-In Area (Informative)"* on page 487.
41. Added this Appendix.
42. Added *Appendix I - "Sample Applications of Events (Informative)"* on page 495.
43. Added *Appendix J - "UDF Key Structure (Informative)"* on page 501 describing the use of the Mt. Fuji Commands to enable reading UDF discs.

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Appendix I - Sample Applications of Events (Informative)

I-1 Overview

Events were designed to be a one-way pipe of information from the Logical Unit to the Host. The original design intent for this functionality was to use Asynchronous Event Notification, where the Logical Unit would issue Commands to the Host to notify the Host about asynchronous events. This behavior cannot be implemented on ATAPI busses. In addition, the software driver stack on most operating systems does not allow for “target mode” operation. Changing the stacks to allow this behavior would require a large effort.

The GET EVENT/STATUS NOTIFICATION Command simply provides for asynchronous event notification through the traditional Command path. It is the “output” of the pipe.

Input to the pipe is generated by the Logical Unit in response to asynchronous events within the Logical Unit. Operation of user controls (buttons, trays, magazines, etc.), resets, requests from other Hosts, and power state changes due to timers are examples of events that cause an Event Descriptor to be placed into the Event Queue (pipe).

An Event is generated when it is placed into the Event Queue. An Event is reported when the GET EVENT/STATUS NOTIFICATION Command is used to read it from the Queue. Unless a GET EVENT/STATUS NOTIFICATION Command was queued because an Event was requested for an empty Queue and the Immed bit was set to zero, there is no timing requirement between generating and reporting events. For example, a new Logical Unit in a legacy system would generate Events and never report them.

The Multi-Host behavior described here is for a co-operative type of shared use. This model is best suited for an occasionally shared environment, particularly use by a single user across multiple machines. It is not suited for frequent intermixed access.

I-2 Example Logical Unit Implementation

Several Commands are used by the Host when utilizing Events. Examples given here show only a few of the possible sequences in which Commands could be received. A Logical Unit should not need any state information for the implementation of Events and Morphing other than that explicitly described here. The following represents one basic model for implementation; it is not intended to be the only possible implementation.

The following is a list of state information that can be modified by a Host. The list does not include Commands that have secondary effects such as ejecting the medium. Some of the state information can be modified by the Logical Unit in addition to the Host. The type of the state information is given in brackets.

1. Persistent Prevented [Boolean]
2. Persistent Prevented Owner [ID]
3. Prevented (one per Host) [Boolean]
4. Event Queue (one queue per Event Class per Host) [Event Data]
5. Sense Data (one per Host) [SK/ASC/ASCQ]

I-2.1 Operation of the PREVENT/ALLOW MEDIUM REMOVAL Command

I-2.1.1 Persistent Prevent

Normally, the Logical Unit executes each Command as received, regardless of the source of each Command. The PREVENT/ALLOW MEDIUM REMOVAL Command is used to modify the state of the Persistent Prevented, Persistent Prevented Owner, and Prevented variables. These bits are checked by most Commands to determine if and how that Command operates.

While in the Persistent Prevented state, Commands from other Hosts that would affect the Host owning the Persitent Prevent will fail. In addition to failing the Command with CHECK CONDITION Status, 5/2C/05 PERSISTENT

PREVENT CONFLICT, the Logical Unit may send an External Request Event to the Host owning the Persistent Prevent. Such Events ***shall not*** be generated for Commands that require data transfer.

If a PREVENT/ALLOW MEDIUM REMOVAL Command with the Persistent and Prevent bits set is received from the Host that originally set the Persistent Prevented state, or the Persistent Prevented state is False, the Logical Unit ***shall*** set the Persistent Prevented state and the Persistent Prevented Owner ***shall*** be set to the ID of the issuing Host. The Logical Unit ***shall*** generate Multi-Host Event, Control Grant Events for all other Hosts.

If a PREVENT/ALLOW MEDIUM REMOVAL Command with the Persistent and Prevent bits set is received from a Host other than the one that set the Persistent Prevent state, the Logical Unit ***shall*** fail the Command with CHECK CONDITION Status, 5/2C/05 PERSISTENT PREVENT CONFLICT. The Logical Unit ***shall*** generate a Multi-Host Event, Control Request Event for the Host owning the Persistent Prevent.

If a PREVENT/ALLOW MEDIUM REMOVAL Command with the Persistent bit set and the Prevent bit cleared is received from the Host owning the Persistent Prevented state, or the Logical Unit is not in the Persistent Prevented state, the Persistent Prevented state ***shall*** be cleared. The Logical Unit ***shall*** generate a Multi-Host Event, Control Release Event for all other Hosts.

If a PREVENT/ALLOW MEDIUM REMOVAL Command with the Persistent bit set and the Prevent bit cleared is received from a Host other than the one that originally set the Persistent Prevent state, the Logical Unit ***shall*** fail the Command with CHECK CONDITION Status, 5/2C/05 PERSISTENT PREVENT CONFLICT. The Logical Unit ***shall*** generate a Multi-Host Event, Control Request Event for the Logical Unit owning the Persistent Prevent.

I-2.1.2 Legacy Prevent

The Logical Unit is in the Prevented state if any Host has a Prevent in place.

If a PREVENT/ALLOW MEDIUM REMOVAL Command with the Persistent bit cleared and the Prevent bit set is received from the Host that originally set the Persistent Prevented state, or the Persistent Prevented state is False, the Logical Unit ***shall*** set the Prevented state for the issuing Host.

If a PREVENT/ALLOW MEDIUM REMOVAL Command with the Persistent bit cleared and the Prevent bit set is received from a Host other than the one that set the Persistent Prevent state, the Logical Unit ***shall*** fail the Command with CHECK CONDITION Status, 5/2C/05 PERSISTENT PREVENT CONFLICT.

If a PREVENT/ALLOW MEDIUM REMOVAL Command with the Persistent bit cleared and the Prevent bit set is received, the Logical Unit ***shall*** clear the Prevent state for that Host.

I-2.2 Operation of the GET CONFIGURATION Command

The GET CONFIGURATION Command result data is determined primarily by state information derived from the medium. This includes media type, presence of certain data types, write protect state, and many other variables not controllable directly through the interface.

The GET CONFIGURATION Command result data may be affected by the Persistent Prevented state. For example, Features that would interfere with Logical Unit operation as seen by the Host owning the Persistent Prevented state might be marked as not Current. Determination of interfering Features is vendor unique. For example, a CD-R drive vendor might determine that reading interferes with the owning Host’s operation, but a CD-ROM drive vendor may not.

I-2.3 Operation of the GET EVENT/STATUS NOTIFICATION Command

In some implementations, the sole job of the GET EVENT/STATUS NOTIFICATION Command is to pop the next Event from the Event Queue (if any) and return it to the host. If no Event is in any of the requested Queues, the Command either completes with the result data indicating No Event (Immed = 1) or is kept in the Command Queue (Immed = 0) until an Event in one of the requested classes occurs.

An implementation that locks the tray when the New Media Event is reported rather than when it is generated must either maintain a state variable to indicate reporting of the New Media Event or provide a function to peek into the Event Queue to see if a New Media Event is present in the Media Event Class Queue.

I-2.4 Operation of the START/STOP UNIT Command

If a Prevent is in place for any Host, all Eject requests ***shall*** fail.

If a Persistent Prevent is in place, all Eject requests from Hosts other than the Persistent Prevent owner ***shall*** fail.

An Eject request from the Host that owns the Persistent Prevent or if no Persistent Prevent is in place ***shall*** succeed.

I-2.5 Operation of the SEND EVENT Command

The SEND EVENT Command simply executes the requested function, if possible. The function will typically correspond to a function that can be requested from the front panel.

The Logical Unit ***shall not*** check to see if a corresponding Event had been reported. The Logical Unit simply determines if the requested function can be performed, and if so, performs the requested function.

If a Host owns a Persistent Prevent, SEND EVENT Commands from other Hosts ***shall*** fail.

I-2.6 Internal functions

A Generate Event function is called in many different situations, including from within commands and external event monitors. It should take Class, Event, Status, Event Data, and Host information as data. Host information includes the ID of a Host and whether the Event is for that Host, all Hosts, or all Hosts but the one identified. The routine that mounts new media would call this function with Media Event Class, New Media, Media Status 2, Slots 1 - 1, all Hosts. The PREVENT/ALLOW MEDIUM REMOVAL Command may call this function with Multi-Host Event Class, Control Release Event, Multi-Host Status Ready, Event Data 0, all Hosts but the one issuing the Command as parameters.

If a Logical Unit locks the tray when Persistent Prevented and the New Media Event is generated, the START/STOP UNIT Command can simply check for the media mounted state and the Persistent Prevented state, since the media mounted state is entered at the same time that the Event is generated (by definition of the New Media Event).

If a Logical Unit locks the tray when Persistent Prevented and the New Media Event is reported, either a separate state variable is needed to track the Event reporting, or a Peek at Event Queue function is needed to determine if a New Media Event is still present (not yet reported). In this model, if a New Media Event is in the Queue, and the eject button is pressed, the Logical Unit ***shall*** remove the New Media Event from the Queue before ejecting the medium.

I-2.7 Summary

Table 447 represents drive behavior upon receipt of various Commands. The Persistent Prevented state represents the state of the Logical Unit before receipt of the Command. The Same Host column identifies Commands that were received from the same Host that owns the Persistent Prevent.

Table 447 - Persistent Prevent Behavior

<table>
<tr><th>Command</th><th>Persistent Prevented</th><th>Same Host</th><th>Action</th></tr>
<tr><td rowspan="3">PREVENT/ALLOW MEDIUM REMOVAL, Persistent = 1, Prevent = 0 (Persistent Allow)</td><td>N</td><td>X</td><td>Generate Control Release Event for all other Hosts.</td></tr>
<tr><td rowspan="2">Y</td><td>N</td><td>Fail the Command</td></tr>
<tr><td>Y</td><td>Leave the Persistent Prevented state. Generate Control Release Event for all other Hosts.</td></tr>
<tr><td rowspan="3">PREVENT/ALLOW MEDIUM REMOVAL, Persistent = 1, Prevent = 1</td><td>N</td><td>X</td><td>Enter the Persistent Prevented state (for that Host). Generate Control Grant for all other Hosts.</td></tr>
<tr><td rowspan="2">Y</td><td>N</td><td>Fail the Command, generate Control Request Event for the Host that owns the Persistent Prevent.</td></tr>
<tr><td>Y</td><td>Generate Control Grant for all other Hosts.</td></tr>
</table>

Table 447 - Persistent Prevent Behavior

Command	Persistent Prevented	Same Host	Action
Any Command that requires data transfer but doesn't affect Logical Unit operation (e.g. INQUIRY)	N	X	Execute the Command
	Y	N	Execute the Command
		Y	Execute the Command
Any Command that requires data transfer and affects Logical Unit operation (e.g. MODE SELECT (10))	N	X	Execute the Command
	Y	N	Fail the Command
		Y	Execute the Command
Any Command that does not require data transfer and does not affect Logical Unit operation (e.g. TEST UNIT READY)	N	X	Execute the Command
	Y	N	Execute the Command
		Y	Execute the Command
Any Command that does not require data transfer but affects Logical Unit operation (e.g. START/STOP UNIT)	N	X	Execute the Command
	Y	N	Fail the Command. May generate an External Request Notification Event.
		Y	Execute the Command

I-3 Example Host Implementations

The following examples are not meant to describe all applications and possibilities. They represent just a few possible implementations.

I-3.1 Host Use of the Multi-Host Event Class

In this model, a single Host requests control of the Logical Unit via the Persistent Prevent Command. If successful, the Host can operate as if it were the only Host. If not successful, most Commands may fail. If the Host requires use of the Logical Unit, the Host should wait for a Control Release Event. After a reasonable time-out (user intervention is probably required on the owning Host), the Host may attempt another Persistent Prevent Command (to trigger another Control Request Event to the owning Host).

Note: The Control Release Event may never occur, especially if the owning Host does not implement this protocol.

If a Host owns the Persistent Prevent, it ***shall*** expect to receive Control Request Events. If a Control Request Event is received, the Host should flush its buffers and unmount any file systems on that Logical Unit. If the unmounting is successful, the Host should issue a PREVENT/ALLOW MEDIUM REMOVAL Command, Persistent = 1, Prevent = 0. If the unmounting is unsuccessful, the Host should notify the user about the attempted operation and the possible reason or reasons for its failure.

A Host will generally not issue a PREVENT/ALLOW MEDIUM REMOVAL Command, Persistent = 1, Prevent = 0 unless:

1. The user explicitly unmounts the Logical Unit.
2. The system is shut down.
3. It is responding to a Control Request Event.

In this model, it is not necessary to do a Persistent Allow when immediate needs are met; it is sufficient to do it when a request comes from another Host.

This results in a ping-pong type behavior that is suited to a single user on several machines, or where a single resource is shared among co-operating users. This model is similar to that of a printer, where the “owner” can only change between “jobs.” The granularity is very coarse. This is necessary because mounting and unmounting file systems is a time consuming process, and should be performed only as often as required.

I-3.2 Host Use of the Operational Event Class

The Operational Event Class was designed for “intelligent” peripherals that have front panel buttons and the ability to perform operations based on those buttons. For example, a Logical Unit that acts as both a CD-R and a standalone CD-R audio component may have “Record” and “Finalize” buttons, among others. Some buttons may have behavior that interferes with operations that the Host may attempt. If the Logical Unit is in the Persistent Prevented state, such interference is not allowed.

However, it is desired that the front panel buttons continue to function. To allow this, the Host is “put in the loop.” That is, instead of acting directly on the button, the Logical Unit generates Events to be reported to the Host.

One implementation possibility is to not look for such Events, or to discard them as received. If a Persistent Prevent is issued, the controls on the front panel essentially are deactivated. If only selected Events are discarded, the corresponding buttons are deactivated.

An implementation that acts on Events may use the SEND EVENT Command to request that the Logical Unit handle the Event as it would if the Persistent Prevent were not in place. If the Event is one that is not known to the Host, it should flush buffers and umount the media before issuing the SEND EVENT Command because the operation to be performed is unknown. The same rule applies for known Events that depend on or modify the state of the medium.

Finally, an implementation may act upon the button presses itself. For example, if a software application is being used to play DVD-Video, it may act on a “Fast Forward” button press by sending a code to the application to perform a “Fast Forward” operation.

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Appendix J - UDF Key Structure (Informative)

J-1 Introduction

OSTA Universal Disk Format (UDF) is the file system that is adopted as the standard DVD file system. OSTA UDF is a subset of the standard ECMA 167 3rd edition. The Command set described in this document was designed to allow easy access to information required by a UDF implementation.

To read UDF written disc, following descriptors and sequences are used to get file structure.

- Volume Recognition Sequence (VRS)
- Anchor Volume Descriptor Sequence (AVDP)
- Volume Descriptor Sequence (VDS)
- File Set Descriptor (FSD)
- Root Directory ICB
- Root Directory file

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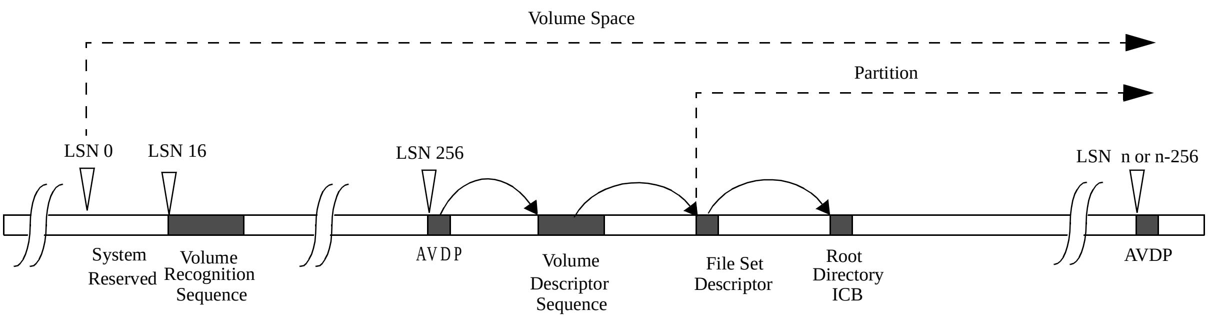

Figure 85 - Basic UDF Structure

For UDF sequential recording, following are also used.

- Virtual Allocation Table ICB (VAT ICB)
- Virtual Allocation Table (VAT)

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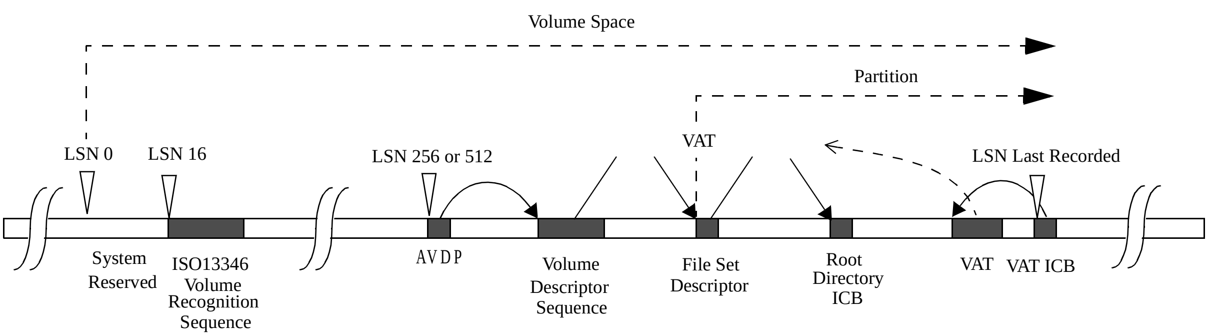

Figure 86 - Basic UDF Structure used on sequentially written media

VRS shall start at LSN 16. VRS contains information on whether the volume complies with ECMA 167. This sequence may contain ISO 9660 descriptors also.

When the volume is sequentially written, a Virtual Allocation Table (VAT) is recorded to translate Virtual Addresses to Logical Addresses. To find the Virtual Allocation Table, the VAT ICB shall be written in the last user data sector.

AVDP shall be recorded at LSN 256, and LSN n or n-256, where n is the last LSN. For sequentially written media, AVDP can be located only at LSN 512 until closing the volume. AVDP contains pointer to the VDS.

The Volume Descriptor Sequence (VDS) is made up of several Volume Descriptors such as a Primary Volume Descriptor, a Logical Volume Descriptor, and a Partition Descriptor. The Logical Volume Descriptor contains pointer to the File Set Descriptor.

The File Set Descriptor contains pointer to the Root Directory ICB.

The Root Directory ICB contains either the Root Directory file or pointers to the Root Directory file.

For further information on UDF, refer to OSTA UDF specification, available from http://www.osta.org/

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