

**DVD+ReWritable**

**Multi-Media Command  
Set Description for the DVD+RW Format**

**Version 1.20**

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**DRAFT**

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# 1 INTRODUCTION/SCOPE

DVD+RW is a new form of DVD rewritable medium. Physically, it is constructed for fully random recording in the 32KB increments common to other DVD rewritable formats. Zero loss linking during ECC block recording allows streamed recording without skipping. At this point, a single logical format has been defined for this medium: the DVD+RW Basic Format. This Basic Format minimizes the rule base required for writing and reading the medium. For example, no defect management mechanism is defined. This tends to maximize compatibility with read-only devices.

Other devices that are functionally equivalent have preceded DVD+RW. For this reason, it is prudent to define the command set to be functionally equivalent. The differences will be highlighted here and solutions provided.

This document is organized to define changes and additions to a standard document such as the NCITS T10 Multi-Media Commands (MMC) standard:

- Clause 1: First, applicable references and definitions are covered.
- Clause 2: The DVD+RW Model describes the basic media format and shows a use model oriented toward producing discs in which DVD-RO device (DVD Video Player, DVD-ROM drive) compatibility is maximized.
- Clause 3: "Features and Profiles" provide a way by which the device is able to tell its host that it has a DVD+RW capability.
- Clause 4: Command descriptions are the primary reason for the existence of this document. The commands are described in terms of their differences from current operating definitions.
- Clause 5: As an extension of clause 4, Mode Pages define how the host may control command execution. These are presented separately.

## 1.1 References

### 1.1.1 References from Public Standards Organizations

SCSI Parallel Interface 3 (SPI-3) ANSI NCITS 336:2000  
SCSI-3 Primary Commands 2 (SPC-2) ANSI NCITS 351:2001  
SCSI-3 MultiMedia Command Set-3 (MMC-3), ANSI INCITS 360:2002  
SCSI-3 Block Command Set (SBC) ANSI NCITS.306:1998  
Serial Bus Protocol 2 (SBP-2) ANSI NCITS.325:1998  
ATA/ATAPI-5 ANSI NCITS 340:2000  
ISO/IEC 16448, 120mm DVD Read-Only-Media (DVD-ROM)  
ISO/IEC 16449, 80mm DVD Read-Only-Media (DVD-ROM)  
ISO/IEC 16824, 120 mm DVD Rewritable Disc (DVD-RAM)  
IEEE High Performance Serial Bus, IEEE 1394-1999B.

### 1.1.2 References Under Development from Public Standards Organizations

SCSI-3 Primary Commands 3 (SPC-3) NCITS T10 Draft Standard 1416-D  
SCSI-3 Block Command Set - 2 (SBC-2) NCITS T10 Draft Standard 1417-D  
Serial Bus Protocol 3 (SBP-3) NCITS T10 Draft Standard 1467-D  
ATA/ATAPI-6 NCITS T13 Draft Standard 1410-D

### 1.1.3 References from Private Sources

OSTA MultiRead Specifications for CD-ROM, CD-R, CD-R/RW, and DVD-ROM Devices, Revision 1.0 or higher.  
DVD+RW 4.7 Gbytes Basic Format Specifications, Version 1.20, May 2002, Hewlett-Packard, Mitsubishi Chemical, Philips, Ricoh, Sony, Yamaha

## **1.2 Definitions, abbreviations and acronyms**

### **ADIP**

Address In Pre-groove. Address and recording information encoded in the wobble groove on DVD+RW media.

### **CDZ**

Control Data Zone

### **De-Icing**

When an ECC block on a DVD+RW medium is blank, no headers are present in any sector of the ECC block. This means that no sector within that ECC block can be located. This has been described as similar to sliding on ice until crashing into a written area. The process of insuring that each ECC block is written at least once to insure the presence of headers is called de-icing.

### **DVD-ROM**

The medium specified by ISO/IEC 16448.

### **DVD-RAM**

The medium specified by ISO/IEC 16824.

### **DZ**

Data Zone

### **Logical Block**

A host addressable unit of data is a logical block. Each logical block on DVD+RW media is the user data of one of the 16 sectors within an ECC block.

### **Logical Block Address (LBA)**

A host referenced mapping to a linear address space of logical blocks.

### **Logical Sector Number (LSN)**

Logical Sector Numbers are assigned contiguously from LSN 0, starting from the first PSN (030000h) to the end of the Data Zone. On DVD+RW this is the same as Logical Block Address (LBA).

### **Physical Sector Number (PSN)**

The first Physical Sector of the Data Zone shall be numbered 030000h. The PSNs increase by 1 for each next Physical Sector in the whole of the Information Zone.



## 2 DVD+RW Basic Format Model

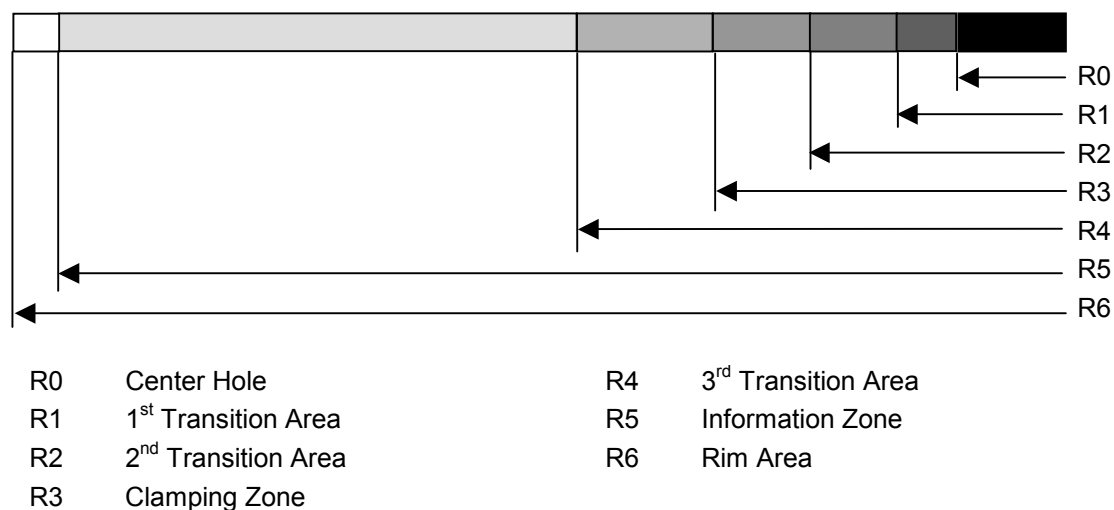
The DVD+RW medium was originally defined according to a simple, basic requirement of compatibility: when a fully recorded DVD+RW medium is mounted on the spindle of a standard DVD player, the medium should be accepted as if it were a stamped DVD-ROM disc.

That was a good starting point, but the potential was greater, so the definition was expanded.

Meeting the original requirement means that the medium must have the physical characteristics to allow the DVD player to find the recording groove, track on the data, seek across the groove, and read and decode written data. Clearly, physical compatibility is important. Logical compatibility is also required, and that is where this document begins.

### 2.1 Physical Overview

DVD+RW media is either 8 or 12 centimeters in diameter and separated into zones as shown in .



**Figure 1 – The Zones of a DVD+RW Medium**

The Center Hole, 1<sup>st</sup> Transition Area, 2<sup>nd</sup> Transition Area, Clamping Zone, and 3<sup>rd</sup> Transition Area are all part of the alignment and clamping mechanisms. These areas have no direct involvement with the writable areas of the medium.

The Information Zone is the area in which actual recording may occur. It contains the lead-in, the data area, and the lead-out. This area begins at a radius of 22 millimeters and proceeds to the outer radius. For 120-millimeter media, the information zone ends at a nominal radius of 58.5 millimeters. For 80-millimeter media, the information zone ends at a nominal radius of 38.5 millimeters.

The Rim Area is simply the area beyond the data groove. For 120-millimeter media, it typically ends at a radius of 60 millimeters. For 80-millimeter media, it typically ends at a radius of 40 millimeters.

## 2.2 Logical Overview

The Information zone is organized as a sequence of independently recorded units called ECC blocks. Each ECC block contains 16 user sectors. Each sector is identified by its PSN and contains 2048 bytes of data.

The physical addresses advance incrementally beginning at the virtual address 00000000h. It is virtual, because the physical nature of a DVD+RW device guarantees that no drive will ever be able to reach the sector with PSN = 0. Similarly, the media is made with a zone of protection in the groove. Consequently, the first sector which is required to exist, has PSN = 1D830h. As with DVD-ROM, the first user accessible sector has PSN = 30000h. The DVD+RW 120-mm one-sided disc has 4.70GB available to the user, while the two-sided disc has 9.40GB. The DVD+RW 80-mm one-sided disc has 1.46GB available to the user, while the two-sided disc has 2.92GB.

### 2.2.1 The ADIP (Address in Pre-groove)

Like CD-RW media:

- DVD+RW media has a wobble structure which defines the groove
- Information is modulated onto the wobble
- Within the Information Zone, this information contains the address of the associated sector
- Within the lead-in, there is additional information about the disc

This is generally called Address-In-Pre-groove or ADIP.

### 2.2.2 The ECC Block

The DVD+RW ECC block is defined according to the DVD-ROM standard.

Unlike CD-RW media, adjacent sectors of DVD+RW media are not necessarily interleaved. An ECC block consists of 16 sectors with headers, EDC symbols, and ECC symbols. Individual sector data are interleaved in order to minimize the effects of a large media flaw. These ECC blocks are recorded serially on the medium.

#### 2.2.2.1 The Structure of the Data Sector

A DVD+RW data sector contains 2064 bytes, 2048 bytes of main data and 16 bytes of additional information.

The logical layout of a DVD+RW data sector is shown in Figure 2.



**Figure 2 – Logical Layout of a DVD+RW Data Sector**

ID is a field that identifies the sector

IED contains 2 bytes of redundancy as an error detection code (EDC) for the ID field.

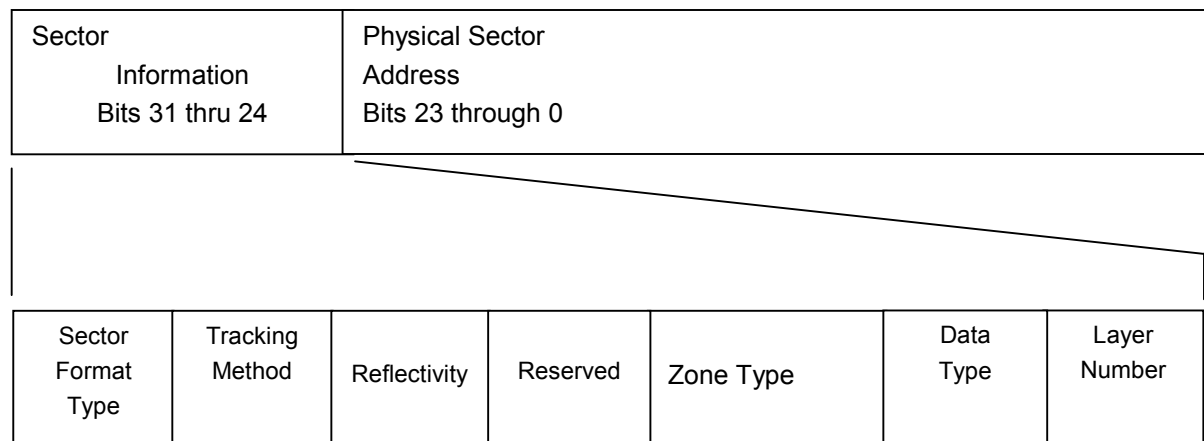
RSV is reserved and must be recorded with zeros.

MAIN DATA contains 2048 bytes and has 2 possible sources. The source is determined by the reference: *DVD+RW 4.7 Gbytes Basic Format Specifications*. Except for the formatting function, the host is the source of Main Data for the part of the Information Zone called the Data Zone. For all other areas,

the drive must generate the Main Data from information provides by the host according to the format requirements of *DVD+RW 4.7 Gbytes Basic Format Specifications*.

EDC contains 4 bytes of redundancy as an error detection code (EDC) for the entire sector.

The ID field is viewed as a 32 bit field as shown in Figure 3.



**Figure 3 – ID Field Details**

Sector Format Type (Bit 31)	is cleared to ZERO, indicating a CLV format
Tracking Method (Bit 30)	is set to ONE, indicating groove tracking
Reflectivity (Bit 29)	is set to ONE indicating that the reflectivity does not exceed 40 %
Reserved (Bit 28)	and must be cleared to ZERO
Zone Type (Bits 27 and 26)	is valued as: 00 when the sector is in the Data Zone 01 when the sector is in the Lead-in Zone 10 when the sector is in the Lead-out Zone (This includes the temporary lead-out.)
Data Type (Bit 25)	is set to ONE, indicating Rewritable data.
Layer Number (Bit 24)	is cleared to ZERO, indicating that through an entrance surface only one recording layer can be accessed

The least significant 24 bits (bits 23 through 0) contains the PSN in binary notation. The PSN of the first Physical Sector of an ECC Block shall be an integer multiple of 16.

### 2.2.2.2 The Structure of the ECC Block

A 2064 byte sector is divided into 12 rows of 172 bytes each. Main data is scrambled similar to CD-ROM data scrambling. Pack 16 sequential sectors in this way and there are 192 rows, each with 172 bytes. Error correction redundancy symbols are appended in order to produce 208 rows of 182 bytes each.

The organization of sector data and redundancy symbols within an ECC block is illustrated in Figure 4. Columnar symbols ( $C_{x,y}$ ) are calculated and appended to rows, then Row symbols ( $R_{x,y}$ ) are calculated and appended to columns. Columnar redundancy symbols are collectively known as Inner Parity (PI). Row redundancy symbols are collectively known as Outer Parity (PO).

		User Data					ECC Parity on Rows				
User Data		B1,0	B1,1	B1,2	...	B1,171	C1,0	C1,1	C1,2	...	C1,9
		B2,0	B2,1	B2,2	...	B2,171	C2,0	C2,1	C2,2	...	C2,9
		B3,0	B3,1	B3,2	...	B3,171	C3,0	C3,1	C3,2	...	C3,9
		...	...	...	...	...	...	...	...	...	...
		B190,0	B190,1	B190,2	...	B190,171	C190,0	C190,1	C190,2	...	C190,9
		B191,0	B191,1	B191,2	...	B191,171	C191,0	C191,1	C191,2	...	C191,9
ECC Parity		R0,0	R0,1	R0,2	...	R0,171	C192,0	C192,1	C192,2	...	C192,9
		R1,0	R1,1	R1,2	...	R1,171	C193,0	C193,1	C193,2	...	C193,9
		R2,0	R2,1	R2,2	...	R2,171	C194,0	C194,1	C194,2	...	C194,9
		...	...	...	...	...	...	...	...	...	...
		R15,0	R15,1	R15,2	...	R15,171	C207,0	C207,1	C207,2	...	C207,9

**Figure 4 – ECC Block Structure**

Each of the 16 sectors of an ECC block has a unique PSN. The PSNs are sequential such that if the smallest is N, then N+1, N+2, N+3, ..., N+15 are also present in the ECC block. That is, the sectors are sequenced in an intuitively correct way.

### 2.2.3 The Groove Layout

The groove, when recorded, is a continuous sequence of ECC blocks. If ECC block E and E+1 are consecutive, then whenever N is the largest PSN in E, then N+1 is the smallest PSN in E+1. That is, the ECC blocks are sequenced in an intuitively correct way.

The rest of logical groove architecture is given by specific use of individual sectors.

The DVD+RW format provides only a continuous address space with no possibility of defect management. If defect management is desired, it is recommended that the host's system software provide the function.

Table 1 shows the zoned layout of the DVD+RW formatted groove.

**Table 1 – DVD+RW Format Lay-out**

Disc Area	Zone	120 mm Disc		80 mm Disc	
		Start PSN (h)	Length (d)	Start PSN (h)	Length (d)
LEAD-IN	Initial Zone	01D830h	nominal=52 304	01D830h	nominal=52 304
	Inner Disc Test Zone	02A480h	2 048	02A480h	2 048
	Inner Drive Test Zone	02AC80h	12 288	02AC80h	12 288
	Guard Zone 1	02DC80h	512	02DC80h	512
	Reserved Zone 1	02DE80h	4 096	02DE80h	4 096
	Reserved Zone 2	02EE80h	64	02EE80h	64
	Inner Disc Identification Zone	02EEC0h	256	02EEC0h	256
	Reserved Zone 3	02EFC0h	64	02EFC0h	64
	Reference Code Zone	02F000h	32	02F000h	32
	Buffer Zone 1	02F020h	480	02F020h	480
	Control Data Zone	02F200h	3 072	02F200h	3 072
	Buffer Zone 2	02FE00h	512	02FE00h	512
DATA	Data Zone	030000h	max=2 295 104	030000h	max=714 544
LEAD-OUT	Buffer Zone 3	max=260540h	768	max=0DE730h	768
	Outer Disc Identification Zone	max=260840h	256	max=0DEA30h	256
	Guard Zone 2	max=260940h	4 096	max=0DEB30h	4 096
	Reserved Zone 4	261940h	4 096	0DFB30h	4 096
	Outer Drive Test Zone	262940h	12 288	0E0B30h	12 228
	Outer Disc Test Zone	265940h	2 048	0E3B30h	2 048
	Guard Zone 3	266140h	nominal=24 400	0E4330h	nominal=7 936

Relative to the host, the Data Zone is the user space and should be addressed according to LSN. The physical to logical address mapping for DVD+RW is the same as that for DVD-ROM: When PSN represents a sector in the data zone, its LSN = PSN - 030000h.

## 2.3 Using DVD+RW Media

### 2.3.1 Reading

When recorded, DVD+RW medium is ECC block readable. An intelligent controller can separate individual sector data from a decoded ECC block. Thus for the host, DVD+RW media is 2 048 byte sector readable.

NOTE: The function of locating and separating the data of one specific sector from the appropriate ECC block is typically an automated feature within a silicon sub-system. So, select any 2 sectors within the ECC block. There is virtually no difference in the times required to separate each sector's data from the ECC block. That is, there is no real performance difference.

### 2.3.2 Writing

Since the host's perception is that the media is sector readable, then in order to maintain compatibility with other block devices, a DVD+RW drive must be able to also write single sectors for its host.

The drive is required to write DVD+RW media only in complete ECC blocks. So, the drive must often perform a read/modify/write function in order to place the host's data in the correct position within the ECC block. That works when the ECC block to be written has already been written. When the ECC block has never been written and the drive must write less than a full ECC block, then the drive must create data. The correct method is to zero fill sectors for which no data is available.

### 2.3.3 Formatting

When every ECC block in the Information Zone (lead-in, Data Zone, lead-out) of a DVD+RW has been recorded, the disc is "formatted". Clause 21 of *DVD+RW 4.7 Gbytes Basic Format Specifications*, additionally, defines specific data content for all sectors. This makes it DVD+RW formatted.

Write commands shall not be accepted prior to format of blank media.

Physically blank DVD+RW media has no data recorded in its groove, so those devices can find no references on the surface of a blank DVD+RW disc. This has been compared to trying to run on ice. There is no control. So, in order to assure read compatibility with DVD-RO devices, it is very important to have formatted media.

The high capacity together with the low (relative to HDD) write speeds means that completely formatting a disc requires more time than desired - today, about 30 minutes. This problem is not new with DVD+RW. The solution offered here is recycled from one of many for CD-RW: most of the format time is pushed into background time so that the user never experiences any significant delays. This is done by understanding use models and arranging for both the drive and the host to control those use models in order to make an incompletely formatted media appear to be completely formatted.

Background formatting has some controlling requirements:

- After some minimal amount of formatting has been performed, the operation goes from foreground time to background time. The formatting operation in the drive must strive to maintain the Data Zone in two areas: the inner area written and the outer area unwritten. For data applications devices, the formatting bit map in the FDCB shall be implemented in order to minimize excessive reformatting associated with random writing.
- The host must modify its allocation algorithms to minimize blank area fragmentation.
- If the user wishes to remove the medium prior to format completion, the host may request that the drive create a temporary and minimally acceptable lead-out that allows a continuation of the formatting process at a later time. The host may also request that the medium be ejected in its current state.
- In support of the previous requirement, the drive must provide a format re-start mechanism.
- The drive must always make current format status available to the host.

Details of how background formatting operates relative to the host are to be found in the description of the FORMAT UNIT Command.

### **2.3.4 Disc Control Blocks**

DVD+RW media format includes a generalized structure called the Disc Control Block (DCB). The basic DVD+RW format has only one defined DCB: the Formatting DCB (FDCB).

All DCBs include handling control for DVD+RW devices that have no specific understanding of the specific DCB: the Unknown Content Descriptor (UCD). This bit significant value in the DCB defines actions that the host may take (e.g. write the DCB, do not write the DCB, read the DCB, etc). In the event that the host violates the instructions of the UCD, the associated command shall be terminated with CHECK CONDITION status and sense shall be set to ILLEGAL REQUEST, ILLEGAL FUNCTION (05h/22h/00h).

### 3 Features and Profiles

A DVD+RW drive might be capable of reading many different types of media. A DVD+RW drive might be capable of writing many different types of media. The response from the GET CONFIGURATION Command contains “how” to report each media capability. Rather than attempt to predict the combinations of supported profiles, this document shall only focus on the profiles required to support reading and writing DVD+RW media. The requirements for a read-only device can be extrapolated.

#### 3.1 Feature 002Ah: DVD+RW

A DVD+RW device must report the DVD-ROM Profile (Profile 10h). The DVD Read Feature within the DVD-ROM Profile implies the physical capability of reading DVD+RW media, however, such a device may not recognize logical structures unique to the DVD+RW format (e.g. Disc Control Blocks).

The presence of the DVD+RW Feature indicates that the drive is capable of reading a recorded DVD+RW disc that is formatted according to *DVD+RW 4.7 Gbytes Basic Format Specifications*. Specifically, this includes the capability of reading DCBs. The DVD+RW Feature descriptor is shown in Table 2.

**Table 2 – DVD+RW Feature Descriptor**

Bit	7	6	5	4	3	2	1	0
Byte								
0	Feature Code = 002Ah							
1								
2	Reserved		Feature Version = 0000h				Persistent	Current
3	Additional Length							
4	Reserved							Write
5	Reserved							Close Only
6	Reserved							
7	Reserved							

The Version field shall be set to 0h.

The Persistent bit shall be 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.

Note: When Current = 0, either no disc is mounted or the disc currently mounted is not a DVD+RW disc. When Current = 1, a disc is mounted and it is a DVD+RW disc.

The Additional Length field shall be set to 04h.

This feature may be present only to represent additional capability to the DVD-ROM Profile. If the Write bit is cleared to zero, then no additional capability is claimed. A device may report this feature only when Profile 10h (DVD-ROM) is reported. No additional commands or mode parameters are required.

If the Write bit is set to one, then the drive is also capable of formatting DVD+RW discs according to *DVD+RW 4.7 Gbytes Basic Format Specifications* and is capable of writing DVD+RW discs that have been formatted according to *DVD+RW 4.7 Gbytes Basic Format Specifications*.

If a device reports this feature with the Write bit is set to one, then the drive shall support the commands shown in Table 3.



**Table 3 – Command Support Required by the DVD+RW Feature with Write**

Op Code	Command Description	Reference
5Bh	Close Track/Session	4.1
04h	Format Unit	4.2
BFh	Send DVD Structure	4.21
2Ah	Write (10)	MMC3, 4.30
2Eh	Write and Verify (10)	SBC, 4.32
AAh	Write (12)	MMC3, 4.31

If the Close Only bit is cleared to zero, then the drive supports both forms of background format stop. If the Close Only bit is set to one, then the drive supports only the read compatibility stop.

The Read DVD Structure Command must support format field values 05h, 30h and FFh in addition to 0, 1, 3, and 4 required by the DVD Read Feature.

The Send DVD Structure Command must support format field values 05h and 30h.

### 3.2 Profile 001Ah: DVD+RW

Logical units identifying Profile 001A as current shall support the features listed in Table 4.

**Table 4 – Mandatory Features for DVD+RW**

Feature Number	Feature Name	Description
0000h	Profile List	A list of all Profiles supported by the device
0001h	Core	Mandatory behavior for all devices
0002h	Morphing	Device changes operational behavior due to events external to the Host
0003h	Removable Medium	The medium may be removed from the device
0010h	Random Readable, PP=1	Read ability for storage devices with random addressing
001Fh	DVD Read	The ability to read DVD specific structures
0020h	Random Writable	Write support for randomly addressed writes
0023h	Formattable	Support for formatting of media
002Ah	DVD+RW	Support for reading and optionally writing DVD+RW Basic Format
0100h	Power Management	Host and device directed power management
0105h	Time-Out	Ability to respond to all commands within a specific time
0107h	Real-time Streaming	Ability to read and write using Host requested performance parameters

The presence of the DVD+RW Profile indicates that the drive is capable of reading a DVD+RW disc that has been formatted and recorded according to *DVD+RW 4.7 Gbytes Basic Format Specifications*. In addition, the presence of the DVD+RW Profile indicates that the WRITE bit in the DVD+RW feature must be set to one.

### 3.3 Other Profiles and Features

A drive that reports the DVD+RW Feature shall also claim the DVD-ROM Profile (0010h). Certainly, other media and consequently other profiles may be supported.

## 4 Command Descriptions

The features require that specific commands be implemented. A small number of commands are optional. Table 5 shows the decomposition of the DVD+RW Profile first into Features and then commands and mode pages.

**Table 5 – DVD+RW Profile Decomposition**

<b>DVD+RW Profile</b>	Core Feature	Get Configuration Command Get Event Status Notification Command Inquiry Command Mode Select (10) Mode Sense (10) Request Sense Test Unit Ready
	Morphing Feature	Get Configuration Command Get Event Status Notification Command Prevent Allow Medium Removal Command Send Event Command
	Removable Medium Feature	Mechanism Status Command Prevent Allow Medium Removal Command Start Stop Unit Command
	Random Readable Feature	Read Capacity Command Read (10) Command Read/Write Error Recovery Mode Page
	DVD Read Feature	Read (10) Command Read (12) Command Read DVD Structure Command Read TOC/PMA/ATIP Command
	Random Writable	Read Capacity Write (10) Write and Verify (10) Synchronize Cache
	Formattable	Format Unit Read Formattable Capacities Request Sense Verify (10)
	DVD+RW	Close Track/Session Format Unit Send DVD Structure Write (10) Write and Verify (10) Write (12)

**Table 5 – DVD+RW Profile Decomposition, Continued**

DVD+RW Profile	Real-time Streaming Feature	Get Performance Command Read (12) Command Read Buffer Capacity Command <sup>C</sup> Set CD Speed Command <sup>C</sup> Set Read Ahead Command Set Streaming Command Write (12) Command <sup>C</sup> Capabilities and Mechanical Status Mode Page <sup>C</sup>
	Power Management Feature	Get Event Status Notification Command Start Stop Unit Command Power Condition Page
	Timeout Feature	Timeout and Protect Mode Page
<sup>C</sup> marks a feature conditional command or mode page. All other commands and mode pages are mandatory.		

The decomposition shown in Table 5 results in the command list shown in Table 6.

**Table 6 – Feature Specified Commands**

Command	Op Code	Command	Op Code
CLOSE TRACK/SESSION	5Bh	READ FORMATTED CAPACITIES	23h
FORMAT UNIT	04h	READ TOC/PMA/ATIP	43h
GET CONFIGURATION	46h	REPORT KEY	A4h
GET EVENT/STATUS NOTIFICATION	4Ah	REQUEST SENSE	03h
GET PERFORMANCE	ACh	SEND DVD STRUCTURE	BFh
INQUIRY	12h	SEND EVENT	A2h
MECHANISM STATUS	BDh	SEND KEY	A3h
MODE SELECT (10)	55h	SET READ AHEAD	A7h
MODE SENSE (10)	5Ah	SET STREAMING	B6h
PREVENT/ALLOW MEDIA REMOVAL	1Eh	START/STOP UNIT	1Bh
READ (10)	28h	SYNCHRONIZE CACHE	35h
READ (12)	A8h	TEST UNIT READY	00h
READ BUFFER CAPACITY	5Ch	VERIFY (10)	2Fh
READ CAPACITY	25h	WRITE (10)	2Ah
READ DISC INFORMATION	51h	WRITE (12)	AAh
READ DVD STRUCTURE	ADh	WRITE AND VERIFY (10)	2Eh

## 4.1 CLOSE TRACK/SESSION COMMAND

The CLOSE TRACK/SESSION Command, Table 7, allows closure of either a track or a session. For the specific case of DVD+RW media with the Basic Format, this command is used to stop a background format in progress. The command description that follows is specific to DVD+RW. For other media types and formats, refer to MMC-3.

**Table 7 – Close Track/Session Command Descriptor Block**

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

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

The Session and Track bits have the following meanings:

Session = 0, Track = 0

Optional behavior for DVD+RW media is defined. If a background format is in progress and de-icing is not completed, the format de-icing operation shall be stopped at some DVD+RW ECC block boundary. No further writing shall occur. If the medium mounted is DVD+RW and there is no background format in progress, then no operation shall occur and this shall not be considered an error. In this case, the drive shall support FDCB bit maps.

Session = 0, Track = 1

For DVD+RW Basic format, this combination is reserved, not valid. If discovered, the drive shall terminate the command with CHECK CONDITION Status and set sense data to ILLEGAL REQUEST, INVALID FIELD IN CDB (5/24/00).

Session = 1, Track = 0

If a DVD+RW background format is in progress, the format operation shall be stopped and the disc shall be structured for removal according to the *DVD+RW 4.7 Gbytes Basic Format Specifications* for the specific purpose of providing DVD-RO compatibility. In general, this means that a [partial] lead-in shall be written, a [temporary] lead-out shall be appended and all unrecorded gaps between lead-in and lead-out shall be format written. The data zone shall be expanded to ensure that the total recorded area reaches at least a radius of 30 mm. i.e. PSN = 70DE0h (462 304)

Session = 1, Track = 1

If a DVD+RW background format is in progress, the format operation shall be stopped and the disc shall be structured for removal according to the *DVD+RW 4.7 Gbytes Basic Format Specifications* for the specific purpose of providing DVD-RO compatibility. In general, this means that a [partial] lead-in shall be written, a [temporary] lead-out shall be appended and all unrecorded gaps between lead-in and lead-out shall be format written.

If the last session is blank and a Close Session is requested, no error shall be reported.

During the Close operation, the DVD+RW Drive shall respond to commands as follows:

1. The drive may respond to commands that are allowed to return NOT READY sense by terminating the command with CHECK CONDITION Status and setting sense data to NOT READY, LOGICAL UNIT NOT READY, OPERATION IN PROGRESS.
2. In response to the INQUIRY, GET CONFIGURATION, and GET EVENT/STATUS NOTIFICATION commands, the drive shall respond as commanded.
3. Closing a Session shall cause a Class 1 Event when the command is issued if the drive becomes NOT READY. A Class 1 Event shall occur if the medium returns to READY or if the medium becomes not writable. Other Class 1 Events may occur due to closing a Track or Session.

## 4.2 FORMAT UNIT COMMAND

The FORMAT UNIT Command (Table 8) formats a medium into host addressable logical blocks per the host defined options. The medium may be certified and control structures created for the management of the medium and defects. There is no guarantee that the medium will not be altered.

**Table 8 – Format Unit Command Descriptor Block**

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

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

A CmpList bit of zero indicates that the parameter list provided is in addition to those already available to the device. A CmpList bit of one indicates that the parameter list is complete and the device is to ignore any existing parameters. For CD-RW and DVD+RW, CmpList shall be cleared to zero.

Format Code is used by the device to identify the format descriptor from the host. Format Codes are defined for CD-RW in Table 9.

**Table 9 – Format Descriptor Included**

Format Code	Format Descriptor Included in Parameter Data
000b	Not defined for either CD or DVD devices.
001b	A Format Descriptor that is consistent with the READ FORMAT CAPACITIES Command is present.
010b – 110b	Not defined for either CD or DVD devices.
111b	The CD-RW specific descriptor (MMC1) is present.

Parameter data from the host is structured as shown in Table 10.

**Table 10 – Format Unit Parameter List**

Bit	7	6	5	4	3	2	1	0
Byte								
0 – 3	Format List Header							
4 – n	Initialization Pattern Descriptor							
n+1 to n+8	Format Descriptor							

A DVD+RW compliant device shall support Format Code 1.

The Format List Header (Table 11) identifies any and all additional parameter data.

**Table 11 – Format List Header**

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

A Format Options Valid (FOV) bit of zero indicates that the CD-RW device shall use its default settings for the DPRY, DCRT, STPF, IP, TRY and IMMED bits. For a DVD+RW compliant device, the defaults shall be: DPRY = 0, DCRT = 0, STPF = 0, IP = 0, TRY = 0 and IMMED = 1.

If FOV is set to one, the CD-RW drive shall examine the settings of the DPRY, DCRT, STPF, IP, TRY and IMMED bits. DPRY, STPF, IP and TRY are not used by a CD-RW drive and must be cleared to zero. If any of these bits are not zero, the CD-RW drive shall terminate the command with CHECK CONDITION status. The sense key shall be set to ILLEGAL REQUEST and the additional sense code shall be set to INVALID FIELD IN PARAMETER LIST.

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

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

The VS bit is used exclusively for vendor specific purposes.

The Format Descriptor Length field in the Format list header specifies the total length in bytes of the Format descriptors that follow and does not include the initialization pattern descriptor or initialization pattern, if any. The Format Descriptor Length shall be set to 8. Any other value in this field shall return CHECK CONDITION with the Sense Key set to ILLEGAL REQUEST and the Sense Code set to INVALID FIELD IN PARAMETER LIST.

#### 4.2.1 Format Code 001b

If the Format Code in the CDB is 001b the host shall send a Format Descriptor as defined in Table 12.

**Table 12 – Format Descriptor**

Bit	7	6	5	4	3	2	1	0
Byte								
0	(MSB) <div>Number of Blocks</div> (LSB)							
1								
2								
3								
4	Format Type						Reserved	
5	Type dependent parameter(s)							
6								
7								

The Type Dependent Parameter contents are as specified for each Format Type. The DVD+RW Basic Format is type 26h. Other Format Types listed in MMC-3 are not associated with DVD+RW media.

Format Type = 26h, DVD+RW Basic Format, Mandatory when the Write bit in the DVD+RW

Feature Descriptor is set to one. The Number of Blocks field shall be set to either the value returned by the READ FORMAT CAPACITIES command or 0xFFFFFFFF. The drive shall accept either value. If any other value is sent by the host, then the drive shall terminate the command with CHECK CONDITION status and set sense bytes (Sense Key/ASC/ASCQ) to ILLEGAL REQUEST/ILLEGAL VALUE IN PARAMETER BLOCK. Implementation of background format is mandatory.

The Type Dependent Parameter is shown in Table 13.

**Table 13 – Type Dependent Parameter for Format Type 26h**

Bit	7	6	5	4	3	2	1	0
Byte								
0	Reserved							
1								
2	Reserved							Restart

When Restart is cleared to zero, the drive shall perform a new format.

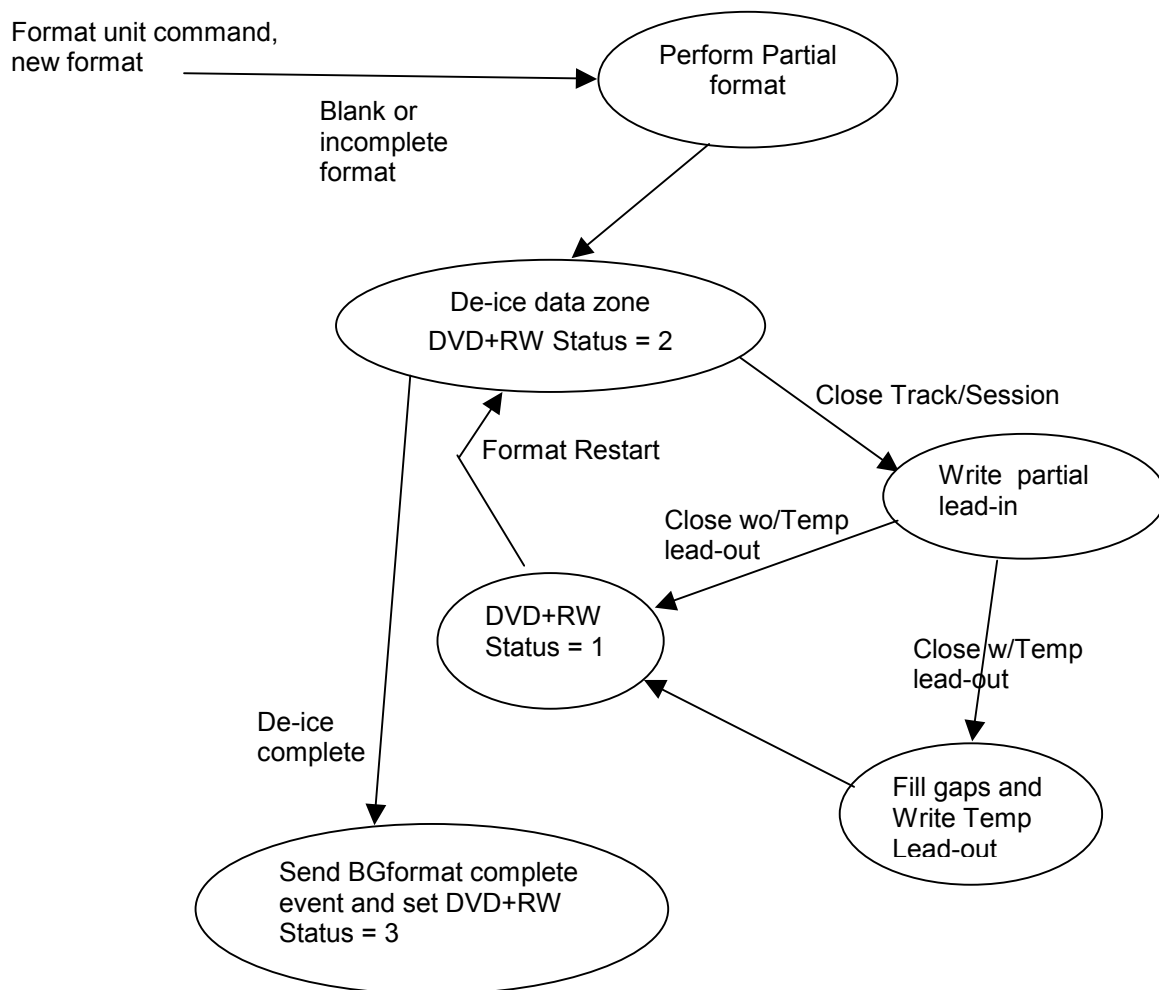
When Restart is set to one, the DVD+RW Drive shall continue a suspended background format. All other fields in the Type Dependent Parameter shall be ignored. If there is no suspended background format to continue, the DVD+RW Drive shall terminate the command with CHECK CONDITION status and set sense data to ILLEGAL REQUEST, COMMAND SEQUENCE ERROR.

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



#### 4.2.2 Background Formatting for Format Type 26h

The background formatting process is best illustrated in Figure 5.



**Figure 5 – Background Process Flow**

#### **4.2.2.1 Background Formatting: Getting Started**

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

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

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

#### **4.2.2.2 Background Formatting: Stopping the Format**

If a format is executing in background:

- The formatting process may be stopped by issuing the CLOSE TRACK/SESSION Command.
- If the host sends a SCSI command block which requires that the medium spin down, the Drive shall terminate the command with CHECK CONDITION status and set sense data to NOT READY, LOGICAL UNIT NOT READY, FORMAT IN PROGRESS (02/04/04). Example: START/STOP UNIT Command is issued with Start = 0.
- If the host/drive physical interface provides a command layer with commands that can cause the medium to spin down, then those commands will be terminated with the appropriate error status. For example if the interface is ATA and the command is IDLE or SLEEP, then the command shall be terminated with the status register ERROR bit set to true.
- If any other command is issued to the drive, it shall be executed normally.

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

#### **4.2.2.3 Background Formatting: Restarting**

If an incompletely formatted disc is mounted in a write capable DVD+RW drive, formatting will not continue automatically.

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

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

#### **4.2.2.4 Background Formatting: Progress Reporting**

If the IMMED bit is set to one, then the Format Unit Command will terminate with GOOD status and proceed with all format-writing functions performed in the background. If any media accessing command is issued while the initial areas are being formatted, the DVD+RW Drive shall terminate the command with CHECK CONDITION status and set sense data to NOT READY, LOGICAL UNIT NOT READY, FORMAT IN PROGRESS (02/04/04).

Regardless of the setting of IMMED, once the partial formatting has completed, background formatting begins. The host may monitor format progress. The response to a TEST UNIT READY Command shall be: the command shall be terminated with GOOD status and sense data shall be set to NO SENSE, FORMAT IN PROGRESS (00/04/04), unless an error has occurred. The sense key specific bytes (Table 14) shall be set as a progress indicator.

**Table 14 – Sense Key Specific Bytes in Sense Data**

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

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

Once the background format operation has completed, the DVD+RW drive shall post a Background Format Completed Media Event. The response to a TEST UNIT READY Command shall then be: the command shall be terminated with GOOD status and sense data shall be set to NO SENSE, NO ADDITIONAL SENSE, NO ADDITIONAL SENSE QUALIFIER, and SKSV shall be cleared to zero. The REQUEST SENSE command shall report these values correctly whenever no error conditions exists. Thus, there is no pre-condition that the TEST UNIT READY command shall be sent first.

#### **4.2.2.5 Background Formatting: Formatting Concurrently with Writing**

Once the partial format has completed, the host may issue a write to any address that will exist after formatting has completed. It is possible for the drive to locate and write the data as requested.

Suppose the host wishes to write a sector within an ECC block that has either been format written or written with data from the host. The drive shall read the ECC block into its internal buffer, modify the content only with the host's new data, and then write the ECC block to the same location. This results in random write capability with 2048 byte sectors.

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

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

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

Important Note: All blank areas must be written either with host data or format patterns. The drive must fill all blank fragments.

#### **4.2.2.6 Background Formatting: Formatting Concurrently with Reading**

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

#### **4.2.2.7 Background Formatting: Early Eject**

When the host wishes to stop the background format, it must first notify the drive with the CLOSE TRACK/SESSION Command.

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

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

### **4.3 GET CONFIGURATION COMMAND**

Although a new feature has been defined, DVD+RW requires no modification to the behavior of this command.

#### 4.4 GET EVENT STATUS NOTIFICATION COMMAND

There is no need to modify the GET EVENT STATUS NOTIFICATION Command, however, we do need to add a new Media Event: Background Format Completed. We'll begin with a review of Media Events.

The data returned, with a class code 100b, is defined in Table 15.

**Table 15 – Media Event Descriptor**

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

The Media Event Code is defined in Table 16.

**Table 16 – Media Event Codes**

Code	Event	Description
0h	NoEvent	Media status is unchanged
1h	EjectRequest	The Drive has received a request from the user (usually through a mechanical switch on the Drive) to eject the specified slot or media.
2h	NewMedia	The specified slot (or the Drive) has received new media and is ready to access it.
3h	MediaRemoval	The media has been removed from the specified slot (or the Drive), and the CD-RW Drive is unable to access the media without user intervention.
4h	MediaChanged	The user has requested that the media in the specified slot (or the Drive's tray) be loaded.
5h	BGformatCompleted	A background format has completed
6h	BGformatRestarted	A background format was automatically restarted by the drive.
6h – Fh	Reserved	-

Since DVD+RW compliant drives are capable of generating more than one media event, such drives must be capable of queuing media events. Events shall be reported in the order in which they occur.

The Media Status byte is defined in Table 17.

**Table 17 – Media Status Byte**

7	6	5	4	3	2	1	0
Reserved						Media Present	Door or Tray Open

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

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

Start Slot field defines the first slot of a multiple slot DVD+RW Drive to which the media status notification applies. For DVD+RW Drives that do not support multiple slots, this field shall be reserved.

End Slot field defines the last slot of a multiple slot DVD+RW Drive to which the media status notification applies. For DVD+RW Drives that do not support multiple slots, this field shall be reserved

#### **4.5 GET PERFORMANCE COMMAND**

DVD+RW requires no changes or additions.

#### **4.6 INQUIRY COMMAND**

DVD+RW requires no changes or additions.

#### **4.7 MECHANISM STATUS COMMAND**

DVD+RW requires no changes or additions.

#### **4.8 MODE SELECT (10) COMMAND**

DVD+RW requires no changes or additions.

#### **4.9 MODE SENSE (10) COMMAND**

DVD+RW requires no changes or additions.

#### **4.10 PREVENT/ALLOW MEDIA REMOVAL COMMAND**

DVD+RW requires no changes or additions.

#### **4.11 READ (10) COMMAND**

The presence of the DVD+RW Feature has no effect upon the host/drive interface when there is no DVD+RW background format in progress. In that case, this command shall function as described in SBC and MMC-3.

When a DVD+RW background format in progress, the drive shall respond to this command as if the format has completed. If any of the sector(s) to be read have not been initially written by the de-icing process, the drive shall return all zeros as sector data.

If a sector contains an unrecoverable error and the RC bit in the Read/Write Error Recovery Mode Page is cleared to zero, this command shall be terminated with CHECK CONDITION status and sense data shall be set according to the specific error.

## **4.12 READ (12) COMMAND**

The presence of the DVD+RW Feature has no effect upon the host/drive interface when there is no DVD+RW background format in progress. In that case, this command shall function as described in SBC and MMC-3.

When a DVD+RW background format in progress, the drive shall respond to this command as if the format has completed. If any of the sector(s) to be read have not been initially written by the de-icing process, the drive shall return all zeros as sector data.

If a sector contains an unrecoverable error, the streaming bit is switched off, and the RC bit in the Read/Write Error Recovery Mode Page is cleared to zero, this command shall be terminated with CHECK CONDITION status and sense data shall be set according to the specific error.

If a sector contains an unrecoverable error and the streaming bit is switched on, this command shall be executed as if the RC bit in the Read/Write Error Recovery Mode Page had been set to one.

## **4.13 READ BUFFER CAPACITY**

DVD+RW requires no changes or additions.

## 4.14 READ CAPACITY

The READ CAPACITY command (Table 18) provides a means for the Host to request information regarding the capacity of the currently mounted medium. The command description that follows is specific to DVD+RW Basic format. For other media and format types, refer to MMC-3.

**Table 18 – READ CAPACITY Command Descriptor Block**

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

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

Eight bytes of READ CAPACITY response data (Table 19) shall be returned in response to the command.

**Table 19 – READ CAPACITY Response Data**

Bit	7	6	5	4	3	2	1	0
Byte								
0	(MSB) Logical Block Address (LSB)							
1								
2								
3								
4	(MSB) Block Size (Shall be 2048d) (LSB)							
5								
6								
7								

The Logical Block Address represents the last addressable LBA on the medium. If the currently mounted medium is recognized as a DVD+RW Basic formatted disc (i.e. fully formatted or format is in progress), the only valid response for Logical Block Address is the last addressable LBA when formatting has completed. If a DVD+RW disc is mounted and blank, then the response shall be 00000000h.

The Block Length shall always be reported, in bytes, as 2048d.



## 4.15 READ DISC INFORMATION COMMAND

The Read Disc Information Command (the CDB is unchanged and thus not shown) returns detailed information about the medium. This information is returned in the Disc Information Block. All fields currently defined in MMC-3 shall remain unchanged.

Additional information is needed. We need to know the state of the background format operation. There are 4 possible states. The appropriate value is placed in Disc Information Block in the Background Format Status field.

**Table 20 – Disc Information Block**

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

For DVD+RW Basic Format media:

- Disc Information Length shall be set to  $32+8*N_{OPC}$ , where  $N_{OPC}$  is the number of OPC table entries.
  - Erasable shall be set to 1.
  - State of last Session shall be set to 00b if the disc is blank. Otherwise, State of last Session shall be set to 11b.
  - Disc Status shall be set to 00b if the disc is blank. Otherwise, Disc status shall be set to 11b.
  - Number of First Track on Disc shall be set to 1.
  - Number of Sessions shall be set to 1.
  - First Track Number in Last Session is set to 1.
  - Last Track Number in Last Session is set to 1.
  - DID\_V shall be cleared to zero.
  - DBC\_V shall be cleared to zero.
  - Certain host applications may be restricted to writing only media that has a specific Disc Application Code (byte 32). If the media has one of those restricted use codes, then URU (UnRestricted Use) shall be zero. Otherwise, URU shall be set to one. See the appropriate media specification for restricted code values.
  - DAC\_V specifies the validity of the Disc Application Code in byte 32.
  - The Background Format status is represented by bits 0 and 1 of byte 7. The value gives the DVD+RW format status of the mounted disc:
    - 00b Not any DVD+RW format. For each disc which cannot be identified as a DVD+RW format with status 01b, 10b, or 11b, DVD+RW status shall be set to 00b. For example, with a blank disc, the DVD+RW status is 00b.
    - 01b DVD+RW background format was started but is not currently running and is not complete.
    - 10b DVD+RW background format is in progress. A format has been started or restarted and is not yet completed.
    - 11b DVD+RW formatting completed. When a completely DVD+RW formatted disc is mounted, DVD+RW status is set to 11b.
- When the DVD+RW status indicates that a format is in progress the disc size values are specified as if the format had completed.
- Disc Type shall be set to 00h,
  - Disc Identification shall be cleared to zero,
  - Last Session Lead-in Start Time shall be reported as a LBA or all zeros.
  - Last Possible Start Time for Start of Lead-out shall be reported as a LBA or all zeros.
  - Disc Bar Code shall be cleared to zero,
  - Disc Application Code shall be the value discovered on the disc. If the disc has no Disc Application Code, then the contents shall be set to zero.
  - Number of OPC Table Entries shall not exceed 27.
  - Disc Application Code shall be the value discovered on the disc. If the disc has no Disc Application Code, then the contents shall be set to zero.

## 4.16 READ DVD STRUCTURE COMMAND

A DVD+RW drive must support all formats supported by DVD-ROM devices. This is simply a requirement of the DVD Read Feature.

A DVD+RW drive shall support the format field codes shown in Table 21.

**Table 21 – DVD+RW Format Code Support for Read DVD Structure Command**

Format Code	Description
00h	Information in the DVD Lead-in area.
01h	The Copyright information from the DVD Lead-in area
03h	The BCA information on DVD media
04h	The Disc Manufacturing information from the DVD Lead-in area
05h	The Copyright Management Information written to DVD+RW media
30h	Disc Control Block identified by the Content Descriptor (DVD+RW specific)
FFh	A list of DVD Structures present in the specified Layer

### 4.16.1 Information from the Lead-in (Format Code = 00h)

Following the structure header, MMC-3 describes data formats for other DVD media types in a layer descriptor. For DVD+RW, the layer descriptor is shown in Table 22.

**Table 22 – DVD+RW Layer Descriptor**

Bit	7	6	5	4	3	2	1	0
Byte								
0 - 8	CDZ if written, else optionally, Copy of bytes 0 through 8 from ADIP information block							
9	If CDZ PSN $\leq$ 2F2FFh, then this value shall be the PSN of last recorded sector in DZ. Otherwise, this value may be either the PSN of last recorded sector in DZ, or the last possible PSN in the DZ.							
10								
11								
12 - 18	00h							
19 - 255	CDZ if written, else optionally, Copy of bytes 19 - 255 from ADIP information block							
256 - 2048	Reserved							

#### 4.16.2 Copyright Management Information (Format Code = 05h)

The Copyright Management Information structure contains additional information since MMC-3 as shown in Table 23. MMC-3 information for DVD-ROM remains unchanged.

**Table 23 – Copyright Management Information (FC = 5h)**

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

The ADP\_TY field, if set to 01b, this sector contains copyrighted video material. A value of 00b indicates that the data in this sector contains no copyrighted video material. All other values of ADP\_TY are reserved.

## 4.17 READ FORMATTED CAPACITIES COMMAND

The READ FORMAT CAPACITIES command (Table 24) allows the Host to request a list of the possible format capacities for an installed (and potentially) random-Writable media. This command also has the capability to report the capacity for a media when it is installed. If the command is required, by an implemented Feature it shall function independently of the state of that Feature's Current bit.

**Table 24 – READ FORMAT CAPACITIES Command Descriptor Block**

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

The Allocation Length field specifies the maximum number of bytes that a Host has allocated for returned data. An Allocation Length of zero indicates that no data shall be transferred. This condition shall not be considered as an error. The drive shall terminate the data transfer when Allocation Length bytes have been transferred or when all available data have been transferred to the Host, whatever is less. The returned data format is shown in Table 25.

**Table 25 – Read Format Capacities Data Format**

Bit	7	6	5	4	3	2	1	0
Byte								
0 – 3	Capacity List Header							
4 – 11	Current/Maximum Capacity Descriptor							
Format Capacity Descriptor(s)								
0	Format Capacity Descriptor #0							
...								
7								
...								
0	Format Capacity Descriptor #n							
...								
7								

The Capacity List Header is shown in Table 26. The Capacity List Length specifies the length in bytes of the Capacity Descriptors that follow. Each Capacity Descriptor is eight bytes in length, making the Capacity List Length equal to eight times the number of descriptors. Values of  $n * 8$  are valid. Although it is possible that 64 descriptors are supported, we do not expect that any drive will support so many.

**Table 26 – Capacity List Header**

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

The Current/Maximum Capacity Descriptor is shown in Table 27. The Number of Blocks indicates the number of addressable blocks for the capacity defined by each Descriptor Type.

The Descriptor Type field (Table 28) indicates the type of information the descriptor contains. The Block Length specifies the length in bytes of each logical block.

**Table 27 – Current/Maximum Capacity Descriptor**

Bit	7	6	5	4	3	2	1	0
Byte								
0	(MSB) <div>Number of Blocks</div> (LSB)							
1								
2								
3								
4	Reserved						Descriptor type	
5	Type Dependent Parameter							
6								
7								

**Table 28 – Descriptor Types**

Descriptor Type	Description
00b	Reserved
01b	Unformatted Media. The reported value is for the maximum formatted capacity for this media. For DVD+RW medium, the value reported is the maximum possible when using Format Type 26h.
10b	Formatted Media. The reported value is the current media's capacity. This is the number of user addressable blocks. This value is exactly the value returned by the READ CAPACITY command minus 1.
11b	No Media Present. The reported value is for the maximum capacity of a media that the drive is capable of reading.

The Formattable Capacity Descriptor format is shown in Table 29. The Number of Blocks field indicates the number of addressable blocks for the capacity defined by the Format Type.

**Table 29 – Formattable Capacity Descriptor**

Bit	7	6	5	4	3	2	1	0
Byte								
0	<div>(MSB)<div>Number of Blocks</div>(LSB)</div>							
1								
2								
3								
4	Format Type						Reserved	
5	Type dependent parameter							
6								
7								

Format Type = 26h, DVD+RW Basic Format

The descriptor shall contain the maximum number of Data Zone addressable blocks. The Type Dependent Parameter is not used and shall be cleared to zero.

For all other Format Types, refer to MMC-3.

#### 4.18 READ TOC/PMA/ATIP COMMAND

For all DVD media types, if the form field of the READ TOC/PMA/ATIP Command is neither zero nor one, then the command shall be terminated with CHECK CONDITION status and sense data shall be set to ILLEGAL REQUEST INVALID FIELD IN CDB (05/24/00).

When DVD media is present, the TOC forms 0 and 1 shall report only in the LBA format.

If the media is DVD+RW, then exactly one track is reported which is the capacity as is expected when background format has completed. The drive shall not report partial format capacities.

#### 4.19 REPORT KEY COMMAND

DVD+RW requires no changes or additions.

#### 4.20 REQUEST SENSE COMMAND

The presence of the DVD+RW Feature has no effect upon the host/drive interface, but some sense codes not now used by other DVD rewritable devices must be implemented by a write capable DVD+RW compliant drive.

#### 4.21 SEND DVD STRUCTURE COMMAND

A DVD+RW drive shall support the format field codes shown in Table 30, as required by the DVD+RW Feature description.

**Table 30 – DVD+RW Format Code Support for Send DVD Structure Command**

Format Code	Data Description
05h	Copyright Management Information

The definition for the structure sent with format code 05h is described in the Read DVD Structure command description (4.16).

#### 4.22 SEND EVENT COMMAND

This command is required only when the drive supports Event Notification Class 3 (external request). Generally, drives do not support Event Notification Class 3. It is recommended that this command not be supported by DVD+RW drives.

#### 4.23 SEND KEY COMMAND

DVD+RW requires no changes or additions.

#### 4.24 SET READ AHEAD COMMAND

DVD+RW requires no changes or additions.

#### 4.25 SET STREAMING COMMAND

DVD+RW requires no changes or additions.

#### 4.26 START/STOP UNIT COMMAND

The presence of the DVD+RW Feature has a small effect upon the host/drive interface. When a background format is in progress and this command is issued requesting a media spin-down (Start = 0), the DVD+RW Drive shall terminate the command with CHECK CONDITION status and set sense data to NOT READY, LOGICAL UNIT NOT READY, FORMAT IN PROGRESS (02/04/04).

Otherwise, DVD+RW requires no changes or additions from the SBC standard.

#### 4.27 SYNCHRONIZE CACHE COMMAND

DVD+RW requires no changes or additions.



#### **4.28 TEST UNIT READY COMMAND**

DVD+RW requires no changes or additions.

#### **4.29 VERIFY (10) COMMAND**

DVD+RW requires no changes or additions.

#### **4.30 WRITE (10) COMMAND**

If the DVD+RW medium is blank (never formatted), then a WRITE (10) to any address shall be terminated with CHECK CONDITION status and sense data shall be set to 05/30/10, ILLEGAL REQUEST, MEDIUM NOT FORMATTED.

Otherwise, DVD+RW requires no changes or additions.

#### **4.31 WRITE (12) COMMAND**

If the DVD+RW medium is blank (never formatted), then a WRITE (12) to any address shall be terminated with CHECK CONDITION status and sense data shall be set to 05/30/10, ILLEGAL REQUEST, MEDIUM NOT FORMATTED.

Otherwise, DVD+RW requires no changes or additions.

#### **4.32 WRITE AND VERIFY (10) COMMAND**

If the DVD+RW medium is blank (never formatted), then a WRITE AND VERIFY (10) to any address shall be terminated with CHECK CONDITION status and sense data shall be set to 05/30/10, ILLEGAL REQUEST, MEDIUM NOT FORMATTED.

Otherwise, DVD+RW requires no changes or additions.

## 5 MODE PAGES

Required features of the DVD+RW read/write device also dictate support of certain mode pages.

**Table 31 – Feature Specified DVD+RW Mode Page Support**

Description	Page Code	Reference
Read/Write Error Recovery Page	01h	MMC-3
Power Condition Page	1Ah	MMC-3
Fault/Failure Reporting Mode page	1Ch	MMC-3
Time-out and Protect Page	1Dh	MMC-3
Capabilities and Mechanism Status Page	2Ah	MMC-3

### 5.1 Read/Write Error Recovery Page

Since DVD+RW has no defect management system, ARRE and AWRE shall default to zero and cannot be set to one by the host.

Otherwise, DVD+RW requires no changes or additions.

### 5.2 Power Condition Page

DVD+RW requires no changes or additions.

### 5.3 Fault/Failure Reporting Mode page

DVD+RW requires no changes or additions.

### 5.4 Time-out and Protect Page

DVD+RW requires no changes or additions.

### 5.5 Capabilities and Mechanical Status Page

DVD+RW requires no changes or additions.

## 6 Host Usage

Host usage of DVD+RW media is not nearly as complex as CD. A blank media must be formatted with the basic format before use. Once formatted, the media is randomly readable and randomly writable in 2 048 byte sectors. Special case usage is defined for streamed applications.

### 6.1 Media Recognition

It is presumed that the host has a continuous Get Event Status Notification poll operating in its background. The host is expected to take no additional action until a NewMedia Media Event is detected.

#### 6.1.1 Discovering Blank DVD+RW Media

The GESN poll reports a NewMedia Media Event.

The GESN poll reports NoEvent (no additional Media Events to report).

The GET CONFIGURATION Command is issued, and reports DVD+RW Profile as current.

The READ DISC INFORMATION Command is issued.

It is discovered that the media is RW, BLANK, and the Background Format Status is 00b.

The host may now conclude that the media mounted is DVD+RW and blank.

#### 6.1.2 Discovering DVD+RW Media with the Basic Format

The GESN poll reports a NewMedia Media Event.

The GESN poll reports NoEvent (no additional Media Events to report).

The GET CONFIGURATION Command is issued, and reports DVD+RW Profile as current.

The READ DISC INFORMATION Command is issued.

It is discovered that the media is RW and BLANK is zero.

The host may now conclude that the media mounted is DVD+RW on which a basic format has at least been started.

### 6.2 Formatting

If it is determined that the currently mounted medium is blank DVD+RW, and the user desires to format the medium, then:

The parameter list for a FORMAT UNIT command is initialized for Format Type 26h, basic DVD+RW. It is preferred to have the IMMED bit cleared to zero. The FORMAT UNIT Command is then issued. The FORMAT UNIT command should not terminate until the background format initialization (see *DVD+RW 4.7 Gbytes Basic Format Specifications*) has completed. This assures no waiting for additional action before writes are accepted.

The host writes file system structures for initialization, as required.

If the Format completes, the GESN poll will report a BGformatCompleted Media Event.

If our user wishes to remove the medium, and no BGformatCompleted Media Event has been seen, a CLOSE TRACK/SESSION Command is issued to stop the background formatting. It is recommended that the CLOSE TRACK/SESSION command be issued with session = 1 and track = 0 in order to maximize interchange compatibility.

### 6.3 Reading

When a basic formatted DVD+RW media has been identified, it is randomly readable in 2 048 byte sectors. The drive must emulate this capability by reading only ECC blocks and separating individual sector data in its buffer. In the event that an unrecoverable read error occurs (READ (10) or READ (12) with streaming = 0), the drive must terminate the command with CHECK CONDITION status and set sense data to reflect the appropriate error.

If the basic format has completed and the sector had not yet been written with host data, then the sector data will contain all zeros. If the host wishes to read that sector, then the host will receive the sector data

- all zeros. If a background format is either incomplete or in progress and the host requests to read a sector that is in a blank ECC block, the drive shall return zero for each byte of the blank sector data. This ensures consistency in each case.

The DVD+RW basic format is best suited for streamed applications. In using the media for that purpose, the READ (12) command should be used with the streaming bit set to one. All unrecoverable read errors will be ignored by the drive and whatever data has been recovered will be delivered to the host.

## **6.4 Writing**

Writing mirrors reading.

When a basic formatted DVD+RW media has been identified, it is randomly writable in 2 048 byte sectors. The drive must emulate this capability by writing only ECC blocks and editing individual sector data in its buffer using a read-modify-write process. In the event that an unrecoverable write error occurs (WRITE (10), WRITE and VERIFY (10) or WRITE (12) with streaming = 0), the drive must terminate the command with CHECK CONDITION status and set sense data to reflect the appropriate error.

Suppose the host wishes to write a single sector. The ECC block containing that sector must be checked for blank or non-blank. If not blank, the ECC block containing the addressed sector is read into the drive's buffer and the host's data is used to overwrite the appropriate buffer positions. This ECC block shall then be rewritten with the buffered data. If blank, an ECC block size of buffer shall be zero filled (the format pattern) and the host's data is used to overwrite the appropriate buffer positions. This ECC block shall then be written.

The DVD+RW basic format is best suited for streamed applications. In using the media for that purpose, the WRITE (12) command should be used with the streaming bit set to one. All unrecoverable write errors will be ignored by the drive.

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