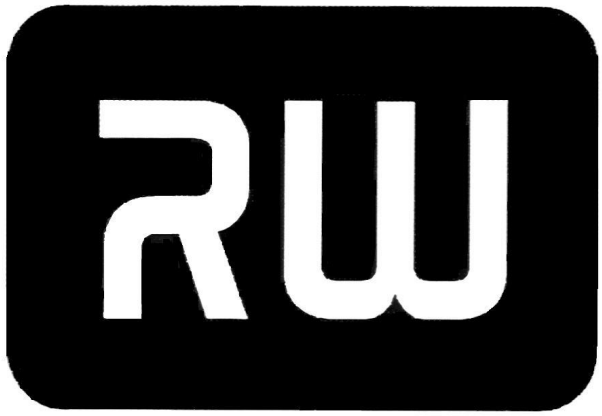

DVD+ReWritable

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

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1 INTRODUCTION/SCOPE

DVD+RW is the newest form of DVD rewritable medium. It is constructed for fully random recording in the 32KB increments common to other DVD rewritable formats. Streamed recording is possible, however, a defect management scheme has been defined for reliable operation as a data storage medium. Most importantly, existing DVD-ROM drives and DVD Video players are capable of reading DVD+RW.

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 T10 Multi-Media Commands (MMC) standard:

Clause 1: First, applicable references and definitions are covered.

Clause 2: The DVD+RW Model clearly shows that the medium can be used in a way that is functionally equivalent to DVD-RAM.

Clause 3: Features and Profiles provides a way by which the device is able to tell its host that it is a Removable Disk Device (similar to a DVD-RAM device).

Clause 4: Although equivalent behaviour is desired, it is not possible to have full precision in the emulation. This is described in how the device responds to commands when DVD+RW media is present and ready.

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 Organisations

SCSI Parallel Interface 2 (SPI-2) ANSI Standard X3.302:1998

SCSI-3 Primary Commands (SPC) ANSI Standard X3.301:1997

SCSI-3 MultiMedia Command Set (MMC-1) ANSI Standard X3.304:1997

SCSI-3 MultiMedia Command Set (MMC-2) ANSI Standard NCITS 333

SCSI-3 Block Command Set (SBC) NCITS.306:1998

Serial Bus Protocol - 2 (SBP-2) NCITS.325:1998

ATA/ATAPI-4 NCITS.317:1998

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 1394-1995.

1.1.2 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 Formats Specifications, version 0.9, September 2000, 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.

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.

DMA – Defect Management Area. This disc area is reserved for storing management information for the disc defect management system

DVD-ROM – The medium specified by ISO/IEC 16448.

DVD-RAM – The medium specified by ISO/IEC 16824.

LSN – Logical Sector Number. This is not the same as Logical Block Address (LBA).

OPC – Optimum Power Calibration. A procedure performed by the drive to calibrate the laser power to be used for a particular disc. Values from this calibration are used for subsequent write operations.

PSN – Physical Sector Number.

2 DVD+RW 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.

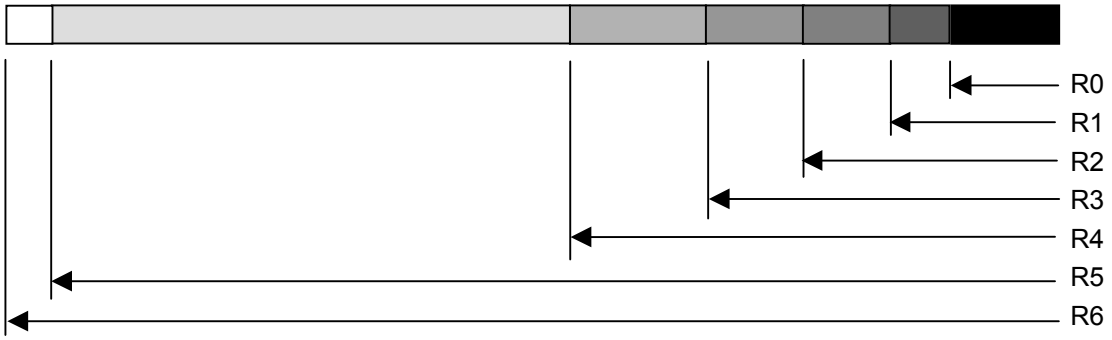
That was a good starting point, but the potential was greater, so the definition was expanded.

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 12 centimeters in diameter and separated into zones as shown in Figure 1.

Figure 1: The Zones of a DVD+RW Medium



R0	Center Hole	R4	3rd Transition Area
R1	1st Transition Area	R5	Information Zone
R2	2nd Transition Area	R6	Rim Area
R3	Clamping Zone		

The Center Hole, 1st Transition Area, 2nd Transition Area, Clamping Zone, and 3rd 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 an outer radius of 58.5 millimeters.

The Rim Area is simply the area beyond the data groove. It ends at a radius of 60 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 a Physical Sector Number (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. When defect management is used, the last user accessible sector is at least

PSN = 25253Fh. Thus, a defect managed DVD+RW disc has 4.58GB available to the user. With no defect management, the DVD+RW disc has 4.70GB available to the user.

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.

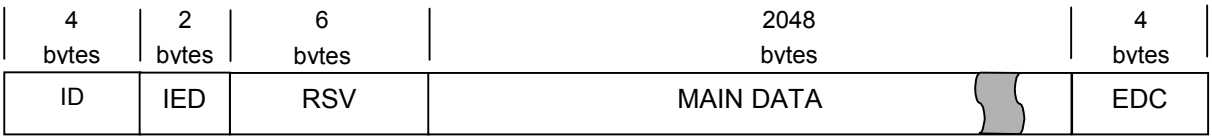


Figure 2: Logical Layout of a DVD+RW Data Sector

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.

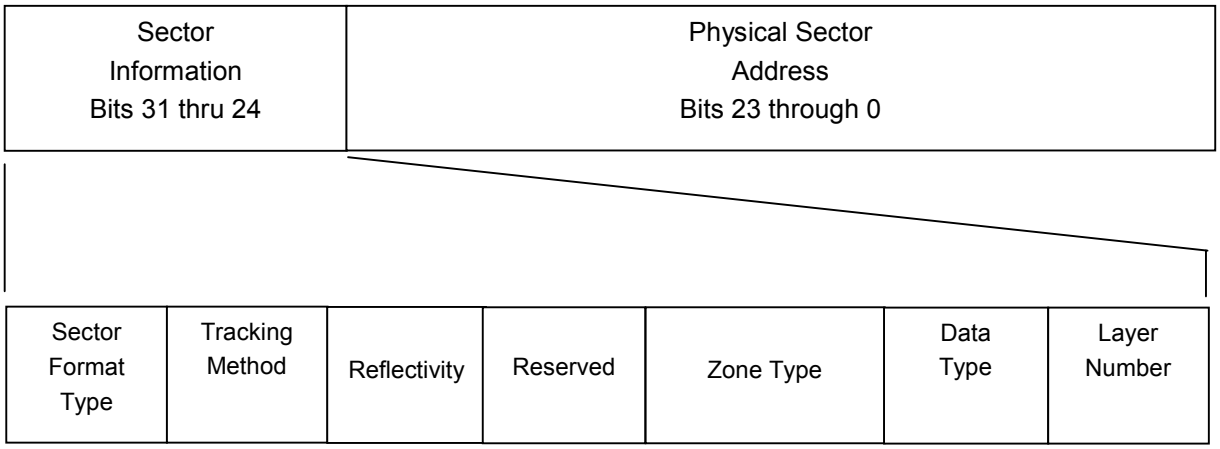


Figure 3: ID Field Details

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. See Table 1: DVD+RW Format Lay-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 Physical Sector Number in binary notation. The Physical Sector Number 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 (Cx,y) are calculated and appended to rows, then Row symbols (Rx,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 address 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 requires the possibility of defect management. Defect management areas are placed in the lead-in and lead-out, leaving the Data Zone as a single, contiguous zone of sectors between the lead-in and lead-out. This leads to a very flexible usage:

- Use defect management and maximize data reliability.
- Switch off defect management and use the Data Zone as a stream access area.

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

Table 1: DVD+RW Format Lay-out

Disc Area	Zone	Start PSN (h)	Length (d)
LEAD-IN	Initial Zone	01D830h	52,304 nominal
	Inner Disc Test Zone	02A480h	2,048
	Inner Drive Test Zone	02AC80h	12,288
	Guard Zone 1	02DC80h	512
	Replacement Zone 1	02DE80h	4,096
	DMA Zone 1	02EE80h	64
	Inner Disc Identification Zone	02EEC0h	256
	DMA Zone 2	02EFC0h	64
	Reference Code Zone	02F000h	32
	Buffer Zone 1	02F020h	480
	Control Data Zone	02F200h	3,072
	Buffer Zone 2	02FE00h	512
DATA	Data Zone	030000h	max = 2,295,104
LEAD-OUT	Buffer Zone 3	min = 252540h max = 260540h	32
	Replacement Zone 2	min = 252560h max = 260560h	min = 4,064 max = 61,408
	DMA Zone 3	261540h	64
	Outer Disc Identification Zone	261580h	256
	DMA Zone 4	261680h	64
	Guard Zone 2	2616C0h	1,024
	Outer Drive Test Zone	261AC0h	12,288
	Outer Disc Test Zone	264AC0h	2,048
	Guard Zone 3	2652C0h	28,112 nominal

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 2048 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.

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.

It is most unfortunate, but the high capacity together with the low (relative to HDD) write speeds means that completely formatting a disc requires more time than desired - today, greater than 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.
- 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.

3 Profiles and Features

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 Profiles

A DVD+RW read/write device shall claim the following profiles:

Removable disk	Profile 0002h
DVD-ROM	Profile 0010h
DVD-RAM or DVD+RW	Profile 0012h

Certainly, other profiles may be supported.

The above list requires certain features, but does not definitively separate a DVD+RW device from a DVD-RAM device. In order to provide that distinguishing capability, an additional feature is required: the DVD+RW Capability Feature.

3.2 Features

The required profiles demand the following features:

Core	Feature 0001h
Morphing	Feature 0002h
Removable Medium	Feature 0003h
Random Readable	Feature 0010h
DVD Read	Feature 001Fh
Random Writable	Feature 0020h
Formattable	Feature 0023h
Defect Management	Feature 0024h
Power Management	Feature 0100h
Time-out	Feature 0105h
Real-Time Streaming	Feature 0107h

The DVD+RW device and DVD+RW media is uniquely be specified with the DVD+RW capability feature.

DVD+RW Capability Feature	Feature 002Ah

The DVD+RW Capability Feature descriptor is shown in Table 2.

The SMART feature is not required by the profiles, however, its use is growing more common. Thus, in order that DVD+RW devices be consistent with current trends, the SMART feature is required whenever the DVD+RW Capability Feature is present.

SMART	Feature 0101h

Table 2: DVD+RW Capability Feature Descriptor

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

The presence of the DVD+RW Capability Feature indicates that the drive is capable of reading a recorded DVD+RW disc which is formatted according to *DVD+RW 4.7 Gbytes Basic Format Specifications.* When this feature is present, then the drive shall also list all features required by the DVD-ROM Profile.

The Persistent bit shall be defined as in MMC2 sub-clause 5.2.2. This bit shall be set to zero if the medium is removable.

The Current bit shall be defined as in MMC2 sub-clause 5.2.3. This bit shall be set to zero if CD media is not present.

Note: The MMC2 references above carry the following meanings:

Since DVD+RW medium is removable, Persistent is cleared to zero. 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.

If the Write bit is cleared to zero, then no additional capability is claimed.

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*. When the Write bit is set to one, then the drive shall list all features required by the Removable Disk Profile.

A device may report this feature only when Profile 10h (DVD-ROM) is reported.

A device may report this feature with the Write bit is set to one only when Profile 12h (DVD-RAM or DVD+RW) is reported.

If a device reports this feature with the Write bit is set to one, then the Close Track/Session command shall be supported. If the Write bit is set to one, then the Format Unit Command must support format type 28h.

3.3 Feature Specified Commands

The features specify that specific commands are required and a small number of commands are optional. For the most part, these commands are adequately described by the appropriate reference. In a small number of cases, changes/additions have been made in order to provide support for DVD+RW medium. Table 3 lists all commands referenced by the possible features.

Table 3: Feature Specified Commands

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

Note: Although MMC-2 may be sufficient, Mt Fuji 5 is most often referenced since it is the newer document.

3.4 Feature Specified Mode Pages

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

Table 4: DVD+RW Mode Page Support

Description	Page Code	Reference
Read/Write Error Recovery Page	01h	Mt Fuji 5
Power Condition Page	1Ah	Mt Fuji 5
Fault/Failure Reporting Mode page	1Ch	Mt Fuji 5
Time-out and Protect Page	1Dh	Mt Fuji 5
Capabilities and Mechanism Status Page	2Ah	Mt Fuji 5

4 Command Descriptions

Many commands have the same description across many device types (profiles). For these, we simply reference the appropriate standard. When DVD+RW Capability Feature is current, some commands exhibit unique behaviour. These affected commands require some additional explanation.

All commands listed in Table 3 are described. In most cases, it is only noted that behaviour is not different from the standard reference.

4.1 CLOSE TRACK/SESSION COMMAND

The CLOSE TRACK/SESSION (aka CLOSE TRACK/RZONE/SESSION/BORDER) Command (Table 5) allows closure of a CD track, a DVD-R RZone, a CD Session or a DVD-R Border. If the Multisession/Border field in the *Write Parameters* Mode Page (05h) is set to 11b and there is not sufficient space for the next Session/Border, the Session/Border to be closed shall be closed and next Session/Border shall not be allowed. For CD, the Session is closed without the B0 pointer. For DVD, the Border is closed with Lead-out and the Start PSN of the next Border-in field of Lead-in/Border-in set to 0.

Table 5: Close Track/Session Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
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

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 = 0, Track = 1

Close the Track/RZone associated with the Track/RZone number in the CDB.

For CD, if this is the incomplete track, the Logical Unit shall pad with all zero main data to the minimum length of 4 seconds. No other padding is to be done. If this is the partially recorded or empty reserved track, the Logical Unit shall pad the track. In the case of an empty reserved track, the Logical Unit shall write the track according to the Write Parameters Mode Page (05h). If the Write Parameters Mode Page (05h) is inconsistent with the PMA or TDB, the drive shall terminate the command with CHECK CONDITION Status and set sense data to ILLEGAL REQUEST, ILLEGAL MODE FOR THIS TRACK (05/64/00). For a partially recorded reserved track, the Logical Unit shall continue writing in the same mode as the data already recorded.

For DVD-R and DVD-RW, if this is the Partially Recorded Reserved RZone or the Empty Reserved RZone, the drive shall pad the RZone with 00h bytes. If the RZone status is Invisible, no close operation is to be done. In the case of an Incomplete RZone, no padding is to be done and cached RMD shall be written into the RMA.

Session = 1, Track = 0

Close Session/Border. If all Tracks/RZones in the last Session/Border are not complete, the drive shall terminate the command with CHECK CONDITION Status and set sense data to ILLEGAL REQUEST, SESSION FIXATION ERROR - INCOMPLETE TRACK IN SESSION (5/72/03). Behavior of the closing operation is dependent on the Multisession/Border field in the Write Parameters Mode Page (05h). Closing an empty Session/Border shall not be considered an error and writing to the media shall not occur.

For DVD-RW media, when the last bordered area is in the intermediate state, Lead-in and/or Border-out are recorded to make the bordered area complete state. (If the bordered area is to be closed that is the first one, Lead-in and Border-out shall be recorded. If the bordered area is to be closed that is second or later one, only the Border-out shall be recorded.)

For DVD+RW media, if a background format is in progress, the format operation shall be stopped and the disc shall be structured for removal according to a closed, partially formatted DVD+RW disc. The temporary lead-out written shall conform with the definition in *DVD+RW 4.7 Gbytes Basic Formats Specifications.*

Session = 1, Track = 1

Normally, this combination is reserved and 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).

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 the next DVD+RW ECC block boundary. No temporary lead-out shall be written.

If the optional behavior is absent or if there is no background format in progress, the drive shall terminate the command with CHECK CONDITION Status and set sense data to ILLEGAL REQUEST, INVALID FIELD IN CDB (5/24/00).

If a Session or Track is to be closed that is already closed, no error shall be reported.

If Session bit is set to zero and Track bit is set to one, the Track Number field indicates the number of the track to close.

Bytes 4 and 5 of the CDB shall be ignored if the Session bit is set to one.

DVD-R, closing an incomplete Session shall cause the Lead-in or Border-in and Border-out to be written for the incomplete Session. If the Multi-Session field in the Write Parameters Mode Page (05h) is set to 00b, a Lead-out shall be appended to last Border-out. Once the Lead-out has been written for DVD media, data can not be further appended to the medium.

During the Close Track operation, the 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, OPERATION IN PROGRESS (02/04/07).
2. In response to the INQUIRY, GET CONFIGURATION, and GET EVENT/STATUS NOTIFICATION commands, the Drive shall respond as commanded.
3. Closing a Track or 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 6) 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 6: 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							
4	Size (LSB)							
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 in Table 7.

Table 7: 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 8.

Table 8: Format Unit Parameter List

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

A DVD+RW drive shall support Format Code 1 and optionally support Format Code 7 and requires 12 parameter bytes: a format list header and a single format descriptor.

The Format List Header (Table 9) identifies any and all additional parameter data.

Table 9: 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							
3	Length (LSB)							

A Format Options Valid (FOV) bit of zero indicates that the Drive shall use its default settings for the DPRY, DCRT, STPF, IP and Try-out and Immed bits.

When the FOV bit is zero, the host shall set the DPRY, DCRT, STPF, IP, Try-out and Immed bits to zero. If any of these bits are not zero, the Drive shall terminate the command with CHECK CONDITION Status, 5/26/00 INVALID FIELD IN PARAMETER LIST.

An FOV bit of one indicates that the Drive shall examine the setting of the DPRY, DCRT, STPF, IP and Tr y - o u t and Immed bits. When the FOV bit is one, the DPRY, DCRT, STPF, IP and Try-out and Immed bits are defined as follows:

A Disable Primary (DPRY) bit, when set to zero, shall indicate that the Drive shall retain the manufacturer's certification list (PList). When set to one, shall indicate that the manufacturer's certification list be retained but not used for defect management. DPRY bit shall be set to zero for CD-RW, DVD-RAM, DVD-RW, and DVD+RW media.

A disable certification (DCRT) bit of zero indicates that the Drive shall perform a vendor-specific medium certification operation to generate a G 1 -list (C-list) or a Defect Status bitmap (DS #n bits) in the Format 3 RMD on DVD-RW media. A DCRT bit of one indicates that the Drive shall not perform any vendor-specific medium certification process or format verification operation while executing the FORMAT UNIT Command. DCRT bit shall be set to zero for CD-RW media.

The Stop Format (STPF) bit shall be set to zero.

The Initialization Pattern (IP) bit shall be set to zero. If the IP bit is set to zero, the Initialization Pattern Descriptor shall not be included in the Format Unit Parameter data sent to the drive, and the Format Descriptor shall begin at byte offset 4.

A Try-out bit of one indicates that the Drive shall not change the media format but shall examine whether the specified FORMAT UNIT Command can be performed without error, based on available information before starting the formatting.

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

If the Immed bit was set to one or the FORMAT UNIT Command was queued, then in response to the REQUEST SENSE Command during the formatting operation, unless an error in the Command has occurred, the drive shall return no CHECK CONDITION Status, 2/04/04 LOGICAL UNIT NOT READY, FORMAT IN PROGRESS in the result data and the Sense Key Specific field set to the percentage of the operation that has completed.

The Vendor Specific (VS) bit indicates a vendor-specific format.

The Format Descriptor Length field in the Format list header specifies the total length in bytes of the Format descriptors that follow and does not include the initialization pattern descriptor or initialization pattern, if any.

The Format Descriptor Length shall be set to 8. Any other value in this field shall return CHECK CONDITION Status, 5/26/00 INVALID FIELD IN PARAMETER LIST.

4.2.1 Format Code 111b

If the Format Code, in the CDB, is 111b the CD-RW Format Descriptor defined in Table 10 shall be sent.

Table 10: CD-RW Format Descriptor

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

Grow = 0, Session = 0

The format operation shall format (Format Size) user sectors. Format Size shall be integrally divisible by the Packet Size field in the WRITE PARAMETERS mode page. The first formatted user sector shall be LBA 0. Existing information on the disc may be overwritten. After the format, a single session containing a single, fixed packet track will exist on the medium.

Grow = 0, Session = 1

The format operation shall create a new session that contains (Format Size) user sectors. Format Size shall be integrally divisible by the Packet Size field in the WRITE PARAMETERS mode page. If the last session on the disc is not complete when this command is issued, a CHECK CONDITION status shall be generated.

Grow = 1, Session = 0, 1 (The session bit shall be ignored when the Grow bit is set)

A Grow bit of 1 indicates that the final session shall be "grown" to (Format Size) from its original size. This is accomplished by appending packets to the existing session, writing a new Lead-out, and updating the PMA and Lead-in to change the track size to reflect the new size. Data in existing packets shall not be affected. If the Format Size is smaller than the existing size, a CHECK CONDITION status shall be returned. The order of updating the PMA, Lead-in, Lead-out, and data area is not specified.

4.2.2 Format Code 001b

If the Format Code in the CDB is 001b the host shall send a Format Descriptor as defined in Table 11.

Table 11: Format Descriptor

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

The Type Dependent Parameter contents are as specified for each Format Type. Format Types are defined below.

Format Type = 00h

Formatting for the entire medium is specified. The Number of Blocks field specifies the number of addressable blocks for the whole disc and the Type Dependent Parameter field specifies the Block Size. Neither field is changeable from the values reported by the READ FORMAT CAPACITIES Command.

On DVD-RAM media, the defect list handling is specified by the combination of the CmpLst bit and the DCRT bits. In the case that the CmpLst bit is set to zero and the DCRT bit is set to one, the Number of Blocks field shall be ignored and the number of addressable blocks shall be retained. In other cases, the Number of Blocks field specifies the number of addressable blocks for the whole disc. The Type Dependent Parameter field specifies the Block Length. On CD-RW media, the whole media shall be formatted using the Write Parameters Mode Page (05h). On DVD-RW media, this format operation is available on any recording mode and any state of a bordered area. The area from the beginning of the RMA to the end of the Lead-out shall be recorded. There is only one bordered area on the medium and the number of RZone is one after this operation. The Disc Status field of Format 3 RMD shall be set to 12h when the operation is completed.

Format Type = 01h

This Format Type is used in order to allocate more space for the Spares Area on DVD-RAM. Eventually the capacity of the formatted area is reduced. Therefore, this formatting type is just available with the case of reduction of formatted capacity. The Logical Unit shall ignore the defect list handling specified by the combination of the CmpLst bit and the DCRT bit. The defect list entries and the written user data within the range of the area that is specified by this command shall be preserved through the execution of this command. The Number of Blocks field specifies the number of addressable blocks for the whole disc and the Type Dependent Parameter field specifies the Block Length. Neither field is changeable from the values reported by the READ FORMAT CAPACITIES Command.

Format Type = 02h, 03h

Reserved.

Format Type = 04h

The Zoned formatting for a zone of the media is specified, where the size of zone is not constant across zones. The defect list handling is specified by the combination of the CmpLst bit and the DCRT bit. The Number of Blocks field specifies the number of addressable blocks for the zone and the Type Dependent Parameter field specifies the Zone number of the zone to be formatted. If a spare sector is used as a replacement for another zone, zoned formatting cannot be preformed, and the command shall be terminated with CHECK CONDITION Status, 3/31/02 ZONED FORMATTING FAILED DUE TO SPARE LINKING, with the sense key specific bytes set to zone number of the first zone which has a spare linking into the designated zone. The discarding of G 1 -list, G 2 -list, and SDL is only applicable to defects within the zone being reformatted.

Format Type = 05h

The Zoned formatting for a zone of the media is specified, where the size of zone is constant for each zone, e.g. floppy media where each track is labeled a zone. The Number of Blocks field specifies the number of addressable blocks for the zone and the Type Dependent Parameter field specifies the Zone number of the zone to be formatted. The zone number shall be in the range of 0 to the Type Dependent Parameter reported in the READ FORMAT CAPACITIES Command.

Format Type = 06h - 0Fh

Reserved.

Format Type = 10h, For CD-RW or DVD-RW

Formatting to create a Session/Border on C/DVD-RW media is specified. The created Session/Border shall become the only Session/Border on the medium. The Number of Blocks field specifies the number of addressable blocks for the new Session/Border and the Type Dependent Parameter field specifies the Fixed Packet Size for CD or set to ECC block size (16) for DVD-RW. The Number of Blocks field may be adjusted to a value less than or equal to the values reported by the READ FORMAT CAPACITIES Command. The Logical Unit shall round the Number of Blocks up to be an integral multiple of the packet size for CD or the ECC block size for DVD. The Packet Size field may not be adjusted. In the case of CD media, if a different Fixed Packet Size is desired, the Host must modify the Write Parameters Mode Page.

On DVD-RW media, this format operation is available on any recording mode and any state of a bordered area. The number of RZone in the created Border is one after this operation. The Disc Status field of Format 3 RMD shall be set to 12h when the operation is completed.

Format Type = 11h, For CD-RW or DVD-RW

Formatting to expand the last session/Border of a C/DVD-RW medium is specified. The Number of Blocks field specifies the number of addressable blocks to be enlarged and the Type Dependent Parameter field specifies the Packet Length for CD or set to ECC block size (16) for DVD-RW. The Number of Blocks field may be adjusted to a value greater than the existing Session/Border size and less than or equal to the values reported by the READ FORMAT CAPACITIES Command. The Logical Unit shall round the Number of Blocks up to be an integral multiple of the packet size for CD or the ECC block size for DVD. The Packet Size field may not be adjusted. On DVD-RW media, this format operation is available only when a disc is in Restricted overwrite mode and the last bordered area is in a complete state. Growing of border operation shall start from the next sector of End Sector Number of RZone #n field that is corresponded to the last RZone. End PSN of Data Area and Start PSN of the current Border-out field of Lead-in/Border-in shall be changed to reflect the expanded, bordered area. The number of bordered areas and RZones does not change after this operation.

Format Type = 12h, For CD-RW or DVD-RW

Formatting to add a new session/Border to a C/DVD-RW media is specified. The Number of Blocks field specifies the number of addressable blocks for the new Session/Border and the Type Dependent Parameter field specifies the Fixed Packet Size for CD or set to ECC block size (16) for DVD-RW. The Number of Blocks field may be adjusted to a value less than or equal to the values reported by the READ FORMAT CAPACITIES Command. The Logical Unit shall round the Number of Blocks up to be an integral multiple of the packet size for CD or the ECC block size for DVD. The Packet Size field may not be adjusted. On CD media, if a different Fixed Packet Size is desired, the Host must modify the Write Parameters Mode Page. On DVD-RW media, this format operation is available only when a disc is in Restricted overwrite mode and the last bordered area is in a complete state. Start PSN of the next Border-in field in the previous Border-in/Lead-in shall be updated.

Format Type = 13h, For DVD-RW only

Formatting to expand the last Border and enter the last bordered area into intermediate state of a DVD-RW medium is specified. The Number of Blocks field specifies the number of addressable blocks to be enlarged and the Type Dependent Parameter field is set to ECC block size (16). The Number of Blocks field may be adjusted to a value greater than the existing Border size and less than or equal to the values reported by the READ FORMAT CAPACITIES Command. The Logical Unit shall round the Number of Blocks up to be an integral multiple of the ECC block size. This format operation is available only when the disc is in Restricted overwrite mode and the last bordered area is complete state. Growing of border operation shall start from the next sector of End Sector Number of RZone #n field that is corresponded to the last RZone. The number of bordered areas and RZones does not change after this operation. The Disc Status field of Format 3 RMD shall be set to 13h when the operation is completed. End PSN of Data Area field in Lead-in/Border-in of the last Border shall be set to 30000h. And Start PSN of the current Border-out and Start PSN of the next Border-in field in Lead-in/Border-in of the last Border shall be set to 00h.

Format Type = 14h, For DVD-RW only

Formatting to add a new intermediate state Border to an existing Border on DVD-RW media is specified. At least one or more Border shall exist on a medium and the last Border shall not be an intermediate state before start this operation. The area from the beginning of Border-in that follows the last Border-out, user data blocks and 32 ECC blocks with lead-out attribute is recorded. Start PSN of the next Border-in field in the previous Border-in/Lead-in shall not be changed to reflect the intermediate state bordered area that is added. If FORMAT UNIT Command with this Format Type is issued when the last Border is already intermediate state, the command shall be terminated with CHECK CONDITION Status, 5/26/00 INVALID FIELD IN PARAMETER LIST. The Number of Blocks field specifies the number of addressable blocks for the new Border and the Type Dependent Parameter field is set to ECC block size (16). The Number of Blocks field may be adjusted to a value less than or equal to the values reported by the READ FORMAT CAPACITIES Command. The Logical Unit shall round the Number of Blocks up to be an integral multiple of the ECC block size.

Format Type = 15h, For DVD-RW only

Formatting to create a Intermediate state Border on DVD-RW media is specified. The created Border shall become the only Border on the medium. The Number of Blocks field specifies the number of addressable blocks for the new Border and the Type Dependent Parameter field is set to ECC block size (16). The Number of Blocks field may be adjusted to a value less than or equal to the values reported by the READ FORMAT CAPACITIES Command. The Logical Unit shall round the Number of Blocks up to be an integral multiple of the ECC block size for DVD. This format operation is available on any recording mode and any state of a bordered area. If a disc is to be formatted that is in Sequential recording mode, new intermediate state bordered area is created at the beginning of the disc and the recording mode is changed to Restricted overwrite mode. The number of RZone in the created Border is one after this operation. The Disc Status field of Format 3 RMD shall be set to 12h when the operation is completed.

Format 16h - 1Fh

Reserved.

Format Type = 20h, For all multimedia types with both PDL and SDL

Formatting for the whole media is specified. The Number of Blocks field specifies the maximum number of addressable blocks for the whole disc and the Type Dependent Parameter field specifies the sparing parameters SL and SI. The drive shall verify that SL and SI are usable values (will not cause overflow of the SDL). Table 109 describes errors that may occur during the operation of the Command or which may cause a CHECK CONDITION status to be reported.

Format Types = 21h – 27h, Reserved.

Format Type = 28h, DVD+RW Background Format - Mandatory for the DVD+RW Capability feature when Write bit is set to 1.

The Number of Blocks field shall contain the number of blocks to be defined in the data zone. The Type Dependent Parameter is defined as follows:

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			Number of Spare				
1				ECC Blocks				(LSB)
2	Reserved						NSV	Restart

When NSV is set to one, the Number of Spare ECC Blocks is to be considered valid.

When NSV is cleared to zero, the drive shall use its default value for spares and the Number of Spare ECC Blocks field shall be ignored. If the Number of Spare ECC Blocks is non-zero but smaller than 128 or larger than 2047, the DVD+RW Drive shall terminate the command with CHECK CONDITION status and set sense data to ILLEGAL REQUEST, INVALID FIELD IN PARAMETER LIST.

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.

Format Types = 29h – 3Fh, Reserved

4.2.3 Background Formatting for Format Type 28h

The background formatting process is best illustrated in Figure 5.

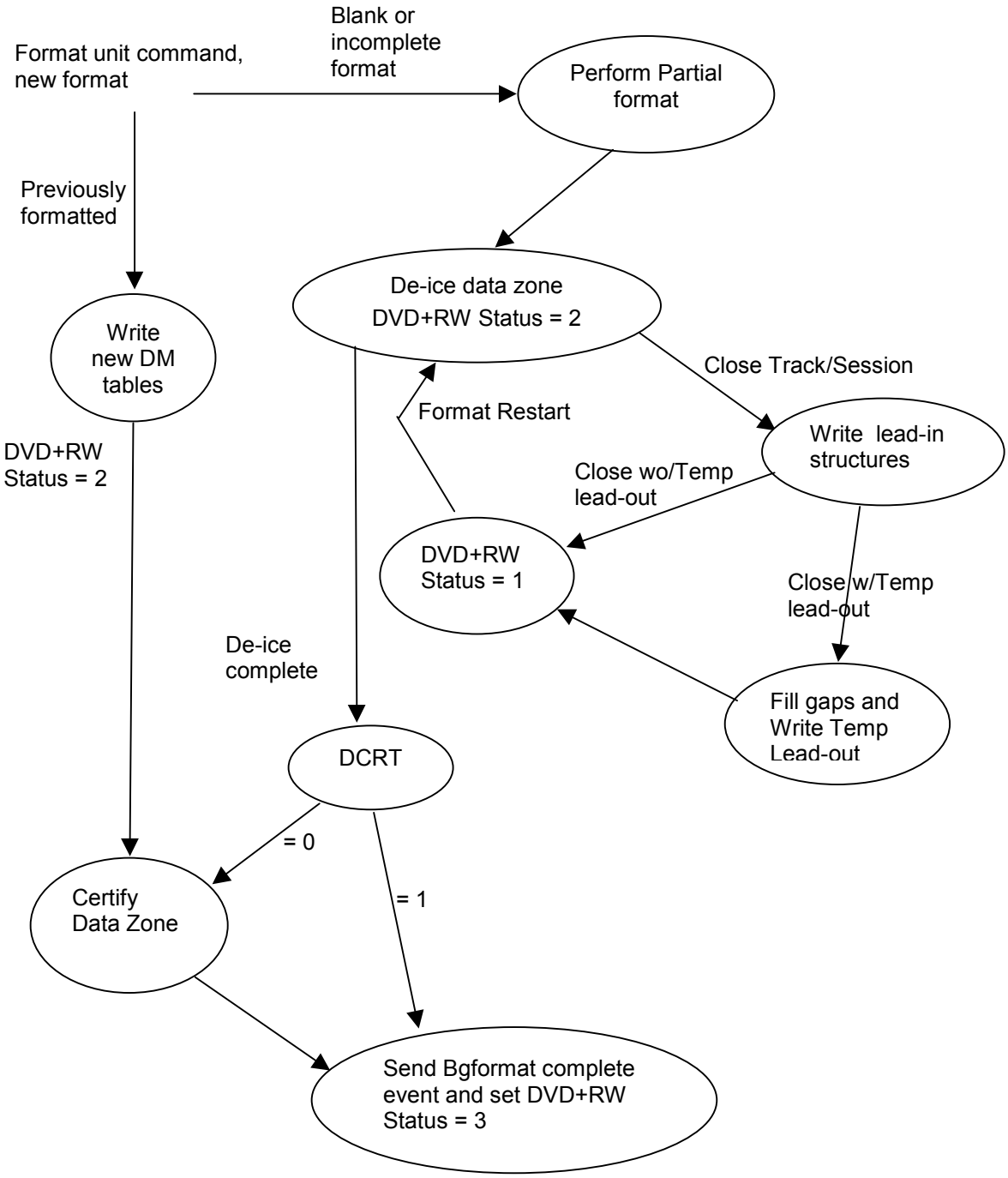


Figure 5: Background Process Flow

4.2.3.1 Background Formatting: Getting Started

The *DVD+RW 4.7 Gbytes Basic Format Specifications* tells us: “The disc shall be considered partially formatted if at least the Guard Zone 1, the Replacement Zone 1, the DMA Zone 1, the Inner Disc Identification Zone, the DMA Zone 2, the Reference Code Zone, the Buffer Zone 1, the Control Data Zone and the Buffer Zone 2 in the Lead-in Zone have been recorded.”

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

All format write functions shall write only complete CD-RW packets or DVD+RW ECC blocks.

4.2.3.2 Background Formatting: Formatting Concurrently with Writing

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

Suppose some write request is made to a CD-RW packet or a DVD+RW ECC block that is completely blank. When this occurs, the data shall be placed into the correct packet/ECC block buffer positions and unaddressed 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.

4.2.3.3 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.

4.2.3.4 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 = 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.

When track = 1 and session = 1, 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.

4.2.3.5 Background Formatting: Restarting

If an incompletely formatted disc is mounted in a write capable DVD+RW drive, formatting will not continue automatically. The rationale is simply that the host best knows when to restart a format. The host may restart the format by sending the format command again with restart specified in the type dependent parameter of the format descriptor. Formatting will proceed.

The FDCB (See *DVD+RW 4.7 Gbytes Basic Format Specifications)* should be consulted in order to restart the background format.

4.2.3.6 Background Formatting: Progress Reporting

If the IMMED bit is set to one, 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 12) shall be set as a progress indicator.

Table 12: Sense Key Specific Bytes in Sense Data

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

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

If a format is executing in background:

- The formatting process may be stopped only by issuing the CLOSE TRACK/SESSION Command. See section 4.1 for details.
- 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 which 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 (see 4.14).

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 13.

Table 13: Media Event Descriptor

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

The Media Event Code is defined in Table 14.

Table 14: 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 – Fh	Reserved	-

The Media Status byte is defined in Table 15.

Table 15: 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 MMC2.

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.

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 MMC2.

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.

4.13 READ CAPACITY

The READ CAPACITY command (Table 16) provides a means for the Host to request information regarding the capacity of the currently mounted medium. This command may not report the correct capacity of the recorded data for CD-R, CD-RW and DVD-R media that does not have a Lead-out in the last Session.

For CD-ROM, the returned logical block address is modified to allow returning a possibly inexact value (but one with a known error bound) based on the Table of Contents data.

Table 16: READ CAPACITY Command Descriptor Block

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

Eight bytes of READ CAPACITY response data (Table 17) shall be returned in response to the command. The returned Logical Block Address is defined in Table 18. The Block Length shall be reported, in bytes, as 2048d.

Table 17: READ CAPACITY Response Data

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

Table 18: Response LBA Values

LBA in CDB	PMI	LBA in Response
= 0	0	User area capacity: If the mounted medium is a DVD+RW disc, formatted as type 28h, the last logical block shall be determined by that format. If a format is in progress, the LBA reported is the same as that which will be reported when the format is completed.
≠ 0	0	The Drive shall terminate the command with CHECK CONDITION status and set sense codes to ILLEGAL REQUEST, LBA OUT OF RANGE
= 0	1	The Drive shall terminate the command with CHECK CONDITION status and set sense codes to ILLEGAL REQUEST, INVALID FIELD IN CDB.

4.14 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-2 shall remain unchanged.

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

Table 19: Disc Information Block

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB) Disc Information							
1	Length							(LSB)
2	Reserved			Erasable	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	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							
13								
14								
15								(LSB)
16	(MSB) Last Session Lead-in Start Time MSF							
17								
18								
19								(LSB)
20	(MSB) Last Possible Start Time for Start of Lead-out MSF							
21								
22								
23								(LSB)
24	(MSB) Disc Bar Code							
...								
31								(LSB)
32	Reserved							
33	Number of OPC Table Entries							
34 - n	OPC Table Entries							

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:

00 Not a 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, a blank disc (both physically blank and logically blank) the DVD+RW status is 00b.

01 DVD+RW background format was started but is not currently running and is not complete. .

02 DVD+RW background format is in progress. A format has been started or restarted and is not yet completed.

03 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.

4.15 READ DVD STRUCTURE COMMAND

The behavior of this command remains the same as defined in Mt Fuji 5. The behavior is defined for all DVD media except for DVD+RW media. A DVD+RW drive shall return structures for a DVD+RW medium as it would for DVD-RAM medium – with the exception of format code 31h, Spare Area Information.

Table 20: READ DVD STRUCTURE Data Format (With Format field = 31h)

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			DVD STRUCTURE				
1				Data Length				(LSB)
2				Reserved				
3				Reserved				
				DVD+RW Spare Area Information				
4	(MSB)			Size of Replacement				
5				Zone 1 (in ECC blocks)				(LSB)
6	(MSB)			Currently Available Spares in				
7				Replacement Zone 1 (in ECC blocks)				(LSB)
8	(MSB)			Size of Replacement				
9				Zone 2 (in ECC blocks)				(LSB)
10	(MSB)			Currently Available Spares in				
11				Replacement Zone 2 (in ECC blocks)				(LSB)
12								
13				Reserved				
14								
15								

4.16 READ FORMAT CAPACITIES COMMAND

The READ FORMAT CAPACITIES command (Table 21) 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 21: READ FORMAT CAPACITIES Command Descriptor Block

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							
8	Length							(LSB)
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 CD-R/RW 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 22..

Table 22: 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							
Format Capacity Descriptor(s)								
0	Format Capacity Descriptor #0							
...								
7								
...								
0	Format Capacity Descriptor #n							
...								
7								

The Capacity List Header is shown in Table 23. 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 23: Capacity List Header

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

The Current/Maximum Capacity Descriptor is shown in Table 24. The Number of Blocks indicates the number of addressable blocks for the capacity defined by each Descriptor Type.

The Descriptor Type field (Table 25) indicates the type of information the descriptor contains. The Block Length specifies the length in bytes of each logical block.

Table 24: Current/Maximum Capacity Descriptor

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

Table 25: 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 28h with spares size set to 128 (i.e. replacement zone 2 is zero in size).
10b	Formatted Media. The reported value is the current media's capacity. This is the number of user addressable blocks. When the media does not have a complete session it shall be reported as "No Media Present" with Descriptor Type = 11b.
11b	No Media Present. The reported value is for the maximum capacity of a media that the drive is capable of reading.

When Descriptor Type is 10b, Format Type contains a meaningful value. In this case, the Format Type contains:

00h, when the format is either unknown or has no assigned format type. The type dependent parameter contains the blocksize.

10h, when this is a standard CD-RW fixed packet Format. The type dependent parameter is the packet size.

For CD-RW media, all other values are reserved.

The Formattable Capacity Descriptor format is shown in Table 26. The Number of Blocks field indicates the number of addressable blocks for the capacity defined by the Format Type.

Table 26: Formattable Capacity Descriptor

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

The Type Dependent Parameter contents are as specified for each Format Type. Format Types are defined below.

Format Type = 00h

The descriptor shall contain the number of addressable blocks and the block size used for formatting the whole media. If multiple formatting for the whole media is possible, each capacity/block size combination shall be reported as a separate descriptor. The Type Dependent Parameter shall contain the Block Length in bytes.

Format Type = 01h

The descriptor shall contain the number of addressable blocks and the block size used for formatting the whole media. If multiple formatting for the whole media is possible, each capacity/block size combination shall be reported as a separate descriptor. This Format Type is used to expand a Spare area. The Type Dependent Parameter shall contain the Block Length in bytes.

Format Type = 02h - 03h

Reserved

Format Type = 04h

The descriptor shall contain the number of addressable blocks in the zone and zone number used by zoned formatting for a zone of the media, where the size of zone is not constant for each zone. The information for each zone shall be reported as a separate descriptor. The Type Dependent Parameter shall contain the Zone Number of the descriptor.

Format Type = 05h

The descriptor shall contain the number of addressable blocks per zone and zone number of the highest numbered zone. This descriptor is used for zoned formatting of the media, where the size of zone is constant for each zone. The Type Dependent Parameter shall contain the Zone Number of the last zone.

Format Type = 06h - 0Fh

Reserved

Format Type = 10h

The descriptor shall contain the maximum number of addressable blocks and maximum packet size that can be used to fully format C/DVD-RW media. The packet size and number of addressable blocks may be adjusted downward by the Host before sending this descriptor back via the FORMAT UNIT Command.

The Type Dependent Parameter shall contain Fixed Packet Size in sectors/ECC block size in sectors.

Format Type = 11h

The descriptor shall contain the maximum number of addressable blocks and the packet size which can be used to expand (grow) the last complete session/Border of C/DVD-RW media. The number of addressable blocks may be adjusted downward by the Host before sending this descriptor back via the FORMAT UNIT Command. The Type Dependent Parameter shall contain Fixed Packet Size in sectors/ECC block size in sectors

Format Type = 12h

The descriptor shall contain the maximum number of addressable blocks and the maximum packet size which can be used to add a new session/Border to a C/DVD-RW media. The packet size and number of addressable blocks may be adjusted downward by the Host before sending this descriptor back via the FORMAT UNIT Command. The Type Dependent Parameter shall contain Fixed Packet Size in sectors/ECC block size in sectors

Format Type = 13h

The descriptor shall contain the maximum number of addressable blocks and the ECC block size which can be used to expand (grow) the last complete Border of DVD-RW media as an intermediate state. The number of addressable blocks may be adjusted downward by the Host before sending this descriptor back via the FORMAT UNIT Command. The Type Dependent Parameter shall contain the ECC block Size in sectors

Format Type = 14h

The descriptor shall contain the maximum number of addressable blocks and the ECC block size which can be used to add a new intermediate state Border to a DVD-RW media. The number of addressable blocks may be adjusted downward by the Host before sending this descriptor back via the FORMAT UNIT Command. The Type Dependent Parameter shall contain the ECC block Size in sectors

Format Type = 15h

The descriptor shall contain the maximum number of addressable blocks and ECC block size that can be used to fully format DVD-RW media as an intermediate state. The number of addressable blocks may be adjusted downward by the Host before sending this descriptor back via the FORMAT UNIT Command. The Type Dependent Parameter shall contain the ECC block Size in sectors

Format Type = 16h - 1Fh

Reserved

Format Type = 20h

The descriptor shall contain the maximum number of addressable blocks and the sparing parameters to be used. M specifies SL where SL = 2^M, $4 \leq M \leq 15$ or SL = 0 if M = 0 and N identifies SI where SI = 2^N, $4 \leq N \leq 24$. The Type Dependent Parameter shall be set to M * 10000h + N, effectively placing M in byte offset 5 and N in byte offset 7, and making byte 8 reserved. The device shall supply its default values for M and N.

Format Type = 21h - 27h

Reserved

Format Type = 28h, DVD+RW Background Format , Mandatory for the DVD+RW Feature when the Write bit is set to one.

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. Editor Note: Report maximum Data Zone size in “Number of Blocks”. Report minimum spares in “Type Dependent Parameter” first 2 bytes. Last byte of “Type Dependent Parameter” is reserved.

Format Types = 29h - 3Fh, Reserved

4.17 READ TOC/PMA/ATIP COMMAND

DVD+RW requires no changes or additions.

4.18 REPORT KEY COMMAND

DVD+RW requires no changes or additions.

4.19 REQUEST SENSE COMMAND

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

New sense codes are needed for the DVD+RW formatted media due to the addition of the SMART feature. These are used only with sense keys 01 (RECOVERED ERROR) and 03 (MEDIUM ERROR). The ASC must be 1Dh. The ASCQ values of 80h through 0FEh are only for vendor unique reports.

Table 27: SMART Oriented Sense Codes

Sense Key	ASC	ASCQ	Meaning
03	32h	00	No defect spares are available, relocation required
01	1Dh	01	No defect spares are available, no relocation required.
01	1Dh	03	Less than 5% of the defect spares remain available Once the “less than 5% boundary” has been crossed, the command must be terminated with a CHECK CONDITION and sense codes set to these values only according to the settings in the Informational Exceptions Control Page.

4.20 SEND DVD STRUCTURE COMMAND

DVD+RW requires no changes or additions.

4.21 SEND EVENT COMMAND

This command is actually optional and should not be supported by any DVD+RW drive.

5 MODE PAGES

5.1 Read/Write Error Recovery Page

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.