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

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1 Scope

Blu-ray Disc Recordable is a media type that requires special behavior by the Host and device. This document describes the set of Multi-Media commands that allow an Host to utilize the capabilities of BD-R Drives. 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. Basic definitions are in SPC-3. General Multimedia definitions are found in MMC-4.
4. Models - Modeling for the various media oriented behaviors that the Host may witness from BD-R devices provides an overview of internal drive operation for the Host application developer.
5. Features and Profiles - Features describe Drive capabilities while Profiles exist to claim a collection of features.
6. Commands - Commands are described from the Host's point of view.
7. Mode Parameters - Inputs required by the Drive are not always a part of a command. Inputs associated with mode of operation are readable and sometimes writable.

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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 Write-Once 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)
	Volume 1: ATA Command Set
	Volume 2: Parallel ATA
	Volume 3: Serial ATA
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

Universal Disk Format™ Specification, Revision 2.6, Published by Optical Storage Technology Association. For more information, see: www.osta.org.

System Description Blu-ray Disc Recordable 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-R

BD-R disc is a BD disc that is write-once. BD-R devices are devices that are able to read and Write BD-R discs.

3.2.3 Cluster

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

3.2.4 Defect List (DFL).

The DFL is a part of the DMS that maps defective Clusters to spare Clusters or replacement Clusters in the case of POW. The DFL consists of four consecutive Clusters on an SL disc and of 8 consecutive Clusters on a DL disc and can be repeated 7 times.

3.2.5 Disc Management Structure (DMS)

The DMS holds structures for Defect & POW Management and Recording Mode information. There are two kinds of Disc Management Structures:

1. Temporary Disc Management Structures (TDMS), recorded in the TDMA Zones as long as the disc has not been closed.
2. Disc Management Structures (DMS), recorded in the DMA Zones when a disc is closed (to preserve all Disc Management information contained in the last Temporary Disc Management Structure),

3.2.6 Disc Definition Structure (DDS)

The DDS is is a part of the DMS that is combined in one Cluster with a Space Bitmap in case of RRM and with an SRRI in case of SRM and shall be repeated for robustness reasons.

3.2.7 Drive

A Logical Unit that operates as a single MM disc accessing unit. e.g. a BD-R Drive.

3.2.8 Host

A SCSI device with the characteristics of a primary computing device, typically a personal computer, workstation, minicomputer, mainframe computer, or auxiliary computing device or server. A host includes one or more SCSI initiator devices.

3.2.9 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.

3.2.10 Logical Overwrite

See Pseudo-Overwrite.

3.2.11 Logical Sector Number (LSN)

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

3.2.12 Orphan LBA(s)

When a POW is executed, the relocation occurs at the NWA, N of some SRR, T. After the POW execution, the NWA is now N+32*K, where K is the number of POWed Clusters. LBAs N, N+1, ..., N+32*K-1 cannot be used in the next appending write to T. Consequently, these LBAs may be used only by additional POW operations. However, since there is not previous data to replace, these LBAs are Orphans.

3.2.13 Outer Spare Area (OSA0, OSA1)

When defect management is used, a spare area is 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.

3.2.14 Permanent Information & Control data (PIC) Zone

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

3.2.15 Pseudo-Overwrite (POW)

By using the Linear Replacement algorithm of the BD Recordable system, overwriting of a recorded Cluster is allowed. POW replacements are taken from the user data area and mapped using DFL. (POW is only defined for SRM formatted BD-R discs.)

3.2.16 Random Recording Mode (RRM)

In the Random Recording Mode, data can be randomly written at every un-recorded Cluster.

3.2.17 Sequential Recording Mode (SRM)

Sequential Recording Mode on BD-R is recorded in defined, sequential ranges. To facilitate the recording of specific data at some pre-defined location on the disc at a later moment in time (such as for instance File System data), the disc can be divided into several continuous areas, referred to as Sequential Recording Ranges.

3.2.18 Sequential Recording Range (SRR)

BD-R in SRM has a physical representation of the Logical Track: a Sequential Recording Range (SRR).

3.2.19 Sequential Recording Range Information (SRRI)

Information about the location and status of all SRRs shall be stored in the Sequential Recording Range Information (SRRI) structures. While the disc is not finalized, the SRRI shall be recorded in the Temporary Disc Management Areas (TDMAs). At finalization, the most recent version of the SRRI is recorded in the Disc Management Area (DMA).

3.2.20 Space Bit Map (SBM)

A Space Bit Map specifies the recording status for a Recording Layer a BD-R disc formatted in Random Recording Mode (RRM).

3.2.21 Temporary Disc Management Area (TDMA)

The defect management and recording management information needs to be updated many times during use. For this purpose special areas are available in the Lead-in/Lead-out Zone called the Temporary Disc Management Area. Additional TDMAs may be defined within spare areas.

3.2.22 Temporary Disc Management Structure (TDMS)

The Temporary Disc Management Structure (TDMS) is a version of the DMS recorded in a TDMA. The TDMS consists of the following three elements depending on the recording mode.

For sequential recording mode the TDMS consists of:

1. Temporary Disc Definition Structure (TDDS),
2. Temporary Defect List (TDFL),
3. Sequential Recording Range Information (SRRI).

For random recording mode the TDMS consists of:

1. Temporary Disc Definition Structure (TDDS),
2. Temporary Defect List (TDFL),
3. Space Bit Maps (SBM).

All of these elements shall be present in the TDMA currently in use. Whenever a disc leaves a recorder, the TDMS shall correctly reflect the current status of the disc.

3.3 Abbreviations

BD	Blu-ray Disc
BD-R	Blu-ray Disc Recordable
BD-RE	Blu-ray Disc Rewritable
BD-ROM	Blu-ray Disc Read-only
DDS	Disc Definition Structure
DFL(x)	Defect List (x=0..7)
DL	Dual Layer
DMA(x)	Disc Management Area (x=1..4)
DMS	Disc Management Structure
INFOx	Information Zone (x=1..4)
ISA0	Inner Spare Area, layer 0
ISA1	Inner Spare Area, layer 1
L0	Layer 0
L1	Layer 1
LSN	Logical Sector Number
OSA0	Outer Spare Area, layer 0
OSA1	Outer Spare Area, layer 1
PIC	Permanent Information & Control data
POW	Pseudo-Overwrite
RRM	Random Recording Mode
SBM	Space Bit Map
SL	Single Layer
SRM	Sequential Recording Mode
SRR	Sequential Recording Range
SRRI	Sequential Recording Range Information
TDDS	Temporary Disc Definition Structure
TDFL	Temporary Defect List
TDMA	Temporary Disc Management Area
TDMS	Temporary Disc Management Structure

4 Models

4.1 BD Description

4.1.1 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. BD is typically available in both 120 mm and 80 mm 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 Host as a single continuous address space. Each layer has a continuous spiral track.

The logical block size of BD is 2 048 bytes collected into recordable units called clusters:

- A Cluster contains 32 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.

4.1.2 Physical Characteristics

A BD disc have either 80 or 120 mm diameter and is separated into zones as shown in Figure 1.

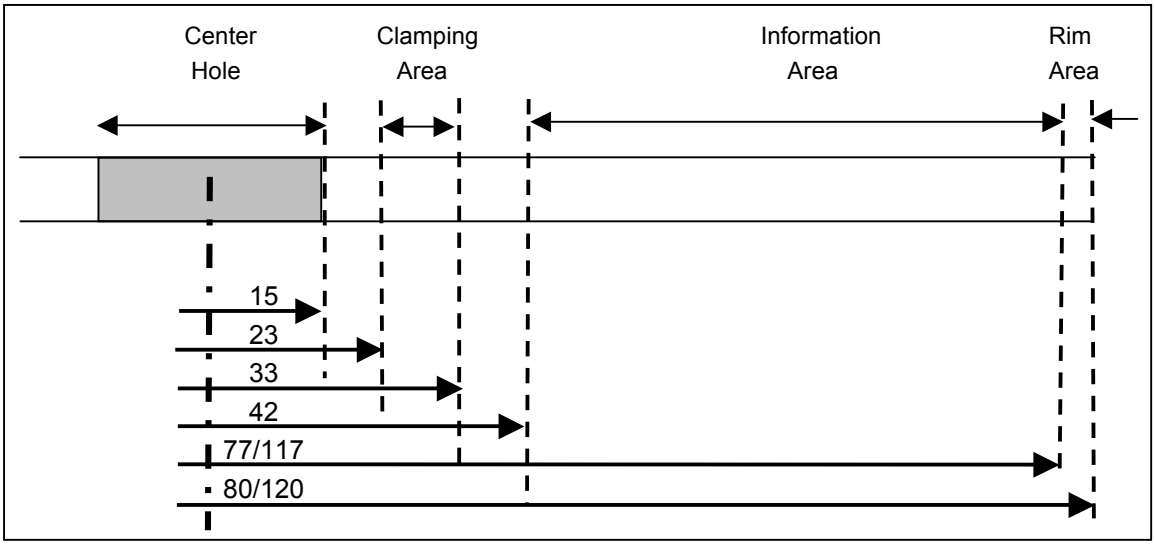

Figure 1 - The Areas of a BD-R Disc

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 mm and proceeds to the outer diameter. For 120 mm media, the information zone ends at a nominal diameter of 117 mm, whereas the 80 mm media information zone ends at a nominal diameter of 77 mm. The Rim Area is simply the area beyond the data groove. For 120-millimeter media, it typically ends at a diameter of 120 mm.

4.2 BD-R Description

4.2.1 Blank Media Structure

BD-R is a write-once media that may consist of one or two layers. Each layer consists of single continuous groove structured only as opposite-track-path.

4.2.1.1 Primary Zones

Each layer is separated into 3 primary zones: Inner, Data, and Outer.

On single layer discs, the Inner Zone is used as the disc Lead-in and the Outer Zone is used as the disc Lead-out. See Figure 2.

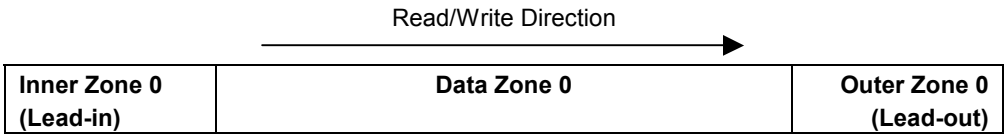

Figure 2 — Primary Zones of a Single Layer BD-R

On dual layer discs, the layer 0 Inner Zone is used as the disc Lead-in and the layer 1 Inner Zone is used as the disc Lead-out. The two Outer Zones are used as layer transition zones. See Figure 3.

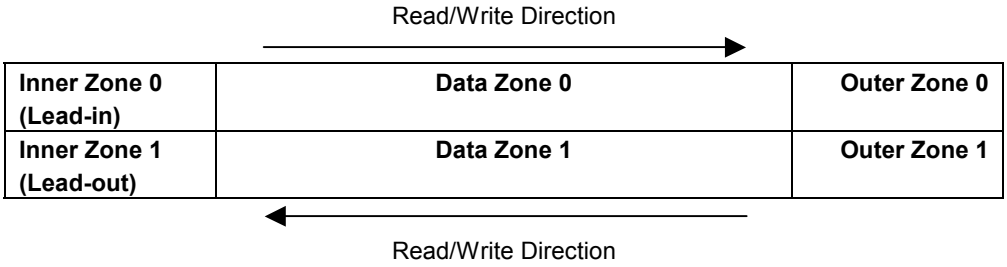

Figure 3 — Primary Zones of a Dual Layer BD-R

4.2.1.2 Capacity

BD-R capacity is determined by the size of the Data Zones. Possible BD-R disc capacities are shown in Table 1.

Table 1 — BD-R Disc Capacities

Diameter	Single Layer	Dual Layer
80 mm	7.8 GB	15.6 GB
120 mm	23.3 GB	46.6 GB
	25.0 GB	50.0 GB

4.2.1.3 ADIP

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

In the Inner Zones, the ADIP address information is interleaved with disc information called Disc Information (DI) frames. The collection of DI frames contains information about the logical disc structure as well as recording parameters.

The DI is repeated in pre-recorded areas that occur prior to the Inner Zones.

4.2.1.4 Un-recorded Sector Addressing

In all recording modes, seek to any sector shall be supported by all BD Drives. Neither Lead-in Zone and/or Lead-out Zone needs to be completely written.

4.2.2 Groove Layout

Each layer of the BD-R Information Zone is divided into an embossed (pre-recorded) high frequency modulated (HFM) area and a recordable area. The detailed groove layout is shown in Figure 4.

Layer 0 Information Zone	Pre-recorded Area	BCA		
			Protection zone 1	Seek overshoot protection zone
			PIC	Permanent Information & Control data Zone
	Recordable Area	Inner Zone 0 (Lead-in Zone)	Protection zone 2	Seek overshoot protection zone
			INFO2	DMA2 and PAC2
			OPC0	Optimum Power Calibration Zone
			OPC buffer	-
			TDMA0	Temporary Disc Management Area 0
			INFO1	DMA1 and PAC1
		Data Zone	ISA0	Inner Spare Area
			User Data Area	Primary user data area 0
			OSA0	Outer Spare Area
		Outer Zone 0	INFO3/4	DMA3, DMA4 and control info
			DCZ0	Disc Calibration Zone
			Protection zone 3	Seek overshoot protection zone
Read Direction				
Layer 1 Information Zone	Recordable Area	Outer Zone 1	Protection zone 3	Seek overshoot protection zone
			DCZ1	Disc Calibration Zone
			INFO3/4	DMA3, DMA4 and control info
		Data Zone	OSA1	Outer Spare Area 1
			User Data Area	Primary user data area 1
			ISA1	Inner Spare Area 1
		Lead-out Zone (Inner Zone 1)	INFO1	DMA1 and PAC1
			Reserved	—
			TDMA1	Temporary Disc Management Area 1
			INFO2	DMA2 and PAC2
			Buffer Zone	
			OPC1	Optimum Power Calibration Zone
			Buffer Zone	
			Protection Zone 1	Seek overshoot protection zone

Figure 4 —BD-R Information Zones

The recordable area of each layer is divided into an Inner Zone, a data zone, and a Outer Zone.

On a single layer disc the Inner Zone is used as a disc Lead-in and the Outer Zone is used as a Lead-out.

On dual layer disc, Inner Zone 0 is the disc lead-in, Inner Zone 1 is the disc lead-out, and the Outer Zones are layer transition areas.

For a detailed description of specific zones, consult *System Description Blu-ray Disc Recordable Format, Part 1 Basic Format Specifications*.

4.2.2.1 Pre-recorded Zone

The Pre-recorded zone consists of:

Burst Cutting Area (BCA)	The BCA is used to add information to the disc after completion of the manufacturing process. The BCA-code can be written by a high-power laser system in case of Recordable discs.
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 (BCA) 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 The PIC zone on layer 1 is not required to be recorded.

4.2.2.2 Lead-in Zone (Inner Zone 0)

An Inner Zone consists of:

Protection Zone 2	On both layers, this zone buffers the writable area from the embossed area.
INFO2	On both layers, INFO2 is reserved for DMA and PAC storage.
Optimum Power Calibration (OPC) Zone	On both layers, the OPC Zone is reserved for testing and calibration.
TDMA0, 1	Temporary Disc Management Areas
INFO1	On both layers, this area is reserved for DMA and PAC storage.

4.2.2.3 Data Zone

The Data Zone consists of:

Inner Spare Areas (ISA0, ISA1)	If spare Clusters are allocated for defect management, then ISA0 contains 4 096 Clusters and ISA1 has a maximum size of 16 384 Clusters allocated in 256 Cluster increments. Any part of the data zone that is not allocated for the ISAs is part of the User Data Area. A TDMA may be allocated in increments of 256 Clusters from any Spare Area. This action reduces the size of the Spare Area by the amount allocated for the TDMA.
User Data Area	The User Data Area is the logically addressed area of the disc.
Outer Spare Areas (OSA0, OSA1)	If spare Clusters are allocated for defect management, then, OSA0 has a maximum size of 196 608 Clusters, allocated in 256 Cluster increments. On DL discs, OSA1 shall be the same size as OSA0. A TDMA may be allocated in increments of 256 Clusters from any Spare Area. This action reduces the size of the Spare Area by the amount allocated for the TDMA.

4.2.2.4 Outer Zone 0 (Lead-out Zone on a SL disc)

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 between the two layers. The Outer Zone consists of:

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

4.2.3 Logical Structure

4.2.3.1 Logical Structure of Single Layer BD-R

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).

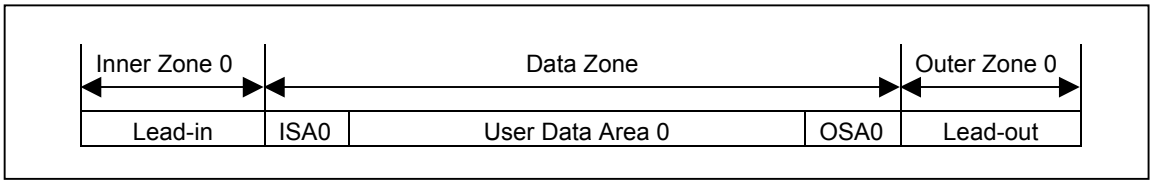

Figure 5 — SL BD-R Information Zone

Regardless of disc diameter, if ISA0 is present, it has a fixed size of 4096 Clusters. On 120 mm media, OSA0 has a variable size from 0 to 196 608 Clusters, allocated in increments of 256 Clusters. On 80 mm media, OSA0 has a variable size from 0 to 65 536 Clusters, allocated in increments of 256 Clusters.

The defect management and recording management information needs to be updated many times during use. For this purpose a special area is available in the Lead-in/Lead-out Zone called a Temporary Disc Management Area (TDMA). Additional TDMAs can be defined to facilitate more space for more updates of the defect and recording management information. These areas can be useful in the case of many ejects after short recordings or when a more frequent update scheme is desired for more robustness against for example power failures.

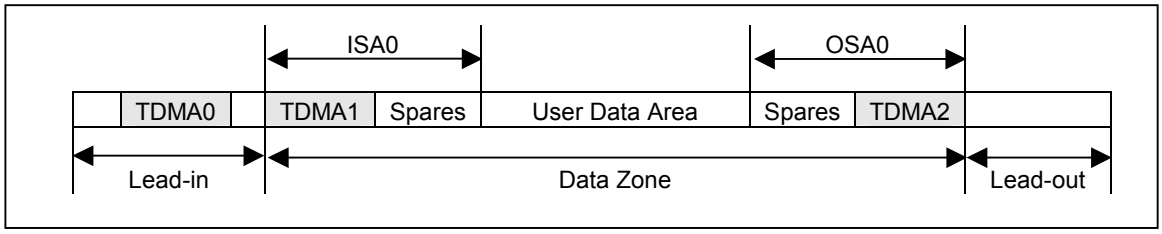

Figure 6 — TDMA Allocation on SL BD-R

TDMA0 is allocated from the Lead-in with 2 048 Clusters.

If necessary, TDMA1 may be allocated from ISA0. The size of TDMA1 shall be an integral multiple of 256 Clusters. TDMA1 is permitted to contain all of the Clusters of ISA0.

If necessary, TDMA2 may be allocated from OSA0. The size of TDMA2 shall be an integral multiple of 256 Clusters. TDMA2 is permitted to contain all of the Clusters of OSA0.

4.2.3.2 Logical Structure of Dual Layer BD-R

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. Defect Management areas are intermingled with these zones.

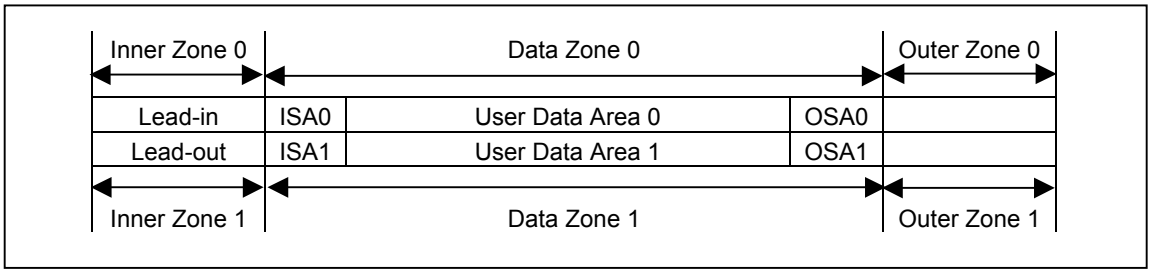

Figure 7 — DL BD-R Information Zones

Regardless of disc diameter, if ISA0 is present, it has a fixed size of 4096 clusters, and ISA1 has a variable size from 0 to 16 384 Clusters, in increments of 256 Clusters.

On 120 mm media, OSA0 has a variable size from 0 to 196 608 Clusters in increments of 256 Clusters. On 80 mm media, OSA0 has a variable size from 0 to 65 536 Clusters in increments of 256 Clusters. Regardless of disc diameter, OSA1 has the same size as OSA0.

The defect management and recording management information needs to be updated many times during use. For this purpose a special area is available in the Lead-in/Lead-out Zone called a Temporary Disc Management Area (TDMA). Additional TDMAs can be defined to facilitate more space for more updates of the defect and recording management information. These areas can be useful in the case of many ejects after short recordings or when a more frequent update scheme is desired for more robustness against for example power failures.

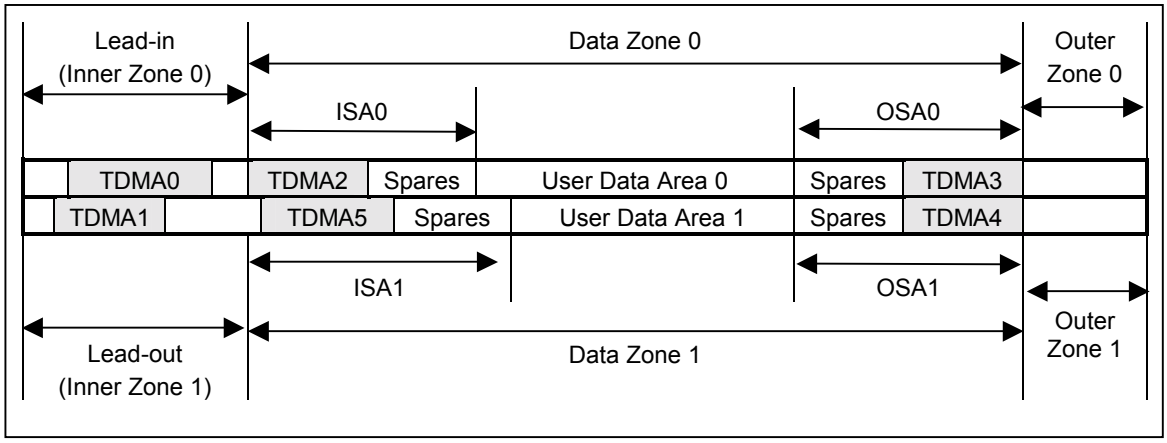

Figure 8 — TDMA Allocation on DL BD-R

TDMA0 is allocated in Inner Zone 0 (lead-in) and is 2 048 Clusters in size.

TDMA1 is allocated in Inner Zone 1 (lead-out) and is 2 048 Clusters in size.

TDMA2 may be allocated from ISA0. The size of TDMA2 shall be an integral multiple of 256 Clusters. TDMA2 is permitted to contain all of the Clusters of ISA0.

TDMA3 may be allocated from OSA0. The size of TDMA3 shall be an integral multiple of 256 Clusters. TDMA3 is permitted to contain all of the Clusters of OSA0.

TDMA4 may be allocated from OSA1. The size of TDMA4 shall be an integral multiple of 256 Clusters. TDMA4 is permitted to contain all of the Clusters of OSA1.

TDMA5 may be allocated from ISA1. The size of TDMA5 shall be an integral multiple of 256 Clusters. TDMA5 is permitted to contain all of the Clusters of ISA1.

4.2.3.3 Sectors and Clusters

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

- The user data within a BD sector is protected by the error correction coding in the Cluster that contains the sector.
- 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 Host as a single continuous address space.

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

- The user data space is organized in fixed size blocks (2 048 bytes/block) and addressed as logical blocks. Blocks in this Logical Block Address space may be read using only the READ (10) and READ (12) commands. If a READ command is issued for the LBA of a blank sector, the Drive shall return zeros (00h) for each byte of the sector.
- Logical addresses are numbered from 0 through CAPACITY LBA. The value of CAPACITY LBA is the logical block address returned by the READ CAPACITY command.
  - When the recording mode is SRM (without POW), the READ CAPACITY command returns the last logical block address in the last complete session. If no sessions are closed, the READ CAPACITY command returns zero.
  - When the recording mode is either RRM or SRM+POW, the READ CAPACITY command returns the LBA of the last recordable block in the User Data Zone.
- The READ TOC/PMA/ATIP command is implemented to assure compatibility with existing applications. Only formats 0 and 1 are implemented. Some structures may be fabricated.
- Structures unique to BD may be read using the READ DISC STRUCTURES command.
- Logical sectors are written to the BD-R disc using the WRITE (10), WRITE (12), or the WRITE AND VERIFY (10) commands.

4.3 BD-R Recording Models

BD-R has two basic recording modes: SRM (Sequential Recording Mode) and RRM (Random Recording Mode). Pseudo-Overwrite (POW) is defined as an additional capability for SRM.

The default mode for a blank BD-R disc is SRM with no spares allocated. Default mode is established if a blank BD-R is mounted and ready, and the Drive accepts and executes a RESERVED TRACK command, a WRITE (10) command or a WRITE (12) command.

Otherwise, specific recording mode is selected by use of the FORMAT UNIT command. If spares are to be allocated, the FORMAT UNIT command is used to select either default size or actual size of spare area.

Once the recording mode has been established, it is not changeable.

4.3.1 Random Recording Mode (RRM)

The Random Recording Mode (RRM) is an application of a Random Recording model that is similar to the Write-Once device model. A RRM formatted disc may be randomly recorded in Clusters.

The written status of user data area Clusters is maintained in a structure called the Space Bitmap. The Space Bitmap contains one bit per Cluster in Logical Address order. If a bit is set to zero, the associated Cluster has never been written. If the bit is set to one, the associated Cluster has been recorded.

4.3.2 Sequential Recording Mode (SRM)

4.3.2.1 General

The Sequential Recording Mode (SRM) is an application of the Track/Session model that has been previously defined for CD and DVD. In order to maintain a structure that is consistent with the historical models, all definitions are made with respect to logical addressing.

During the time that the Track/Session status of the disc is dynamic (i.e. when the disc is not finalized), status and boundary information about Tracks/Sessions are stored in a TDMS (Temporary Disc Management Structure). TDMS updates are made serially in areas called Temporary Disc Management Areas (TDMAs). When the disc is finalized (i.e. no further changes are permitted), all pending TDMS updates shall be written, and the most recent copy of the TDMS is copied into each of the DMAs (4 on SL and 8 on DL) on the disc.

4.3.2.2 Definitions

4.3.2.2.1 Logical Blocks

A Logical Block is the smallest logically addressable unit of data that is readable by the Host. For BD-R, the Logical Block size is 2048 bytes. This value is specified in the Logical Block Size field in the Random Readable Feature Descriptor.

4.3.2.2.2 Recordable Units

A recordable unit is the smallest physically writable collection of contiguous Logical Blocks. For BD-R the recordable unit size is 32 Logical Blocks, one Cluster. This value is specified in the Blocking field of the Random Readable Feature Descriptor.

4.3.2.2.3 Logical Track: Sequential Recording Range (SRR)

A Logical Track is a set of sequential recordable units. Logical Tracks are numbered consecutively, starting with number one. On BD-R, the Logical Track is defined as a Sequential Recording Range (SRR). The physical extents of each SRR and the status of each SRR is defined in the SRR Information (SRRI) structure. The SRRI is a structure in the TDMS that is maintained in the Temporary Disc Management Areas (TDMA).

BD-R Logical Tracks bounds are defined only in the SRRI. No overhead blocks are used in the definition of a Logical Track on BD-R.

4.3.2.2.3.1 Logical Track Starting Address

The LBA of the first Logical Block of the Logical Track is the starting address of the Logical Track.

4.3.2.2.3.2 Logical Track Length

The number of Logical Blocks in the Logical Track is the track length. Since a BD-R Logical Track is a collection of Clusters, this value is an integral multiple of 32.

4.3.2.2.3.3 Next Writable Address (NWA)

The Host is only permitted to record a Logical Track sequentially, beginning with it's starting address. To facilitate this, the Drive maintains a Next Writable Address (NWA) for each open Logical Track. There is at most one NWA in a Logical Track.

If the Logical Track is blank, then the NWA is initialized to the starting address of the Logical Track. The NWA is advanced by the number of LBAs written in each write command after each write command has terminated.

Since writes may be buffered, the NWA may not always be at a Cluster boundary. If buffer synchronization is forced (e.g. SYNCHONIZE CACHE command), all buffered data is written to the disc. If the last buffered block is not sector 31 of a Cluster, then zero padding shall be added to the end of the Cluster prior to writing.

4.3.2.2.3.4 Last Recorded Address (LRA)

The last Cluster addressed by a WRITE command may be written in which 1 to 32 Logical Blocks contain Host supplied data. The Last Recorded Address (LRA) is the LBA of the last Logical Block of the Cluster that contains Host supplied data.

4.3.2.2.3.5 Blank Logical Track

If every Logical Block in a Logical Track is blank, the Logical Track is blank. The NWA of a blank Logical Track is the Logical Track starting address.

4.3.2.2.3.6 Open Logical Track

The SRRI contains a list of open SRRs. A Logical Track is open if it is in the list. In order to be in the list of open Logical Tracks: Start Address + Track Length - 1 > NWA. The SRRI open SRR list is limited to 16 open SRRs.

4.3.2.2.3.7 Closed Logical Track

A Logical Track is closed when the Logical Track is defined, but not in the SRRI list of open Logical Tracks. The Host may request that a Logical Track be closed by sending the CLOSE TRACK/SESSION command. A Logical Track becomes closed when:

1. All of its Logical Blocks have been written, or
2. When the Host has requested that the Logical Track be closed.

When a Logical Track is closed, the NWA no longer valid for appending new data.

If the invisible Logical Track, numbered N, is partially recorded and a close is requested by the Host, the Logical Track bounds are specified to include only the recorded Logical Blocks and a new, blank invisible Logical Track is created with Logical Track number N+1.

4.3.2.2.4 Session

A session is a collection of contiguous Logical Tracks. The bounds of a session are defined in the SRRI. Unlike CD and DVD sessions, the BD-R SRM session is defined only by the SRRI. Consequently, there is neither a session lead-in nor a session lead-out. Sessions are numbered consecutively, starting with session one.

4.3.2.2.4.1 Open Session

A session is open if any of the Logical Tracks within the session are open.

4.3.2.2.4.2 Closed Session

A session is closed if all of the Logical Tracks within the session are closed. Once a session is closed, it is not permitted to add new Logical Tracks.

4.3.2.2.4.3 Finalized (Closed) Disc

A disc is finalized when all sessions are closed and each DMS copy is recorded. Since the DMS on layer 0 is different from the DMS on layer 1, the process for dual layer media is different from the process for single layer media.

Once each DMS is recorded in the appropriate DMA, is It is not necessary to record any other part of the Inner or Outer zones.

4.3.2.3 Logical to Physical Addressing

Logical to physical addressing maps differently on single layer and dual layer media.

On single layer media, the user data area begins at some physical address, K, where K is the PBA of the first block of the first Cluster after ISA0. $K+J_0$ is the PBA of the first block of the first Cluster of OSA0.

The primary Logical to physical mapping is defined as: For $0 \le N \le J_0-1$, Map(N) = N+K. Otherwise, N is not in the range of the mapping. See Figure 9.

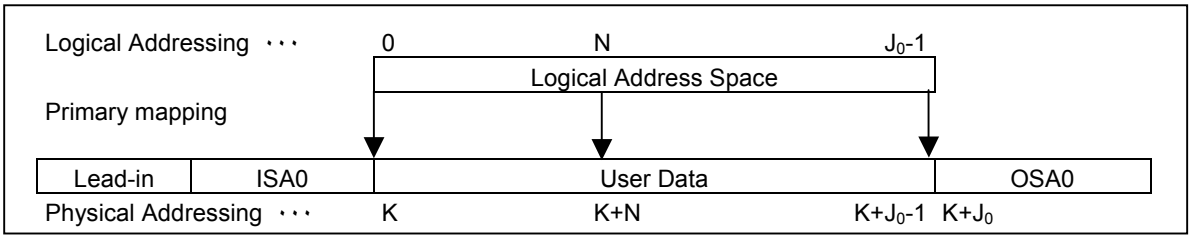

Figure 9 — Logical to Physical Addressing on Single Layer

If the disc is formatted with defect management, and if upon use, N+K is found to be defective, N may be mapped from the primary address of N+K to a Cluster in a spare area.

If the media is dual layer, the disc's user data area continues with the first block of the first Cluster after OSA1, J_1. The user data area continues until the first block of the first Cluster of ISA1, at C. The primary Logical to physical mapping is extended to include layer 1:

$$\text{Map(N)} = \begin{cases} \text{N+K when } 0 \le N \le J_0-1. \\ (N-J_0)+J_1 \text{ when } J_0 \le N \le C-1. \end{cases}$$

See Figure 10.

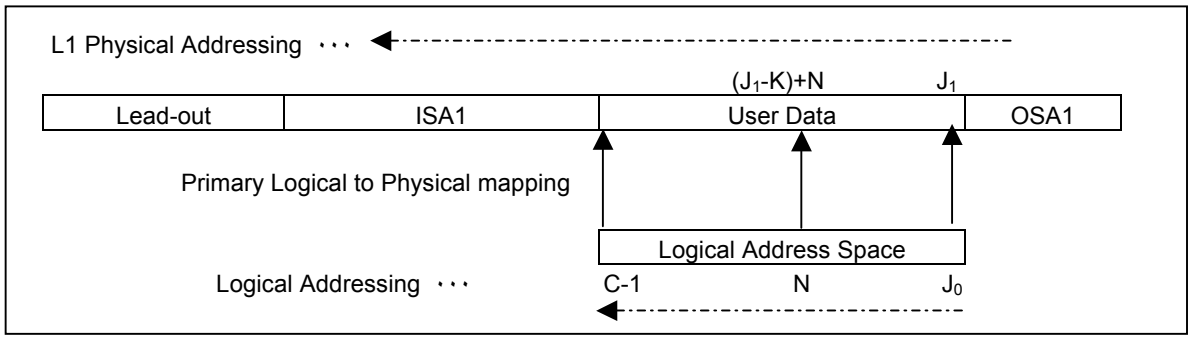

Figure 10 — Logical to Physical Addressing on Dual Layer

As with single layer media, if the disc is formatted with defect management, and if upon use, the primary physical block is defective, the block may mapped from the primary address to a Cluster in a spare area.

4.3.2.4 Status after Formatting a Blank BD-R

If a blank BD-R disc is formatted in SRM, the User Data Area consists of one open session with one open Logical Track (SRR). This Logical Track is the invisible Logical Track. As shown in Figure 11, the number of the track is 1, its start address is LBA = 0, and its length is the size of the User Data Area (CAP). The Next Writable Address (NWA) for Logical Track 1 is LBA = 0.

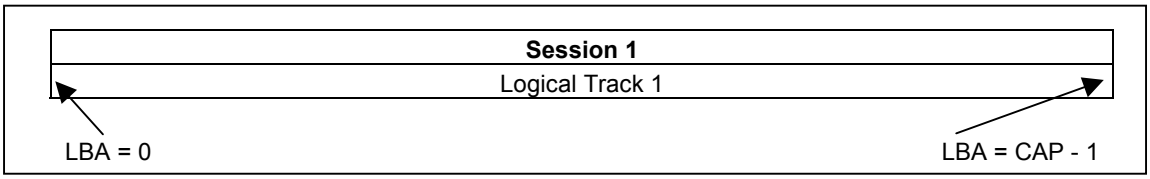

Figure 11 — Status of a BD-R Disc After Fomattting in SRM

If a WRITE command is issued to the Drive, the Starting LBA must be equal to the NWA. If the starting LBA of a WRITE command is not the NWA of some Logical Track, then the WRITE command shall be terminated with CHECK CONDITION status, and the sense shall be set to indicate ILLEGAL REQUEST/INVALID ADDRESS FOR WRITE.

4.3.2.5 Creating Additional Logical Tracks

The RESERVE TRACK command, may be used to define a fixed length Logical Track from the invisible track. The length of the new track, N2, is defined by the execution of the RESERVE TRACK command using parameters from the CDB. The length is specified as a number of Logical Blocks, but the RESERVE TRACK command performs the creation of the new track as a integral number of Clusters. Figure 12 shows the newly defined track is track 1, its start address is LBA = 0, its length is N2, and its NWA is 0. The invisible track is track 2, its start address is N2, its length is the remaining size of the User Data Area, and its NWA = N2.

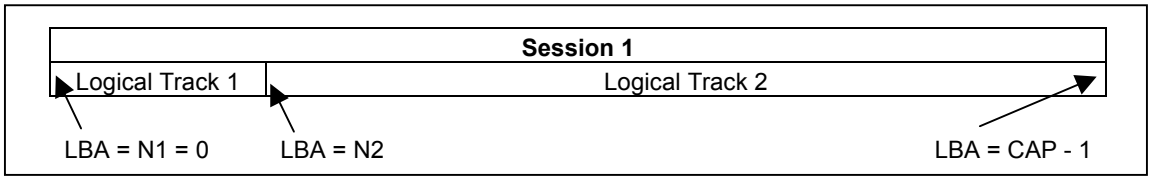

Figure 12 — Status of BD-R Disc After First RESERVE TRACK Command

The RESERVE TRACK command, may be used iteratively to define additional Logical Tracks from the invisible track as shown in Figure 13.

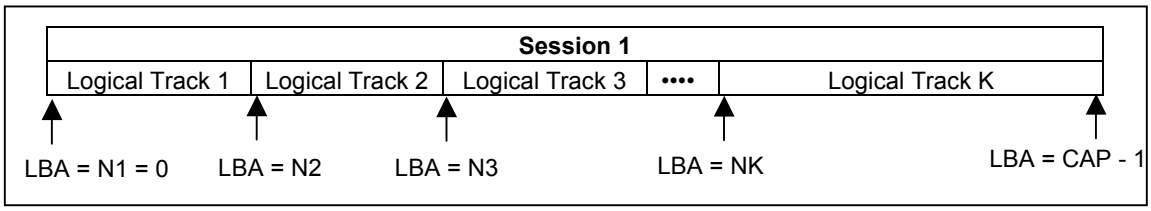

Figure 13 — Status of BD-R Disc Multiple RESERVE TRACK Commands

It is also possible to split an open Logical Track into two Logical Tracks. The split shall occur at the start of a Cluster within the Logical Track that is at or after the NWA. If the split occurs at the NWA, then the first of the two new tracks is created closed and the second is blank.

4.3.2.6 Creating New Sessions

When a session is closed and the disc is not finalized, a new session is created that contains only the invisible Logical Track. See Figure 14.

Session 1				Session 2
Logical Track 1	Logical Track 2	••••	Logical Track K	Logical Track K+1 (Invisible Logical Track)

Figure 14 — Status of BD-R Disc after Closing Session 1

The process of creating session 2 can be iterated as with session 1 until the disc is finalized.

4.3.3 Defect Management

Defect management is used to solve problems related to areas on the disc that may become defective or unreliable due to damage or contamination. The Drive redirects the recording of the involved user data to another location, called spare areas. Information about these redirections is stored in the Defect List.

In order to ensure data integrity, it is recommended that WRITE (10) data be verified during the write process when the Defect Management feature is current. This is also recommended that WRITE (12) data be verified except when either VNR is set to one or Streaming is set to one.

4.3.4 Pseudo-OverWrite (POW)

Pseudo-Overwrite (POW) is used to make Write-Once media behave like Rewritable media. When the Host requests recording of user data on an already recorded area, then the Drive redirects the recording of the involved user data to an alternative location. Such Logical Overwrites (writing to the same LBA, but actually recording at a reassigned PBA) are treated in the same way as defects, i.e. information about the redirections is stored in the Defect List.

4.3.4.1 POW on SRM

When a SRM disc has the POW capability, the Logical Overwrite of a Cluster is redirected to the NWA of some open Logical Track. POW recording is permitted on the SRM logical structure:

a. A SRM disc with POW shall be initialized by the formatting process as a single session disc with a single Logical Track.
b. POW is not permitted on a finalized disc, because no NWA is valid.
c. If the disc is not finalized, POW is permitted in both open and closed Logical Tracks.
d. On SRM, each WRITE command shall start and end within the same Logical Track. This restriction does not apply to SRM+POW.

When POW is performed, it is recommended that the redirection be to a Cluster with NWA that is near the addressed Cluster. The actual algorithm for selecting the physical Cluster for the redirection is vendor specific.

4.3.4.2 Orphans

There is exactly one NWA for each Logical Track. The NWA follows the physical usage of the Logical Track rather than the Logical usage.

When a POW is applied to a Logical Block, the relocation occurs at the NWA of some open Logical Track. An entire Cluster must be used in the relocation, so the NWA is advanced by 32. Prior to the POW, 32 LBAs were associated with the Cluster beginning at the NWA. After the POW operation, those 32 LBAs are no longer available for append. The LBAs have not been lost, but they may be written only via another POW. Until written, these LBAs are called Orphans.

An orphan LBA has no associated logical content. If a READ command is issued to an orphan LBA, the Drive is permitted to either return all zeros or the data associated with the POWed LBA.

4.3.4.3 Closed Logical Tracks with Blank Clusters

Although a closed Logical Track has no valid NWA, it may contain blank Clusters. A POW to a Logical Block in a closed Logical Track may require a read-modify-write operation. Consequently, determination of blankness is necessary. If a POW of a blank Cluster is indicated, then any unsent Logical Blocks shall be zero padded prior to writing. Due to the inefficiency, it is recommended to avoid POWing blank Clusters in closed tracks.

4.3.5 SRM and SRM+POW Examples

For simplicity, the examples are described for single layer media.

4.3.5.1 Initialize the Disc as SRM+POW

A blank BD-R disc is formatted as SRM+POW. The PBA of the first block of the first Cluster after ISA0 is K. The PBA of the first block of the first Cluster of OSA0 is K+C, where C is the number of blocks in the User Data Area.

The READ TRACK INFORMATION command for Logical Track 1 returns:

Start address = 0, NWA = 0 and free blocks = C.

The READ CAPACITY command returns C-1 as the last addressable logical block on the media.

See Figure 15.

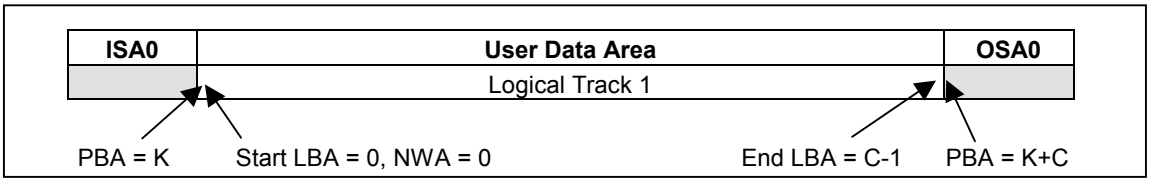

Figure 15 — Status after Formatting SRM+POW

4.3.5.2 Create a Small Outer Logical Track, Write it, and Close it

The RESERVE TRACK command is used to split the single, invisible track at LBA = C-256. This creates one large track, C-256 blocks in length, and one small track, 256 blocks in length.

The READ DISC INFORMATION command (requesting standard disc information) shall show one track prior to the RESERVE TRACK command and two tracks afterward.

A WRITE (10) command sends 64 blocks of data starting at the NWA (C-256) of Logical Track 2.

The CLOSE TRACK/SESSION command is used to close Logical Track 2.

The READ TRACK INFORMATION command for Logical Track 1 returns:

Start address = 0, NWA = 0 and free blocks = C-256.

The READ TRACK INFORMATION command for Logical Track 2 returns:

Start address = C-256, NWA is not valid, and free blocks = 0.

See Figure 16.

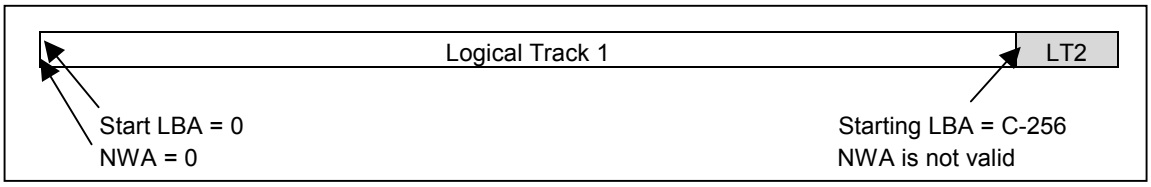

Figure 16 — Create, Write, and Close Small Outer Logical Track

4.3.5.3 Split Logical Track 1

The RESERVE TRACK command is used to split Logical Track 2 from Logical Track 1.

The READ TRACK INFORMATION command for Logical Track 1 returns:

Start address = 0, NWA = 0 and free blocks = 320.

The READ TRACK INFORMATION command for Logical Track 2 returns:

Start address = 320, NWA = 320 and free blocks = C-576.

See Figure 17.

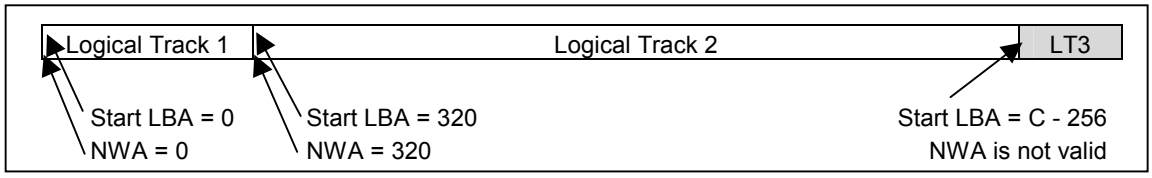

Figure 17 — Status after Splitting Logical Track 1

4.3.5.4 Split Logical Track 2

The RESERVE TRACK command is used to split Logical Track 3 from Logical Track 2.

The READ TRACK INFORMATION command for Logical Track 1 returns:

Start address = 0, NWA = 0 and free blocks = 320.

The READ TRACK INFORMATION command for Logical Track 2 returns:

Start address = 320, NWA = 320 and free blocks = 320.

The READ TRACK INFORMATION command for Logical Track 3 returns:

Start address = 640, NWA = 640 and free blocks = C-896.

See Figure 18.

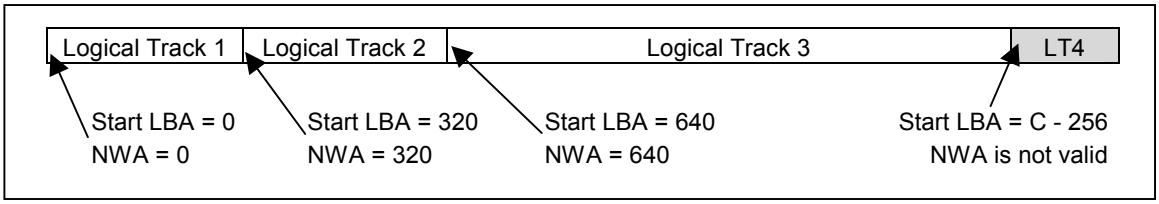

Figure 18 — Status after Splitting Logical Track 2

4.3.5.5 Write to Each Logical Track

A WRITE (10) command sends 160 blocks of data starting at the NWA (0) of Logical Track 1.

A WRITE (10) command sends 160 blocks of data starting at the NWA (320) of Logical Track 2.

A WRITE (10) command sends 32 blocks of data starting at the NWA (640) of Logical Track 3.

The READ TRACK INFORMATION command for Logical Track 1 returns:

Start address = 0, NWA = 160 and free blocks = 160.

The READ TRACK INFORMATION command for Logical Track 2 returns:

Start address = 320, NWA = 480 and free blocks = 160.

The READ TRACK INFORMATION command for Logical Track 3 returns:

Start address = 640, NWA = 672 and free blocks = C-864.

See Figure 19. Note that All 3 Logical Tracks are open.

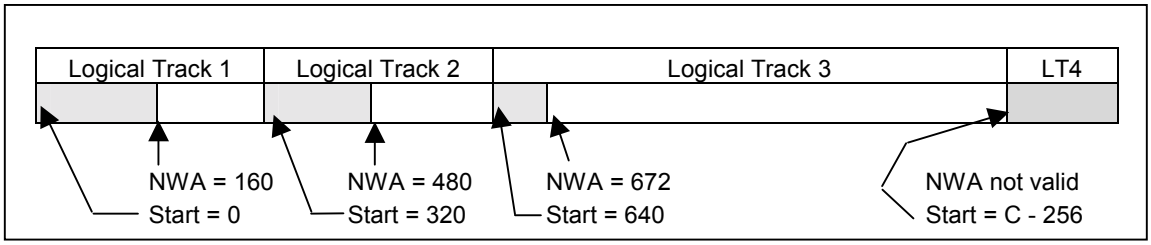

Figure 19 — Status after Writing to each Logical Track

4.3.5.6 POW a Logical Block in Logical Track 1

A WRITE (10) command writes one block of user data at LBA = 128.

This Logically OverWrites sector 128. The Cluster beginning at LBA 128 is read internally, the new data replaces the data for sector 128, and the Cluster is rewritten at the Logical Track 1 NWA (160). The NWA is now 192.

The READ TRACK INFORMATION command for Logical Track 1 returns:

Start address = 0, NWA = 192 and free blocks = 128.

In Figure 20, note that LBAs 160,..., 191 are now Orphans.

The logical length of Logical Track 1 is 320, however, the number of written LBAs in Logical Track 1 (160) plus the free blocks of Logical Track 1 (128) can be at most 288.

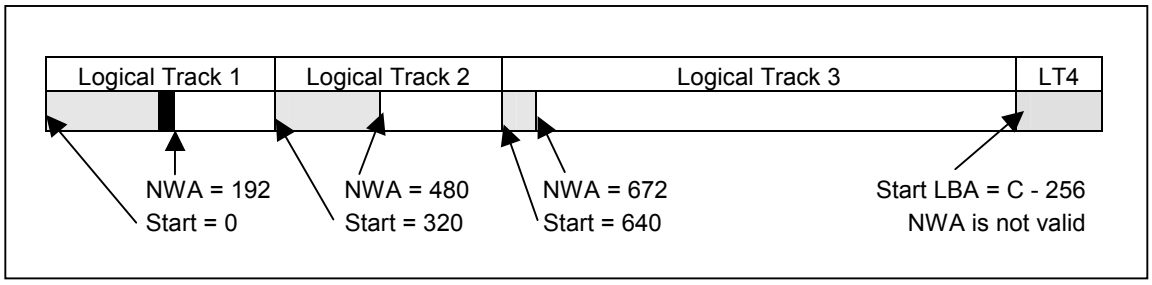

Figure 20 — Status after POW to LBA 128

4.3.5.7 Complete Writing Logical Track 1, POW LBA = 128 a Second Time

A WRITE (10) command sends 128 blocks of data starting at the NWA (192) of Logical Track 1.

A WRITE (10) command writes one block of user data at LBA = 128.

This Logically OverWrites sector 128. The Cluster beginning at LBA 128 is read internally, the new data replaces the data for sector 128, and the Cluster is rewritten at the Logical Track 2 NWA (480). The NWA is now 512. It is also permitted to POW to the NWA of another track.

The READ TRACK INFORMATION command for Logical Track 1 returns:

Start Address = 0, NWA is not valid, and free blocks = 0. Logical Track 1 is closed.

The READ TRACK INFORMATION command for Logical Track 2 returns:

Start address = 320, NWA = 512 and free blocks = 128.

The READ TRACK INFORMATION command for Logical Track 3 returns:

Start address = 640, NWA = 672 and free blocks = C-864.

See Figure 21.

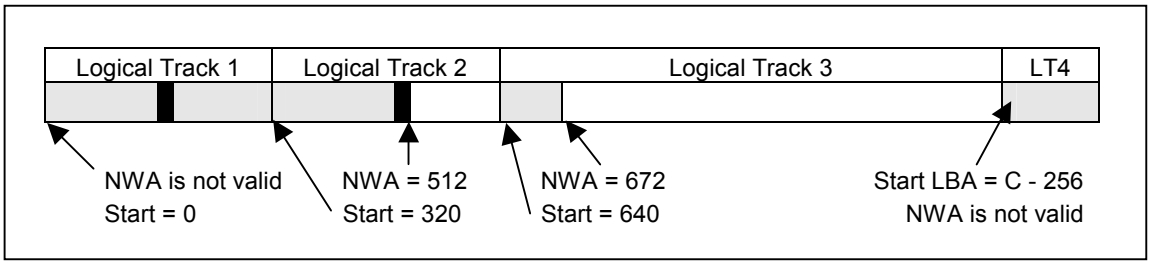

Figure 21 — Status after writing to Logical Track 1

4.3.5.8 Using Orphaned LBAs via POW

A WRITE (10) command writes 32 blocks of user data at LBA = 160.

This uses the LBAs that were orphaned by a previous POW. Using orphaned LBAs requires a new POW. The new data from the Host is written at the Logical Track 2 NWA (512). The NWA is now 544.

The READ TRACK INFORMATION command for Logical Track 1 returns:

Start Address = 0, NWA is not valid, and free blocks = 0. Logical Track 1 is closed.

The READ TRACK INFORMATION command for Logical Track 2 returns:

Start address = 320, NWA = 544 and free blocks = 96.

The READ TRACK INFORMATION command for Logical Track 3 returns:

Start address = 640, NWA = 672 and free blocks = C-672.

See Figure 22.

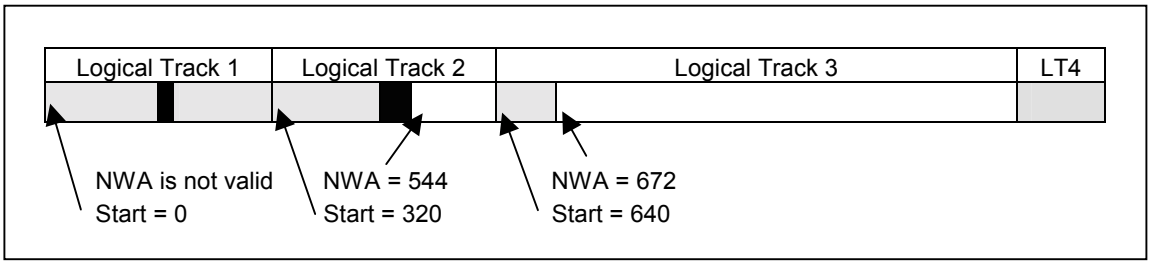

Figure 22 — Status after POW of LBA 160

Note that LBAs 512,...,543 are now orphaned.

4.3.5.9 The Expanding Orphanage

Each time a POW is performed, 32 orphaned LBAs are created. Orphans can be used, but since it is only possible to do so with a POW, new orphans are created in the process. Consequently, the number of Orphan LBAs is a monotonically increasing function. In 4.3.5.6, Orphan LBAs 160 through 191 were created by the POW of LBA 128.

In 4.3.5.7, Orphan LBAs 480 through 511 were created by the POW of LBA 128.

In 4.3.5.8, Orphan LBAs 512 through 543 were created when Orphan LBAs 160 through 191 were used.

Due to the inefficiency of media use and degradation of performance, it is preferred that the Host never use orphan LBAs.

4.3.6 Considerations for the Host When Writing on SRM+POW Discs

4.3.6.1 POW of Less than a Cluster

A WRITE command may request POW of less than one Cluster. The WRITE range is represented in Figure 23 by part E. Size of Part D + Size of Part E + Size of Part F = 32. It is possible that either part D or part F has zero length. In the most general case, it is assumed that both parts D and F have non-zero length.

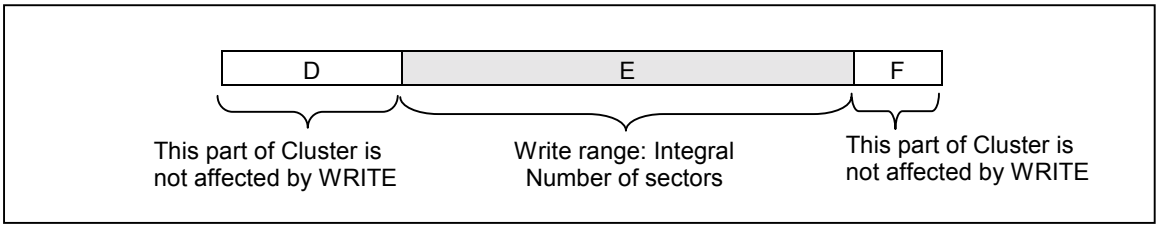

Figure 23 — Parts of a POWed Cluster

Parts D and F must be written using a read-modify-write operation through the buffer. If any padding is required, it shall be performed by the Drive.

The sectors of Part E may be written directly with no modification.

4.3.6.2 POW and Append in the Same Range

A WRITE command is permitted to start at a previously written LBA and end at never before written LBAs. See Figure 24.

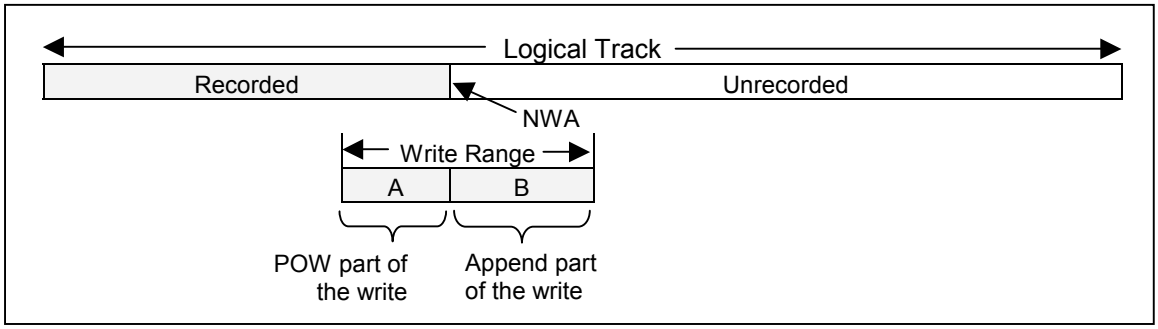

Figure 24 — POW and Append Parts of WRITE

WRITE range begins prior to the Logical Track NWA and ends after the Logical Track NWA. The Host may choose to control the writing. There are 2 possibilities:

1. In order to minimize the number of POWed Clusters, the Host should send two WRITE commands: the first WRITE command appends part B, and the second WRITE command performs the part A POW.
2. In order to maximize performance, the Host should send two WRITE commands: the first WRITE command performs the part A POW, and the second WRITE command performs the part B POW.

Some Host applications are constructed to be unaware of POWs. In this case, the Host is permitted to issue a single WRITE for all of the logical blocks. There are also two possibilities for the Drive:

1. In order to minimize the number of POWed Clusters, the Drive first appends part B. Next the Drive performs the part A POW. This has the same result as management by the Host in the case 1, above.
2. In order to maximize performance, the Drive performs POW of all the sectors in the range. This has the same result as management by the Host in the case 2, above.

The actual Drive behavior is vendor specific.

4.3.7 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 2.

Table 2 – 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 Recordable 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.

4.3.8 BD-R/-RE Write Protection

4.3.8.1 General

Writable BD media provides Host access to the Disc Write Protect (DWP) PAC for the purpose of controlling BD write access.

The READ DISC STRUCTURE command is used to read the DWP PAC. This allows the Host to examine the following:

a. Write protect status of the disc,
b. If write protected, the type of write protect: virtual or physical,
c. Status of an associated write protect password.

The SEND DISC STRUCTURE command is used to write the DWP PAC. This allows the Host to perform the following functions:

a. Write protect a a write enabled disc.
b. Write enable a write protected disc.
c. Set, change, or remove the write protect password.

4.3.8.2 The DWP PAC

The Disc Write Protect PAC has a standard 384-byte PAC Header, where the PAC ID is 445750h, representing the characters “DWP”, and the PAC format is 00h, indicating version 0. There are two additional DWP PAC fields: the Write Protect Control Byte and the Write Protect Password.

4.3.8.2.1 Write Protect Password

The Write protect password can consist of up to 32 characters from the ISO 646 character set. Trailing bytes not used shall be set to 00h. The write protect password shall never be transferred outside the Drive.

If all bytes of the Write protect password field are set to 00h, then the Write protect password feature is inactive. If the Write protect password field is set to all FFh, then the disc is permanently write protected and further recording on the disc shall not be allowed.

4.3.8.2.2 Write Protect Control Byte

The Write protect control byte (Table 3) specifies allowed and required actions.

Table 3 — Write Protect Control Byte

7	6	5	4	3	2	1	0
Reserved					PWD	PHYS	WP

The WP bit indicates the current status of write protection. If WP is set to 0, write protection is switched off and writing of user data is allowed without any restrictions. If WP is set to 1, write protection is switched on, and writing of user data or re-initializing the disc is restricted. WP is present in the Write Protect Control Byte when the disc is BD-RE. When the disc is BD-R, WP is not in the Write Protect Control Byte, but is instead in bit 0 of byte 1025 of the Temporary Disc Definition Structure. This permits a great many more changes of WP than are otherwise

The PHYS bit indicates the method of write protection. If PHYS is set to 0, virtual write protection is enabled. After host confirmation (including optional password), writing of user data can be performed without changing the write protection settings on the disc. If PHYS is set to 1, physical write protection is switched on.

The PWD bit indicates if write protection includes a password.

4.3.8.2.3 Virtual Write Enable (VWE)

The Virtual Write Enable is a bit in the header of the SEND BD STRUCTURE command when format code = 30h. The Virtual Write Enable bit enables or disables writing to a virtually write

protected disc. When set to 1, it indicates that the host is requesting the capability to write on a virtually write protected disc. This is a temporary write capability, a media change or drive reset will cause the system to return to a write protected state. When VWE is set to 0, it indicates that the host is rescinding any temporary write capability.

Table 4 — Examples of Drive/Host Interaction

Initial PAC Write Protect Control Byte	Drive Behavior on Disc Mount	Host Command Issued	Drive Behavior after Host Command
No PWD/virtual/WP off 000b	No restrictions	No PWD/virtual/WP on 001b	Disc virtually write protected. PAC updated with new write protect control byte.
No PWD/virtual/WP on 001b	No data writing or WP changes until host confirmation	VWE = 1	Data writing or WP changes temporarily allowed (no changes to PAC). Media change, drive reset, host rescind (VWE=0 sent) returns disc to write protected state
No PWD/phys/WP off 010b	No restrictions	No PWD/phys/WP on 011b	Disc physically write protected. PAC updated with new write protect control byte.
No PWD/phys/WP on 011b	No data writing until confirmation and WP changed to off. No WP changes until host confirmation	No PWD/phys/WP off 010b	Data writing and WP changes allowed. PAC updated with new write protect control byte.
PWD/virtual/WP off 100b	Data writing permitted. No WP changes until host confirms password	No PWD/virtual/WP off 000b Matching password	No restrictions. PAC updated with new write protect control byte.
		Incorrect password	Error reported to host, no change in drive behavior or PAC.
PWD/virtual/WP on 101b	No data writing or WP changes until host confirms password	VWE=1 Matching password	Data writing or WP changes temporarily allowed (no changes to PAC). Media change, drive reset, host rescind (VWE=0 sent) returns disc to write protected state
PWD/phys/WP off 110b	No WP changes until host confirms password	PWD/phys/WP on Matching password	Disc is physically write protected with an associated password. PAC updated with new write protect control byte.
PWD/phys/WP on 111b	No data writing until confirmation and WP changed to off. No WP changes until host confirms password	PWD/phys/WP off Matching password	Data writing and WP changes allowed. PAC updated with new write protect control byte.

Changing the password in the PAC requires two separate steps from the host. If the current write protection method includes a password, the host must first send the matching password to the drive, followed by a separate command with the new password. Note: I considered having a single operation, (both confirming the old password and sending a new password), but decided against it. We cannot define an extra password field in this command, since there is only 1 password field defined in the DWP PAC (in the physical specification). It's also important to note that we are not expecting users to perform this operation often, so having a sequence of 2 commands did not seem too burdensome.

Table 5 — Changing the Write Protect Password

Current write protection status on the disc	Host actions required to change password
Virtual write protection with existing password	Step 1: Host sends DWP PAC to logical unit with correct password set, and VWE=1. Step 2: Host sends DWP PAC to logical unit with new password, and same WP control byte settings (PWD=1, PHYS=0, WP=1). Logical unit records new password onto the disc.
Virtual write protection without password	Step 1: Host sends DWP PAC to logical unit with VWE=1. Step 2: Host sends DWP PAC to logical unit with password set, and WP control byte settings set to indicate password protection (PWD=1, PHYS=0, WP=1). Logical unit records new password and WP control byte settings onto the disc.
Physical write protection with existing password	Step 1: Host sends DWP PAC to logical unit with correct password set, and WP control byte settings to turn off physical write protection (PWD=0, PHYS=1, WP=0). Logical unit records new WP control byte settings onto the disc. Step 2: Host sends DWP PAC to logical unit with password set, and WP control byte settings set to indicate password and write protection enabled (PWD=1, PHYS=1, WP=1). Logical unit records new password and WP control byte settings onto the disc.
Physical write protection without password	Step 1: Host sends DWP PAC to logical unit to turn off write protection (PWD=0, PHYS=1, WP=0). Logical unit records new WP control byte settings onto the disc. Step 2: Host sends DWP PAC to logical unit with password set, and WP control byte settings set to indicate password and physical write protection (PWD=1, PHYS=1, WP=1). Logical unit records new password and WP control byte settings onto the disc.
No write protection enabled, but password (PWD bit) is set. Note that this is not likely to be used by the host.	Step 1: Host sends DWP PAC to logical unit with correct password set and WP control byte settings to turn off password protection (PWD=0, PHYS=same setting, WP=0). Logical unit records new WP control byte settings onto the disc. Step 2: Host sends DWP PAC to logical unit with new password and WP control byte settings set to indicate password protection (PWD=1, PHYS=same setting, WP=0). Logical unit records new password and WP control byte settings onto the disc.

4.3.9 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 Recordable Format, Part 1 Basic Format Specifications”).

Error reporting associated with Emergency Brake conditions are described in Table 6.

4.3.10 Not Ready Conditions

If the TEST UNIT READY command responds with GOOD status, then the Drive is ready to accept some media accessing command. The readiness of the Drive is command dependent. Table 6 lists some conditions under which the Drive responds with GOOD status to the TEST UNIT READY command, but may not respond with GOOD status to a READ or WRITE command.

Table 6 — BD disc READY Conditions

Situation	Response from Drive
BD disc 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 or Drive does not support mounted media class and version.	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

5.1 Features

5.1.1 Write Protect Feature (0004h)

This Feature identifies reporting capability and changing capability for Write protection status of the Drive. The Write Protect Feature descriptor response data to be returned to the Initiator is defined in Table 7.

Table 7 — Write Protect Feature Descriptor

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB) Feature Code = 0004h							
1								(LSB)
2	Reserved			Version = 0010b			Persistent	Current
3	Additional Length = 04h							
4	Reserved				DWP	WDCB	SPWP	SSWPP
5	Reserved							
6	Reserved							
7	Reserved							

The Feature Code field shall be set to 0004h.

The Version Field shall be set to 0010b.

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

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

The Current bit, when set to one, indicates that Drive is capable of changing some write protect status on the medium surface. This bit shall be set to zero if the Drive is unable to set/release some write protect status on the medium surface. The reporting capability of the Write Protect status is persistent and shall be supported regardless of the setting of the Current bit.

The Additional Length field shall be set to 04h.

The WDCB bit indicates that the Drive supports reading/writing the Write Inhibit DCB on DVD+RW media. If WCDB is set to one, the READ/SEND DVD STRUCTURE command with format code = 30h shall be supported.

The DWP bit indicates that the Drive supports reading/writing the Disc Write Protect PAC on BD-R/-RE media. If DWP is set to one, the READ/SEND BD STRUCTURE command with format code = 30h shall be supported.

The Supports PWP (SPWP) bit indicates that the Drive supports set/release PWP status. If SPWP bit is set to one, the SEND DVD STRUCTURE command with Format = C0h shall be supported.

The Supports SWPP (SSWPP) bit indicates that the Drive supports SWPP bit of Timeout & Protect Mode Page. This bit does not affect Current bit of this Feature Descriptor. If SWPP bit is set to one, the Drive shall support SWPP bit of Timeout & Protect Mode Page.

If Drive supports reporting Write Protection status but does not support changing, the Drive returns this Feature descriptor, however the Current bit is never set to one in the descriptor.

Drives with installed medium that support this Feature shall implement the commands listed in Table 8.

Table 8 — Write Protect Feature Commands

Op Code	Command Description	Reference
ADh	READ DVD STRUCTURE Format codes C0h and FFh when SPWP = 1 Format codes 30h and FFh when WDCB = 1	MMC-4
	READ BD STRUCTURE Format codes 30h and FFh when DWP = 1	6.17
BFh	SEND DVD STRUCTURE Format codes C0h and FFh when SPWP = 1 Format codes 30h and FFh when WDCB = 1	MMC-4
	SEND BD STRUCTURE Format codes 30h and FFh when DWP = 1	6.23

5.1.2 Incremental Streaming Writable Feature (0021h)

This Feature identifies a Drive that is able to write data to a contiguous region, and is able to append data to a limited number of locations on the media. On CD media, this is known as packet recording, on DVD media it is known as Incremental Recording, and on a BD-R disc it is known as SRM recording.

The Feature descriptor response data is defined in Table 9.

Table 9 — Incremental Streaming Writable Feature Descriptor Format

Byte \ Bit	7	6	5	4	3	2	1	0
0	(MSB) Feature Code = 0021h							
1								(LSB)
2	Reserved			Version = 0001b			Persistent	Current
3	Additional Length = 4							
4	(MSB) Data Block Types Supported							
5								(LSB)
6	Reserved						ARSV	BUF
7	Number of Link Sizes (L)							
8	Link Size							
9	Link Size							
...	...							
L+7	Link Size							
L+7+P	4 - (L MOD 4) Zero Pad bytes to ensure a structure size that is an integral multiple of 4							

The Feature Code field shall be set to 0021h.

The Version field is set to 1h.

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

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

The Additional Length field shall be set to 4 + (Number of Link Sizes) + (Number of Pad bytes).

The Data Block Types Supported field is a bit field that identifies the supported Data Types as specifieded in the MMC-4 Write Parameters Mode Page description. A bit set to zero indicates the Data Type is not supported. A bit set to one indicates the Data Type is supported. Bit 0 equates to Data Type 0 and bit 15 equates to Data Type 15, etc.

If ARSV (Address field of RESERVE TRACK Command) is set to 1, the Drive's implementation of the RESERVE TRACK command supports Logical Track splitting by LBA.

If the BUF bit is set to 1, the Drive is capable of zero loss linking.

The Number of Link Sizes shall specify the number of link sizes available for the current media. For CD media, this field should be 1. For DVD-R, this field should be 2. For a BD-R disc formatted in SRM, this field is set to 1.

Each Link Size field shall indicate the number of logical blocks per link. Links occur on sequentially written media between independent write operations. The link size does not include any logical blocks written by the Drive to satisfy the writable unit specified by the Blocking field in the Random Readable Feature. This field is 7 for CD-R media, and may be 0, 1, or 16 for DVD media. This field contains 0 for BD-R. Link Size fields are reported by the Drive in the Drive's preferred order, most desirable first.

The Pad field shall contain zeros. The number of Pad bytes shall be 4 - (Number of Link Sizes MODULO 4). The Pad field is present to make the length of the Feature Descriptor a multiple of 4 bytes.

If a Drive reports this feature with the Current bit set to one, then the Drive shall support the commands shown in Table 10.

Table 10 — Command Support Required by the Incremental Streaming Writable Feature

Op Code	Command Description	Reference
A1h	BLANK (Use of this command is not defined for BD)	MMC-4
5Bh	CLOSE TRACK/SESSION	6.2
51h	READ DISC INFORMATION	6.16
52h	READ TRACK INFORMATION	6.20
53h	RESERVE TRACK	6.22
54h	SEND OPC INFORMATION (Shall be supported if OPC information is ever returned in the READ DISC INFORMATION return data.)	6.24
35h	SYNCHRONIZE CACHE	6.28
2Ah	WRITE (10)	6.31
35h	SYNCHRONIZE CACHE	6.28

Drives that support this Feature shall implement the mode pages shown in Table 11.

Table 11 — Incremental Streaming Writable Feature Parameters

Page Code	Mode Page	Reference
05h	Write Parameters (Use of this mode page is not defined for BD)	MMC-4

5.1.3 The Formattable Feature (0023h)

This Feature identifies a Drive that can format media into logical blocks. The Feature descriptor response data to be returned to the Host is defined in Table 12.

Table 12 — Formattable Feature Descriptor

Byte \ Bit	7	6	5	4	3	2	1	0
0	(MSB) Feature Code = 0023h							
1								(LSB)
2	Reserved		Version = 0001b				Persistent	Current
3	Additional Length = 8							
4	**Options for formatting BD-RE**							
	Reserved				RENoSA	Expand	QCert	Cert
5	Reserved							
6	Reserved							
7	Reserved							
8	**Options for formatting BD-R**							
	Reserved							RRM
9	Reserved							
10	Reserved							
11	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-R or 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 Drive 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 Drive 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 Drive 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.

If no BD-R profile is supported, byte 8 of the Formattable Feature Descriptor shall be set to zero.

If any BD-R Profiles are supported, then when a blank BD-R disc is present:

1. If a WRITE (10), WRITE (12), WRITE AND VERIFY (10), WRITE AND VERIFY (12), or RESERVE TRACK command is sent to the Drive when a blank BD-R disc is present and ready, then the disc shall be formatted as SRM with no spare areas allocated.
2. If the FORMAT UNIT command is used to select a BD-R format, SRM with defect management shall be an option for the Host.
3. If the FORMAT UNIT command is used to select a BD-R format, SRM+POW shall be an option for the Host.

If the RRM bit is set to zero, then formatting a blank BD-R disc in RRM is not supported. If the RRM bit is set to one, then the FORMAT UNIT command shall provide RRM as an option for the Host.

Drives that support this Feature shall implement the commands listed in Table 13.

Table 13 — Formattable Feature Commands

Op Code	Command	Reference
04h	FORMAT UNIT, Format Types 00h and 32h	6.3
23h	READ FORMAT CAPACITIES	6.18
03h	REQUEST SENSE	6.21
2Fh	VERIFY (10)	6.30

5.1.4 The BD Read Feature (0040h)

This Feature identifies a Drive 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 Host is defined in Table 14.

Table 14 — BD Read Feature Descriptor

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB) Feature Code = 40h							
1								(LSB)
2	Reserved		Version				Persistent	Current
3	Additional Length = 1Ch							
4	Reserved							
5	Reserved							
6	Reserved							
7	Reserved							
8 ... 31	Read Support Bitmaps							

The Feature Code field shall be set to 0040h.

The Version field shall be set to 0h.

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

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

The Additional Length field shall be set to 1Ch.

If the EB (Emergency Brake) bit is set to zero, provides no specific protection from Drive/disc incompatibilities. If the EB bit is set to one, the Drive provides Emergency Brake protection from incompatible Drive/disc combinations according to the EB data set in the PIC.

Bytes 8 through 15 (Table 15) contain version bitmaps of BD-RE disc classes 0 that indicate read support provided by the Drive. If a bit is set to one, the Drive supports reading BD-RE discs of the Class and version.

Table 15 — BD-RE Read Support Bitmap

BD-RE Class	Bit / Byte	7	6	5	4	3	2	1	0
0	8	Ver 15	Ver 14	Ver 13	Ver 12	Ver 11	Ver 10	Ver 9	Ver 8
	9	Ver 7	Ver 6	Ver 5	Ver 4	Ver 3	Ver 2	Ver 1	Ver 0
1	10	Ver 15	Ver 14	Ver 13	Ver 12	Ver 11	Ver 10	Ver 9	Ver 8
	11	Ver 7	Ver 6	Ver 5	Ver 4	Ver 3	Ver 2	Ver 1	Ver 0
2	12	Ver 15	Ver 14	Ver 13	Ver 12	Ver 11	Ver 10	Ver 9	Ver 8
	13	Ver 7	Ver 6	Ver 5	Ver 4	Ver 3	Ver 2	Ver 1	Ver 0
3	14	Ver 15	Ver 14	Ver 13	Ver 12	Ver 11	Ver 10	Ver 9	Ver 8
	15	Ver 7	Ver 6	Ver 5	Ver 4	Ver 3	Ver 2	Ver 1	Ver 0

Bytes 16 through 23 (Table 16) contain version bitmaps of BD-R disc classes 0 that indicate read support provided by the Drive. If a bit is set to one, the Drive supports reading BD-R discs of the Class and version.

Table 16 — BD-R Read Support Bitmap

BD-R Class	Bit / Byte	7	6	5	4	3	2	1	0
0	16	Ver 15	Ver 14	Ver 13	Ver 12	Ver 11	Ver 10	Ver 9	Ver 8
	17	Ver 7	Ver 6	Ver 5	Ver 4	Ver 3	Ver 2	Ver 1	Ver 0
1	18	Ver 15	Ver 14	Ver 13	Ver 12	Ver 11	Ver 10	Ver 9	Ver 8
	19	Ver 7	Ver 6	Ver 5	Ver 4	Ver 3	Ver 2	Ver 1	Ver 0
2	20	Ver 15	Ver 14	Ver 13	Ver 12	Ver 11	Ver 10	Ver 9	Ver 8
	21	Ver 7	Ver 6	Ver 5	Ver 4	Ver 3	Ver 2	Ver 1	Ver 0
3	22	Ver 15	Ver 14	Ver 13	Ver 12	Ver 11	Ver 10	Ver 9	Ver 8
	23	Ver 7	Ver 6	Ver 5	Ver 4	Ver 3	Ver 2	Ver 1	Ver 0

Bytes 24 through 31 (Table 19) contain version bitmaps of BD-ROM disc classes 0 that indicate read support provided by the Drive. If a bit is set to one, the Drive supports reading BD-ROM discs of the Class and version.

Table 17 — BD-ROM Read Support Bitmap

BD-ROM Class	Bit / Byte	7	6	5	4	3	2	1	0
0	24	Ver 15	Ver 14	Ver 13	Ver 12	Ver 11	Ver 10	Ver 9	Ver 8
	25	Ver 7	Ver 6	Ver 5	Ver 4	Ver 3	Ver 2	Ver 1	Ver 0
1	26	Ver 15	Ver 14	Ver 13	Ver 12	Ver 11	Ver 10	Ver 9	Ver 8
	27	Ver 7	Ver 6	Ver 5	Ver 4	Ver 3	Ver 2	Ver 1	Ver 0
2	28	Ver 15	Ver 14	Ver 13	Ver 12	Ver 11	Ver 10	Ver 9	Ver 8
	29	Ver 7	Ver 6	Ver 5	Ver 4	Ver 3	Ver 2	Ver 1	Ver 0
3	30	Ver 15	Ver 14	Ver 13	Ver 12	Ver 11	Ver 10	Ver 9	Ver 8
	31	Ver 7	Ver 6	Ver 5	Ver 4	Ver 3	Ver 2	Ver 1	Ver 0

If a Drive reports this feature with the Current bit set to one, then the Drive shall support the commands shown in Table 18.

Table 18 - Command Support Required by the BD Read Feature

Op Code	Command Description	Reference
28h	READ (10)	6.12
A8h	READ (12)	6.13
ADh	READ DISC STRUCTURE (format = 0, 30h, FFh)	6.17
43h	READ TOC/PMA/ATIP (format 0 and 1)	6.19

5.1.5 The BD Write Feature (0041h)

This Feature identifies a Drive that is able to write control structures and user data to certain BD discs. The BD Write Feature descriptor response data to be returned to the Host is defined in Table 19.

Table 19 — BD Write Feature Descriptor

Byte \ Bit	7	6	5	4	3	2	1	0
0	(MSB) Feature Code = 0041h							
1								(LSB)
2	Reserved		Version				Persistent	Current
3	Additional Length = 14h							
4	Reserved							SVNR
5	Reserved							
6	Reserved							
7	Reserved							
8 ... 23	Write Support Bitmaps							

The Feature Code field shall be set to 0041h.

The Version field shall be set to 0h.

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

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

The Additional Length field shall be set to 20.

If the SVNR bit (Supports Verify Not Required) is set to one, then the WRITE (12) command supports the VNR bit set to one.

Bytes 8 through 15 (Table 15) contain version bitmaps of BD-RE disc classes 0 that indicate write support provided by the Drive. If a bit is set to one, the Drive supports writing BD-RE discs of the Class and version.

Table 20 — BD-RE Write Support Bitmap

BD-RE Class	Byte \ Bit	7	6	5	4	3	2	1	0
0	8	Ver 15	Ver 14	Ver 13	Ver 12	Ver 11	Ver 10	Ver 9	Ver 8
	9	Ver 7	Ver 6	Ver 5	Ver 4	Ver 3	Ver 2	Ver 1	Ver 0
1	10	Ver 15	Ver 14	Ver 13	Ver 12	Ver 11	Ver 10	Ver 9	Ver 8
	11	Ver 7	Ver 6	Ver 5	Ver 4	Ver 3	Ver 2	Ver 1	Ver 0
2	12	Ver 15	Ver 14	Ver 13	Ver 12	Ver 11	Ver 10	Ver 9	Ver 8
	13	Ver 7	Ver 6	Ver 5	Ver 4	Ver 3	Ver 2	Ver 1	Ver 0
3	14	Ver 15	Ver 14	Ver 13	Ver 12	Ver 11	Ver 10	Ver 9	Ver 8
	15	Ver 7	Ver 6	Ver 5	Ver 4	Ver 3	Ver 2	Ver 1	Ver 0

Bytes 16 through 23 (Table 16) contain version bitmaps of BD-R disc classes 0 that indicate write support provided by the Drive. If a bit is set to one, the Drive supports writing BD-R discs of the Class and version.

Table 21 — BD-R Write Support Bitmap

BD-R Class	Bit / Byte	7	6	5	4	3	2	1	0
0	16	Ver 15	Ver 14	Ver 13	Ver 12	Ver 11	Ver 10	Ver 9	Ver 8
	17	Ver 7	Ver 6	Ver 5	Ver 4	Ver 3	Ver 2	Ver 1	Ver 0
1	18	Ver 15	Ver 14	Ver 13	Ver 12	Ver 11	Ver 10	Ver 9	Ver 8
	19	Ver 7	Ver 6	Ver 5	Ver 4	Ver 3	Ver 2	Ver 1	Ver 0
2	20	Ver 15	Ver 14	Ver 13	Ver 12	Ver 11	Ver 10	Ver 9	Ver 8
	21	Ver 7	Ver 6	Ver 5	Ver 4	Ver 3	Ver 2	Ver 1	Ver 0
3	22	Ver 15	Ver 14	Ver 13	Ver 12	Ver 11	Ver 10	Ver 9	Ver 8
	23	Ver 7	Ver 6	Ver 5	Ver 4	Ver 3	Ver 2	Ver 1	Ver 0

If a Drive reports this feature with the Current bit set to one, then the Drive shall support the commands shown in Table 22.

Table 22 - Command Support Required by the BD Write Feature

Op Code	Command Description	Reference
04h	FORMAT UNIT	6.3
2Ah	WRITE (10)	6.31
AAh	WRITE (12)	6.32

5.1.6 BD-R Pseudo-Overwrite (POW) Feature

A Drive that reports the feature is able to provide Logical Block overwrite service on BD-R discs that are formatted as SRM+POW. The feature descriptor is defined in Table 23.

Table 23 — Pseudo-OverWrite Feature Descriptor

Byte \ Bit	7	6	5	4	3	2	1	0
0	(MSB) Feature Code = 0038h							
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 0038h.

The Version field shall be set to 0h.

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

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

The Additional Length field shall be set to 04h.

When this feature is current, the Drive shall provide Pseudo-overwrite services as described in UDF 2.60. The physical implementation shall be according to the rules for Logical OverWrite described in System Description Blu-ray Disc Recordable Format, Part 1 Basic Format Specifications. See 4.3.4, Pseudo-OverWrite (POW) for a description of implementation requirements. This feature shall not be current on multi-session discs.

5.2 Profiles

5.2.1 Profile 0041h: BD-R Sequential Recording (SRM) Profile

Drives identifying Profile 0041h as current shall support the features listed in Table 24.

Table 24 — Features For BD-R SRM Profile

Feature Number	Feature Name	Description
0000h	Profile List	A list of all Profiles supported by the device
0001h	Core	Mandatory behavior for all devices
0002h	Morphing	Device changes operational behavior upon events external to the Host
0003h	Removable Medium	The medium may be removed from the device
0010h	Random Readable[1]	Read ability for storage devices with random addressing
0021h	Incremental Streaming Writable	Write support for sequential recording
0023h	Formattable	Support for formatting of media
0024h	Defect Management[2]	The Drive/media system is able to provide an apparently defect-free LBA space
0038h	BD-R POW[3]	The ability to permit logical overwrites from the user data area of the disc
0040h	BD Read	The ability to read BD specific structures
0041h	BD Write	The ability to write BD user data areas and certain BD specific structures
0100h	Power Management	Host 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 Host 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]If both the BD-R SRM profile and the BD-R POW feature are current, then the basic characteristics of sequential recording are maintained, but limited Logical Overwrite is permitted. Such a disc is SRM+POW.

Table 25 shows the commands and Mode Pages required when the BD-R SRM Profile is current.

Table 25 — BD-R SRM Profile Decomposition

Features	Commands and Mode Pages
Core	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	Get Configuration command, Get Event Status Notification command, Prevent Allow Medium Removal command
Removable Medium	Mechanism Status command, Prevent Allow Medium Removal command, Start Stop Unit command
Random Readable	Read Capacity command, Read (10) command, Read/Write Error Recovery Parameters Mode Page
Incremental Streaming Writable	BLANK command[1], Close Track Session command, Read Disc Information command, Read Disc Structure command, Read Track Information command, Reserve Track command, Send OPC Information command, Synchronize Cache command, Write (10) command, Write Parameters Mode Page[1]
Formattable	Format Unit command, Read Format Capacities command, Verify (10) command, Request Sense command
Defect Management	Read/Write Error Recovery Parameters Mode Page
BD-R POW	—
BD Read	Read (10) command, Read (12) command, Read BD Structure command, Read TOC/PMA/ATIP command, Read/Write Error Recovery Parameters Mode Page
BD Write	Format Unit command, Write (10) command
Power Management	Get Event Status Notification command, Start Stop Unit command, Power Condition Page
Timeout	Timeout and Protect Mode Page
Real-time Streaming	Get Performance command, Read (12) command, Read Buffer Capacity command[1], Set Streaming command, Set Read Ahead command, Write (12) command[1]
[1]The command or mode page is conditional according to the feature description.	

5.2.2 Profile 0042h: BD-R Random Recording (RRM) Profile

Drives identifying Profile 0042h as current shall support the features listed in Table 26.

Table 26 — Features For BD-R RRM Profile

Feature Number	Feature Name	Description
0000h	Profile List	A list of all Profiles supported by the device
0001h	Core	Mandatory behavior for all devices
0002h	Morphing	Device changes operational behavior upon events external to the Host
0003h	Removable Medium	The medium may be removed from the device
0010h	Random Readable[1]	Read ability for storage devices with random addressing
0023h	Formattable	Support for formatting of media
0024h	Defect Management[2]	The Drive/media system is able to provide an apparently defect-free LBA space
0025h	Write-once	Write support for write-once media that is writable in random order
0040h	BD Read[3]	The ability to read BD user data areas and certain BD specific structures
0041h	BD Write	The ability to write BD user data areas and certain BD specific structures
0100h	Power Management	Host 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 Host 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 27 shows the commands and Mode Pages required when the BD-R RRM Profile is current.

Table 27 — BD-R RRM Profile Decomposition

Features	Commands and Mode Pages
Core	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	Get Configuration command, Get Event Status Notification command, Prevent Allow Medium Removal command
Removable Medium	Mechanism Status command, Prevent Allow Medium Removal command, Start Stop Unit command
Random Readable	Read Capacity command, Read (10) command, Read/Write Error Recovery Parameters Mode Page
Formattable	Format Unit command, Read Format Capacities command, Verify (10) command, Request Sense command
Defect Management	Read/Write Error Recovery Parameters Mode Page
Write-Once	Read Capacity command, Synchronize Cache command, Write (10), Write and Verify (10), Read/Write Error Recovery Parameters Mode Page[1]
BD Read	Read (10) command, Read (12) command, Read BD Structure command, Read TOC/PMA/ATIP command, Read/Write Error Recovery Parameters Mode Page
BD Write	Format Unit command, Write (10) command
Power Management	Get Event Status Notification command, Start Stop Unit command, Power Condition Page
Timeout	Timeout and Protect Mode Page
Real-time Streaming	Get Performance command, Read (12) command, Read Buffer Capacity command[1], Set Streaming command, Set Read Ahead command, Write (12) command[1]

[1]The command or mode page is conditional according to the feature description.

6 Commands

6.1 Overview

The commands described in this clause are defined uniquely for BD Multi-Media Drives or have a unique behavior when executed by a BD Multi-Media Drive. The commands described in this clause are listed in Table 28. 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 28 — Commands for BD-R Devices

Command Name	Op Code	Reference
CLOSE TRACK SESSION	5Bh	6.2
FORMAT UNIT	04h	6.3
GET CONFIGURATION	46h	6.4
GET EVENT STATUS NOTIFICATION	4Ah	6.5
GET PERFORMANCE	ACh	6.6
INQUIRY	12h	6.7
MECHANISM STATUS	BDh	6.8
MODE SELECT (10)	55h	6.9
MODE SENSE (10)	5Ah	6.10
PREVENT ALLOW MEDIUM REMOVAL	1Eh	6.11
READ (10)	28h	6.12
READ (12)	A8h	6.13
READ BUFFER CAPACITY	5Ch	6.14
READ CAPACITY	25h	6.15
READ DISC INFORMATION	51h	6.16
READ DISC (BD) STRUCTURE	ADh	6.17
READ FORMAT CAPACITIES	23h	6.18
READ TOC/PMA/ATIP	43h	6.19
READ TRACK INFORMATION	52h	6.20
REQUEST SENSE	03h	6.21
RESERVE TRACK	53h	6.22
SEND DISC (BD) STRUCTURE	BFh	6.23
SEND OPC INFORMATION	54h	6.24
SET READ-AHEAD	A7h	6.25
SET STREAMING	B6h	6.26
START STOP UNIT	1Bh	6.27
SYNCHRONIZE CACHE	35h	6.28
TEST UNIT READY	01h	6.29
VERIFY (10)	2Fh	6.30
WRITE (10)	2Ah	6.31
WRITE (12)	AAh	6.32
WRITE AND VERIFY (10)	2Eh	6.33

6.2 CLOSE TRACK SESSION Command

The CLOSE TRACK/SESSION command allows closure of either a track or a session.

6.2.1 The CDB and Its Parameters

The CLOSE TRACK/SESSION CDB is shown in Table 29.

Table 29 — CLOSE TRACK SESSION CDB

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code (5Bh)							
1	Reserved							IMMED
2	Reserved					Close Function		
3								
4	(MSB) Logical Track Number							
5								(LSB)
6	Reserved							
7	Reserved							
8	Reserved							
9	Control							

6.2.1.1 IMMED

The IMMED bit allows execution of the close function as an immediate operation. If IMMED is zero, then the requested close operation is processed to completion prior to returning status. If IMMED is one, then status is returned once the close operation has begun.

6.2.1.2 Close Function

Close Function definitions are media specific. See 6.2.2.1.1 through 6.2.2.1.4.

6.2.1.3 Logical Track Number

The Logical Track Number (T) is valid only when the Close Function = 001b. If T_{MAX}.is the maximum Logical Track number currently defined on the disc and $T > T_{MAX}$, the command shall be terminated with CHECK CONDITION status and SK/ASC/ASCQ values shall be set to ILLEGAL REQUEST/INVALID FIELD IN CDB.

6.2.2 Command Execution

6.2.2.1 Close Functions for BD-R in SRM

6.2.2.1.1 Close Function 001b: Close a Logical Track

Close the Logical Track (SRR) identified by Logical Track Number field (T) in the CDB.

A BD-R SRR is closed by removing its number from the list of open SRRs in the SRRI. Padding is not required. Since the disc is not finalized, the updated SRRI shall be written into the current TDMA as a TDMS update unit. The actual write may be deferred.

If T is the invisible SRR and the invisible SRR is blank, then the command shall be terminated with GOOD status and sense data shall be set to NO SENSE/NO ADDITIONAL INFORMATION. If T is the invisible SRR and the invisible SRR is not blank, then the length of T shall be set to its recorded length, creating a new, blank invisible SRR with Logical Track Number = T+1.

6.2.2.1.2 Close Function 010b: Close the Open Session

Close the currently open session on a SRM Disc.

If the currently mounted disc is formatted SRM+POW, the command shall be terminated with CHECK CONDITION and sense bytes SK/ASC/ASCQ shall be set to ILLEGAL REQUEST/INVALID FIELD IN CDB.

If the currently mounted disc is SRM and the currently open session is empty, the command shall be terminated with GOOD status.

If the currently mounted disc is SRM and the currently open session is non-empty, each open SRR in the last Session shall be closed by the Drive prior to closing the session.

6.2.2.1.3 Close Function 110b: Close the Open Session and Finalize the Disc

Close the last session and finalize the disc. Once this close function has been processed, no more writing to the disc is allowed. Each open SRR in the last Session shall be closed by the Drive prior to closing the session.

6.2.2.1.4 Reserved Close Functions

When a BD-R disc is present, Close Functions 000b, 011b, 100b, 101b, and 111b are reserved. If the Close Function is reserved for the currently mounted medium the command shall be terminated with CHECK CONDITION status and SK/ASC/ASCQ values shall be set to ILLEGAL REQUEST/INVALID FIELD IN CDB.

6.2.2.2 Immediate Operation

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

a) In response to all commands except REQUEST SENSE, INQUIRY, GET CONFIGURATION, GET EVENT STATUS NOTIFICATION, and TEST UNIT READY, the Drive shall return CHECK CONDITION status and set SK/ASC/ASCQ to NOT READY/LOGICAL UNIT NOT READY/OPERATION IN PROGRESS.
b) In response to the TEST UNIT READY command, the Drive should return CHECK CONDITION status and set SK/ASC/ASCQ to NOT READY/LOGICAL UNIT NOT READY/OPERATION IN PROGRESS. Some legacy implementations allowed for a GOOD status response to a TEST UNIT READY command. This behavior is not recommended.
c) In response to the INQUIRY, GET CONFIGURATION, GET EVENT STATUS NOTIFICATION commands, the Drive shall respond as commanded.
d) In response to the REQUEST SENSE command, unless an error has occurred, the Drive shall return with SK/ASC/ASCQ values set to NOT READY/LOGICAL UNIT NOT READY/LONG WRITE IN PROGRESS or NOT READY/LOGICAL UNIT NOT READY/OPERATION IN PROGRESS, with the sense key specific bytes set for progress indication.

If the Drive changes to a not ready state during execution, an Operational Change Event shall be generated. When execution is completed and the state returns to ready, an Operational Change Event shall be generated. If the Closing a Track or Session results in one or more features changing currency, an additional Operational Change Event shall be generated.

6.3 FORMAT UNIT

The FORMAT UNIT command formats a medium into Host addressable logical blocks according to Host 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.

6.3.1 The CDB and Its Parameters

The FORMAT UNIT command descriptor block is shown in Table 30.

Table 30 — 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							

6.3.1.1 FmtData

If the FmtData bit is zero, there is no parameter list. If FmtData is one, a parameter list is available from the Host. For all Multi-media Drives, 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.

6.3.1.2 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.

6.3.1.3 Format Code

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

6.3.1.4 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.

6.3.2 Format Parameter List

The FORMAT UNIT parameter list (Table 31) consists of three descriptors: the Format List Header, the Initialization Pattern Descriptor, and the Format Descriptor.

Table 31 — 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							

6.3.2.1 Format List Header

The Format List Header (Table 32) provides several format control bits. Drives that implement these bits give Hosts additional control over the formatting operation. If the Host attempts to select any function not implemented by the Drive, the Drive 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 32 — 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 Drive 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 Drive shall examine the setting of the DPRY, DCRT, STPF, IP, and Try-out. When BD-R 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 Drive 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 Drive 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 Drive shall terminate the command with CHECK CONDITION status and SK/ASC/ASCQ values shall be set to ILLEGAL REQUEST/INVALID FIELD IN PARAMETER LIST.

6.3.2.2 Format Descriptor

When the CDB Format Code is 001b, a Format Descriptor is included in the FORMAT UNIT Parameter List. The Format Descriptor (Table 33) is a structure that is 8 bytes in length.

Table 33 — 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)

6.3.2.2.1 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.

6.3.2.2.2 Format Type

The Format Type field specifies the type of formatting. When a BD-R disc is present, only Format Types 00h and 32h shall be supported.

6.3.2.2.3 Format Sub-type

Format Sub-type is dependent upon the Format Type.

6.3.2.2.4 Type Dependent Parameter

Type Dependent Parameter field depends on Format Type.

6.3.3 Command Execution

6.3.3.1 Format Type = 00h (Default, Format)

The disc shall be formatted in SRM+POW with non-zero spares.

Table 34 shows the Format Descriptor for Format Type 00h.

Table 34 - Format Descriptor (Format Type = 00h)

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)							
1	Number of Blocks							
2								
3								(LSB)
4	Format Type = 00h						Reserved	
5	(MSB)							
6	Block Length = 0800h							
7								(LSB)

Format Type 00h requires that the Drive execute the formatting process by using its default User Data Area size, default spares allocation, and default TDMA allocation. The Drive ignores the Number of Blocks field, and the Block Length field. 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.

As a part of the format process, the Drive shall allocate TDMA and spare areas according to vendor specific defaults. Table 35 shows an example of defaults for different BD-R discs.

Table 35 — Example of Default Allocations for Format Type 0

BD-R Disc	Allocations			
	Area	Spares	TDMA	Totals
80 mm Single Layer	ISA0	1 024	1 024	2 048
	OSA0	1 280	1 280	2 560
80 mm Dual Layer	ISA0	1 024	1 024	2 048
	OSA0	1 280	1 280	2 560
	OSA1	1 280	1 280	2 560
	ISA1	1 024	1 024	2 048
120 mm Single Layer	ISA0	1 024	1 024	2 048
	OSA0	5 632	5 632	11 264
120 mm Dual Layer	ISA0	1 024	1 024	2 048
	OSA0	5 632	5 632	11 264
	OSA1	5 632	5 632	11 264
	ISA1	1 024	1 024	2 048

6.3.3.2 Format Type = 32h (Format BD-R)

Format Type 32h permits formatting a BD-R disc in SRM+POW, SRM, or RRM. When formatted with Format Type 32h, the BD-R disc is required to allocate a non-zero number of spares.

Table 34 shows the Format Descriptor for Format Type 32h.

Table 36 - Format Descriptor (Format Type = 32h)

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)							
1	Number of Blocks							
2								
3								(LSB)
4	Format Type = 32h						Format Sub-type	
	Type Dependent Parameters							
5	ISA_V	Reserved			Spare Area Distribution Parameter			
6	TDMA_V	Reserved			TDMA Distribution Parameter			
7	Reserved							

Number of Blocks contains the minimum number of LBAs that shall be formatted on the disc.

Format Sub-type selects a sub-type of format Type 32h.

Table 37 — Sub-type Field

Sub-type Value	Description
00b	SRM+POW
01b	SRM
10b	RRM
11b	Reserved

If ISA_V is set to one, the Spare Area Distribution Parameter is valid.

If ISA_V is set to zero, a vendor specific default shall be assigned for the numeric value of the Spare Area Distribution Parameter.

If TDMA_V is set to one, the TDMA Distribution Parameter is valid.

If TDMA_V is set to zero, a vendor specific default shall be assigned for the numeric value of the TDMA Distribution Parameter.

6.3.3.2.1 Calculating Spare Size

Format Type 32h requires that the Drive 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 = 256*IP[(Data Zone Size - Number of Blocks)/8192], 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.

On single layer media, the size of ISA0 is fixed at either 4096. Consequently, the size if OSA0 is MIN(65536, S-4096) on 80 mm discs and MIN(196608, S - 4096) on 120 mm discs.

On dual layer media, when the Spare Area Distribution Parameter is non-zero, the size of ISA1 is calculated as follows:

$$ISA1Size = MIN\left(\frac{S * SpareAreaDistributionParameter - 65536}{16}, 16384\right)$$

When the Spare Area Distribution Parameter is zero, ISA1 Size shall be set to maximum possible.

$$ISA1Size = MIN(S - 4096, 16384).$$

Once the size of ISA1 is known, the size of each OSA is calculated as follows:

$$OSA0Size = OSA1Size = \frac{S - 4096 - ISA1Size}{2}$$

6.3.3.2.2 Calculating Additional TDMA Space

Additional TDMA allocation is determined by the TDMA Distribution Parameter.

Determine the SA fractional multiplier, F by:

$$F = \frac{TDMADistributionParameter}{16}$$

When the BD-R disc is single layer:

$$TDMA1Size = F * ISA0Size$$

and

$$TDMA2Size = F * OSA0Size$$

When the BD-R disc is dual layer:

$$TDMA2Size = F * ISA0Size ,$$

$$TDMA3Size = TDMA4Size = F * OSA0Size = F * OSA1Size ,$$

and

$$TDMA5Size = F * ISA1Size .$$

6.4 GET CONFIGURATION Command

The Core Feature requires that this command be implemented. Each BD-R Profile includes the Core Feature. From the Host's perspective, use of this command requires no special behavior from the Drive.

See MMC-4 for a description of this command.

6.5 GET EVENT STATUS NOTIFICATION Command

The Core Feature requires that this command be implemented. Each BD-R Profile includes the Core Feature. From the Host's perspective, use of this command requires no special behavior from the Drive.

Drives that support BD-R 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.

6.6 GET PERFORMANCE Command

The Real-time Streaming Feature requires that this command be implemented. Each BD-R 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 Host's perspective, use of this command requires no special behavior from the Drive.

See MMC-4 for a description of this command.

6.7 INQUIRY Command

The Core Feature requires that this command be implemented. Each BD-R Profile includes the Core Feature. From the Host's perspective, use of this command requires no special behavior from the Drive.

See MMC-4 for a description of this command.

6.8 MECHANISM STATUS Command

The Removable Medium Feature requires that this command be implemented. Each BD-R Profile includes the Removable Medium Feature. From the Host's perspective, use of this command requires no special behavior from the Drive.

See MMC-4 for a description of this command.

6.9 MODE SELECT (10) Command

The Core Feature requires that this command be implemented. Each BD-R Profile includes the Core Feature. From the Host's perspective, use of this command requires no special behavior from the Drive.

See MMC-4 for a description of this command.

6.10 MODE SENSE (10) Command

The Core Feature requires that this command be implemented. Each BD-R Profile includes the Core Feature. From the Host's perspective, use of this command requires no special behavior from the Drive.

See MMC-4 for a description of this command.

6.11 PREVENT ALLOW MEDIUM REMOVAL Command

The Removable Media Feature requires that this command be implemented. Each BD-R Profile includes the Removable Media Feature. From the Host's perspective, use of this command requires no special behavior from the Drive.

See MMC-4 for a description of this command.

6.12 READ (10) Command

The Random Readable Feature requires that this command be implemented. Each BD-R Profile includes the Random Readable Feature. From the Host's perspective, use of this command requires no special behavior from the Drive.

See MMC-4 for a description of this command.

6.13 READ (12) Command

The BD Read Feature requires that this command be implemented. Each BD-R Profile includes the BD Read Feature. From the Host's perspective, use of this command requires no special behavior from the Drive.

See MMC-4 for a description of this command.

6.14 READ BUFFER CAPACITY Command

The Real-time Streaming Feature requires that this command be implemented. Each BD-R Profile includes the Real-time Streaming Feature. From the Host's perspective, use of this command requires no special behavior from the Drive.

See MMC-4 for a description of this command.

6.15 READ CAPACITY Command

The READ CAPACITY command provides a means for the Host to request information regarding the capacity of media currently loaded into the Drive. This capacity is reported with respect to reading operations. For capacity associated with writing operations, see 6.18, READ FORMAT CAPACITIES.

6.15.1 The CDB and Its Parameters

6.15.1.1 The CDB

The READ CAPACITY CDB is shown in Table 38.

Table 38 – READ CAPACITY CDB

Bit / Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (25h)							
1	Reserved							RelAdr=0
2	(MSB)							
3	Logical Block Address=0000 0000h							
4								
5								(LSB)
6	Reserved							
7	Reserved							
8	Reserved							PMI=0
9	Control							

6.15.1.2 RelAdr

The RelAdr field is not used by MM Drives and shall be set to zero.

6.15.1.3 Logical Block Address

The Logical Block Address field is not used by MM Drives and shall be set to zero.

6.15.1.4 PMI

The PMI field is not used by MM Drives and shall be set to zero.

6.15.2 Command Execution

The Drive shall respond to this command by returning eight bytes of READ CAPACITY response data. The format of response data is shown in Table 39.

Table 39 – READ CAPACITY Response Data

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

The returned Logical Block Address is dependent upon media and format type according to Table 40.

Table 40 — READ CAPACITY LBA

BD-R Format	READ CAPACITY LBA
RRM and SRM+POW	LBA of the last sector of the last writable Cluster in the User Data Area
SRM	The LBA of the last addressable user data block (= Last Recorded Address) in the last track of the last complete session.

6.16 READ DISC INFORMATION

The READ DISC INFORMATION command allows the Host 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.

6.16.1 The CDB and Its Parameters

The READ DISC INFORMATION CDB is shown in Table 41.

Table 41 — READ DISC INFORMATION CDB

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

Data Type defines the specific information requested. Defined data types are shown in Table 42.

Table 42 — Disc Information Data Types

Data Type	Returned Data
000b	Standard Disc Information
001b	Track Resources
010b	DM and POW Resources
011b - 111b	Reserved

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.

6.16.2 Command Execution

6.16.2.1 General

The Drive shall gather information about the medium, format it as shown in Table 43, and transfer to the Host, limited by the Allocation Length.

Table 43 — Disc Information Block - General Structure

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB) Disc Information Block Length = N							
1								(LSB)
2	Disc Information Data Type							
3	Data Type defined information							
4 - (N-2)	...							

6.16.2.2 Format of Standard Disc Information

The format of Standard Disc Information is shown in Table 44.

Table 44 — Standard Disc Information Block

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB) Disc Information Length							
1	(LSB)							
2	Disc Information Data Type = 000b			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 45 shows Standard Disc Information Block (DIB) values when the disc is a blank BD-R.

Table 45 — DIB of a Blank BD-R Disc

DIB Field	Value	Meaning
Disc Information Length	20h	BD-R does not report OPC tables
Erasable	0b	R is not rewritable.
State of Last Session	00b	Empty Session
Disc Status	00b	Empty Disc
Number of First Track on Disc	0001h	A blank disc is assumed to be SRM
Number of Sessions	0001h	A blank disc is assumed to be SRM
First Track Number in Last Session	0001h	A blank disc is assumed to be SRM
Last Track Number in Last Session	0001h	A blank disc is assumed to be SRM
DID_V	0b	BD does not have a CD equivalent Disc ID
DBC_V	0b	BD does not have a bar codes
URU	1b	BD-R is an unrestricted use disc
DAC_V	0b	BD has no defined application code
Dbit	0b	BD-R is always formatted in foreground
BG Status	00b	BD-R is always formatted 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	BD-R SRM has no session lead-ins
Last Possible Lead-out Start Address	Capacity	Number of blocks From READ FORMAT CAPACITIES maximum capacity descriptor
Disc Bar Code	All zeros	BD does not have bar codes
Disc Application Code	00h	BD has no defined application code
Number of OPC Table entries	00h	BD-R Devices do not report OPC information
OPC Table	None	BD-R Devices do not report OPC information

Table 46 shows Standard Disc Information Block (DIB) values when the disc is BD-R formatted in either SRM or SRM+POW.

Table 46 — DIB of a BD-R Disc Formatted as SRM or SRM+POW

DIB Field	Value	Meaning
Disc Information Length	20h	BD-R does not report OPC tables
Erasable	0b	R is not rewritable.
State of Last Session	01b	SRM reports according to MMC-4. SRM+POW reports Incomplete session until the disc is closed.
Disc Status	01b	Incomplete disc until disc is closed.
Number of First Track on Disc	0001h	BD-R requires first track be numbered 1
Number of Sessions	S	Number of sessions indicated in SRRI.
First Track Number in Last Session	TLS1	Definition is unchanged from CD
Last Track Number in Last Session	TLSL	Definition is unchanged from CD
DID_V	0b	BD does not have a CD equivalent Disc ID
DBC_V	0b	BD does not have a bar codes
URU	1b	BD-R is an unrestricted use disc
DAC_V	0b	BD has no defined application code
Dbit	0b	BD-R is always formatted in foreground
BG Status	00b	BD-R is always formatted 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	BD-R SRM has no session lead-ins
Last Possible Lead-out Start Address	Capacity	Number of blocks From READ FORMAT CAPACITIES current capacity descriptor
Disc Bar Code	All zeros	BD does not have bar codes
Disc Application Code	00h	BD has no defined application code
Number of OPC Table entries	00h	BD-R Devices do not report OPC information
OPC Table	None	BD-R Devices do not report OPC information

Table 47 shows Standard Disc Information Block (DIB) values when the disc is BD-R formatted in RRM.

Table 47 — DIB of a BD-R Disc Formatted as RRM

DIB Field	Value	Meaning
Disc Information Length	20h	BD-R does not report OPC tables
Erasable	0b	R is not rewritable.
State of Last Session	01b	Incomplete session until disc is closed.
Disc Status	01b	Incomplete disc until disc is closed.
Number of First Track on Disc	0001h	RRM is not subdivided into tracks
Number of Sessions	0001h	RRM is not subdivided into sessions
First Track Number in Last Session	0001h	RRM is not subdivided into tracks
Last Track Number in Last Session	0001h	RRM is not subdivided into tracks
DID_V	0b	BD does not have a CD equivalent Disc ID
DBC_V	0b	BD does not have a bar codes
URU	1b	BD-R is an unrestricted use disc
DAC_V	0b	BD has no defined application code
Dbit	0b	BD-R is always formatted in foreground
BG Status	00b	BD-R is always formatted 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	BD-R RRM has no session lead-ins
Last Possible Lead-out Start Address	Capacity	Number of blocks From READ FORMAT CAPACITIES current capacity descriptor
Disc Bar Code	All zeros	BD does not have bar codes
Disc Application Code	00h	BD has no defined application code
Number of OPC Table entries	00h	BD-R Devices do not report OPC information
OPC Table	None	BD-R Devices do not report OPC information

6.16.2.3 Format of Track Resources Disc Information

The format of the Track Resources Disc Information is shown in Table 48.

Table 48 — Track Resources Disc Information Block

Byte \ Bit	7	6	5	4	3	2	1	0
0	(MSB) Disc Information Length = 14							
1								(LSB)
2	Disc Information Data Type = 001b			Reserved				
3	Reserved							
4	(MSB) Maximum possible number of the Tracks on the disc							
5								(LSB)
6	(MSB) Number of the assigned Tracks on the disc							
7								(LSB)
8	(MSB) Maximum possible number of appendable Tracks on the disc							
9								(LSB)
10	(MSB) Current number of appendable Tracks on the disc							
11								(LSB)
12	Reserved							
13	Reserved							
14	Reserved							
15	Reserved							

On BD-R, the Maximum possible number of the Tracks on the disc is fixed at 7927.

On BD-R, Number of the assigned Tracks on the disc is the number of active entries in the SRRI.

On BD-R, Maximum possible number of appendable Tracks on the disc is 16.

On BD-R, Current number of appendable Tracks on the disc is the currently number of open Logical Tracks.

6.16.2.4 Format of Recordable Resources Disc Information

The format of the Write-once Resources Disc Information is shown in Table 49.

Table 49 — Write-once Resources Disc Information Block

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB) Disc Information Length = 18							
1								(LSB)
2	Disc Information Data Type = 010b			Reserved				
3	Reserved							
4	(MSB) Number of Writable Units remaining in User Data Area							
5								
6								
7								(LSB)
8	(MSB) Remaining Available Reallocation Management Entries							
9								
10								
11								(LSB)
12	(MSB) Number of Remaining Disc Management Updates							
13								
14								
15								(LSB)

On BD-R, the Number of Writable Units remaining in User Data Area is the sum of all the Free Blocks fields of all the Track Information Blocks (See 6.20, READ TRACK INFORMATION) divided by Cluster size in Logical Blocks (32). This is the number of potential POWs that may be performed.

On BD-R, Remaining Available Reallocation Management Entries is the number of unused entries in the (T)DFL.

On BD-R, Number of Remaining Disc Management Updates is the number of unused Clusters in the TDMAs.

6.17 READ DISC (BD) STRUCTURE

The READ DISC STRUCTURE command requests that the Drive transfer to the Host information about the currently mounted disc.

6.17.1 The CDB and Its Parameters

The READ DISC STRUCTURE CDB is shown in Table 50.

Table 50 — 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							

6.17.1.1 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.

6.17.1.2 Address

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

6.17.1.3 Layer Number

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

6.17.1.4 Format Code

The Format Code (Table 51) indicates the type of information that is requested by the Host.

Table 51 - 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
31h — FEh	Reserved	-	-	-
FFh	Structure List	-	-	BD Structure list

6.17.1.5 Allocation Length

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

6.17.1.6 AGID

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

6.17.2 Command Execution

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

6.17.2.1 Format Code 00h: Disc Information (DI)

A DI unit is 112 bytes in PIC on a BD-R 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 Recordable Format, Part 1 Basic Format Specifications* for DI unit detailed definition.

Table 52 — 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								

6.17.2.2 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.

On BD-R, the DDS is written only when the disc is finalized. Prior to finalization, the DDS is represented by the TDDS that is recorded in a TDMA. If the disc is not finalized, the structure returned shall be the most recent version found in the current TDMA.

The DDS structure format is shown in Table 53.

Table 53 — 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 Recordable Format, Part 1 Basic Format Specifications* for detailed format of the DDS.

6.17.2.3 Format Code 09h: Cartridge Status

The Medium Status structure (Table 54) includes information about cartridge status.

Table 54 — 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.

6.17.2.4 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 55.

Table 55 — 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.

6.17.2.5 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.

On BD-R, the DFL is written only when the disc is finalized. Prior to finalization, the DFL is represented by the TDFL that is recorded in a TDMA. If the disc is not finalized, the structure returned shall be the most recent version found in the current TDMA.

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 Recordable 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 56.

Table 56 — 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 Host 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 Recordable Format, Part 1 Basic Format Specifications* for detailed format of the DFL.

6.17.2.6 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 57.

Table 57 — 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 58.

Table 58 — 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 Drive. 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 Drive 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 59 — 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 Drive 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 60.

Table 60 — 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 Drive shall return a list of the headers of all PACs that are known to the Drive. The PAC headers shall be ordered according to PAC ID.

Table 61 — 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								

6.17.2.7 Format Code FFh: BD Structure List

The BD Structure List is returned in the format as shown in Table 62.

Table 62 — 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 Host. 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 63.

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

Table 63 — 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.

6.18 READ FORMAT CAPACITIES Command

The READ FORMAT CAPACITIES command allows the Host 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.

6.18.1 The CDB and Its Parameters

The READ FORMAT CAPACITIES CDB is shown in Table 64.

Table 64 — 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 Host has allocated for returned data. An Allocation Length of zero indicates that no data shall be transferred. This condition shall not be considered as an error. The Drive shall terminate the data transfer when Allocation Length bytes have been transferred or when all available data have been transferred to the Host, whatever is less.

6.18.2 Command Execution

The Drive shall construct a set of data structures that shall be transferred to the Host. 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 65.

Table 65 — 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								

6.18.2.1 Capacity List Header

The Capacity List Header precedes all other returned data.

Table 66 — 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.

6.18.2.2 Current/Maximum Capacity Descriptor

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

Table 67 — 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 68) indicates the type of information the descriptor contains.

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

Table 68 — Descriptor Types for BD-R

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-R 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-R disc.
11b	No Media Present	The reported value is for the maximum capacity of a media that the Drive is capable of reading.	Block Length that specifies the length in bytes of each logical blocks. 800h for Multi-Media devices.

6.18.2.3 Formattable Capacity Descriptor(s)

The Drive shall return only Formattable Capacity Descriptors (Table 69) that apply to the installed media. If there is no medium installed, the Drive shall return only the Current/Maximum Capacity Descriptor, with the maximum capacity of a medium that the Drive is capable of reading.

Table 69 — 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 Drive 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-R or BD-RE, refer to MMC-4 for the permitted Formattable Capacity Descriptors.

When a BD-R Profile is current the format descriptors shown in Table 70 shall be returned.

Table 70 — Format Descriptors Returned for BD-R

Format Type	Description	Type Dependent Parameter
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-R discs.	Total Spare Area size in Clusters
32h	The descriptor shall contain the total number of addressable blocks and the total number of Spare Area sizes used for formatting the whole media. Three descriptors are reported: The first descriptor values are vendor preferred for the BD device. The second descriptor values are selected to reflect maximum Spare Area sizes, resulting in minimum User Data Area size. The third descriptor values are selected to reflect minimum (but non-zero) Spare Area size, resulting in maximum User Data Area size.	Set to zeros

6.19 READ TOC/PMA/ATIP

READ TOC/PMA/ATIP (Table 71) is a CD function that has been adapted to other media. For BD discs, returned data shall be fabricated by the Drive. The information returned is minimized and may have no relationship to media structure.

6.19.1 The CDB and Its Parameters

The READ TOC/PMA/ATIP CDB is shown in Table 71.

Table 71 — 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							

6.19.1.1 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.

6.19.1.2 Format field

The Format field is used to select a specific returned data format. For a BD-R 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.

6.19.1.3 Track/Session Number field

Track/Session Number shall be set to either zero or one when BD-R 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.

6.19.1.4 Allocation Length

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

6.19.2 Command Execution

A BD-R disc formatted in RRM shall be reported as a single track, single session disc.

The READ TOC/PMA/ATIP command was originally designed for CD media. Since the lead-out is reported as Logical Track AAh (=170, at most 169 Logical Tracks can be reported). Accurately adapting this command to BD-R formatted in SRM or SRM+POW cannot be done, so the returned data is fabricated to maximize backward compatibility without being limited by the Logical Track number range. The disc shall be viewed as a single session containing at most two tracks as shown in .Table 72

Table 72 — BD-R SRM and SRM+POW Track Translation for READ TOC/PMA/ATIP

BD-R SRM Structure	TOC Fabrication
Blank	Terminate the command with CHECK CONDITION status and set SK/ASC/ASCQ values to ILLEGAL REQUEST/INVALID FIELD IN CDB.
One open session	Terminate the command with CHECK CONDITION status and set SK/ASC/ASCQ values to ILLEGAL REQUEST/INVALID FIELD IN CDB.
One Closed Session	Viewed as one track.
N > 1 Closed Sessions	Viewed as two tracks: The first is the concatentation of the first N-1 sesions. The second is the last closed session.

This permits a consistent translation and fabrication for RRM, SRM, and SRM+POW.

6.19.2.1 Format 0: Track List

TOC format 0 is intended to list Logical Tracks. The fabricated information is intended to provide backward compatibility for Host applications, not produce useful information.

If a formatted BD-R disc is present, the TOC Format 0 returned data shall have the format shown in Table 73.

Table 73 — TOC Data Format 0: Data Returned for formatted BD-R discs

	Byte(s)	Field	Value
Header	0, 1	TOC Data Length	0012h
	2	First Track	01h
	3	Last Track	02h
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 2 Descriptor (if present)	12	Reserved	00h
	13	ADR/CTL	14h
	14	Track Number	02h
	15	Reserved	00h
	16-19	Track Start Address	LBA form = Start LBA of last closed session. MSF form = MSF translation of LBA form with a maximum MSF address of 00h, FFh, 3Bh, 4Ah
Track AAh (Lead-out) Descriptor	12/20	Reserved	00h
	13/21	ADR/CTL	14h
	14/22	Track Number	AAh
	15/23	Reserved	00h
	16-19/ 24-27	Track Start Address	LBA form = READ CAPACITY LBA + 1 MSF form = MSF translation of LBA form with a maximum MSF address of 00h, FFh, 3Bh, 4Ah

6.19.2.2 Format 1: Session Information

When formatted BD-R is present, the TOC Format 1 returned data shall have the format shown in Table 74.

Table 74 — 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

6.20 READ TRACK INFORMATION

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

6.20.1 The CDB and Its Parameters

The READ TRACK INFORMATION CDB is shown in Table 75.

Table 75 — READ TRACK INFORMATION CDB

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code (52h)							
1	Reserved						Open	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							

6.20.1.1 Determining the Specific Logical Track

The Drive shall decode the CDB in order to determine, T, the Logical Track number for which Track Information shall be returned.

The Address/Number Type and the Logical Block Address/Track/Session Number fields specify an addressed logical track, T_A. Determining T_A is described in Table 76.

Table 76 — Determining Addressed Track (T_A) from LBA/Track/Session Number Field

Address/ Number Type field	Logical Block Address/Track/Session Number	Description
00b	Logical Block Address (LBA)	MAX = Last Possible Lead-out Start Address as returned by the READ DISC INFORMATION command. If LBA ≥ MAX, 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. Otherwise, LBA lies within some logical track, T_A.
01b	Logical track number (LTN)	T_M = Last Track Number in the Last Session as returned by the READ DISC INFORMATION command. If LTN > T_M, 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. Otherwise, T_A = LTN.
10b	Session Number (SN)	S_M is the Number of Sessions as returned by the READ DISC INFORMATION command. If SN > S_M, 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. Otherwise the TA = the first logical track in session SN.
11b	Reserved	

T_O is the smallest track number such that T_O is open and $T_A \leq T_O$. If the disc contains no open tracks, then T_O shall be set to FFFFh.

If Open is set to zero, then T shall be set to T_A. If Open is set to one, then T shall be set to T_O.

6.20.1.2 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.

6.20.2 Command Execution

The Drive shall collect the information for Logical Track, T, format it into a Track Information Block structure, and transfer to the Host, restricted by Allocation Length. The format and content of the Track Information Block is shown in Table 77.

Table 77 — 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 78 describes TIB fields when the currently mounted disc is SRM or SRM with POW.

Table 78 — TIB Fields for a Disc Formatted as SRM or SRM with POW

TIB Field	Value	Meaning
Track Number	T	Current Track Number: 1 ≤ T ≤ 7927
Session Number	S	Current Sesion Number: 1 ≤ S ≤ 7927
Damage	0b	TBD
Copy	0b	Not used by BD-R and shall be 0b
Track Mode	4h	BD sectors approximate CD track mode 4
RT	0b	The invisible/incomplete track
	1b	Track is not invisible/incomplete
Blank	0b	When Track NWA = Track Start Address
	1b	When Track NWA ≠ Track Start Address
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	xb	Specifies validity of LRA field
NWA_V	xb	Specifies validity of NWA field
Track Start Address	SLBA	LBA of first user block in track.
Next Writable Address	NWA	Append LBA for track
Free Blocks	FB	Number of blocks in track from NWA until end
Fixed Packet Size/Blocking Factor	00000020h	Cluster size in sectors
Track Size	Capacity + 1	Capacity = Last LBA from READ CAPACITY command
Last Recorded Address	LRA	LBA of last block appended with Initator supplied data
Read Compatibility LBA	00000000h	This field is not used by BD devices and shall be 00000000h

Table 79 describes TIB fields when the currently mounted disc is RRM.

Table 79 —TIB Fields for a BD-R Disc Formatted as RRM

TIB Field	Value	Meaning
Track Number	1	BD-R RRM is viewed as one track
Session Number	1	BD-R RRM is viewed as one session
Damage	0	Not used by BD-R and shall be 0b
Copy	0	Not used by BD-R and shall be 0b
Track Mode	4h	BD sectors approximate CD mode 1
RT	0	Not used by BD-R and shall be 0b
Blank	1b	A formatted RRM disc is not blank
Packet/Inc	1	Recording is incremental by Cluster
FP	1	Recording is incremental by Cluster
Data Mode	1	BD sectors approximate CD mode 1
LRA_V	0	Not used by BD-R RRM and shall be 0b
NWA_V	0	Not used by BD-R RRM 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	CAP + 1	CAP = Last LBA from READ CAPACITY command
Last Recorded Address	00000000h	This field is not used for RRM discs and shall be 00000000h
Read Compatibility LBA	00000000h	This field is not used by BD devices and shall be 00000000h

6.21 REQUEST SENSE

The Core Feature requires that this command be implemented. Each BD-R Profile includes the Core Feature. From the Host's perspective, use of this command requires no special behavior from the Drive.

See MMC-4 for a description of this command.

6.22 RESERVE TRACK Command

6.22.1 Introduction

The RESERVE TRACK command allows creation of a new logical track.

6.22.2 The CDB and Its Parameters

The RESERVE TRACK CDB is shown in Table 80.

Table 80 — RESERVE TRACK CDB

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code (53h)							
1	Reserved							ARSV
2	Logical Track Reservation Parameter							
3								
4								
5								
6								
7								
8								
9	Control							

If the currently mounted disc is BD-R formatted as RRM, the command shall be terminated with CHECK CONDITION status ans SK/ASC/ASCQ values shall be set to ILLEGAL REQUEST/ CANNOT WRITE MEDIUM/INCOMPATIBLE FORMAT.

If the currently mounted disc is BD-R - either blank or formatted as SRM and ARSV is set to zero, the Logical Track Reservation Parameter is Reservation Size as shown in Table 81. The Reservation Size is the number of user blocks desired for the track reservation. The actual number of blocks allocated is calculated according to the currently mounted media. Rounding up is permitted. For BD-R, rounding shall be to the next Cluster boundary. In all cases, if Reservation Size is larger than available space, the command shall be terminated with CHECK CONDITION status and SK/ASC/ASCQ values shall be set to ILLEGAL REQUEST/ INVALID FIELD IN CDB.

If Reservation Size is set to zero, the command shall be terminated with CHECK CONDITION status and SK/ASC/ASCQ values shall be set to ILLEGAL REQUEST/ INVALID FIELD IN CDB.

Table 81 — Reservation Size form of Logical Track Reservation Parameter

Bit / Byte	7	6	5	4	3	2	1	0
0	Reserved							
1	Reserved							
2	Reserved							
3	(MSB)							(LSB)
4	Reservation Size							
5								
6								(LSB)

If the currently mounted disc is BD-R - either blank or formatted as SRM and ARSV is set to one, the Reservation Size/LBA field is Reservation LBA as shown in Table 83. If Reservation by LBA is not supported for the currently mounted disc, then the command shall be terminated with CHECK CONDITION status and SK/ASC/ASCQ values shall be set to ILLEGAL REQUEST/INVALID FIELD IN CDB.

Table 82 — LBA form of Logical Track Reservation Parameter

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)							
1	Logical Block Address							
2								
3								(LSB)
4	Reserved							
5	Reserved							
6	Reserved							

Otherwise a new logical track is created with starting LBA set to the Reservation LBA unless:

1. If Reservation LBA is greater than the largest possible user data area LBA for this disc, the command shall be the the command shall be terminated with CHECK CONDITION status and SK/ASC/ASCQ values shall be set to ILLEGAL REQUEST/ LOGICAL BLOCK ADDRESS OUT OF RANGE.
2. Logical Tracks on BD-R shall begin with the first block of a Cluster. If the LBA is not the address of the first block of a Cluster, the the command shall be terminated with CHECK CONDITION status and SK/ASC/ASCQ values shall be set to ILLEGAL REQUEST/ INVALID FIELD IN CDB.
3. The second track of of a split shall be blank. If if the track is closed or Reservtion LBA is less than the NWA of the logical track that contains the LBA, then the command shall be terminated with CHECK CONDITION status and SK/ASC/ASCQ values shall be set to ILLEGAL REQUEST/INVALID ADDRESS FOR WRITE.
4. It is not permitted to use track splitting to create a Logical Track with a length less than 32. If Reservation LBA = Logical Track Start Address of any Logical Track, then the command shall be terminated with CHECK CONDITION status and SK/ASC/ASCQ values shall be set to ILLEGAL REQUEST/ INVALID FIELD IN CDB.

6.22.3 Command Execution

6.22.3.1 Logical Track Creation by Number of Blocks

Regardless of media type, it is not recommended to permit track reservation when the invisible track is not blank. The command should be terminated with CHECK CONDITION status and sense bytes SK/ASC/ASCQ should be set to ILLEGAL REQUEST/COMMAND SEQUENCE ERROR.

A new logical track shall be created from the invisible/incomplete track as shown in Table 83.

Table 83 — Track Creation from the Invisible/Incomplete Track

Logical Track	Invisible/Incomplete Track Prior to Reservation	New Logical Track	Invisible/Incomplete Track After Reservation
Track Number	N[1]	N	N+1
Start LBA	A[2]	A	A+L
Length	RC[3]-A	L	RC-(A+L)

[1] N is at least 1. The maximum value is media type dependent.
[2] LBA A may be any valid LBA within any logical track. On BD-R, A shall be the LBA of the first block of a Cluster.

[3] RC is the recordable capacity of the media. If the largest possible recordable LBA is CAP, then RC = CAP + 1.

6.22.3.2 Logical Track Creation by LBA (Track Splitting)

When a logical track is split by specifying the start LBA of the new track, the new logical track shall be blank. If Reservation LBA is in logical track N, then the new track with start address equal to Reservation LBA shall be numbered N+1. If M is a logical track and M > N prior to the track split, then it shall be numbered M+1 after the track split.

6.23 SEND DISC STRUCTURE Command

The SEND DISC STRUCTURE command provides a means for the Host to transfer BD STRUCTURE data to the Drive.

6.23.1 The CDB and Its Parameters

The SEND DISC STRUCTURE CDB is shown in

Table 84.

Table 84 — 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							

6.23.1.1 Media Type

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

6.23.1.2 Format

The Format field (Table 85) indicates the type of information that the Host is requesting to send.

Table 85 — Format Field Definition

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

6.23.1.3 Parameter List Length

The Parameter List Length field specifies the length in bytes of the DISC STRUCTURE data to be transferred from the Host to the Drive 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.

6.23.2 Command Execution

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

6.23.2.1 Format Code = 0Fh: Timestamp

The format of Timestamp field is structured as shown in Table 86.

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

Table 86 — 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”.

6.23.2.2 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 Host is shown in Table 87.

Table 87 — 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 Drive shall neither record nor erase any PAC that is unknown to the Drive.

The Drive shall support writing the Disc Write Protect (DWP) PAC.

6.24 SEND OPC INFORMATION

The SEND OPC INFORMATION command descriptor block (Table 88) allows the Host to request that the Drive perform Optimum Power Calibration (OPC) on the currently mounted medium.

Table 88 — 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 Drive 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 Drive shall perform no OPC operation.

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

Table 89 shows the behaviour given various combinations of control bits from byte 1.

Table 89 — Drive Action with Combinations of DoOPC, Exclude0, and Exclude1

DoOpc	Exclude0	Exclude1	Drive 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 Drive 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-R Drives do not support receiving OPC information from the Host. 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.

6.25 SET READ-AHEAD

The Real-time Streaming Feature requires that this command be implemented. Each BD-R Profile includes the Real-time Streaming Feature. From the Host's perspective, use of this command requires no special behavior from the Drive.

See MMC-4 for a description of this command.

6.26 SET STREAMING

The Real-time Streaming Feature requires that this command be implemented. Each BD-R Profile includes the Real-time Streaming Feature. From the Host's perspective, use of this command requires no special behavior from the Drive.

See MMC-4 for a description of this command.

6.27 START STOP UNIT

The Removable Medium Feature requires that this command be implemented. Each BD-R Profile includes the Removable Medium Feature. From the Host's perspective, use of this command requires no special behavior from the Drive.

See MMC-4 for a description of this command.

6.28 SYNCHRONIZE CACHE

The Incremental Streaming Writable Feature requires that this command be implemented. Each BD-R Profile includes the Incremental Streaming Writable Feature. From the Host's perspective, use of this command requires no special behavior from the Drive.

See MMC-4 for a description of this command.

6.29 TEST UNIT READY

The Core Feature requires that this command be implemented. Each BD-R Profile includes the Core Feature. From the Host's perspective, use of this command requires no special behavior from the Drive.

See MMC-4 for a description of this command.

6.30 VERIFY (10)

The Formattable Feature requires that this command be implemented. Each BD-R Profile includes the Formattable Feature. From the Host's perspective, use of this command requires no special behavior from the Drive.

See MMC-4 for a description of this command.

6.31 WRITE (10)

The WRITE (10) Command requests that the Drive write Host provided data to the medium.

6.31.1 The CDB and its Parameters

The WRITE (10) CDB is shown in Table 90.

Table 90 — 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)							
8	Transfer Length							(LSB)
9	Control							

6.31.1.1 DPO

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

6.31.1.2 FUA

A FUA (force unit access) bit, set to one, indicates that the Drive 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 Drive 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 Host 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.

6.31.1.3 RelAdr

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

6.31.1.4 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.

6.31.1.5 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.

6.31.2 Command Execution

6.31.2.1 RRM

If the LBA of any block in the write range has already been written, the command shall be terminated with CHECK CONDITION and SK/ASC/ASCQ values shall be set to ILLEGAL REQUEST/INVALID ADDRESS FOR WRITE.

6.31.2.2 SRM

If the Logical Block Address field is not the NWA of some open Logical Track, then the command shall be terminated with CHECK CONDITION status and SK/ASC/ASCQ values shall be set to ILLEGAL REQUEST/INVALID ADDRESS FOR WRITE.

Data from a previous write command(s) may be buffered for recording to Logical Track N. If the current WRITE command starts with the NWA of Logical Track M ≠ N, then it is recommended that the Drive pad the buffered data to a Cluster boundary and flush to the disc prior to buffering for data for append to Logical Track M.

If the FUA bit is set to 1 all data supplied from this command shall be recorded prior to returning command status. If the data for last block of this command is not stored in sector 31 of the targeted Cluster, the Drive shall append padding blocks until the end of the Cluster.

6.31.2.3 Flush Conditions

If a sequence of appending write commands leaves the last Cluster buffer only partially filled, the Drive shall typically wait for additional appending write commands in order to complete filling the Cluster buffer. If instead, a different disc accessing command is received, the Cluster buffer shall be padded with zeros and written to the disc prior to executing the new command. This is called flushing the Cluster. If the new command is:

TEST UNIT READY,
READ TRACK INFORMATION,
GET EVENT/STATUS NOTIFICATION,
GET CONFIGURATION,
REQUEST SENSE,
INQUIRY, or
READ BUFFER CAPACITY,

the command shall be executed to completion and the Cluster shall not be flushed.

TDMS updates are not typically performed each time the TDMS changes. Updates are collected and performed at some vendor specific time. If a

CLOSE TRACK/SESSION command,
FORMAT UNIT command,
RESERVE TRACK command,
SEND DISC STRUCTURE command,(PAC),
SYNCHRONIZE CACHE command, or
START STOP UNIT command (Eject, Sleep)

is received while TDMS changes are pending, the TDMS shall be updated prior to executing any subsequent WRITE command.

6.32 WRITE (12)

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

6.32.1 The CDB and Its Parameters

The WRITE (12) CDB is shown in Table 91.

Table 91 — 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	VNR	Reserved					
11	Control							

6.32.1.1 FUA

A FUA (Force Unit Access) bit, set to one, indicates that the Drive 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 Drive 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 Host 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.

6.32.1.2 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.

6.32.1.3 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.

6.32.1.4 Streaming

According to MMC-4.

6.32.1.5 VNR

If Streaming is set to zero and VNR is set to zero, it is recommended that all writes be read verified. If Streaming is set to zero and VNR is set to one, read verify is not recommended.

If Streaming is set to one, VNR has no meaning.

6.32.1.6 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 Host 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.

6.32.2 Command Execution

See 6.31.2.

6.33 WRITE AND VERIFY (10)

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

6.33.1 The CDB and Its Parameters

The WRITE AND VERIFY (10) CDB is shown in Table 92.

Table 92 — 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)			Tansfer Length				
8								(LSB)
9	Control							

6.33.1.1 Starting Logical Block Address

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

6.33.1.2 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.

6.33.2 Command Execution

Writing shall be according to the description of the WRITE (10) command when the FUA bit is set to one. Verify Error Recovery Mode Page parameters are not supported by MM Drives. The Drive shall utilize the Read/Write Error Recovery Mode Page as verify parameters. The AWRE and ARRE bits shall control automatic reallocation.

7 Mode Parameters

7.1 Mode Parameter List

The presence of a BD-R 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. Each BD-R Profile includes the Defect Management Feature. From the Host's perspective, use of this mode page requires no special behavior from a Drive when a BD-R 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. Each BD-R Profile includes the Power Management Feature. From the Host's perspective, use of this mode page requires no special behavior from a Drive when a BD-R 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. Each BD-R Profile includes the Timeout Feature. From the Host's perspective, use of this mode page requires no special behavior from a Drive when a BD-R Profile is current. The Host 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.

END