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

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1 Scope

Rewritable Blu-ray Disc 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-RE 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-RE Devices - Features describe Logical Unit capabilities while Profiles exist to claim a collection of features.
6. Commands for BD Devices - Commands are described from the Initiator's point of view.
7. Mode Parameters for BD-RE 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 Rewritable Format, Part 1 Basic Format Specifications. 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 writes to recordable sub-types of that media.

3.2.2 BD-RE

BD-RE disc is a BD disc that is Rewritable. BD-RE devices are devices that are able to read, write and rewrite BD-RE disc.

3.2.3 Certification

When a BD-RE Cluster is certified the BD-RE Cluster is written and then read in order to certify its data content. A Cluster that is determined to be defective is registered in the DFL.

3.2.4 Cluster

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

3.2.5 Full Certification

As a part of the execution of the FORMAT UNIT command, the Logical Unit may certify each Cluster in the User Data Area. This is Full Certification.

3.2.6 Inner Spare Area (ISA0, ISA1)

When defect management is used, a spare area is allocated in the inner radius of each layer. Each of these areas is an “Inner Spare Area”. The ISA on layer x is referenced as ISAx.

3.2.7 LSN (Logical Sector Number)

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

3.2.8 Outer Spare Area (OSA0, OSA1)

When defect management is used, a spare area may be allocated in the outer radius of each layer. Each of these areas is an “Outer Spare Area”. The OSA on layer x is referenced as OSAx.

3.2.9 Permanent Information & Control data (PIC) Zone

This zone contains general information about the disc. The PIC is pre-recorded.

3.2.10 Quick Certification

If a FORMAT UNIT command is issued by the Initiator for a BD-RE disc that was previously formatted, then the requested process is a reformat. Before starting the reformat, the DFL contains a list of Clusters that have been determined to be defective. As a part of the execution of the FORMAT UNIT command that is requesting a reformat, the Logical Unit may certify only Clusters registered in the DFL as defective. Since this process requires significantly less execution time than Full Certification, it is called Quick Certification.

3.2.11 Quick Reformat

If a FORMAT UNIT command is issued by the Initiator for a BD-RE disc that was previously formatted, then the requested process is a reformat. Before starting the reformat, the DFL contains a list of Clusters that have been determined to be defective.

If a FORMAT UNIT command is requesting a reformat, the Logical Unit may convert each registered defective Cluster information on the disc to a re-usable Cluster status and perform no certification. The Logical Unit shall certify each Cluster that is registered a re-usable - effectively deferring all certfications until actual use. Since this process can make a reformat execute much faster than Quick Certfication, this process is called Quick Reformat..

3.3 Abbreviations

BD	Blu-ray Disc
BD-RE	Rewritable Blu-ray Disc
DDS	Disc Definition Structure
DFLx	Defect List (x=0..7)
DL	Dual Layer
DMAx	Defect Management Area (x=1..4)
DMS	Defect Management Structure
INFOx	Information Zone (x=1..4)
ISA0	Inner Spare Area, layer 0
ISA1	Inner Spare Area, layer 1
LSN	Logical Sector Number
OSA0	Outer Spare Area, layer 0
OSA1	Outer Spare Area, layer 1
PIC	Permanent Information & Control data
SL	Single Layer

4 BD-RE Models

4.1 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 2048 bytes collected into recordable units called Clusters:

- A Cluster contains 32 logical 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-RE.

4.2 BD-RE

The Initiator access model for BD-RE is based upon a random access model. BD-RE is Formattable. Hardware defect management is mandatory. The size of the spare areas is selectable according to *System Description Blu-ray Disc Rewritable Format, Part 1 Basic Format Specifications*.

4.3 Physical Media Structure

BD-RE disc has a 12 centimeters diameter and is separated into zones as shown in Figure 1

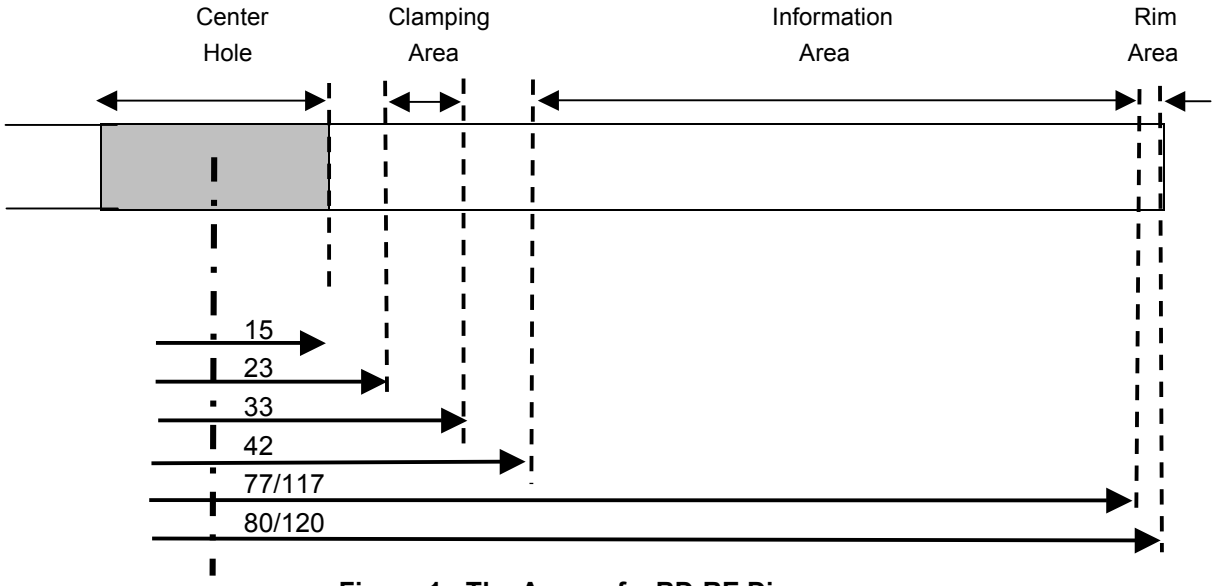

Figure 1 - The Areas of a BD-RE Disc

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 writable areas of the BD disc.

The Information Zone is the area in which actual recording 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 80-millimeter media, the information zone ends at a nominal diameter of 77 millimeters. For 120-millimeter media, the information zone ends at a nominal diameter of 117 millimeters.

The Rim Area is simply the area beyond the data groove. For 80-millimeter media, it typically ends at a diameter of 80 millimeters. For 120-millimeter media, it typically ends at a diameter of 120 millimeters.

4.4 Logical Media Structure

BD-RE disc is a rewritable media with 3 possible capacities per layer (23.3 GB, 25.0 GB, and 27.0 GB on 120 mm discs and 7.3 GB, 7.8 GB, and 8.4 GB on 80 mm discs). BD 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.

4.4.1 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, Data Zone, and Lead-out Zone.

Spare Areas are allocated from the Data Zone, creating three areas within the data zone: Inner Spare Area (ISA0), User Data Area, and Outer Spare Area (OSA0).

If ISA0 is present, it has a fixed size of 4096 Clusters. OSA0 has a variable size from 0 to 16384 Clusters, allocated in increments of 256 Clusters. Consequently, OSA0 size in Clusters = N*256 Clusters, where 0 ≤ N ≤ 64. See Figure 2.

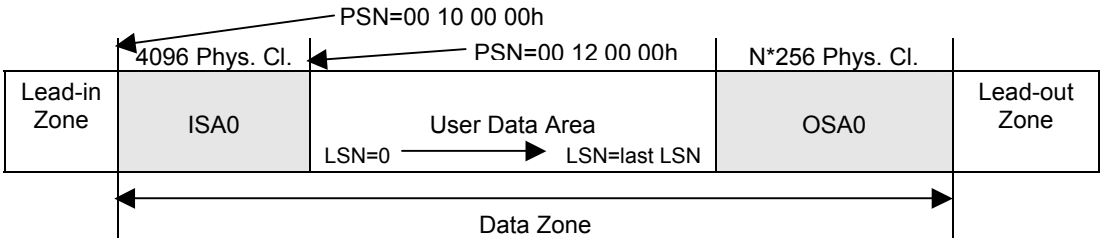

Figure 2 – Layout of Single Layer BD Disc

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, Data Zone 0, and the Outer Zone 0. The layer 1 information zone is divided into three areas: the Outer zone 1, Data Zone 1, and the Lead-out zone.

Spare Areas are allocated from the Data Zones, creating three areas within each data zone: Inner Spare Areas (ISA0 and ISA1), User Data Area, and Outer Spare Areas (OSA0 and OSA1).

If ISA0 is present, it has a fixed size of 4096 clusters. OSA0 has a variable size from 0 to 8192 Clusters in increments of 256 Clusters. OSA0 size in Clusters = N*256 Clusters, where 0 ≤ N ≤ 32. OSA1 has the same size as OSA0. ISA1 has a variable size from 0 to 16 384 Clusters, in increments of 256 Clusters. Consequently, ISA1 size in Clusters = L*256 Clusters, where 0 ≤ L ≤ 64. See Figure 3.

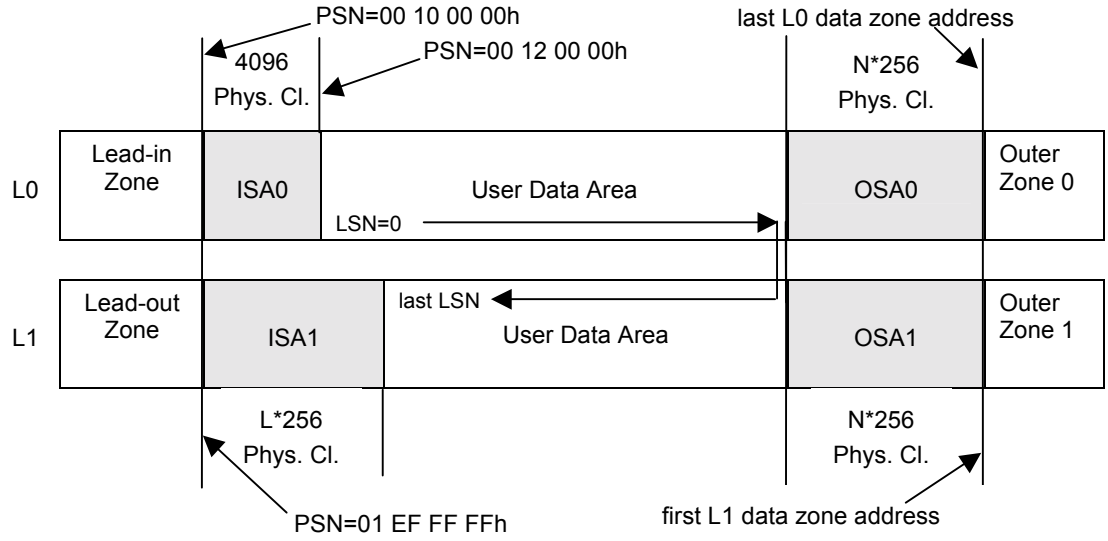

Figure 3 – Layout of Dual Layer BD Disc

4.4.2 Sectors and Clusters

The logical block size of BD is 2048 bytes collected into recordable units called Clusters. A Cluster contains 32 logical sectors.

a. The user data within a BD sector is protected by the error correction coding in the Cluster that contains the sector.

b. BD discs may be recorded over 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 device model:

a. The user data space is organized in fixed size blocks (2048 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.

b. Logical block addresses are numbered from 0 through CAPACITY-1. The value of CAPACITY-1 is the logical block address returned by the READ CAPACITY command.

c. 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.

d. Structures unique to BD may be read using the READ DISC STRUCTURE command.

4.4.3 The Information Zone

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

Layer 0 Information Zone	**Embossed HFM**		Protection Zone 1	Seek overshoot protection zone
			PIC	Permanent Information & Control data Zone
	Rewritable Area	Lead-in Zone (Inner Zone 0)	Protection Zone 2	Seek overshoot protection zone
			INFO2	Defect Management information
			OPC	Optimum Power Calibration Zone
			Reserved	-
			INFO1	Drive information area
		Data Zone 0	ISA0	Inner Spare Area
			User Data Area	Primary user data area
			OSA0	Outer Spare Area
		Outer Zone 0 (Lead-out Zone)	INFO3/4	Defect management and control info
			Protection Zone 3	Seek overshoot protection zone
Read Direction				
Layer 1 Information Zone	**Rewritable Area**	Outer Zone 1	Protection Zone 3	Seek overshoot protection zone
			INFO3/4	Defect management and control info
		Data Zone 1	OSA1	Outer Spare Area
			User Data Area	Primary user data area
			ISA1	Inner Spare Area
		Lead-out Zone (Inner Zone 1)	INFO1	Drive information area
			Reserved	-
			OPC	Optimum Power Calibration Zone
			INFO2	Defect Management information
			Protection Zone 2	Seek overshoot protection zone
	Embossed HFM		PIC	Permanent Information & Control data Zone
			Protection Zone 1	Seek overshoot protection zone

Figure 4 –BD-RE Information Zone

Each layer of the Information Zone is divided into an embossed (pre-recorded) high frequency modulated (HFM) area and a rewritable area. The rewritable area of layer 0 is divided into a lead-in zone, a data zone, and a Outer Area. On single layer media, the outer area is the disc lead-out zone. On dual layer media the outer area is a layer transition area.

4.4.3.1 Embossed HFM Zone

The Embossed HFM zone consists of:

Protection Zone 1	Protection Zone 1, on each layer, is meant as a protection area against overwriting the PIC zone by the Burst Cutting Area that precedes the normal recording spiral.
Permanent Information & Control data Zone (PIC)	On layer zero, this pre-recorded area contains disc information that includes, but is not restricted to: a. Physical media class and version b. Physical address of the start of the Data Zone c. Physical address of the start of the outer zone (if this is a single layer media, this is the lead-out) d. Number of layers e. Recording Density f. Write power information On layer 1 this pre-recorded area contains a copy of the layer 0 information, but the physical addresses refer to physical addresses on layer 1.

4.4.3.2 Inner Zone 0/Inner Zone 1 (Lead-in Zone/Lead-out Zone)

An Inner Zone consists of:

Protection Zone 2	On both layers, this zone buffers the rewritable area from the embossed area.
INFO2	On both layers, INFO2 is reserved for defect management information and PAC storage.
Optimum Power Calibration (OPC) Zone	On both layers, the OPC Zone is reserved for testing and calibration.
INFO1	On both layers, this area is reserved for drive specific information and PAC storage.

4.4.3.3 Data Zone

The Data Zone consists of:

Inner Spare Areas (ISA0, ISA1)	If spare Clusters are allocated for defect management, then ISA0 is allocated with 4096 Clusters. If spare Clusters are allocated for defect management, ISA1 is a 16384-Cluster area available for spare area allocation in 256 Cluster increments. Any part of the data zone that is not allocated for spare Clusters is part of the User Data Area.
User Data Area	The User Data Area is the logically addressed area of the disc. When no spares are allocated, this area has a maximum layer capacity of 23.3 GB, 25.0 GB, and 27.0 GB on 120 mm discs and 7.3 GB, 7.8 GB, and 8.4 GB on 80 mm discs.
Outer Spare Areas (OSA0, OSA1)	If spare Clusters are allocated for defect management, OSA0 is an 8192 (16384 on single layer) Cluster area available for spare area allocation in 256 Cluster increments. Any part of this area that is not allocated for spare Clusters is part of the User Data Area. If spare Clusters are allocated for defect management, OSA1 is an 8192-Cluster area available for spare area allocation in 256 Cluster increments. Any part of the data zone that is not allocated for spare Clusters is part of the User Data Area. OSA1 has the same size as OSA0.

4.4.3.4 Lead-out Zone/Outer Zone 0/Outer Zone 1

On single layer media the Outer Zone has the function of the Lead-out Zone..

On dual layer media, the Outer Zone 0 and Outer Zone 1 are layer transition zones on layer 0 and layer 1, respectively.

The Outer Zone consists of:

INFO3/4	On both layers, INFO3/4 is reserved for defect management and control information.
Protection Zone 3	On both layers, this zone exists for seek overshoot protection at the disc's outer radius.

4.4.4 Blank Media Structure

BD-RE is a grooved media with a fixed frequency wobble. The wobble contains modulated location information called Address In Pre-groove (ADIP).

In the lead-in area, the ADIP address information is interleaved with disc information called Disc Information (DI) frames. The DI frames contain information about the logical disc structure as well as recording parameters.

The DI is repeated in pre-recorded areas that occur prior to the lead-in zone.

4.4.5 Physical Access Control (PAC)

Physical Access Control (PAC) Clusters are disc structures that include additional information for interchange between interchange parties. PAC Clusters shall be recorded in the INFO1/PAC1 Zone and backup copies shall be recorded in the INFO2/PAC2 Zone.

A PAC may be read by using the READ DISC STRUCTURE command. If permitted, a PAC may be written by using the SEND DISC STRUCTURE command.

New PACs may be defined in the future for specific applications/functions. Drives designed before the introduction date of such new PACs shall treat such PACs as "Unknown PACs". The "Unknown PAC Rules" defined in the PAC header, provide a method to avoid compatibility problems. There are no generalized physical access restrictions for a "Known PAC".

The general PAC format is shown in Table 1.

Table 1 – General PAC Format

Cluster Offset	Field Length	Field Name
0	3	PAC ID
3	1	PAC format number
4	4	PAC Update Count
8	4	Unknown PAC Rules
12	1	Entire Disc Flags
13	2	Reserved (set to zeros)
15	1	Number of Segments

Cluster Offset	Field Length	Field Name
16	8	Segment 0
24	8	Segment 1
...	...	...
264	8	Segment 31
272	112	Reserved (set to zeros)
384 ... 65535	...	PAC Specific Information

PAC ID and Format — The PAC ID (3 bytes) identifies the specific PAC Cluster. PAC IDs 000000h and FFFFFFh are reserved.

The Format number of the PAC identifies the PAC format version.

PAC Update Count — The PAC Update Count shall specify the total number of update operations of the current PAC. This field shall be set to 00000000h during the first format operation only, and shall be incremented by one each time the current PAC is re-written.

Unknown PAC Rules	The Unknown PAC Rules shall specify the required actions when the PAC ID is not set to a known value. These bytes form a field consisting of 32 individual bits. If a drive encounters multiple unknown PACs on one disc, it shall use the OR-function of the unknown PAC rules. Each bit is either reserved, a write Control type, or a read Conrol type. Each Control type is associated with a specific disc area. If a write Control type is set to zero, writing in the associated area is permitted. If a write Control type bit is set to one, writing in the associated area is prohibited. If a read Control type is set to zero, reading in the associated area is permitted. If a read Control type bit is set to one, reading in the associated area is prohibited. See System Description Blu-ray Disc Rewritable Format, Part 1 Basic Format Specifications for specific Control type bit assignments.
Entire Disc Flags	The Entire Disc Flags byte specifies Unknown PAC Rules that cover the entire disc. Bits 1 through 7 are reserved. Bit 0 specifies PAC initialization rules. If bit 0 is set to zero, Reinitialization is permitted unless it is not blocked by any other mechanism. If bit 0 is set to one reinitialization is prohibited.
Segments	A Segment field shall specify the start and end address of a contiguous range of Clusters, called a Segment. Segments are defined starting from Segment 0 to Segment N-1, where N is specified in the Number of Segments field ($0 \leq N \leq 32$). Segments shall not overlap and shall be sorted in ascending order according to their addresses. Segments shall only start and end at Cluster boundaries. All Segment i fields, where $i \geq N$, shall be set to zeros. The first four bytes of the Segment i field, if used, shall contain the first PSN of the first Cluster belonging to the Segment, and the last four bytes shall contain the last PSN of the last Cluster belonging to the Segment.
PAC specific Information	The PAC specific information fields contain information that is specific to the current PAC.

4.4.6 Emergency Brake

The term “Emergency Brake” refers to a protection mechanism that prevents drive/media combinations from causing catastrophic failures. For example, having a new media type released at a future time that is incompatible with legacy drives and/or firmware.

An “Emergency Brake data set” is defined to be used by specific drive models to recognize discs that need special handling (see System Description Blu-ray Disc Rewritable Format, Part 1 Basic Format Specifications”).

Error reporting associated with Emergency Brake conditions are described in Table 2.

4.4.7 Not Ready Conditions

If the TEST UNIT READY command responds with GOOD status, then the Logical Unit is ready to accept some media accessing command. The readiness of the Logical Unit is command dependent. Table 2 lists some conditions under which the Logical Unit responds with GOOD status to the TEST UNIT READY command, but may not respond with GOOD status to a READ or WRITE command.

Table 2 -BD-RE READY Conditions

Situation	Response from Logical Unit
BD-RE media is present and ready. Disc has never been formatted.	Response to read command or write command: NOT READY/MEDIUM NOT FORMATTED, ILLEGAL REQUEST/MEDIUM NOT FORMATTED, NOT READY/MEDIUM FORMAT CORRUPTED, or MEDIUM ERROR/MEDIUM FORMAT CORRUPTED
Unknown PAC is discovered	TEST UNIT READY responds with GOOD status, but specific disc access types are disallowed according to Unknown PAC rules. When the Unknown PAC rules disallow reading, response to a READ command is: CHECK CONDITION status with sense bytes SK/ASC/ASCQ set to ILLEGAL REQUEST/INCOMPATIBLE MEDIUM INSTALLED When the Unknown PAC rules disallow writing, response to a WRITE command is: CHECK CONDITION status with sense bytes SK/ASC/ASCQ set to ILLEGAL REQUEST/ INCOMPATIBLE MEDIUM INSTALLED
Emergency Brake is active	TEST UNIT READY responds with CHECK CONDITION status with sense bytes SK/ASC/ASCQ set to NOT READY/ INCOMPATIBLE MEDIUM INSTALLED. All media accessing commands shall respond in the same way as TEST UNIT READY.

5 Features and Profiles for BD-RE Devices

5.1 Feature Descriptions

5.1.1 The Formattable Feature (0023h)

This Feature identifies a Logical Unit that can format media into logical blocks. The Feature descriptor response data to be returned to the Initiator is defined in Table 3.

Table 3 – Formattable Feature Descriptor

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB) Feature Code = 0023h							
1								(LSB)
2	Reserved			Version = 0001b			Persistent	Current
3	Additional Length = 4							
4	**Options for formatting BD-RE**							
	Reserved				RENoSA	Expand	QCert	Cert
5	Reserved							
6	Reserved							
7	Reserved							

The Feature Code field shall be set to 0023h.

The Version field shall be set to 0001b.

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. If a blank BD-RE disc is present and the response to the TEST UNIT READY command is GOOD status, then the Current bit of this feature shall be set to one.

The Additional Length field shall be set to 4.

If the BD-RE Profile is not supported, byte 4 of the Formattable Feature Descriptor shall be set to zero.

If the BD-RE Profile is supported, Format Types 00h and 30h with Sub-type 00b shall be supported for BD-RE disc. Quick Reformat shall be supported.

If the Cert bit is set to zero, the Logical Unit does not support Sub-type 10b (Full Certification) on formatting BD-RE disc. If the Cert bit is set to one, Format Type 30h with Sub-type 10b shall be supported for BD-RE disc.

If the Qcert bit is set to zero, the Logical Unit does not support Sub-type 11b (Quick Certification) during formatting of previously formatted BD-RE disc. If the QCert bit is set to one, Format Type 30h with Sub-type 11b shall be supported for BD-RE disc.

If the Expand bit is set to zero, the Logical Unit does not support Format Type 01h (Spare Area Expansion). If the Expand bit is set to zero, Format Type 01h is supported for the expansion of the spare area on formatted BD-RE disc.

If the RENoSA bit is set to zero, Format Type 31h (BD-RE with no spares allocated) is not supported for BD-RE disc. If the RENoSA bit is set to one, Format Type 31h shall be supported for BD-RE disc.

Logical Units that support this Feature shall implement the commands listed in Table 4.

Table 4 – Formattable Feature Commands

Op Code	Command	Reference
04h	FORMAT UNIT with format code = 001b	6.2
23h	READ FORMAT CAPACITIES	6.16
03h	REQUEST SENSE	MMC-4, 6.34
2Fh	VERIFY (10)	MMC-4, 6.49

5.1.2 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 5.

Table 5 – 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. If a BD-RE disc is present and ready, the Current bit shall be set to zero when the disc is not completely formatted..

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 6.

Table 6 - Command Support Required by the BD Read Feature

Op Code	Command Description	Reference
28h	READ (10)	6.11
A8h	READ (12)	6.12
ADh	READ DISC STRUCTURE (format = 0, FFh)	6.15
43h	READ TOC/PMA/ATIP (format 0 and 1)	6.17

5.2 Profile Descriptions

5.2.1 Profile 0043h: BD-RE

Logical Units identifying Profile 0043h as current shall support the features listed in Table 7.

Table 7 - Mandatory Features for BD-RE

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
0020h	Random Writable	Write support for randomly addressed writes
0023h	Formattable	Support for formatting of media
0024h	Defect Management[2]	The Logical Unit/media system is able to provide an apparently defect-free LBA space
0040h	BD Read[3]	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.

[1]PP bit in Random Readable Feature shall be set to 1.
[2]Defect Management Feature shall be marked not Current when no spares are allocated.
[3]BD Read Feature shall be marked not Current when media is physically blank.

Table 8 shows the decomposition of the profile into features and features into commands and mode pages.

Table 8 – BD-RE Profile Decomposition

BD-RE 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 Parameters Mode Page
	Random Writable Feature	Read Capacity command, Write (10) command, Write and Verify (10) command, Synchronize Cache command
	Formattable Feature	Format Unit command, Read Format Capacities command, Verify (10) command, Request Sense command
	BD Read Feature	Read (10) command, Read (12) command, Read Disc Structure command, Read TOC/PMA/ATIP command, Read/Write Error Recovery Parameters Mode Page
	Defect Management Feature	Read/Write Error Recovery Parameters Mode Page
	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, Read Buffer Capacity command[C], Set Streaming command, Set Read Ahead command, Write (12) command[C]

[C] marks a feature conditional command or mode page. All other commands and mode pages are mandatory.

6 Commands for BD 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 9. 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 9 – Commands for Multi-Media Logical Units

Command Name	Op Code	Reference
FORMAT UNIT	04h	6.2
GET CONFIGURATION	46h	6.3
GET EVENT STATUS NOTIFICATION	4Ah	6.4
GET PERFORMANCE	ACh	6.5
INQUIRY	12h	6.6
MECHANISM STATUS	BDh	6.7
MODE SELECT (10)	55h	6.8
MODE SENSE (10)	5Ah	6.9
PREVENT ALLOW MEDIUM REMOVAL	1Eh	6.10
READ (10)	28h	6.11
READ (12)	A8h	6.12
READ CAPACITY	25h	6.13
READ DISC INFORMATION	51h	6.14
READ DISC STRUCTURE	ADh	6.15
READ FORMAT CAPACITIES	23h	6.16
READ TOC/PMA/ATIP	43h	6.17
READ TRACK INFORMATION	52h	6.18
REQUEST SENSE	03h	6.19
SEND DISC STRUCTURE	BFh	6.20
SEND OPC INFORMATION	54h	6.21
START STOP UNIT	1Bh	6.22
SYNCHRONIZE CACHE	35h	6.23
TEST UNIT READY	00h	6.24
VERIFY (10)	2Fh	6.25
WRITE (10)	2Ah	6.26
WRITE (12)	AAh	6.27
WRITE AND VERIFY (10)	2Eh	6.28

6.2 FORMAT UNIT

The FORMAT UNIT command formats a medium into Initiator addressable logical blocks according to Initiator defined options. The medium may be certified and control structures created for the management of the medium and defects. The medium may or may not be altered.

6.2.1 The CDB and Its Parameters

The FORMAT UNIT command descriptor block is shown in Table 10.

Table 10 – FORMAT UNIT Command Descriptor Block

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

6.2.1.1 FmtData

If the FmtData bit is zero, there is no parameter list. If FmtData is one, a parameter list is available from the Initiator. For all Multi-media Logical Units, FmtData shall be set to one. If FmtData is zero, the command shall be terminated with CHECK CONDITION status and SK/ASC/ASCQ shall be set to to ILLEGAL REQUEST/INVALID FIELD IN CDB.

6.2.1.2 CmpList

For recordable BD discs, CmpList bit shall be set to zero. If CmpList is set to one, the command shall be terminated with CHECK CONDITION status and SK/ASC/ASCQ shall be set to to ILLEGAL REQUEST/INVALID FIELD IN CDB.

6.2.1.3 Format Code

The Format Code identifies the parameter list format. When BD-RE disc is present, the Format Code shall be set to one (001b).

6.2.1.4 Interleave Value

For BD, Interleave Value shall be zero. If Interleave Value is not set to zero, the command shall be terminated with CHECK CONDITION status and SK/ASC/ASCQ shall be set to to ILLEGAL REQUEST/INVALID FIELD IN CDB.

6.2.2 Format Parameter List

The FORMAT UNIT parameter list (Table 11) consists of three descriptors: the Format List Header, the Initialization Pattern Descriptor, and the Format Descriptor.

Table 11 – Format Unit Parameter List

Bit / Byte	7	6	5	4	3	2	1	0
0 – 3	Format List Header							
4 – n	Initialization Pattern Descriptor (present if IP = 1)							
n+1 to n+8	Format Descriptor							

6.2.2.1 Format List Header

The Format List Header (Table 12) provides several format control bits. Logical Units that implement these bits give Initiators additional control over the formatting operation. If the Initiator attempts to select any function not implemented by the Logical Unit, the Logical Unit shall terminate the command with CHECK CONDITION status and SK/ASC/ASCQ values shall be set to ILLEGAL REQUEST/INVALID FIELD IN PARAMETER LIST.

Table 12 – Format List Header

Bit / Byte	7	6	5	4	3	2	1	0
0	Reserved							
1	FOV	DPRY	DCRT	STPF	IP	Try-out	IMMED	VS
2	(MSB) Format Descriptor Length							
3								(LSB)

If the Format Options Valid (FOV) bit is zero, the Logical Unit shall use its default settings for the values of DPRY, DCRT, STPF, IP, and Try-out. For recordable BD discs, the defaults shall be all bits set to zero.

If FOV is one, the Logical Unit shall examine the setting of the DPRY, DCRT, STPF, IP, and Try-out. When BD-RE disc is present, the DPRY, DCRT, STPF, IP, Try-out, IMMED, and VS bits are defined as follows:

Disable primary (DPRY), Disable Certification (DCRT), Stop Format (STPF), Initialization Pattern (IP), and Try-out bits are reserved and shall be set to zero. If any of these bits is set to one, the Logical Unit shall terminate the command with CHECK CONDITION status and set SK/ASC/ASCQ values to ILLEGAL REQUEST/INVALID FIELD IN PARAMETER LIST.

If the immediate (IMMED) bit is zero, status shall be returned only after the format operation has completed. If the IMMED bit is set to one, the Logical Unit shall return status as soon as the CDB and the Format Descriptor have been validated and the format process has begun.

The Vendor Specific (VS) bit has a vendor-specific definition.

The Format Descriptor Length field in the Format list header specifies the total length in bytes of the Format descriptors. The Format Descriptor Length shall be set to 8. If any other value in found in this field, the Logical Unit shall terminate the command with CHECK CONDITION status and SK/ASC/ASCQ values shall be set to ILLEGAL REQUEST/INVALID FIELD IN PARAMETER LIST.

6.2.2.2 Format Descriptor

When the CDB Format Code is 001b, a Format Descriptor is included in the FORMAT UNIT Parameter List. The Format Descriptor (Table 13) is an eight-byte entry.

Table 13 – Format Code 001b Format Descriptor

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)							
1	Number of Blocks							
2								
3								(LSB)
4	Format Type						Format Sub-type	
5	(MSB)							
6	Type Dependent Parameter							
7								(LSB)

6.2.2.2.1 Number of Blocks

The Number of Blocks field provides a method for specifying the number of addressable blocks that shall be formatted for the entire disc. The method of specification is dependent upon the Format Type.

6.2.2.2.2 Format Type

The Format Type field specifies the type of formatting. When BD-RE disc is present, Format Types 00h and 30h shall be supported. Format Types 01h and 31h are optional for BD-RE disc.

6.2.2.2.3 Format Sub-type

The Format Sub-type field specifies additional behavior beyond that specified by the Format Type code.

6.2.2.2.4 Type Dependent Parameter

The definition of the Type Dependent Parameter field depends on Format Type.

6.2.3 Command Execution

6.2.3.1 Format Type = 00h (Default Format)

Format Type 00h requires that the Logical Unit execute the formatting process by using its default User Data Area size. The Logical Unit ignores the Number of Blocks field, and the Block Length field. The Sub-type field is reserved. The default behavior of the format process is Quick Reformat.

The total User Data Area on the disc shall be the default size as reported by the Format Type 00h format descriptor returned by READ FORMAT CAPACITIES command.

The Spare Area size shall be the default size as resulting from the default User Data Area Size.

6.2.3.2 Format Type = 01h (Spare Area Expansion)

If the Expand bit is set to one in the Formattable Feature descriptor, Format Type 01h is supported and is used to convert some of the User Data Area into Spare Area. Spare areas are permitted to be expanded when the total spare area size is non-zero. If the current disc formatting has no spare area allocated, then this command shall be terminated with CHECK CONDITION status and the sense bytes SK/ASC/ASCQ shall be set to ILLEGAL REQUEST/INVALID FIELD IN PARAMETER LIST.

Only the last spare area may be expanded. On a SL disc, only the OSA0 may be expanded. On a DL disc, only the ISA1 may be expanded.

The Initiator should determine the location and size of the part of the User Data Area that it expects to be taken as spares. User Data in that area should be preserved by the Initiator and all address links to that User Data should be removed.

The defect list entries within the range of the area that is taken as spares by this command shall be preserved through the execution of this command. The Number of Blocks field specifies the number of addressable blocks for the whole disc and the Type Dependent Parameter field specifies the Block Length. Neither field is changeable from the values reported by the READ FORMAT CAPACITIES command.

Once formatting has completed, if space is available, the Initiator should restore the data that was copied off the disc.

6.2.3.3 Format Type = 30h (Format with Spare Area)

Table 14 shows the Format Descriptor for Format Type 30h.

Table 14 - Format Descriptor (Format Type = 30h)

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)							
1				Number of Blocks				
2								
3								(LSB)
4	Format Type = 30h						Format Sub-type	
5	(MSB)							
6				Spare Area size in Clusters				
7								(LSB)

Format Sub-type selects a sub-type of format Type 30h that is independent of the setting of the DCRT bit in the Format List Header.

Table 15 – Sub-type Field

Sub-type Value	Description
00b	Quick Reformat: If the disc is blank, the format process shall simply initialize the disc structures with no certification. If the disc has been previously formatted, a Quick Reformat shall be performed. Quick Reformat consists of declaring that all Clusters marked as defective in the DFL become marked as possibly bad during the reformat. Assigned spares are released.
01b	No Certification: No certification shall be applied to the data area after disc structures have been initialized. The defect tables shall be initialized to indicate no media defects.
10b	Full Certification: The entire data area shall be certified. The defect tables shall be initialized with defects discovered during the certification process.
11b	Quick Certification: If the media has been previously formatted, the defect tables shall be reconstructed by certifying only the Clusters that were previously declared to be defective.

Format Type 30h requires that the Logical Unit format the disc in order that the User Data Area contains at least Number of Blocks. The number of spare Clusters allocated shall be less than or equal to:

S = IP[(Data Zone Size - Number of Blocks)/32], where IP is the integer part of the result.

S is the maximum number of spare Clusters that may be allocated. Allocation rules differ for disc size (i.e. 80mm or 120mm) and number of layers.

Since the formatted capacity of the media may be larger than the Number of Blocks field, when formatting has completed, the Initiator should send the READ CAPACITY command in order to determine the actual capacity.

Sub-type identifies certification to be performed as described in Table 15. The Spare Area size in Clusters field is ignored by the Logical Unit.

6.2.3.3.1 Spares Allocation on 80mm Single Layer BD-RE

If the BD-RE disc is a single layer 80mm disc, then 4096 spare Clusters shall be allocated in ISA0. Consequently, S shall be at least 4096. If S is less than 4096, then the command shall be terminated with CHECK CONDITION status and sense bytes SK/ASC/ASCQ shall be set to ILLEGAL REQUEST/INVALID FIELD IN PARAMETER LIST.

6.2.3.3.2 Spares Allocation on 80mm Dual Layer BD-RE

If the BD-RE disc is a dual layer 80mm disc, then 4096 spare Clusters shall be allocated in ISA0 and up to 16384 spare Clusters may be allocated in ISA1 in increments of 256 Clusters.

Minimally, the 4096 Clusters in ISA0 shall be allocated for spares. If S is less than 4096, then the command shall be terminated with CHECK CONDITION status and sense bytes SK/ASC/ASCQ shall be set to ILLEGAL REQUEST/INVALID FIELD IN PARAMETER LIST.

If S > 4096, then set S_1 to the minimum of 64 and IP[(S - 4096)/256]. Otherwise, set S_1 to zero. ISA1 shall be allocated 256* S_1 spare Clusters.

6.2.3.3.3 Spares Allocation on 120mm Single Layer BD-RE

If the BD-RE disc is single layer 120mm disc, then 4096 spare Clusters shall be allocated in ISA0 and up to 16384 spare Clusters may be allocated in OSA0 in increments of 256 Clusters.

Minimally, the 4096 Clusters in ISA0 shall be allocated for spares. If S is less than 4096, then the command shall be terminated with CHECK CONDITION status and sense bytes SK/ASC/ASCQ shall be set to ILLEGAL REQUEST/INVALID FIELD IN PARAMETER LIST.

If S > 4096, then set S_1 to the minimum of 64 and IP[(S - 4096)/256]. Otherwise, set S_1 to zero. OSA0 shall be allocated 256* S_1 spare Clusters.

6.2.3.3.4 Spares Allocation on 120mm Dual Layer BD-RE

If the BD-RE disc is a dual layer 120mm disc, then:

1. 4096 spare Clusters shall be allocated in ISA0,
2. Up to 16384 spare Clusters may be allocated equally to OSA0 and OSA1 (i.e. a maximum of 8192 each) in increments of 256 Clusters, and
3. Up to 16384 spare Clusters may be allocated to ISA1 in increments of 256 Clusters.

Minimally, the 4096 Clusters in ISA0 shall be allocated for spares. If S is less than 4096, then the command shall be terminated with CHECK CONDITION status and sense bytes SK/ASC/ASCQ shall be set to ILLEGAL REQUEST/INVALID FIELD IN PARAMETER LIST.

With these rules, many allocation schemes are possible. The actual allocation scheme used is vendor specific, however, the following scheme is recommended:

If S > 4096, then set S_1 to the minimum of 128 and IP[(S - 4096)/256]. Otherwise, set S_1 to zero.

Set S_2 = IP(S_1/4), (i.e. the integral quotient of S_1/4).

Set S_3 = 4*S_2 - S_1. (i.e. the integral remainder of S_1/4).

Allocate 256* S_2 Clusters to OSA0.

Allocate 256* S_2 Clusters to OSA1.

Allocate 512* S_2+256* S_3 Clusters to ISA1.

In general, this assures that ISA1 to OSA1 ratio is at least 2 to 1.

6.2.3.4 Format Type = 31h (Format without Spare Area)

If the RENoSA bit is set to one in the Formattable Feature descriptor, Format Type 31h is supported. Format Type 31h specifies the drive to execute the formatting process with no Spare Area.

Table 16 - Format Descriptor (Format Type = 31h)

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)							
1	User Data Area Size							
2								
3								(LSB)
4	Format Type = 31h						Sub-type	
5	(MSB)							
6	Block Length							
7								(LSB)

The User Data Area size specifies the total number of user accessible blocks on all layers of the disc. The recommended value of this field for the mounted disc is obtained by READ FORMAT CAPACITIES command. The value of User Data Area size field shall be less than or equal to the Number of Blocks field value in the Formattable Capacity Descriptor for the minimum Spare Area size, and shall be greater than or equal to the Number of Blocks field value in the Formattable Capacity Descriptor for the maximum Spare Area size.

Sub-type identifies certification to be performed as described in Table 15.

The Block Length specifies the length in bytes of each sector.

6.3 GET CONFIGURATION Command

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

See MMC-4 for a description of this command.

6.4 GET EVENT STATUS NOTIFICATION Command

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

Logical Units that support BD-RE shall implement the Operational Change Event class, the Media Event class, and the Device Busy class.

See MMC-4 for a description of this command.

6.5 GET PERFORMANCE Command

The Real-time Streaming Feature requires that this command be implemented. The BD-RE Profile includes the Real-time Streaming Feature. If the SW bit in the Real-time Streaming Feature Descriptor is set to one, support of Type 01h is mandatory. Otherwise, from the Initiator's perspective, use of this command requires no special behavior from a Logical Unit when a BD Feature is current.

See MMC-4 for a description of this command.

6.6 INQUIRY Command

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

See MMC-4 for a description of this command.

6.7 MECHANISM STATUS Command

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

See MMC-4 for a description of this command.

6.8 MODE SELECT (10) Command

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

See MMC-4 for a description of this command.

6.9 MODE SENSE (10) Command

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

See MMC-4 for a description of this command.

6.10 PREVENT ALLOW MEDIUM REMOVAL Command

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

See MMC-4 for a description of this command.

6.11 READ (10) Command

The Random Readable Feature requires that this command be implemented. The BD-RE 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 Feature is current.

See MMC-4 for a description of this command.

6.12 READ (12) Command

The BD Read Feature requires that this command be implemented. The BD-RE Profile includes the BD Read 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 CAPACITY Command

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

See MMC-4 for a description of this command.

6.14 READ DISC INFORMATION Command

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

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

6.14.1 The CDB and Its Parameters

The READ DISC INFORMATION CDB is shown in Table 17.

Table 17 – 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 parameter of the CDB. An Allocation Length of zero shall not be considered an error. If the Allocation Length is greater than the amount of available Disc Information Data, only the available data is transferred.

6.14.2 Command Execution

The Logical Unit shall gather information about the medium, format it as shown in Table 18, and transfer to the Initiator, limited by the Allocation Length.

BD-RE devices do not send OPC information to the host. Consequently, the Number of OPC Table Entries field in the Disc Information Block shall be set to zero.

Table 18 – 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 19 – DIB of BD Discs

DIB Field	BD-RE	
	Value	Meaning
Erasable	RE = 1b	RE is rewritable.
State of Last Session	Empty = 00b Complete=11b	The last session of a blank RE is always empty. The last session of a formatted RE is always complete.
Disc Status	Blank = 00b Finalized=10b	A blank RE is empty. A formatted RE is always finalized.
Number of First Track on Disc	0001h	Formatted RE has exactly 1 logical track.
Number of Sessions	0001h	Formatted RE has exactly 1 session.
First Track Number in Last Session	0001h	Formatted RE has exactly 1 logical track.
Last Track Number in Last Session	0001h	Formatted RE has exactly 1 logical track.
DID_V	0b	BD does not have a Disc ID
DBC_V	0b	BD does not have a disc bar code
URU	0b	BD disc is unrestricted use
DAC_V	0b	BD does not have an Application Code.
Dbit	0b	RE always formats in foreground.
BG Status	00b	RE always formats in foreground.
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	RE is single session.
Last Possible Lead-out Start Address	Capacity+1	RE is single track, single session.
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	RE devices do not provide OPC info.
OPC Table	None	RE devices do not provide OPC info.

6.15 READ DISC STRUCTURE Command

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

6.15.1 The CDB and Its Parameters

The READ DISC STRUCTURE CDB is shown in Table 20.

Table 20 – 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	AGID		Reserved					
11	Control							

6.15.1.1 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.

6.15.1.2 Address

The Address field definition is dependent upon the value in the Format code.

6.15.1.3 Layer Number

Use of the Layer Number field is dependent upon the Format code.

6.15.1.4 Format Code

The Format Code (Table 21) indicates the type of information that is requested by the Initiator.

Table 21 - Format Code Definitions

Format Code	Structure	Address	Layer Number	Description
00h	DI	-	Layer	Disc Information from PIC in pre-recorded area
01h – 07h	Reserved	-	-	-
08h	DDS	-	-	Disc Definition Structure
09h	Cartridge Status	-	-	Cartridge status.
0Ah	Spare Area Information	-	-	Status of Spare Areas
0Bh - 11h	Reserved	-	-	-
12h	Raw DFL	Offset	-	Unmodified DFL
13h – 2Fh	Reserved	-	-	-
30h	PAC	ID and Format Number	-	Physical Access Control Structure
FFh	Structure List	-	-	BD Structure list

6.15.1.5 Allocation Length

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

6.15.1.6 AGID

The AGID field shall be set to 00b when Media Type is 0001b (BD).

6.15.2 Command Execution

The description of command execution is dependent upon the Format field of the CDB.

6.15.2.1 Format Code 00h: Disc Information (DI)

A DI unit is 112 bytes in PIC on a BD-RE disc. The DI unit that contains 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 Rewritable Format, Part 1 Basic Format Specifications* for DI unit detailed definition.

Table 22 – BD Structure Format Code 00h: Disc Information

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			Data Structure Length = 114				
1								(LSB)
2	Reserved							
3	Reserved							
Blu-ray Disc Information								
0	DI Units							
1								
…								
111								

6.15.2.2 Format Code 08h: Disc Definition Structure (DDS)

The DDS is a disc management structure that contains basic disc usage parameters. The minimum defined size for the DDS is 60 bytes. The DDS definition is permitted to expand to 2048 bytes.

The DDS structure format is shown in Table 23.

Table 23 – BD Structure Format Code 08h: Disc Definition Structure

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

See *System Description Blu-ray Disc Rewritable Format, Part 1 Basic Format Specifications* for detailed format of the DDS.

6.15.2.3 Format Code 09h: Cartridge Status

The Medium Status structure (Table 24) includes information about cartridge status.

Table 24 – BD Format Structure Code 09h: Cartridge Status

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			Data Structure Length = 6				
1								(LSB)
2	Reserved							
3	Reserved							
Medium Status Structure								
0	Cartridge	OUT	Reserved			CWP	Reserved	
1	Reserved							
2	Reserved							
3	Reserved							

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

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

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

6.15.2.4 Format Code 0Ah: Spare Area Information

The Spare Area Information structure contains status information about the defect management systems spare blocks. The format of the Spare Area Information structure is shown in Table 25.

Table 25 – Format Code 0Ah: Spare Area Information

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			Data Structure Length = 000Eh				
1								(LSB)
2	Reserved							
3	Reserved							
Spare Area Information								
0	(MSB)							
...				Reserved				
3								(LSB)
4	(MSB)							
...				Number of Free Spare Blocks				
7								(LSB)
8	(MSB)							
...				Number of Allocated Spare Blocks				
11								(LSB)

Number of free Spare blocks field is the number of unused spare blocks that are not considered defective in the Spare Areas.

Number of Allocated Spare blocks is the number of spare blocks reserved on the disc as defective block replacements.

6.15.2.5 Format Code 12h: Raw Defect List (DFL)

The DFL is a defect management structure that identifies the locations and status of known defective Clusters on the disc. The length (N) of the DFL is variable. The minimum defined size is 72 bytes. The DFL may occupy as many as 8 Clusters (524 288 bytes). The actual length of the DFL is recorded in the DFL header (see *System Description Blu-ray Disc Rewritable Format, Part 1 Basic Format Specifications*).

The DFL is viewed as being contained within 16 packages (numbered fom 0 through 15), each 32K (32 768) bytes in length. The Address field in the CDB is used to address a specific package. If the Address field value is larger than 15, the command shall be terminated with CHECK CONDITION and sense bytes SK/ASC/ASCQ shall be set to indicate ILLEGAL REQUEST/INVALID FIELD IN CDB. It is only possible to read a single package with one command. In order to read the entire DFL it is necessary to read all of the DFL packages.

The DFL structure format is shown in Table 26.

Table 26 – BD Structure Format Code 12h: Defect List

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB) Data Structure Length							
1								(LSB)
2	Reserved							
3	Number of Packages in DFL							
Defect List Structure								
0	DFL Data from addressed package							
1								
…								
N-1								

The Initiator is required to read packages 0 through "Number of Packages in DFL" - 1 in order to receive all of the DFL.

The Data Structure Length is the number of bytes that follow the Data Structure Length field. The maximum value for this field is 32770 (a complete package + 2). If Data Structure Length = 0002h, the addressed DFL package is empty.

See *System Description Blu-ray Disc Rewritable Format, Part 1 Basic Format Specifications* for detailed format of the DFL.

6.15.2.6 Format Code 30h: Physical Access Control (PAC)

Physical Access Control (PAC) Clusters are provided as structures on the disc to include additional information for interchange between interchange parties. PAC Clusters shall be recorded in the INFO1/PAC1 Zone. Backup copies shall be recorded in the INFO2/PAC2 Zone.

The specific PAC ID and format number of the PAC addressed by the READ DISC STRUCTURE command is contained the Address field of the CDB as shown in Table 27.

Table 27 – PAC ID and Format Number in CDB Address Field

Byte	Field
2	(MSB)
3	PAC ID
4	(LSB)
5	Format Number

Valid values for the PAC ID and Format Number fields are shown in Table 28.

Table 28 – PAC ID and Format Number Fields

PAC		Definition
ID	Format	
000000h	00h	Return a list of PAC headers of all PACs that are written on the currently mounted disc. The list shall be given in ascending order according to PAC ID.
	01h - FFh	Reserved
000001h - FFFFFEh	00h - FFh	The PAC information of the addressed PAC shall be returned.
FFFFFFh	00h - FEh	Reserved
	FFh	Return a list of PAC headers of all PACs that are known to the Logical Unit. The list shall be given in ascending order according to PAC ID.

In the case that the PAC ID and Format Number requested are both zero, the Logical Unit shall return a list of the headers of all PACs that are written on the currently mounted disc. The PAC headers shall be ordered according to PAC ID.

Table 29 – Returned Data Format for PAC ID/Format = 000000h/00h

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB) Data Structure Length							
1	(LSB)							
2	Reserved							
3	Reserved							
PAC Header List								
0	Header of first written PAC							
...								
383								
384	...							
...								
...								
(N-2)*384	Header of Nth written PAC							
...								
(N-1)*384-1								

In the case that the PAC ID/Format Number requested is neither 000000h/00h nor FFFFFFh/FFh, the Logical Unit shall return the most recently recorded copy of the requested PAC. If reading the PAC is not permitted, then only the PAC header shall be returned. If there is no PAC with the specified ID and Format Number, the command shall be terminated with CHECK CONDITION status and sense bytes SK/ASC/ASCQ shall be set to indicate ILLEGAL REQUEST/INVALID FIELD IN CDB. The format of returned PAC data is shown in Table 30. See 4.4.5 for the general PAC structure format.

Table 30 – Returned Data Format for 000000h ≤ PAC ID ≤ FFFFFEh

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			Data Structure Length				
1								(LSB)
2	Reserved							
3	Reserved							
PAC								
0	PAC Header							
...								
383								
384	PAC Specific Information							
...								
N-1								

The length of a PAC is at most 63448 bytes (31 logical blocks).

In the case that the PAC ID requested is FFFFFFFFh, the Logical Unit shall return a list of the headers of all PACs that are known to the Logical Unit. The PAC headers shall be ordered according to PAC ID.

Table 31 – Returned Data Format for PAC ID = FFFFFFFFh

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			Data Structure Length				
1								(LSB)
2	Reserved							
3	Reserved							
PAC Header List								
0	Header of first known PAC							
...								
383								
384	...							
...								
...								
(N-2)*384	Header of Nth known PAC							
...								
(N-1)*384-1								

6.15.2.7 Format Code FFh: BD Structure List

The BD Structure List is returned in the format as shown in Table 32.

Table 32 – BD Structure Format Code FFh: BD Structure List

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

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

The Structure List is returned as a sequence of Structure List Entries as shown in Table 33.

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 33 – 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/writable via the READ/SEND DISC STRUCTURE commands.

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.

6.16 READ FORMAT CAPACITIES

The READ FORMAT CAPACITIES command allows the Initiator to request a list of the possible format capacities for an installed writable media. This command also has the capability to report the writable capacity for a media when it is installed.

Table 34 shows the Features associated with the READ FORMAT CAPACITIES command.

Table 34 – Features Associated with the READ FORMAT CAPACITIES Command

Feature Number	Feature Name	Command Requirement
0023h	Formattable	Mandatory

6.16.1 The CDB and Its Parameters

The READ FORMAT CAPACITIES CDB is shown in Table 35.

Table 35 – READ FORMAT CAPACITIES CDB

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code (23h)							
1	Reserved							
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	(MSB) Allocation Length							
8								(LSB)
9	Control							

The Allocation Length field specifies the maximum number of bytes that an Initiator has allocated for returned data. An Allocation Length of zero indicates that no data shall be transferred. This condition shall not be considered as an error. The Logical Unit shall terminate the data transfer when Allocation Length bytes have been transferred or when all available data have been transferred to the Initiator, whatever is less.

6.16.2 Command Execution

The Logical Unit shall construct a set of data structures that shall be transferred to the Initiator. The format of this returned data is a 4-byte header followed by some non-zero number of 8-byte format descriptors as shown in Table 36.

Table 36 – 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 1							
..								
7								
….								
0	Formattable Capacity Descriptor n							
..								
7								

6.16.2.1 Capacity List Header

The Capacity List Header precedes all other returned data.

Table 37 – Capacity List Header

Bit / Byte	7	6	5	4	3	2	1	0
0	Reserved							
1	Reserved							
2	Reserved							
3	Capacity List Length							

The Capacity List Length specifies the length in bytes of the available 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 < 31.

6.16.2.2 Current/Maximum Capacity Descriptor

The Current/Maximum Capacity Descriptor shall appear after the header.

Table 38 – Current/Maximum Capacity Descriptor

Bit / Byte	7	6	5	4	3	2	1	0
4	(MSB) Number of Blocks							
5								
6								
7								(LSB)
8	Reserved							Descriptor Type
9	(MSB) Block Length/Spare Area Size							
10								
11								(LSB)

The Number of Blocks indicates the number of addressable blocks for the capacity defined by each Descriptor Type.

The Descriptor Type field (Table 39) indicates the type of information the descriptor contains.

The Block Length/Spare Area Size represents Block Size for all non-BD media. For BD-RE, this field contains specifies a number of BD Clusters allocated/allocatable for spares.

Table 39 – Descriptor Types for BD-RE

Descriptor Type	Format Status	Number of Blocks	Block Length/Spare Area Size
00b	Reserved		
01b	Unformatted Media	The reported value is the total number of blocks of the Data Zone(s) on the mounted BD disc	Maximum number of Spare Area Clusters allowed for the currently mounted BD-RE disc.
10b	Formatted Media	The reported value is the current media's total number of blocks in User Data Area(s).	Number of Clusters allocated for Spare Area on the currently mounted BD-RE disc.
11b	No Media Present	The reported value is for the maximum capacity of a media that the Logical Unit is capable of reading.	Block Length that specifies the length in bytes of each logical blocks. 800h for Multi-Media devices.

6.16.2.3 Formattable Capacity Descriptor(s)

The Logical Unit shall return only Formattable Capacity Descriptors (Table 40) 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.

Table 40 – Formattable Capacity Descriptor

Bit / Byte	7	6	5	4	3	2	1	0
4	(MSB)							
5	Number of Blocks							
6								
7								(LSB)
8	Format Type						Reserved	
9	(MSB)							
10	Type Dependent Parameter							
11								(LSB)

A Formattable Capacity Descriptor of Format Type 00h shall be reported if any other Formattable Capacity Descriptor is reported. The Logical Unit may not support type 0 (e.g. CD-RW). The descriptor is reported for the purpose of reporting the recordable capacity of sequentially recorded media.

If the currently mounted media is not BD-RE, refer to MMC-4 for the permitted Formattable Capacity Descriptors.

When the BD-RE Profile is current the format descriptors shown in Table 41 shall be returned.

Table 41 – Format Descriptors Returned for BD-RE

Format Type	Description	Type Dependent Parameter	Spares
00h	The descriptor shall contain the total number of addressable blocks and the block size used for formatting the whole media. Spares shall be allocated. All parameters in the descriptor are vendor selected default values for BD-RE discs. The following are recommended Spare area distributions: For 80mm SL BD-RE discs: ISA0 size = 4096 Clusters and OSA0 size = 0 Clusters. For 80mm DL BD-RE discs: ISA0 size = ISA1 size = 4096 Clusters and OSA0 size = OSA1 size = 0 Clusters. For 120mm SL BD-RE discs: ISA0 size = 4096 Clusters and OSA0 size = 8192 Clusters. For 120mm DL BD-RE discs: ISA0 size = ISA1 size = 4096 Clusters and OSA0 size = OSA1 size = 8192 Clusters.	Block length in bytes	Yes
01h	The descriptor shall contain the minimum User Data Area size in sectors. and the block size used for formatting the whole media. This Format Type is used to expand a Spare Area.	Block length in bytes	Yes
30h	The descriptor shall contain the total number of addressable blocks and the total number of Spare Area size used for formatting the whole media. Three descriptors are reported: The first descriptor values are vendor preferred for the BD device. Spares distribution examples are shown in 6.2.3.3. The second descriptor values are selected to reflect maximum Spare Area sizes: For 80mm SL BD-RE discs, ISA0 size = 4096 Clusters and OSA0 size = 0 Clusters. For 80mm DL BD-RE discs, ISA0 size = 4096 Clusters, OSA0 size = 16384 Clusters and OSA0 size = OSA1 size = 0 Clusters. For 120mm SL BD-RE discs, ISA0 size = 4096 Clusters and OSA0 size = 16384 Clusters. For 120mm DL BD-RE discs, ISA0 size = 4096 Clusters, OSA0 size = OSA1 size = 8192 Clusters, and ISA1 size = 16384 Clusters. The third descriptor values are selected to reflect minimum Spare Area size. For 80mm, 120mm SL and DL BD-RE discs, ISA0 size = 4096 and ISA1 size = OSA0 size = OSA1 size = 0 Clusters.	Total Spare Area size in Clusters	Yes
31h	The descriptor shall contain the total number of addressable blocks and the block size used for formatting the whole media. All parameters in the descriptor is for the format with no Spare Area. By using this parameter in FORMAT UNIT command, the Hardware Defect Management Feature (and consequently, Removable Disk Profile) becomes not Current.	Block length in bytes	No

6.17 READ TOC/PMA/ATIP Command

READ TOC/PMA/ATIP (Table 42) 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.

6.17.1 The CDB and Its Parameters

The READ TOC/PMA/ATIP CDB is shown in Table 42.

Table 42 – 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							

6.17.1.1 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.

6.17.1.2 Format field

The Format field is used to select a specific returned data format. For BD-RE disc, only Format 0 and Format 1 are valid. If a BD 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.

6.17.1.3 Track/Session Number field

Track/Session Number shall be set to one when BD-RE media is present. If Track/Session Number is not set to 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.

6.17.1.4 Allocation Length

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

6.17.2 Command Execution

The READ TOC/PMA/ATIP command was originally designed for CD media. Adapting this command for higher capacity media limits the number of Logical Track numbers available to 170. For BD discs the returned data is fabricated to maximize backward compatibility without limiting Logical Track numbers.

6.17.2.1 Format 0: Data Zone Capacity

Table 43.

Table 43 – TOC Data Format 0: Data Returned for formatted BD-RE 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 = 000000h, MSF form = 00:02:00
Track AAh (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

If BD-RE medium is present and the Logical Unit is unable to report TOC information for the mounted medium, then the command shall be terminated with CHECK CONDITION status. For sense information, see 4.4.7.

If formatted BD-RE disc is present, the TOC Format 0 returned data shall have the format shown in Table 43.

6.17.2.2 Format 1: Session Information

If BD-RE medium is present and the Logical Unit is unable to report TOC information for the mounted medium, then the command shall be terminated with CHECK CONDITION status. For sense information, see 4.4.7.

When formatted BD-RE is present, the TOC Format 1 returned data shall have the format shown in Table 44.

Table 44 – TOC Data Format 1: Data Returned for BD Discs

	Byte(s)	Field	Value
Header	0, 1	TOC Data Length	000Ah
	2	First Session Number	01h
	3	Last 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	Track Start Address	LBA form = 000000h, MSF form = 00:02:00

6.18 READ TRACK INFORMATION Command

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

6.18.1 The CDB and Its Parameters

The READ TRACK INFORMATION CDB is shown in Table 45.

Table 45 – 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							

6.18.1.1 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 46.

6.18.1.2 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 46.

Table 46 – 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. When the Session number is 1, the Logical Track Number shall always be 1.
11b	Reserved	

6.18.1.3 Allocation Length

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

6.18.2 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 47.

Table 47 – 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 48 shows required content when BD-RE disc is present.

Table 48 –TIB Fields for BD Discs

TIB Field	BD-RE	
	Value	Meaning
Track Number	1	BD-RE is viewed as one track
Session Number	1	BD-RE is viewed as one session
Damage	0	Not used by BD-RE and shall be 0b
Copy	0	Not used by BD-RE and shall be 0b
Track Mode	4h	BD sectors approximate CD mode 1
RT	0	Not used by BD-RE and shall be 0b
Blank	1 when disc is blank 0 after first format	If the BD-RE disc is blank, then Blank = 1. Once formatted, Blank = 0.
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-RE and shall be 0b
NWA_V	0	Not used by BD-RE and shall be 0b
Track Start Address	00000000h	Not used by Random Writable devices
Next Writable Address	00000000h	Not used by Random Writable devices
Free Blocks	00000000h	Not used by Random Writable devices
Fixed Packet Size/Blocking Factor	00000020h	Cluster size in sectors
Track Size	READ CAPACITY LBA + 1	
Last Recorded Address	00000000h	This field is not used by BD-RE devices and shall be 00000000h
Read Compatibility LBA	00000000h	This field is not used by BD-RE devices and shall be 00000000h

6.19 REQUEST SENSE Command

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

See MMC-4 for a description of this command.

6.20 SEND DISC STRUCTURE Command

The SEND DISC STRUCTURE command provides a means for the Initiator to transfer BD STRUCTURE data to the Logical Unit.

6.20.1 The CDB and Its Parameters

The SEND DISC STRUCTURE CDB is shown in
Table 49.

Table 49 – SEND DISC STRUCTURE Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code (BFh)							
1	Reserved				Media Type			
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	Format							
8	(MSB) Parameter List Length							
9	(LSB)							
10	Reserved							
11	Control							

6.20.1.1 Media Type

The Media Type field identifies the Media Type to which this command is directed. The BD disc type is 0001b.

6.20.1.2 Format

The Format field (Table 50) indicates the type of information that the Initiator is requesting to send.

Table 50 – Format Field Definition

Format	Data	Description
0Fh	Timestamp	Send Timestamp data
30h	PAC	Send PAC data

6.20.1.3 Parameter List Length

The Parameter List Length field specifies the length in bytes of the DISC STRUCTURE data to be transferred from the Initiator to the Logical Unit after the CDB is transferred. A Structure Data Length field of zero indicates that no data shall be transferred. This condition shall not be considered an error.

6.20.2 Command Execution

The description of the command execution is dependent upon the Format field of the CDB.

6.20.2.1 Format Code = 0Fh: Timestamp

The format of Timestamp field is structured as shown in Table 51.

The time should be current UTC (Universal Coordinated Time) 24 hour clock.

Table 51 – SEND DISC STRUCTURE Data Format (Format Code = 0Fh)

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB) Data Structure Length							
1								(LSB)
2	Reserved							
3	Reserved							
Timestamp Data								
0	Reserved							
1	Reserved							
2	Reserved							
3	Reserved							
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)

The Data Structure Length field specifies the length in bytes of the Timestamp Data to follow. A Data Structure Length field of zero indicates that no Disc Timestamp Data shall be transferred. This condition shall not be considered an error.

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

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

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

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

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

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

6.20.2.2 Format Code 30h: Physical Access Control (PAC)

Physical Access Control (PAC) Clusters are provided as a structure on the disc to include additional information for interchange between interchange parties. PAC Clusters shall be recorded in the INFO1/PAC1 Zone and backup copies shall be recorded in the INFO2/PAC2 Zone. The format of PAC data provided by the Initiator is shown in Table 52. See 4.4.5 for the general PAC structure format.

Table 52 – Physical Access Control Send Data Format

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB) Data Structure Length							
1								(LSB)
2	Reserved							Erase
3	Reserved							
PAC								
0	PAC Header							
...								
383								
384	PAC Specific Information							
...								
65535								

If the Erase bit is set to zero, the remainder of the structure contains the PAC Cluster content that should be written to the media.

If the Erase bit is set to one, each occurance of a PAC with the PAC ID matching the PAC ID in the CDB shall be erased. The PAC information following the disc structure header shall be ignored.

The Logical Unit shall neither record nor erase any PAC that is unknown to the Logical Unit.

6.21 SEND OPC INFORMATION Command

The SEND OPC INFORMATION command descriptor block (Table 53) allows the Initiator to request that the Logical Unit perform Optimum Power Calibration (OPC) on the currently mounted medium.

Table 53 – SEND OPC INFORMATION Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code (54h)							
1	Reserved							DoOpc
2	Reserved						Exclude1	Exclude0
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	(MSB) Parameter List Length							
8								(LSB)
9	Control							

If DoOpc is set to one, the Logical Unit shall determine OPC values for the current recording conditions. It may be necessary to perform an OPC operation. These OPC values shall become current. When DoOpc is set to one, the Parameter List Length field is ignored.

If DoOpc is set to zero, the Logical Unit shall perform no OPC operation.

Exclude0 and Exclude1 allow the Initiator to select the layers to be calibrated.

Table 54 shows the behaviour given various combinations of control bits from byte 1.

Table 54 – Logical Unit Action with Combinations of DoOPC, Exclude0, and Exclude1

DoOpc	Exclude0	Exclude1	Logical Unit Response
1	0	0	Perform OPC operation on each layer to set OPC values for current media speed.
1	0	1	Perform OPC operation only on layer 0 to set OPC values for current media speed.
1	1	0	Perform OPC operation only on layer 1 to set OPC values for current media speed.
1	1	1	No operation – GOOD status shall be returned
0	x	x	No operation – GOOD status shall be returned

If the mounted media is not a recordable dual layer media supported by the Logical Unit and either Exclude0 or Exclude1 is non-zero, then 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.

BD-RE Logical Units do not support receiving OPC information from the Initiator. If DoOPC is set to zero and Parameter List Length is not zero, 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.

6.22 START STOP UNIT Command

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

See MMC-4 for a description of this command.

6.23 SYNCHRONIZE CACHE Command

No change from Removable Disc Profile behavior.

See MMC-4 for a description of this command.

6.24 TEST UNIT READY Command

The Core Feature requires that this command be implemented. The BD-RE 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 Feature is current.

See MMC-4 for a description of this command.

6.25 VERIFY (10) Command

No change from Removable Disc Profile behavior.

See MMC-4 for a description of this command.

6.26 WRITE (10) Command

The WRITE (10) Command requests that the Logical Unit write Initiator provided data to the medium.

Table 55 shows the Features associated with the WRITE (10) command.

Table 55 – Features Associated with the WRITE (10) Command

Feature Number	Feature Name	Command Requirement
0020h	Random Writable	Mandatory

6.26.1 The CDB and its Parameters

The WRITE (10) CDB is shown in Table 56.

Table 56 – WRITE (10) CDB

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code (2Ah)							
1	Reserved			DPO	FUA	Reserved		RelAdr
2	(MSB)							
3	Logical Block Address							
4								
5								(LSB)
6	Reserved							
7	(MSB)			Transfer Length				
8								(LSB)
9	Control							

6.26.1.1 DPO

Disable Page Out (DPO) is not used by MM Logical Units and shall be set to zero.

6.26.1.2 FUA

A FUA (force unit access) bit, set to one, indicates that the Logical Unit shall access the media in performing the command prior to returning GOOD status. In the case where the cache contains a more recent version of a logical block than the media, the logical block shall first be written to the media. WRITE commands shall not return GOOD status until the logical blocks have actually been written on the media, and the Write process is complete. This mode may not operate correctly with a sequence of writes intended to produce a continuous stream unless command queuing is implemented

A FUA bit of zero indicates that the Logical Unit may satisfy the command by accessing the cache memory. For WRITE operations, logical blocks may be transferred directly to the cache memory. GOOD status may be returned to the Initiator prior to writing the logical blocks to the medium. Any error that occurs after the GOOD status is returned is a deferred error, and information regarding the error is not reported until the following command.

6.26.1.3 RelAdr

RelAdr (Relative Address) is not used by MM Logical Units and shall be set to zero.

6.26.1.4 Logical Block Address

The Logical Block Address field specifies the logical block where the write operation shall begin. If Starting Logical Block Address is not within the range specified by the READ CAPACITY command response, 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.

6.26.1.5 Transfer Length

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.

6.26.2 Command Execution

No change from Removable Disc Profile behavior.

If BD-RE medium is present and the Logical Unit is unable to execute the command, then the command shall be terminated with CHECK CONDITION status. For sense information, see 4.4.7.

6.27 WRITE (12) Command

The WRITE (12) command requests that the Logical Unit write Initiator data to the medium. In order to achieve correct operation, the Logical Unit may require information from the Write Parameters Mode Page.

Table 57 shows the Features associated with the WRITE (12) command.

Table 57 – Features Associated with the WRITE (12) Command

Feature Number	Feature Name	Command Requirement
0107h	Real-time Streaming	Mandatory

6.27.1 The CDB and Its Parameters

The WRITE (12) CDB is shown in Table 58.

Table 58 – WRITE (12) CDB

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code (AAh)							
1	Reserved				FUA	Reserved		
2	(MSB)							
3	Logical Block Address							
4								
5								(LSB)
6	(MSB)							
7	Transfer Length							
8								
9								(LSB)
10	Streaming	Reserved						
11	Control							

6.27.1.1 FUA

A FUA (Force Unit Access) bit, set to one, indicates that the Logical Unit shall access the media in performing the command prior to returning GOOD status. In the case where the cache contains a more recent version of a logical block than the media, the logical block shall first be written to the media. WRITE commands shall not return GOOD status until the logical blocks have actually been written on the media, and the Write process is complete. This mode may not operate correctly with a sequence of writes intended to produce a continuous stream unless command queuing is implemented

A FUA bit of zero indicates that the Logical Unit may satisfy the command by accessing the cache memory. For WRITE operations, logical blocks may be transferred directly to the cache memory. GOOD status may be returned to the Initiator prior to writing the logical blocks to the medium. Any error that occurs after the GOOD status is returned is a deferred error, and information regarding the error is not reported until the following command.

6.27.1.2 Logical Block Address

The Logical Block Address field specifies the logical block where the write operation shall begin. If Starting Logical Block Address is not within the range specified by the READ CAPACITY command response, 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.

6.27.1.3 Transfer Length

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.

6.27.1.4 Streaming

According to MMC-4.

6.27.1.5 Blocking Factor

The Starting LBA and the Transfer Length identify a logical track into which the data is to be written. The Track Information for that logical track identifies a Blocking Factor. When the Initiator issues the command with the Streaming bit set to one, the values of the Starting Logical Block Address and the Transfer Length fields shall each be an integral multiple of the Blocking factor. If either the Starting Logical Block Address field or the Transfer Length field is not set to an integral multiple of the Blocking Factor, 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.

6.27.2 Command Execution

According to MMC-4.

If BD-RE medium is present and the Logical Unit is unable to execute the command, then the command shall be terminated with CHECK CONDITION status. For sense information, see 4.4.7.

6.27.3 Timeouts

According to MMC-4.

6.28 WRITE AND VERIFY (10) Command

The WRITE AND VERIFY (10) command requests that the Logical Unit write the data transferred from the Initiator to the medium and then verify that the data is correctly written.

Table 59 shows the Features associated with the WRITE AND VERIFY (10) command.

Table 59 – Features Associated with the WRITE AND VERIFY (10) Command

Feature Number	Feature Name	Command Requirement
0020h	Random Writable	Mandatory

6.28.1 The CDB and Its Parameters

The WRITE AND VERIFY (10) CDB is shown in Table 60.

Table 60 – WRITE AND VERIFY (10) CDB

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code (2Eh)							
1	Reserved							
2	(MSB)							
3	Starting Logical Block Address							
4								
5								(LSB)
6	Reserved							
7	(MSB)			Transfer Length				
8								(LSB)
9	Control							

6.28.1.1 Starting Logical Block Address

Starting Logical Block Address references the block at which the operation shall begin.

6.28.1.2 Transfer Length

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.

6.28.2 Command Execution

Writing shall be according to the description of the WRITE (10) command with the FUA bit is set to one.

Verify Error Recovery Mode Page parameters are not supported by MM Logical Units. The Logical Unit shall utilize the Read/Write Error Recovery Mode Page as verify parameters. The AWRE and ARRE bits shall control automatic reallocation.

If BD-RE medium is present and the Logical Unit is unable to execute the command, then the command shall be terminated with CHECK CONDITION status. For sense information, see 4.4.7.

6.28.3 Timeouts

TBD

7 Mode Parameters for BD-RE Devices

7.1 Mode Parameter List

The presence of the BD-RE 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 Defect Management Feature requires that this mode page be implemented. The BD-RE Profile includes the Defect Management Feature. From the Initiator's perspective, use of this mode page requires no special behavior from a Logical Unit when the BD-RE 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-RE 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-RE 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-RE 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-RE Profile is current. The Initiator should note that the Group 1 and Group 2 minimum timeout values are larger than those for writable BD types.

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

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Annex A Using BD-RE

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. Its intent is to create a minimal list of behaviors for the device. In the case of the BD-RE Profile, the state of the Current bit is based upon presence of BD-RE disc. When BD-RE disc is present, the Current bit in the BD-RE Profile is set to one. Otherwise, the Current bit in the BD-RE 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 bytes.

A.3 Recording BD-RE

A.3.1 Formatting a BD-RE Disc

A new, blank BD-RE disc may be formatted either with or without spare areas allocated. If the disc is formatted with spare areas allocated, the Initiator may either use the default formatting (Format Type = 00h) or the Initiator may select the number of Clusters that shall be allocated as spares (Format Type = 30h).

Formatting the disc with no spares allocated (Format Type 31h), permits a disc that has maximum capacity available for applications (e.g. a mastering application).

A.3.2 Reformatting a BD-RE Disc

When a BD-RE disc has been formatted, a reformat exercises a minimum format certification process by default: Quick Reformat. This is the only option for the default format type 00h. Wit format type 30h, the Initiator may select one of four possible certification types:

Sub-types for Format Type 30h	Certification Description	Requirement
00b	Quick Reformat	Mandatory
01b	No Certification	Mandatory
10b	Quick Certification	Supported only when Qcert in the Formattable Feature Descriptor is set to 1.
11b	Full Certification	Supported only when Cert in the Formattable Feature Descriptor is set to 1.

A.3.3 Recording with Defect Management

When a defective Cluster is discovered during writing (WRITE (10)) the Logical Unit shall automatically replace the Cluster according to the Read/Write Error Recovery Mode Page. When BD-RE is formatted with spare areas, automatic replacement of the defect management feature may be switched off or switched on via the Read/Write Error Recovery Mode Page.

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