T10/04-318R0

Blu-ray Disc ROM (BD-ROM) Multi-Media Command Set Description

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Contents

Figures

Tables

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1 Scope

Blu-ray Disc Read-only is a media type that requires special behavior by the Initiator and device. This document describes the set of Multi-Media commands that allow an Initiator to utilize the capabilities of BD Logical Units. The ultimate destination for the content of this document is MMC-5.

This document is created to match the structure of MMC-4:

1. Scope – This section
2. References – A list of documents that may be needed by the reader for the correct understanding of this document.
3. Definitions, Symbols, Abbreviations, and Conventions – A glossary of terminology unique to this document
4. BD-ROM Models – Modeling for the various media oriented behaviors that the Initiator may witness from the device provides an overview of internal drive operation to the Initiator application developer.
5. Features and Profiles for BD-ROM Devices – Features describe Logical Unit capability while profiles define a general device view.
6. Commands for BD-ROM Devices – Commands are described from the Initiator's point of view.
7. Mode Parameters for BD-ROM Devices – Inputs required by the drive are not always a part of a command. Inputs associated with mode of operation are readable and sometimes writable.

2 References

2.1 Normative References

2.1.1 Approved References

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

ANSI NCITS.351:2001	SCSI-3 Primary Commands (SPC-2)
ANSI INCITS 360:2002	SCSI-3 MultiMedia Command Set 3 (MMC-3)
ANSI NCITS.306:1998	SCSI-3 Block Command Set (SBC)
ANSI NCITS.361:2002	AT Attachment with Packet Interface 6 (ATA/ATAPI-6)
ECMA 167, 3rd Edition	Volume and File Structure for Write-Once and Rewritable Media using Non-Sequential Recording for Information Interchange

2.1.2 References Under Development

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

INCITS T10/1416D	SCSI Primary Command Set - 3 (SPC-3)
INCITS T10/1417D	SCSI Block Command Set - 2 (SBC-2)
INCITS T13/1532D	AT Attachment with Packet Interface 7 (ATA/ATAPI-7)
INCITS T10/1545D	SCSI-3 MultiMedia Command Set 4 (MMC-4)

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

2.2 Other References

Serial ATA: High Speed Serialized AT Attachment, INCITS T13/e03104r0. Note: This document is not a proposed standard. It is available to the public at www.t13.org.

System Description Blu-ray Disc Read-only Format, Part 1 Basic Format Specifications, Version 1.00 (Preliminary), July 2004. For more information, contact: www.blu-raydisc.info.

3 Definitions, Symbols, Abbreviations, and Conventions

3.1 General

The Definitions, Symbols, Abbreviations, and Conventions described in MMC-4 are valid within this document. The Definitions, Symbols, Abbreviations, and Conventions described in this clause are in addition to those found in MMC-4. In the event of duplication, this document shall rule.

3.2 Terms

3.2.1 BD

Blu-ray Disc (BD) is a high capacity system that defines media and includes devices capable of reading such media and optionally writing to recordable sub-types of that media.

3.2.2 BD-ROM

A BD-ROM disc is a read-only BD disc. BD-ROM devices are devices that are able to read a BD-ROM disc.

3.2.3 Block (Logical Block)

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

3.2.4 Cluster

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

3.2.5 Information Area

The area on the disc in which information can be recorded.

3.2.6 Information Zone

The actually recorded part of the information area.

3.2.7 Logical Sector Number (LSN)

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

3.2.8 Permanent Information & Control data (PIC) Zone

This zone contains general information about the disc.

3.2.9 Sector

A BD sector contains control information, one logical block, and logical block EDC.

3.3 Abbreviations

BD	Blu-ray Disc	L0	Layer 0 of a BD disc
BD-ROM	Read-only Blu-ray Disc	L1	Layer 1 of a BD disc
DDS	Disc Definition Structure	LSN	Logical Sector Number
DL	Dual Layer	PIC	Permanent Information & Control data
INFOx	Information Zone (x=1..4)	SL	Single Layer

4 BD-ROM Models

4.1 BD-ROM, General

Blu-ray Disc (BD) is a collection of high-density optical media: ROM (Read-Only Memory), R (write-once Recordable), and RE (Rewritable). There is the possibility of either one or two layer discs.

The BD disc may have one readable/recordable layer or the BD disc may have two readable/recordable layers. In the case of two layers, the BD disc is constructed only as opposite track path (OTP). Logically, the user area of each disc appears to the Initiator as a single continuous address space. Each layer has a continuous spiral track. The logical block size of BD is 2 048 bytes collected into recordable units called Clusters:

- A Cluster contains 32 sectors. The data of these 32 sectors are interleaved, scrambled, and EDC and ECC symbols are attached. The resulting structure is the physical Cluster.
- The error correction for user data within a BD sector is protected by the error correction coding in the Cluster that contains the sector.

This document only addresses commands for BD-ROM.

The Initiator access model for BD-ROM is based upon a random access read-only model.

The READ CAPACITY command is used to determine the recorded capacity of the BD disc. The command reports the last recorded LBA on the BD disc.The capacity of the disc is READ CAPACITY LBA+1.

The READ (10) and READ (12) commands are used to access any sector within the LBA range of 0 through READ CAPACITY LBA.

4.2 Physical Media Structure

BD-ROM disc has a 120 millimeters diameter and is separated into zones as shown in Figure 1

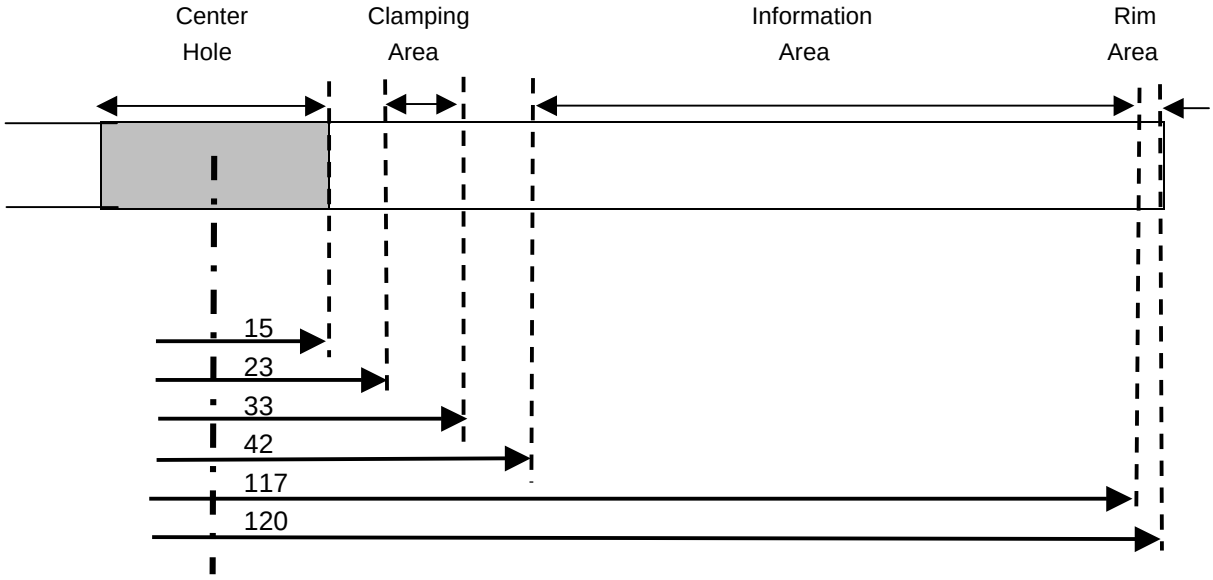

Figure 1 - The Areas of a BD-ROM Disc

The Center Hole, Transition Areas and Clamping Area are all part of the alignment and clamping mechanisms. These areas have no direct involvement with the accessible areas of the BD disc.

The Information area is the area in which actual accessing may occur. It contains the lead-in zone, the data zone, and the lead-out zone. This area begins at a nominal diameter of 42 millimeters and proceeds to the outer diameter. For 120-millimeter media, the information area ends at a nominal diameter of 117 millimeters.

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

4.3 Logical Media Structure

BD-ROM disc is a read-only media with 3 possible layer capacities: 23.3 GB, 25.0 GB, and 27.0 GB. A BD disc layer has a single continuous groove on each layer and may consist of one or two layers. Dual layer media is structured only as opposite-track-path. The capacity of a dual layer disc is twice the single layer capacity.

4.3.1 Track Structure

The single layer BD disc information zone is contained within a continuous spiral that begins near the inner radius and proceeds until the outer radius. The information zone is divided into three areas: the Lead-in Zone (Inner Zone 0), Data Zone, and Lead-out Zone (Outer Zone 0).

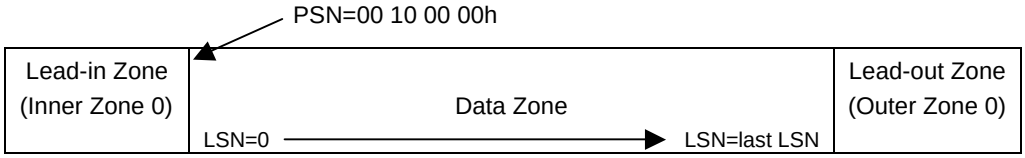

Figure 2 – Layout of Single Layer BD-ROM Information Zone

The layer 0 information zone of a dual layer BD disc is contained within a continuous spiral that begins near the inner radius and proceeds until the outer radius. The layer 1 information zone of a dual layer disc is contained within a continuous spiral that begins near the outer radius and proceeds until the inner radius. The layer 0 information zone is divided into three areas: the Lead-in Zone (Inner Zone 0), Data Zone 0, and Outer Zone 0. The layer 1 information zone is divided into three areas: Outer zone 1, Data Zone 1, and the Lead-out zone (Inner Zone 1).

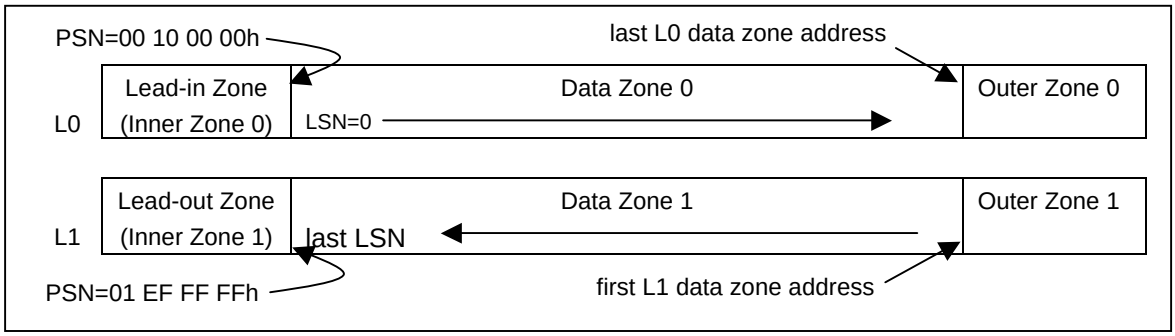

Figure 3 – Layout of Dual Layer BD Disc

4.3.2 Sectors and Clusters

The logical block size of BD is 2 048 bytes collected into recorded units called Clusters. A Cluster contains 32 sectors.

- The user data within a BD sector is protected by the error correction coding in the Cluster that contains the sector.
- BD-ROM discs may consist of one or two layers. In the case of two layers, the user area of each media appears to the Initiator as a single continuous address space.

The access model for BD is based upon the random access read-only device model:

- The user data space is organized in fixed size blocks (2 048 bytes/block) and addressed as logical blocks. Blocks in this Logical Block Address space may be read using only the READ (10) and READ (12) commands.
- Logical block addresses are numbered from 0 through READ CAPACITY LBA. The value of READ CAPACITY LBA is the logical block address returned by the READ CAPACITY command.
- The READ TOC/PMA/ATIP command is implemented to assure compatibility with existing applications. Only formats 0 and 1 are implemented. Some structures may be fabricated.

- Structures unique to BD may be read using the READ DISC STRUCTURES command.

4.3.3 The Information Zone

The information zone of a dual layer BD-ROM disc (Figure 4) is the accessible grooves.

<table>
<tr><td rowspan="10">Layer 0 Information Zone</td><td rowspan="2">Embossed (tracks at wide pitch)</td><td colspan="3">BCA</td></tr>
<tr><td rowspan="9">Lead-in Zone
(Inner Zone 0)</td><td>Protection Zone 1</td><td>Seek overshoot protection zone</td></tr>
<tr><td rowspan="8">Embossed (tracks at normal pitch)</td><td>PIC</td><td>Permanent Information & Control data Zone</td></tr>
<tr><td>Protection Zone 2</td><td>Seek overshoot protection zone</td></tr>
<tr><td>INFO2</td><td>Control Information area</td></tr>
<tr><td>Reserved</td><td>-</td></tr>
<tr><td>INFO1</td><td>Control information area</td></tr>
<tr><td></td><td>Data Zone 0</td><td>Primary user data area</td></tr>
<tr><td>Outer Zone 0</td><td>INFO3/4</td><td>Control Information area</td></tr>
<tr><td>Protection Zone 3</td><td>Seek overshoot protection zone</td></tr>
<tr><td colspan="4">Read Direction</td></tr>
<tr><td rowspan="10">Layer 1 Information Zone</td><td rowspan="8">Embossed (tracks at normal pitch)</td><td>Outer Zone 1</td><td>Protection Zone 3</td><td>Seek overshoot protection zone</td></tr>
<tr><td></td><td>INFO3/4</td><td>Control Information area</td></tr>
<tr><td></td><td>Data Zone 1</td><td>Primary user data area</td></tr>
<tr><td rowspan="5">Lead-out Zone</td><td>INFO1</td><td>Control information area</td></tr>
<tr><td>Reserved</td><td>-</td></tr>
<tr><td>INFO2</td><td>Control Information area</td></tr>
<tr><td>Protection Zone 2</td><td>Seek overshoot protection zone</td></tr>
<tr><td rowspan="3">Embossed (tracks at wide pitch)</td><td rowspan="3">(Inner Zone 1)</td><td>PIC</td><td>Permanent Information & Control data Zone</td></tr>
<tr><td>Protection Zone 1</td><td>Seek overshoot protection zone</td></tr>
</table>

Figure 4 –BD-ROM Information Zone

4.3.3.1 L0 Embossed (tracks at wide pitch)

4.3.3.1.1 BCA

The Burst Cutting Area (BCA), if present, contains application specific information.

4.3.3.1.2 Lead-in Zone (Inner Zone 0)

4.3.3.1.2.1 Protection Zone 1

This zone exists for seek overshoot protection at the disc's inner radius.

4.3.3.1.2.2 PIC

This area contains various data including disc information.

4.3.3.1.2.3 Protection Zone 2

This zone is a buffer area between the 2 track pitches. The first part of this zone has wide pitch.

4.3.3.2 L0 Embossed (tracks at normal pitch)

4.3.3.2.1 Lead-in Zone (Inner Zone 0)

4.3.3.2.1.1 Protection Zone 2

This zone is a buffer area between the 2 track pitches. The second part of this zone has normal pitch.

4.3.3.2.1.2 INFO2

This area is intended to contain data information specific to the application.

4.3.3.2.1.3 Reserved

This area is reserved. Each Cluster shall contain only zeros.

4.3.3.2.1.4 INFO1

This area is intended to contain control information.

4.3.3.2.2 Data Zone 0

The data zone contains application data that is readable by the Initiator as a sequence of sectors.

4.3.3.2.3 Outer Zone 0

4.3.3.2.3.1 INFO3/4

This zone is intended to store control information.

4.3.3.2.3.2 Protection Zone 3

This zone exists for seek overshoot protection at the disc's outer radius.

4.3.3.3 L1 Embossed (tracks at normal pitch)

4.3.3.3.1 Outer Zone 1

If the disc is single layer, this is the disc's lead-out zone.

4.3.3.3.1.1 Protection Zone 3

This zone exists for seek overshoot protection at the disc's outer radius.

4.3.3.3.1.2 INFO3/4

This zone is intended to store control information.

4.3.3.3.2 Data Zone 1

The data zone contains application data that is readable by the Initiator as a sequence of sectors.

4.3.3.3.3 Lead-out Zone (Inner Zone 1)

4.3.3.3.3.1 INFO1

This area is intended to contain control information.

4.3.3.3.3.2 Reserved

This area is reserved. Each Cluster shall contain only zeros.

4.3.3.3.3.3 INFO2

This area is intended to contain data information specific to the application.

4.3.3.3.3.4 Protection Zone 2

This zone is a buffer area between the 2 track pitches. The second part of this zone has normal pitch.

4.3.3.4 L1 Embossed (tracks at wide pitch)

4.3.3.4.1 Lead-out Zone (Inner Zone 1)

4.3.3.4.1.1 Protection Zone 2

This zone is a buffer area between the 2 track pitches. The first part of this zone has wide pitch.

4.3.3.4.1.2 PIC

This area contains various data including disc information.

4.3.3.4.1.3 Protection Zone 1

This zone exists for seek overshoot protection at the disc's inner radius.

5 Features and Profiles for BD-ROM Devices

5.1 Feature Descriptions

5.1.1 The BD Read Feature (0040h)

This Feature identifies a Logical Unit that is able to read control structures and user data from the BD disc. The BD Read Feature descriptor response data to be returned to the Initiator is defined in Table 1.

Table 1 – BD Read Feature Descriptor

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB) Feature Code = 0040h							
1								(LSB)
2	Reserved			Version			Persistent	Current
3	Additional Length = 4							
4	Reserved							
5	Reserved							
6	Reserved							
7	Reserved							

The Feature Code field shall be set to 0040h.

The Version field shall be set to 0h.

The Persistent bit shall be set to zero, indicating that this Feature may change its current status.

The Current bit, when set to zero, indicates that this Feature is not currently active and that the Feature dependent data may not be valid. When set to one, this Feature is currently active and the Feature dependent data is valid.

The Additional Length field shall be set to 04h.

If a Logical Unit reports this feature with the Current bit set to one, then the Logical Unit shall support the commands shown in Table 2.

Table 2 - Command Support Required by the BD Read Feature

Op Code	Command Description	Reference
28h	READ (10)	6.10
A8h	READ (12)	6.11
ADh	READ DISC STRUCTURE (format = 0, FFh)	6.14
43h	READ TOC/PMA/ATIP (format 0 and 1)	6.15

5.2 Profile Descriptions

5.2.1 Profile 0040h: BD-ROM

Logical Units identifying Profile 0040h as current shall support the features listed in Table 3.

Table 3 - Mandatory Features for BD-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	Device changes operational behavior upon events external to the Initiator
0003h	Removable Medium	The medium may be removed from the device
0010h	Random Readable[1]	Read ability for storage devices with random addressing
0040h	BD Read	The ability to read BD specific structures
0100h	Power Management	Initiator and device directed power management
0105h	Timeout	Ability to respond to all commands within a specific time
0107h	Real-time Streaming	Ability to read (and optionally write) using Initiator requested performance parameters.

Notes:
1. PP bit in Random Readable Feature shall be set to 1.

Table 4 shows the decomposition of the profile into features and features into commands and mode pages.

Table 4 – BD-ROM Profile Decomposition

BD-ROM Profile	Core Feature	Get Configuration Command, Get Event Status Notification Command, Inquiry Command, Mode Select (10) Command, Mode Sense (10) Command, Request Sense Command, Test Unit Ready Command
	Morphing Feature	Get Configuration Command, Get Event Status Notification Command, Prevent Allow Medium Removal Command
	Removable Medium Feature	Mechanism Status Command, Prevent Allow Medium Removal Command, Start Stop Unit Command
	Random Readable Feature	Read Capacity Command, Read (10) Command, Read/Write Error Recovery Mode Page
	BD Read Feature	Read (10) Command, Read (12) Command, Read Disc Structure Command, Read TOC/PMA/ATIP Command
	Power Management Feature	Get Event Status Notification Command, Start Stop Unit Command, Power Condition Page
	Timeout Feature	Timeout and Protect Mode Page
	Real-time Streaming	Get Performance Command, Read (12) Command, , Set Streaming Command, Set Read Ahead Command

Note: The Read Buffer Capacity command and the Write (12) command are commands that are mandatory for the Real-time Streaming Feature only when stream writing is supported. Since writing cannot be supported on BD-ROM, these commands are not listed.

6 Commands for BD-ROM Devices

6.1 Overview

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

The commands described in this clause are listed in Table 5. MMC-4 is the primary reference for the command descriptions. For a given command, modified/additional behavior necessary for the support of BD is described in the specified sub-clause.

Table 5 – Commands for Multi-Media Logical Units

Command Name	Op Code	Reference
GET CONFIGURATION	46h	6.2
GET EVENT STATUS NOTIFICATION	4Ah	6.3
GET PERFORMANCE	ACh	6.4
INQUIRY	12h	6.5
MECHANISM STATUS	BDh	6.6
MODE SELECT (10)	55h	6.7
MODE SENSE (10)	5Ah	6.8
PREVENT ALLOW MEDIUM REMOVAL	1Eh	6.9
READ (10)	28h	6.10
READ (12)	A8h	6.11
READ CAPACITY	25h	6.12
READ DISC STRUCTURE	ADh	6.14
READ TOC/PMA/ATIP	43h	6.15
REQUEST SENSE	03h	6.17
SET READ AHEAD	A7h	6.18
SET STREAMING	B6h	6.19
START STOP UNIT	1Bh	6.20
TEST UNIT READY	00h	6.21

6.2 GET CONFIGURATION Command

The Core and Morphing Features require that this command be implemented. The BD-ROM Profile includes the Core Feature. From the Initiator's perspective, use of this command requires no special behavior from a Logical Unit when the BD Read Feature is current.

See MMC-4 for a description of this command.

6.3 GET EVENT STATUS NOTIFICATION Command

The Core and Morphing Features require that this command be implemented. The BD-ROM Profile includes the Core Feature. From the Initiator's perspective, use of this command requires no special behavior from a Logical Unit when the BD Read Feature is current.

Logical Units that support BD shall implement the Operational Change Event class, the Media Event class, the Device Busy class, and the Power Management Class Event.

See MMC-4 for a description of this command.

6.4 GET PERFORMANCE Command

The Real-time Streaming Feature requires that this command be implemented. The BD-ROM Profile
includes the Real-time Streaming Feature. From the Initiator's perspective, use of this command requires no special behavior from a Logical Unit when the BD Read Feature is current.

See MMC-4 for a description of this command.

6.5 INQUIRY Command

The Core Feature requires that this command be implemented. The BD-ROM Profile includes the Core Feature. From the Initiator's perspective, use of this command requires no special behavior from a Logical Unit when the BD Read Feature is current.

See MMC-4 for a description of this command.

6.6 MECHANISM STATUS Command

The Removable Medium Feature requires that this command be implemented. The BD-ROM Profile includes the Removable Medium Feature. From the Initiator's perspective, use of this command requires no special behavior from a Logical Unit when the BD Read Feature is current.

See MMC-4 for a description of this command.

6.7 MODE SELECT (10) Command

The Core Feature and all other features that specify mode page support require that this command be implemented. The BD-ROM Profile includes the Core Feature. From the Initiator's perspective, use of this command requires no special behavior from a Logical Unit when the BD Read Feature is current.

See MMC-4 for a description of this command.

6.8 MODE SENSE (10) Command

The Core Feature and all other features that specify mode page support require that this command be implemented. The BD-ROM Profile includes the Core Feature. From the Initiator's perspective, use of this command requires no special behavior from a Logical Unit when the BD Read Feature is current.

See MMC-4 for a description of this command.

6.9 PREVENT ALLOW MEDIUM REMOVAL Command

The Removable Medium and Morphing Features requires that this command be implemented. The BD-ROM Profile includes the Removable Medium Feature. From the Initiator's perspective, use of this command requires no special behavior from a Logical Unit when the BD Read Feature is current.

See MMC-4 for a description of this command.

6.10 READ (10) Command

The Random Readable and BD Read Features require that this command be implemented. The BD-ROM Profile includes thosefeatures. From the Initiator's perspective, use of this command requires no special behavior from a Logical Unit when the BD Read Feature is current.

See MMC-4 for a description of this command.

6.11 READ (12) Command

The BD Read and Real-time Streaming Features require that this command be implemented. The BD-ROM Profile includes thosefeatures. From the Initiator's perspective, use of this command requires no special behavior from a Logical Unit when the BD Read Feature is current.

See MMC-4 for a description of this command.

6.12 READ CAPACITY Command

The Random Readable Feature requires that this command be implemented. The BD-ROM Profile includes the Random Readable Feature. From the Initiator's perspective, use of this command requires no special behavior from a Logical Unit when the BD Read Feature is current.

See MMC-4 for a description of this command.

6.13 READ DISC INFORMATION Command

The READ DISC INFORMATION command allows the Initiator to request information about the currently mounted MM disc.

When this command is required by an implemented Feature and media is present and ready, the command shall always function, even if that Feature's Current bit becomes zero.

6.13.1 The CDB and Its Parameters

The READ DISC INFORMATION CDB is shown in Table 6.

Table 6 – READ DISC INFORMATION CDB

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

The number of Disc Information bytes returned is limited by the Allocation Length field of the CDB. An Allocation Length of zero shall not be considered an error. If the Allocation Length is greater than the amount of available Disc Information Data, only the available data is transferred.

6.13.2 Command Execution

The Logical Unit shall gather information about the medium, format it as shown in Table 7, and transfer to the Initiator, limited by the Allocation Length.

BD devices cannot record BD-ROM. Consequently, the Number of OPC Table Entries field in the Disc Information Block shall be set to zero.

Table 7 – Disc Information Block

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

Table 8 – DIB of BD-ROM Discs

DIB Field	Value	Meaning
Erasable	ROM = 0b	BD-ROM is not recordable.
State of Last Session	Complete=11b	BD-ROM is always complete.
Disc Status	Finalized=10b	BD-ROM is always finalized.
Number of First Track on Disc	0001h	BD-ROM has exactly 1 logical track.
Number of Sessions	0001h	BD-ROM has exactly 1 session.
First Track Number in Last Session	0001h	BD-ROM has exactly 1 logical track.
Last Track Number in Last Session	0001h	BD-ROM has exactly 1 logical track.
DID_V	0b	BD-ROM does not have a Disc ID
DBC_V	0b	BD-ROM does not have a disc bar code
URU	1b	BD-ROM disc is unrestricted use
DAC_V	0b	BD-ROM does not have an Application Code.
Dbit	0b	BD-ROM is not Formattable
BG Status	00b	BD-ROM is not Formattable
Disc Type	00h	BD has no CD equivalent type.
Disc Identification	00000000h	BD has no CD equivalent type.
Last Session Lead-in Start Address	00000000h	BD-ROM is not recordable
Last Possible Lead-out Start Address	00000000h	BD-ROM is not recordable
Disc Bar Code	All zeros	BD does not have a disc bar code
Disc Application Code	00h	BD does not have an Application Code.
Number of OPC Table entries	0	BD-ROM is not recordable
OPC Table	None	BD-ROM is not recordable

6.14 READ DISC STRUCTURE Command

The READ DISC STRUCTURE command requests that the Logical Unit transfer to the Initiator information about the currently mounted disc.

6.14.1 The CDB and Its Parameters

The READ DISC STRUCTURE CDB is shown in Table 9.

Table 9 – READ DISC STRUCTURE CDB

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code (ADh)							
1	Reserved				Media Type			
2	(MSB)							
3	Address							
4								
5								(LSB)
6	Layer Number							
7	Format Code							
8	(MSB)			Allocation Length				
9								(LSB)
10	Reserved							
11	Control							

6.14.1.1 Media Type

The Media Type field identifies the Media Type to which this command is directed. The BD disc type is 0001b. The Media Type for all other media is 0000b.

6.14.1.2 Address

Use and definition of the Address field is dependent upon the Format Code.

6.14.1.3 Layer Number

Use and definition of the Layer Number field is dependent upon the Format field value.

6.14.1.4 Format

The Format Code (Table 10) indicates the type of information that may be requested by the Initiator.

Table 10 - Format Code Definitions

Format Code	Structure	Address Field	Layer Number	Description
00h	DI	-	Layer	Disc Information from PIC in pre-recorded area • Address field is reserved • Layer field specifies layer for DI read
01h – FEh	Reserved	-	-	-
FFh	Structure List	-	-	BD Structure list • Address field is reserved • Layer field is reserved
Note: Only Format Codes 00h (Disc Information) and FFh (Structure List) are mandatory for BD-ROM.				

6.14.1.5 Allocation Length

The Allocation Length field specifies the maximum number of bytes that may be returned by the Logical Unit. An Allocation Length of zero shall not be considered an error.

6.14.2 Command Execution

6.14.2.1 General

If the READ DISC STRUCTURE CDB validation permits execution of the command, the Logical Unit shall collect the request information and return it to the Initiator according to the general formatting shown in Table 11.

Table 11 – BD Structure Returned Data Format

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB) Data Structure Length = N+2							
1								(LSB)
2	Reserved							
3	Reserved							
Disc Structure Data								
0	Returned Data							
1								
…								
N-1								

6.14.2.2 Format Code 00h: Disc Information (DI)

A DI unit is 64 bytes in PIC on BD-ROM disc. The DI units that contain physical information shall be returned. The information for layer 0 shall be returned when the Layer field of the CDB is set to zero. The information for layer 1 shall be returned when the Layer field of the CDB is set to 1. See *System Description Blu-ray Disc Read-only Format, Part 1 Basic Format Specifications* for DI unit detailed definition.

Table 12 – BD Structure Format Code 00h: Disc Information

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			Data Structure Length = 66 (0042h)				
1								(LSB)
2	Reserved							
3	Reserved							
Blu-ray Disc Information								
0	DI Units							
1								
…								
63								

6.14.2.3 Format Code FFh: BD Structure List

The BD Structure List is returned in the format as shown in Table 13.

Table 13 –BD Structure Format Code FFh: Structure List

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			BD STRUCTURE Data Length				
1								(LSB)
2	Reserved							
3	Reserved							
BD Structure List								
0 - n	Structure List							

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

The Structure List is returned as a sequence of Structure List Entries as shown in Table 14.

Note: This BD Structure is generated by the Logical Unit rather than read from the medium. Consequently, this structure shall be returned regardless of media presence.

Table 14 – 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 BD Structure that is readable via the READ DISC STRUCTURE command.

The SDS bit, when set to zero, shall indicate that the BD structure is not writable via the SEND DISC STRUCTURE command. When set to one, shall indicate that the BD structure is writable via the SEND DISC STRUCTURE command.

The RDS bit, when set to zero, shall indicate that the BD structure is not readable via the READ DISC STRUCTURE command. When set to one, shall indicate that the BD structure is readable via the READ DISC STRUCTURE command.

The Structure Length field shall specify the length of the BD Structure that is identified by the Format Code.

6.15 READ TOC/PMA/ATIP Command

READ TOC/PMA/ATIP (Table 15) is a CD function that has been adapted to other media. For BD discs, returned data shall be fabricated by the Logical Unit. The information returned is minimized and may have no relationship to media structure.

6.15.1 The CDB and Its Parameters

The READ TOC/PMA/ATIP CDB is shown in Table 15.

Table 15 – READ TOC/PMA/ATIP CDB

Bit / Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (43h)							
1	Reserved						MSF	Reserved
2	Reserved				Format			
3	Reserved							
4	Reserved							
5	Reserved							
6	Track/Session Number							
7	(MSB) Allocation Length							
8	(LSB)							
9	Control							

6.15.1.1 MSF bit

When MSF is set to zero, the address fields in returned data formats shall be in LBA form. When MSF is set to one, the address fields in returned data formats shall be in MSF form.

6.15.1.2 Format field

The Format field is used to select a specific returned data format. For BD-ROM discs, only Format 0 and Format 1 are valid. If a BD-ROM disc is present and the Format code is neither 0 nor 1, the command shall be terminated with CHECK CONDITION status and sense bytes SK/ASC/ASCQ shall be set to ILLEGAL REQUEST/INVALID FIELD IN CDB.

6.15.1.3 Track/Session Number field

Track/Session Number shall be set to one when BD-ROM disc is present. If Track/Session Number is neither zero nor one, the command shall be terminated with CHECK CONDITION status and sense bytes SK/ASC/ASCQ shall be set to ILLEGAL REQUEST/INVALID FIELD IN CDB.

6.15.1.4 Allocation Length

The Allocation Length field specifies the maximum number of bytes that may be returned by the Logical Unit. An Allocation Length of zero shall not be considered an error.

6.15.2 Command Execution

The READ TOC/PMA/ATIP command was originally designed for CD media. For BD discs the returned data is fabricated.

6.15.2.1 Format 0: Data Zone Capacity

If a BD-ROM disc is present, the TOC Format 0 returned data shall have the format shown in Table 16.

Table 16 – TOC Data Format 0: Data Returned for formatted BD-ROM disc

	Byte(s)	Field	Value
Header	0, 1	TOC Data Length	0012h
	2	First Track	01h
	3	Last Track	01h
Track 1 Descriptor	4	Reserved	00h
	5	ADR/CTL	14h
	6	Track Number	01h
	7	Reserved	00h
	8 - 11	Track Start Address	LBA form = 00000000h MSF form = 00h,00h, 02h, 00h
Track AA (Lead-out) Descriptor	12	Reserved	00h
	13	ADR/CTL	14h
	14	Track Number	AAh
	15	Reserved	00h
	16 - 19	Track Start Address	LBA form = READ CAPACITY LBA + 1 MSF form = MSF translation of LBA form with a maximum MSF address of 00h, FFh, 3Bh, 4Ah

6.15.2.2 Format 1: Session Information

If a BD-ROM disc is present, the TOC Format 1 returned data shall have the format shown in Table 17.

Table 17 – TOC Data Format 1: Data Returned for BD Discs

	Byte(s)	Field	Value
Header	0, 1	TOC Data Length	000Ah
	2	First Complete Session Number	01h
	3	Last Complete Session Number	01h
Track Descriptor	4	Reserved	00h
	5	ADR/CTL	14h
	6	First Track Number in Last Complete Session	01h
	7	Reserved	00h
	8 - 11	Start Address of First Track Number in Last Complete Session	LBA form = 00000000h MSF form = 00h, 00h, 02h, 00h

6.16 READ TRACK INFORMATION Command

The READ TRACK INFORMATION Command provides information about a logical track.

When this command is required by an implemented Feature, the command shall always function, even if that Feature's Current bit becomes zero.

6.16.1 The CDB and Its Parameters

The READ TRACK INFORMATION CDB is shown in Table 18.

Table 18 – READ TRACK INFORMATION CDB

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code (52h)							
1	Reserved							Address/Number Type
2	(MSB)							
3	Logical Block Address/							
4	Track/Session Number							
5								(LSB)
6	Reserved							
7	(MSB)			Allocation Length				
8								(LSB)
9	Control Byte							

6.16.1.1 Address/Number Type

The Address/Number Type field in byte 1 is used to specify the contents of the Logical Block Address/Track/Session Number field, bytes 2 through 5 of the CDB. The Description of these parameters is shown in Table 19.

6.16.1.2 Logical BlockAddress/Track/Session Number Fields

The Logical Block Address/Track/Session Number field either directly or indirectly specifies the logical track for which the Logical Unit is to provide track information. See Table 19.

Table 19 – LBA/Track/Session Number Field definition

Address/ Number Type field	Logical Block Address/Track/Session Number	Description
00b	Logical Block Address	If the LBA is not within the current LBA Space, the command shall be terminated with CHECK CONDITION status and sense bytes SK/ASC/ASCQ shall be set to ILLEGAL REQUEST/LOGICAL BLOCK ADDRESS OUT OF RANGE. If the LBA is valid, the Logical Track Number shall be determined to be 1.
01b	Logical track number	If the logical track number is any value other than 1, the command shall be terminated with CHECK CONDITION status and sense bytes SK/ASC/ASCQ shall be set to ILLEGAL REQUEST/INVALID FIELD IN CDB.
10b	Session Number	If the Session number is any value other than 1, the command shall be terminated with CHECK CONDITION status and sense bytes SK/ASC/ASCQ shall be set to ILLEGAL REQUEST/INVALID FIELD IN CDB.
11b	Reserved	

6.16.1.3 Allocation Length

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

6.16.2 Command Execution

The Logical Unit shall collect the information requested by the Initiator into a Track Information Block structure, and transfer to the Initiator, restricted by Allocation Length.

The format and content of the Track Information Block is shown in Table 20.

Table 20 – Track Information Block

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB) Data Length							
1								(LSB)
2	Track Number (Least Significant Byte)							
3	Session Number (Least Significant Byte)							
4	Reserved							
5	Reserved		Damage	Copy	Track Mode			
6	RT	Blank	Packet/Inc	FP	Data Mode			
7	Reserved						LRA_V	NWA_V
8	(MSB) Track Start Address							
9								
10								
11								(LSB)
12	(MSB) Next Writable Address							
13								
14								
15								(LSB)
16	(MSB) Free Blocks							
17								
18								
19								(LSB)
20	(MSB) Fixed Packet Size/ Blocking Factor							
21								
22								
23								(LSB)
24	(MSB) Track Size							
25								
26								
27								(LSB)
28	(MSB) Last Recorded Address							
29								
30								
31								(LSB)
32	Track Number (Most Significant Byte)							
33	Session Number (Most Significant Byte)							
34	Reserved							
35	Reserved							
36	(MSB) Read Compatibility LBA							
…								
39								(LSB)

Table 21 shows required content when BD-ROM disc is present.

Table 21 –TIB Fields for BD-ROM Discs

TIB Field	Value	Meaning
Track Number	1	BD-ROM is always one track
Session Number	1	BD-ROM is always one session
Damage	0	Not used by BD-ROM and shall be 0b
Copy	0	Not used by BD-ROM and shall be 0b
Track Mode	4h	BD sectors approximate CD mode 1
RT	1	The BD-ROM track is always reserved.
Blank	0	The BD-ROM track is never blank.
Packet/Inc	1	Recording is incremental by Cluster
FP	1	Recording is incremental by Cluster
Data Mode	1	BD sectors approximate CD mode 1
LRA_V	0	Not used by BD-ROM and shall be 0b
NWA_V	0	Not used by BD-ROM and shall be 0b
Track Start Address	00000000h	Not used by BD-ROM and shall be zeros
Next Writable Address	00000000h	Not used by BD-ROM and shall be zeros
Free Blocks	00000000h	Not used by BD-ROM and shall be zeros
Fixed Packet Size/Blocking Factor	00000020h	Cluster size in sectors
Track Size	READ CAPACITY LBA + 1	BD-ROM is always one track
Last Recorded Address	00000000h	Not used by BD-ROM and shall be zeros
Read Compatibility LBA	00000000h	Not used by BD-ROM and shall be zeros

6.17 REQUEST SENSE Command

The Core Feature requires that this command be implemented. The BD-ROM Profile includes the Core Feature. From the Initiator's perspective, use of this command requires no special behavior from a Logical Unit when the BD Read Feature is current.

See MMC-4 for a description of this command.

6.18 SET READ AHEAD

The Real-time Streaming Feature requires that this command be implemented. The BD-ROM Profile
includes the Real-time Streaming Feature. From the Initiator's perspective, use of this command requires no special behavior from a Logical Unit when the BD Read Feature is current.

See MMC-4 for a description of this command.

6.19 SET STREAMING Command

The Real-time Streaming Feature requires that this command be implemented. The BD-ROM Profile
includes the Real-time Streaming Feature. From the Initiator's perspective, use of this command requires no special behavior from a Logical Unit when the BD Read Feature is current.

See MMC-4 for a description of this command.

6.20 START STOP UNIT Command

The Removable Medium and Power Management Features require that this command be implemented. The BD-ROM Profile includes those features. From the Initiator's perspective, use of this command requires no special behavior from a Logical Unit when the BD Read Feature is current.

See MMC-4 for a description of this command.

6.21 TEST UNIT READY Command

The Core Feature requires that this command be implemented. The BD-ROM Profile includes the Core Feature. From the Initiator's perspective, use of this command requires no special behavior from a Logical Unit when the BD Read Feature is current.

See MMC-4 for a description of this command.

7 Mode Parameters for BD-ROM Devices

7.1 Mode Parameter List

The presence of the BD-ROM Profile causes no change in either the Mode Parameter List or Mode Parameter List Header.

See MMC-4 for a description of this mode page.

7.2 Read/Write Error Recovery Parameters Mode Page (Page Code 01h)

The BD-ROM Profile requires the support of this mode page in the Random Readable Feature. From the Initiator's perspective, use of this mode page requires no special behavior from a Logical Unit when the BD-ROM Profile is current.

See MMC-4 for a description of this mode page.

7.3 Power Condition Page (Page Code 1Ah)

The Power Management Feature requires that this mode page be implemented. The BD-ROM Profile includes the Power Management Feature. From the Initiator's perspective, use of this mode page requires no special behavior from a Logical Unit when the BD-ROM Profile is current.

See MMC-4 for a description of this mode page.

7.4 Timeout and Protect Page (Page Code 1Dh)

The Timeout Feature requires that this mode page be implemented. The BD-ROM Profile includes the Timeout Feature. From the Initiator's perspective, use of this mode page requires no special behavior from a Logical Unit when the BD-ROM Profile is current.

See MMC-4 for a description of this mode page.

Annex A Using BD

The command set has two viewpoints: the Initiator's view of the Logical Unit/media combination and reality as known by the Logical Unit. This annex presents an Initiator's viewpoint.

A.1 Features and Profiles for BD

A.1.1 Features

In general, the BD features are defined to specify capability. Most features specify mandatory commands and sometimes mandatory command behavior.

A.1.2 Profiles

A profile typically has no technical value to either the Logical Unit or the Initiator. It's intent is to create a minimal list of behaviors for the device. In the case of the BD-ROM Profile, the state of the Current bit is based upon presence of a recorded BD disc. When a recorded BD disc is present, the Current bit in the BD-ROM Profile is set to one. Otherwise, the Current bit in the BD-ROM Profile is set to zero. Some applications use a current profile to select a unique icon for the Logical Unit/media combination.

A.2 Reading a BD Disc

Only READ (10) and READ (12) may be used to read the LBA space. The block size is 2 048.