MRW

Multi-Media Command (MMC) Set for the MRW Formats

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1 INTRODUCTION/SCOPE

The Mount Rainier Initiative provides for the consolidation of multi-media devices and media usage via the Mount Rainier ReWritable (MRW) formats. MRW has been defined for both CD-RW and DVD+RW for the purpose of defining common usage while maintaining format features that minimize legacy problems. This document refers to each new format as simply, MRW. MRW is applicable to 8 cm and 12 cm media of both CD-RW and DVD+RW.

The CD-RW medium format is defined in the Mount Rainier document: *CD-MRW Defect Management & Physical Formatting*. The DVD+RW medium format is defined in the Mount Rainier document: *DVD+MRW Defect Management & Physical Formatting*. Both formats specify a defect management system by the device such that presentation to the host maximizes commonality of use.

ATAPI is by far the most common interface used for communication with multi-media devices. This document restricts its descriptions to that interface.

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: Applicable references and definitions are included.

Clause 2: The models for both CD-MRW and DVD+MRW describe the MRW format and usage.

Clause 3: The MRW feature is required to claim recognition and compliance with the MRW format. When the MRW Feature is current, the currency of other features is affected.

Clause 4: All supported commands are listed. Some command descriptions are changed when the MRW Feature is current. These commands are described with special attention to the MRW uniqueness. In the cases of commands that are not changed by the currency of the MRW format, no detail is given and only a reference to MMC-3, SPC-2, or SBC is given

Clause 5: All supported mode pages are listed. The MRW Mode Page is valid only when the MRW Feature is present. Other mode pages are generally unchanged. Special cases are described with special attention given to the MRW specifics. In the cases of mode pages that are not affected by the presence of the MRW format, no detail is given and only a reference to MMC-3, SPC-2, or SBC is given.

Clause 6: Media usage is described. Recognition, Formatting, Reading, Writing, and re-use are addressed.

1.1 References

1.1.1 References from Public Standards Organisations

SCSI Parallel Interface 3 (SPI-3) ANSI NCITS 336:2000

SCSI-3 Primary Commands 2 (SPC-2) ANSI NCITS 351:2001

SCSI-3 Multi-Media 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

CD-MRW Defect Management & Physical Formatting revision 1.1, Mount Rainier Promoters Group, August 2001

DVD+MRW Defect Management & Physical Formatting revision 1.0, Mount Rainier Promoters Group, December 2001

DVD+RW 4.7 Gbytes Basic Format Specifications, Version 1.2, May 2002, Hewlett-Packard, Mitsubishi Chemical, Philips, Ricoh, Sony, Yamaha

1.2 Abbreviations And Definitions

Some of the following are definitions and abbreviations in the MMC3 standard that are specific to MRW. Others have been created or amended in support of DVD+MRW.

Data Area (DA)
A MRW disc reserves this space in the user storage zones of the media for primary sector allocation. Spares are allocated separately. Location, size, and layout vary according to base media type (CD-RW, DVD+RW).

Defect Managed Area (DMA)
A MRW disc contains a logical address space that is completely covered by the defect management system of the MRW format. This logical address space is the Defect Managed Area, or DMA.

Extensive Use
MRW formatting for DVD has the "normal use" default for sparing - approximately 3% sparing. If the media is expected to have higher than normal defects due to a higher than normal write duty cycle, the extensive use format option may be selected. Extensive use provides approximately 13% sparing.

General Application Area (GAA)
When a CD-RW or DVD+RW disc is formatted as a MRW disc, the GAA consists of the first 2 MB of user space under the default logical addressing scheme for the media. This area is not covered by the MRW defect management mechanism. The GAA exists as a linkage mechanism for legacy environments.

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

Logical Sector Number
Logical Sector Numbers are assigned contiguously from LSN 0, starting from the first PSN (030000h) to the end of the Data Zone. On DVD+MRW this is not necessarily the same as Logical Block Address (LBA).

Main Defect Table (MDT)
A MRW disc stores its defect mappings in this structure that is written in the disc lead-in.

Main Information Packet (MIP)
The Main Information Packet contains information describing the MRW defect management system. The MIP is written within the disc lead-in.

Main Table Area (MTA)
The area of the disc lead-in that is reserved for MDT and MIP storage is referred to as the Main Table Area (MTA).

Method 3 Addressing
For CD-R and CD-RW media, method 2 addressing is defined for the logical numbering of sectors on a fixed packet written track. CD-MRW extends this logical addressing for the MRW format. This logical addressing is method 3 addressing.

MM
This is an abbreviation for Multi-media.

MRW Accessible
MRW formatting has two components: first a foreground part and then a background part. Once in the background part, the drive must provide read/write access for the host. When that capability has been provided, the media is MRW Accessible.

Spare Area (SA)
On MRW formatted CD-RW media, each DA is preceded by an associated 8-packet zone that is reserved as the primary spares space for the DA that it precedes. Each of these is a Spares Area (SA).

On MRW formatted DVD+RW media, the DA is preceded by a 4096 sector spares area (SA1). An additional 61 440 sectors spares area (SA2) immediately follows the last sector of the DA.

Secondary Defect Table (SDT)
The MRW format requires a back-up copy of the MDT within the user storage area of the disc's basic format. This back-up copy is the SDT.

Secondary Information Packet (SIP)
The MRW format requires a back-up copy of the MIP within the user storage area of the disc's basic format. This back-up copy is the SIP.

Secondary Table Area (STA)
The area of the disc lead-in that is reserved for SDT and SIP storage is referred to as the Secondary Table Area (STA).

2 THE MRW MODEL

2.1 General

A MRW format cannot be defined for all media, however the specific requirements are minimal:

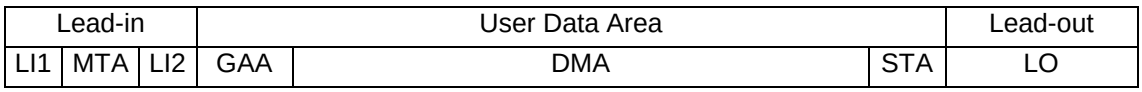
- The media must consist of a continuously recordable zone that is divided into a lead-in area, followed by a user data area, followed by a lead-out area. See Figure 1.
- The medium must be randomly rewritable.
- From the host's perspective, the recordable block size and readable block size must be equal and fixed at 2 048 bytes. If the low-level writable block size is greater than 2 048 bytes, then that block size shall be an integral multiple of 2 048 and an integral divisor of 65 536.
- The basic medium format must allow blocks to be written in the lead-in without interfering with the basic medium format.
- The media must have a firm, traditional definition for the physical location of LBA 0.

Figure 1 - General Structure of MRW Candidate Media

Each area is redefined by the MRW format as shown in Figure 2:

- A Main Table Area (MTA) is reserved from the lead-in. The MTA contains structures that identify the media format and structures for management of the defect replacement system. Parts LI1 and LI2 are not used by the MRW format and either or both may be zero in length.
- The General Application Area (GAA) provides minimally 2 Megabytes (2 097 152 bytes) of user space and must align its logical address space exactly with the logical address space associated with the traditional media format.
- The Defect Managed Area (DMA) contains both primary user data zones and spare sector zones. The layout is media specific. The DMA is independently addressable, so it contains its own well-defined LBA 0. The actual spared block size must be an integral multiple of 2 048, but not larger than the low-level writable block size.
- Following the DMA is the Secondary Table Area (STA). The STA is a backup copy of the MTA. The STA provides a way for a host to access the MRW structures when connected to a device that is not MRW capable.
- The MRW format may affect the traditional start location of the disc lead-out (LO), but MRW stores no structural information in the disc LO.

Figure 2 - Main Areas Defined by MRW



2.1.1 Consequences of a Multi-Volume Format

The Mount Rainier format is multi-volume. This simply means that a single, physical medium represents more than a single logical volume. In the case of Mount Rainier, the number of volumes is 2: the GAA and the DMA.

2.1.1.1 LBA Spaces

Two distinct LBA spaces - one for each logical volume - must be provided and under normal host accesses, action on one volume cannot modify data on the other volume. The MRW drive provides a simple method to select between address spaces: the MRW Mode Page.

When a command references the media by LBA, the result is dependent upon the currently selected LBA Space.

2.1.1.2 Features and Events

The feature sets associated with GAA and DMA are different. In particular, the DMA has the Defect Management Feature, while the GAA does not.

When a MRW formatted (or formatting) disc is mounted, the drive shall always default to the LBA Space of the DMA. If the host chooses to select the GAA, then the drive shall generate a Morph Event and change the set of features that are marked current.

2.1.2 Host Requests/Drive Responses

When the DMA is the current LBA Space of a MRW disc, the Removable Medium, Random Read, Random Write, Formattable, and Defect Management Features are current. Since the Core, Morphing, Time-out, and Power Management Features are common to all defined Profiles, the DMA volume has the Removable Disk Profile as current. Consequently, the host may view the DMA volume of the MRW disc as a removable magnetic medium with a 2 048-byte sector size.

2.1.2.1 Streamed Writing

MRW requires streamed writing. This simply disables the defect management system during the streamed writing, thereby providing a writing method that yields fixed rate data flows principally for video applications. Streamed writing uses only the primary user space. The spare area is not used. The MRW format has no mechanism for tracking areas that are stream written versus areas that are not stream written. The host must provide its own mechanism.

The WRITE (12) command is used to control and utilize the streamed write capability. A "streamed" bit in the command descriptor block declares that the data should be written without utilizing the defect management system.

The READ (12) command is used to read streamed written data. A "streamed" bit in the command descriptor block tells the drive to disable use of the defect management system and to ignore data errors.

2.1.2.2 Formatting

In order to assure that a disc be recognized as a MRW disc, physically blank media or media with a non-MRW format must be written. In many cases the entire surface must be written or rewritten. This can require quite a lot of time. For this reason, MRW requires that most of the formatting occur in background. This must be done in such a way that the media is accessible for reading and writing as soon as possible.

Background formatting has specific definitions for specific media, but the following general rules apply:

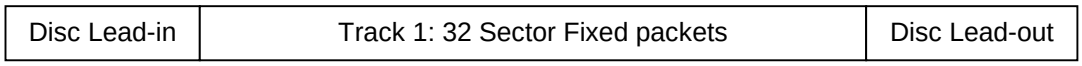
- Some minimal amount of formatting must be done in foreground: initialization of the disc lead-in and GAA. Once this has been performed, the operation can go to background time.
- The drive must support a mechanism for format suspension and restart.
- The drive must always make current format status 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.

2.2 The CD-MRW Model

From the perspective of the original version of Orange Book, part III (CD-RW), the entire capacity of a MRW disc consists of a single session containing a single track of 32 sector fixed packets.

Figure 3 - Track/Session Structure of a MRW Disc

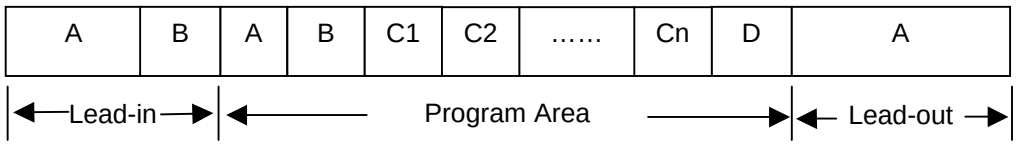


CD-MRW contains additional structure.

2.2.1 CD-MRW Structure

The CD-MRW disc does have this format, but the *CD-MRW Defect Management & Physical Formatting* requires additional features, built upon the basic format (Figure 4).

Figure 4 - The Additional Structure



Lead-in, Part A	TOC, no change
Lead-in, Part B	TOC (in sub-channel Q) along with MTA (information is stored in main channel). The major change: Prior to CD-MRW, the lead-in has always been recorded track-at-once. With this new format, it is recorded as fixed packets. The MTA use begins with the packet that precedes the pre-gap. When needed, the MTA grows backward toward the disc center with a maximum size of 32 packets.
Program Area, Part A	Track 1 pre-gap has a fixed size of 150 sectors. The TDB identifies the track as fixed packet of length 32.
Program Area, Part B	The General Application Area (GAA) is a segment of the track that is NOT covered by the defect management system. This is fixed at 32 packets which is also 1024 sectors which is also 2 MB.
Program Area, Parts Cx	The Defect Managed Area (DMA) consists of DMA segments, Cx. Each Cx consists of a spare area (SA) followed by a data area (DA). Each SA must contain 8 packets. Each DA within C1, C2, …, Cn-1, must contain 136 packets for primary data. Cn may contain less than 136 packets, based upon disc capacity. The DMA is the logical concatenation of all DAs.
Program Area, Part D	STA: 33 packets reserved for secondary copies of the MTA structures.
Lead-out, Part A	Lead-out, no change

The number of Cx is determined as follows: P = number of 32 sector fixed packets available in the formatted track 1. The number of packets in all Cx is Pt = P – GAA size – STA size = P – 65. When Pt is divided by 144 (= 8 + 136), there is a quotient Q and remainder R.

If $R \leq 8$, then Q = n. The DA size for each Cx is 136, and the lead-out begins R packets sooner.

If R > 8, then Q = n – 1. The DA for C1, C2,...Cn-1 is 136, the DA for Cn is R – 8 packets in length, and the lead-out is not offset into the program area.

The Host's primary address space is the DMA. By default, an LBA is presumed to refer to this address space. Note that LBAs for the DMA do NOT match LBAs for a similarly formatted non-MRW disc. The spare block size is 2 048 bytes - one CD user sector from a size 32 fixed packet.

The GAA is available for compatibility with older systems. The GAA LBA space is 0, 1, 2, 3, …, 1 023d. Note that LBAs for the GAA exactly match LBAs for a similarly formatted pre-MRW disc.

2.2.2 CD-MRW Addressing

Since MRW has two LBA spaces, CD-MRW has two logical addressing schemes. The GAA contains 1024 sectors, uses method 2 addressing , and exactly matches sector addressing as defined for traditional CD. See Table 1.

Table 1 - GAA Addressing on CD-MRW

Non-MRW LBA	MRW LBA in GAA
0	0
1	1
2	2
.	.
.	.
1 023	1023
1 024	Out of Range
1 025	Out of Range
....	....

When method 2 addressing is used, the primary LBA of the first sector of the DMA is at the non-MRW LBA of (32 + 8)*32 = 1280d. Table 2 shows the most inequities with non-MRW LBA.

Table 2 - DMA Addressing on CD-MRW

Non-MRW LBA	MRW LBA (primary)
1 280	DMA 0
1 281	DMA 1
1 282	DMA 2
....	....
5 631	DMA 4 351
....	....
5 888	DMA 4 352
5 889	DMA 4 353
....	....
10 239	DMA 8 703
....	....

This method of addressing is named "method 3 addressing" in the *CD-MRW Defect Management & Physical Formatting.*

2.3 The DVD+MRW Model

A description of DVD+RW media can be found in *DVD+RW 4.7 Gbytes Basic Format Specifications.* For the purpose of presenting the mapping of MRW onto DVD+RW media it is only necessary to:

- Identify the location of the MTA within the lead-in.
- Identify the location of the GAA.
- Identify the location of the DMA.
- Identify the location of the STA within the data zone.
- Present use models.

2.3.1 DVD+MRW Structure

The DVD+RW 120-mm one-sided disc has a 4.70GB information zone, while the two-sided disc has 9.40GB. The (one-sided) MRW capacity is either 4.56GB or 4.16GB, based on formatting.

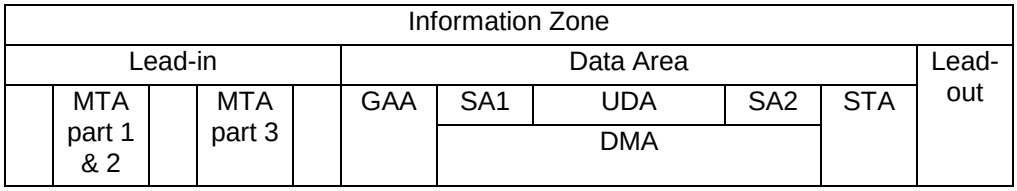
The DVD+RW 80-mm one-sided disc has 1.46GB information zone, while the two-sided disc has 2.92GB. The (one-sided) MRW capacity is 1.33GB.

The Information Zone is divided into the three primary areas: Lead-in, Data Area, and Lead-out.

MRW is mapped onto DVD+RW media as follows (see Figure 5):

- The MTA is 4224 sectors in length in one 4096-sector part and two 64-sector parts.
- The GAA is 1024 sectors in length, beginning with PSN = 30000h
- The DMA is constructed as follows:
  - Spare Area 1 (SA1) has a length of 4 096 sectors.
  - The User Data Area (UDA) has a length of 2 227 488 or 2 030 880 sectors on 12 cm media and a length of 646 928 on 8 cm media.
  - Spare Area 2 (SA2) has a length of 61 440 sectors. On 12 cm media, SA2 may optionally have be 258 048 sectors.
- The STA is 1056 (66 ECC blocks) sectors in length, beginning with PSN = 260120h.
- The Lead-out begins at PSN = 2601A0h and has a nominal length of 47952 sectors.

Figure 5 - MRW Mapping onto DVD+RW, General



A DVD+MRW device relocates only in complete ECC block units.

Table 3 shows the layout of the DVD+MRW formatted groove.

Table 3 - DVD+MRW Format Lay-out

Disc Area	Zone		12 cm Disc		8 cm Disc	
			Start PSN	Length in Sectors	Start PSN	Length in Sectors
LEAD-IN	Initial Zone		01D830h	52 304 nominal	01D830h	52 304 nominal
	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
	MTA, part 1		02DE80h	4 096	02DE80h	4 096
	MTA, part 2		02EE80h	64	02EE80h	64
	Inner Disc Identification Zone		02EEC0h	256	02EEC0h	256
	MTA, part 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	GAA		030000h	1 024	030000h	1 024
	DMA	SA1	030400h	4 096	030400h	4 096
		UDA	031400h	2 227 488/ 2 030 880	031400h	646 928
		SA2	251120h/ 221120h	61 440/ 258 048	0CF310h	61 440
	STA		260120h	1056	0DE310h	1056
LEAD-OUT	Buffer Zone 3		260540h	768	0DE730h	768
	Outer Disc Identification Zone		260840h	256	0DEA30h	256
	Guard Zone 2		260940h	4 096	0DEB30h	4 096
	Reserved Zone 4		261940h	4 096	0DFB30h	4 096
	Outer Drive Test Zone		262940h	12 288	0E0B30h	12 288
	Outer Disc Test Zone		265940h	2 048	0E3B30h	2 048
	Guard Zone 3		266140h	24 400 nominal	0E4330h	7 936 nominal

2.3.2 Addressing

Table 3 shows that the GAA begins at PSA = 030000h and the DMA primary space begins at PSA = 031400h.

Logical addressing for the GAA exactly overlaps the logical addressing for first 1 024 sectors of DVD-ROM.

Logical addressing for the primary DMA sectors is exactly DVD-ROM logical addressing plus the offset of 1 400h. Note that the DMA has two possible sizes for SA2 (spare area 2) and consequently, two possible capacities. The specific capacity must be selected at format time.

3 FEATURES AND PROFILES

A MRW drive is typically a CD-ROM, DVD-ROM, CD-RW, DVD+RW, or combination drive with additional logical capability. The host must be able to discover all capabilities from the Profiles and Features list.

3.1 The MRW Feature

The MRW Feature has been defined to specify that the drive is capable of reading the MRW format on one or more media types. The MRW Feature also reports write capability.

The presence of the MRW Feature indicates that the drive is capable of reading a disc with the MRW format. If the drive supports reading CD-RW media, then it shall be capable of reading CD-MRW formatted media. If the drive supports reading DVD+RW media, then it shall be capable of reading DVD+MRW formatted media. If the drive supports writing CD-RW media, then it shall be capable of formatting and writing CD-MRW. If the drive supports writing DVD+RW media, then it shall be capable of formatting and writing DVD+MRW.

Table 4 - MRW Feature Descriptor

Bit / Byte	7	6	5	4	3	2	1	0
0	Feature Code = 0028h							
1								
2	Reserved		Feature Version = 0010b				Persistent	Current
3	Additional Length = 4							
4	Reserved							Write
5	Reserved							
6	Reserved							
7	Reserved							

In order to be compliant with this specification, the feature version shall be set to 0010b.

The Persistent bit shall be set to zero because the medium is removable.

The Current bit shall be set to one if the currently mounted and formatted or formatting MRW. Otherwise, the Current shall be set to zero.

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 discs in the MRW format and is capable of writing discs that have been MRW formatted. When the Write bit is set to one, then the drive must include the Removable Disk Profile and list all features required of that profile.

The meaning of the Write bit is shown in Table 5.

Table 5 - Meaning of the Write Bit

Current	Write	Explanation
0	0	The drive is not able to write any media for which a MRW format has been defined.
0	1	The drive is capable of MRW formatting and writing some media types for which a MRW format has been defined.
1	0	Although the currently mounted medium is MRW formatted or formatting, the drive has no write capability.
1	1	The drive is capable of MRW formatting and writing the currently mounted medium.

Command support requirements for this feature are shown in Table 6.

Table 6 - Mandatory MRW Feature Commands

Op Code	Command Description	MRW Feature Requirement
5Bh	Close Track/Session	Only when Write = 1
04h	Format Unit	Only when Write = 1
4Ah	Get Event/Status Notification	Always
28h	Read (10)	Always
A8h	Read (12)	Always
BEh	Read CD	Only when CD-MRW media is present
2Ah	Write (10)	Only when Write = 1
AAh	Write (12)	Only when Write = 1
2Eh	Write and Verify (10)	Only when Write = 1
2Fh	Verify (10)	Always
B9h	Read CD MSF	Only when CD-MRW media is present
25h	Read Capacity	Always
23h	Read Format Capacities	Always

The MRW Mode Page is required. MRW formatted (and formatting) discs do not use parameters of the Write Parameters Mode Page.

3.2 The SMART Feature

This Feature identifies a drive that implements Self-Monitoring Analysis and Reporting Technology (SMART). The SMART Feature is present to give the host early warning about impending failures. In the case of the MRW compliant drive, the failure prediction is primarily oriented toward media wear-out. If this feature is present, then controlling information may be presented in the Fault/Failure Reporting Page (1Ch).

The SMART feature is required for MRW compliant drives. The Fault/Failure Reporting Page (1Ch) is optional.

Table 7 - SMART Feature Descriptor

Bit / Byte	7	6	5	4	3	2	1	0
0	Feature Code = 0101h							
1								
2	Reserved		Feature Version				Persistent	Current
3	Additional Length = 4							
4	Reserved							PP
5	Reserved							
6	Reserved							
7	Reserved							

The Feature Code field shall be set to 0101h.

The Persistent bit shall be set to zero because the medium is removable.

The Current bit shall be set to one when the currently mounted disc is MRW and the current LBA Space is DMA. Otherwise, Current shall be cleared to zero.

The Additional Length field shall be set to 04h.

If the Page Present (PP) bit is set in the SMART Feature Descriptor, then the Fault/Failure Reporting Page (1Ch) must be supported. If the Fault / Failure Reporting Mode Page (1Ch) is not supported the drive shall use the following values:

1. Performance (Perf) bit shall be 0 (Delays are acceptable).
2. Enable Warning (EWasc) bit shall be 0 (Disable WARNING Sense Code reporting).
3. Disable Exception Control (DExcept) bit shall be 0 (Do not Disable reporting of exception conditions).
4. Test bit shall be 0.
5. Method of Reporting Informational Exceptions (MRIE) shall be 4 (Unconditionally generate recovered error).
6. Interval Timer shall be set to 6000.

3.3 Real-Time Streaming Feature

This Feature specifies that the drive is capable of reading and writing within Initiator specified (and Logical Unit verified) performance ranges.

3.3.1 Streamed Reading

Streamed reading involves only transferring the amount of data requested by the host regardless of errors in the data stream. When stream reading, the drive shall attempt to correct data errors, but since maintaining the data stream is more important than returning correct data, the drive shall perform data transfers and not report data errors.

3.3.2 Streamed Writing

The *CD-RW Defect Management & Physical Formatting revision 1.1* defines the method for streamed writing on CD-MRW formatted discs. This Feature shall be current when a CD-MRW formatted disc is present. Streamed writing on CD-MRW shall be performed as described in the *CD-RW Defect Management & Physical Formatting revision 1.1*

For DVD+RW, this Feature is current with the DVD+RW Basic Format. The *DVD+RW Defect Management & Physical Formatting revision 1.0* defines the method for streamed writing on DVD+MRW formatted discs. This Feature shall be current when a DVD+MRW formatted disc is present. Streamed writing on CD-MRW shall be performed as described in the *DVD+RW Defect Management & Physical Formatting revision 1.0.*

3.4 Profiles: Including the MRW Features

A CD-RW device that reports the MRW Feature, is still a CD-RW device as defined by the MMC-3 profiles, so no features are lost. The host must be aware of the extra feature in order to recognize and use the MRW capabilities of the device.

A device that supports reading the MRW format on DVD+RW media must report the DVD-ROM Profile. A device that supports formatting and writing the MRW format on DVD+RW media must report the DVD+RW Profile and the Removable Disk Profile. Additionally, the drive must also report the MRW Feature and the SMART Feature.

A DVD+RW device that reports the MRW Feature, is still a DVD+RW device as defined by the MMC-3 profiles, so no features are lost. The host must be aware of the extra feature in order to recognize and use the MRW capabilities of the device.

The host must be aware that a MRW compliant device may have read-only capability. This shall be reflected in the feature list.

3.5 Feature Currency

Media presence/absence, media type, and media format all contribute to the currency of features. Table 8 shows feature currency as associated with various CD discs and formats on a typical CD-RW device with CD-MRW write capability.

Table 8 - Example of Feature Currency Associated with CD Media

Feature ID	Feature	Current when media is					
		No Media	CD-ROM	CD-R	CD-RW	CD-MRW GAA	CD-MRW DMA
0001h	Core	x	x	x	x	x	x
0002h	Morphing	x	x	x	x	x	x
0003h	Removable Medium	x	x	x	x	x	x
0010h	Random Readable		x	x	x	x	x
001Dh	Multi-Read				x	x	x
001Eh	CD Read		x	x	x	x	x
0020h	Random Write[1]					x	x
0021h	Incremental Streaming Writable			x	x		
0023h	Formattable				x	x	x
0026h	Restricted Overwrite				x		
0028h	MRW[1]					x	x
002Dh	CD Track At Once			x	x		
002Eh	CD Mastering			x	x		
0100h	Power Management	x	x	x	x	x	x
0103h	CD Audio External Play[1]		x[3]	x[3]	x[3]		
0105h	Time-out	x	x	x	x	x	x
0107h	Real-time Streaming		x	x	x		x
0101h	SMART[1,2]						x
0108h	Logical Unit Serial Number	x	x	x	x	x	x

Note:

1. Not mandatory in the CD-RW Profile.
2. Mandatory when the MRW Feature is supported.
3. Only when CD-DA tracks are present on disc.

Table 9 shows feature currency as associated with various DVD discs and formats on a typical DVD+RW device with DVD+MRW write capability.

Table 9 - Example Feature Currency Associated with DVD Media

Feature ID	Feature	Current when media is				
		No Media	DVD-ROM[3]	DVD+RW	DVD+MRW GAA	DVD+MRW DMA
0001h	Core	x	x	x	x	x
0002h	Morphing	x	x	x	x	x
0003h	Removable Medium	x	x	x	x	x
0010h	Random Readable		x	x	x	x
001Fh	DVD Read		x	x	x	x
0020h	Random Write			x	x	x
0023h	Formattable			x	x	x
0028h	MRW[1]				x	x
002Ah	DVD+RW Basic Format			x		
0100h	Power Management	x	x	x	x	x
0105h	Time-out	x	x	x	x	x
0107h	Real-time Streaming		x	x		x
0101h	SMART					x
0108h	Logical Unit Serial Number	x	x	x	x	x
010Ah	DCBs			x	x	x

Note:

1. Not mandatory in the DVD+RW Profile.

2. Mandatory when the MRW Feature is supported.

3. A DVD+RW device may only have DVD-ROM Profile capability with some other recordable DVD disc types.

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4 COMMANDS

Some commands reviewed in this section are unique to CD-MRW drives, some are unique to DVD+MRW drives and some are common to both. All commands listed in

Table 10 have definitions within SBC, SPC-2 or MMC-3. Many commands are unchanged from the standards definitions.

Table 10 - CD-MRW / DVD+MRW Commands

Command	Op Code
CLOSE TRACK/SESSION	5Bh
FORMAT UNIT	04h
GET CONFIGURATION	46h
GET EVENT/STATUS NOTIFICATION	4Ah
GET PERFORMANCE	ACh
INQUIRY	12h
MECHANISM STATUS	BDh
MODE SELECT (10)	55h
MODE SENSE (10)	5Ah
PREVENT ALLOW MEDIUM REMOVAL	1Eh
READ (10)	28h
READ (12)	A8h
READ BUFFER CAPACITY	5Ch
READ CAPACITY	25h
READ CD	BEh
READ CD MSF	B9h
READ DISC INFORMATION	51h

Command	Op Code
READ DVD STRUCTURE	ADh
READ FORMAT CAPACITIES	23h
READ TOC/PMA/ATIP	43h
READ TRACK INFORMATION	52h
REQUEST SENSE	03h
SEND DVD STRUCTURE	BFh
SEND OPC INFORMATION	54h
SET CD SPEED	BBh
SET STREAMING	B6h
START STOP UNIT	1Bh
SYNCHRONIZE CACHE	35h
TEST UNIT READY	00h
VERIFY (10)	2Fh
WRITE (10)	2Ah
WRITE (12)	AAh
WRITE AND VERIFY (10)	2Eh

4.1 CLOSE TRACK/SESSION COMMAND

The CLOSE TRACK/SESSION Command, Table 11, allows closure of either a track or a session. For the specific cases of either CD-RW or DVD+RW media with the MRW Format, this command is used to stop a background format in progress. The command description that follows is specific to MRW. For other media types and formats, refer to MMC-3.

Table 11 - 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					Close Function		
3	Reserved							
4	(MSB) Track Number							
5								(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.

When the currently mounted disc is MRW formatted or executing a MRW background format, Track Number is not used and shall be ignored by the drive.

The MRW device shall respond to the Close Function codes as shown in Table 12.

Table 12 – MRW Close Function Responses

Close Function	Close Action by DVD+MRW Drive
0, 1	Reserved
2	If the currently mounted medium is MRW formatted and no background is in progress, the command shall be terminated with GOOD status. If a MRW background format is in progress, the format operation shall be stopped and the disc shall be structured for removal. For CD-RW media, the *CD-MRW Defect Management & Physical Formatting Specification, revision 1.1*, defines the structuring. For DVD+RW media, the *DVD+MRW Defect Management & Physical Formatting Specification, revision 1.0* defines the structuring. Closing a session shall cause a Class 1 Event when the command is issued if the MRW Drive becomes NOT READY. A Class 1 Event shall occur if the medium returns to READY or if the medium becomes not writable. Note: In order to maximize read compatibility with read-only devices, it is recommended that the format writing extend to at least PSN 70DE0h prior to appending the temporary lead-out.
3 - 7	Reserved

During the Close operation, the MRW drive shall respond to commands as follows:

In response to the INQUIRY, GET CONFIGURATION, and GET EVENT/STATUS NOTIFICATION commands, the MRW Drive shall respond as commanded.

The MRW drive may respond to other commands by terminating the command with CHECK CONDITION Status and setting sense data to NOT READY, LOGICAL UNIT NOT READY, OPERATION IN PROGRESS.

4.2 FORMAT UNIT COMMAND

The FORMAT UNIT Command (Table 13) 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 13 - 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 MRW devices, 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 MRW devices, CmpList shall be cleared to zero.

Format Code identifies the format descriptor that the host shall send. For MRW devices, the Format Codes shall be set to one.

Parameter data from the host is structured as shown in Table 14.

Table 14 - 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 MRW compliant MM device requires 12 parameter bytes: a format list header and a single format descriptor.

The Format List Header (Table 15) identifies any and all additional parameter data.

Table 15 - 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							
3	(LSB)							

A Format Options Valid (FOV) bit of zero indicates that the MRW device shall use its default settings for the DPRY, DCRT, STPF, IP, TRY and IMMED bits. For a MRW 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 MRW 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 MRW drive and must be cleared to zero. If any of these bits are not zero, the MRW 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 an MRW formatting, use of the DCRT bit is defined in Table 17.

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 CD-RW Drive shall return status as soon as the command descriptor block has been validated, and the entire Format Descriptor has been transferred. See 4.2.1.1 for specific details on background formatting.

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 and MRW Formatting

If the Format Code in the CDB is 001b the host shall send a Format Descriptor as defined in Table 16.

Table 16 - Format Descriptor

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

When Format Type = 24h, MRW Full Format is specified. For specifications for other format types, refer to MMC-3. If the MRW Feature is present and the Write bit is set to one, then MRW formatting is mandatory.

If the currently mounted medium is neither CD-RW nor DVD+RW, the command shall be terminated with CHECK CONDITION status and sense data shall be set to ILLEGAL REQUEST/INVALID FIELD IN PARAMETER BLOCK.

The Type Dependent Parameter has the meaning of “New format” when it has the value 000000h. The Type Dependent Parameter has the meaning of “Restart format” when it has the value 000001h. If the field contains any other value, the drive shall terminate the command with CHECK CONDITION status and set sense data to ILLEGAL REQUEST, INVALID FIELD IN PARAMETER BLOCK (05/26/00).

If the currently mounted media is CD-RW and a new format is requested, the Number of Blocks parameter shall have the value 0xFFFFFFFF. If the field contains any other value, the drive shall terminate the command with CHECK CONDITION status and set sense data to ILLEGAL REQUEST, INVALID FIELD IN PARAMETER BLOCK (05/26/00).

If the currently mounted media is 8 cm DVD+RW and a new format is requested, the Number of Blocks parameter shall have the value 0xFFFFFFFF. If the field contains any other value, the drive shall terminate the command with CHECK CONDITION status and set sense data to ILLEGAL REQUEST, INVALID FIELD IN PARAMETER BLOCK (05/26/00). Spare area 1 shall be 4 096 sectors in length while spare area 2 shall be 61 440 sectors in length. Sparing represents approximately 10% of the primary user data space.

If the currently mounted media is 12 cm DVD+RW and a new format is requested, the Number of Blocks parameter shall have either the value 0xFFFFFFFF (for normal use) or 0xFFFF0000 (for extensive use). If the field contains any other value, the drive shall terminate the command with CHECK CONDITION status and set sense data to ILLEGAL REQUEST, INVALID FIELD IN PARAMETER BLOCK (05/26/00). Spare area 1 is always 4 096 sectors in length. When the Number of Blocks value is 0xFFFFFFFF, spare area 2 is 61 440 in length. In this case, sparing represents approximately 3% of the primary user data space. When the Number of Blocks value is 0xFFFF0000, spare area 2 is 258 048 in length. In this case, sparing represents approximately 13% of the primary user data space.

The host may suspend a format in progress operation by issuing the CLOSE TRACK/SESSION Command.

For a Restart Format request, the MRW drive shall continue a suspended background format. If the mounted medium is fully MRW formatted or if a MRW format is in progress, the MRW drive shall terminate the command with GOOD status. If the mounted medium is not MRW formatted/formatting, the MRW drive shall terminate the command with CHECK CONDITION status and set sense data to ILLEGAL REQUEST, COMMAND SEQUENCE ERROR.

Certification of the format is based upon current medium status as shown in Table 17.

Table 17 - Use of DCRT when MRW Formatting

Current Disc Status	DCRT = 0	DCRT = 1
Physically Blank	Write entire surface format, verify MRW structures and user areas	Write entire surface format, verify only MRW structures
Written, but not MRW Formatted (includes logically blank)	Write format, verify MRW structures and user areas. Note: In this case, the *CD-MRW Defect Management & Physical Formatting Specification* and the *DVD+MRW Defect Management & Physical Formatting Specification* require certification of the user area.	
MRW formatted	Reinitialize MRW structures, verify MRW structures and user areas. Note: In this case, the *CD-MRW Defect Management & Physical Formatting Specification* and the *DVD+MRW Defect Management & Physical Formatting Specification* require certification of the user area.	

In all cases when:

- DCRT is cleared to zero,
- the host requests to WRITE the sector at LBA = N, and
- sector N has not yet been verified by the format operation,.

The WRITE command shall be treated as a WRITE and VERIFY command.

4.2.1.1 MRW Background Formatting

Formatting begins with initialization of the disc lead-in and GAA. Once that has completed, the format shall continue in background and the disc is MRW available.

If the IMMED bit (See Table 15) is cleared to zero, the drive shall terminate the command with GOOD status only when the disc becomes MRW available.

If the IMMED bit is set to one, the Format Unit Command shall verify the CDB and all parameters prior to terminating the command with GOOD status. The drive shall proceed with all format-writing functions performed in the background.

If any media accessing command is issued before the medium becomes MRW accessible, the MRW 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 disc has become MRW accessible, the response to a TEST UNIT READY Command shall be GOOD status. If a MRW format is in progress and a REQUEST SENSE command is received while no error condition exists, sense data shall be set to NO SENSE, FORMAT IN PROGRESS (00/04/04). The sense key specific bytes (Table 18) shall be set as a progress indicator.

Table 18 - 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.

Note to Implementers:

> Background formatting should operate without confusing the user. The drive should provide no indication to the user that any operation is in progress. Thus, all drive panel indicators (e.g. LEDs) should indicate no activity.

Once the background format operation has completed (including all surface certifications), the MRW drive shall post a Background Format Completed Media Event. A REQUEST SENSE command shall then report sense data of NO SENSE, NO ADDITIONAL SENSE, NO ADDITIONAL SENSE QUALIFIER, and SKSV shall be cleared to zero.

Whenever a MRW formatted/formatting disc is mounted, the MRW drive shall examine the disc structures. The state of MRW formatting is reported in the Disc Information Block (see clause 4.16).

4.2.1.2 Stopping and Restarting Background Format

If a format is executing in background:

- Only issuing the CLOSE TRACK/SESSION Command may stop the formatting process. See 4.1 for details.
- The inactivity timer (CD-ROM Mode Page) is disabled. This insures that lack of host activity will not allow a spin down during background formatting.
- If the host sends a SCSI command block which requires that the medium spin down, the MRW 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 MRW drive, it shall be executed normally.

The format process may be restarted with a FORMAT UNIT Command in which the MRW format descriptor is sent with the type dependent parameter set to 000001h. If the format has been completed, restarting the background format function shall not be considered and error. The command shall terminate with GOOD status and the BGformatCompleted event shall be posted.

The format process may also be restarted automatically by the drive. See 4.2.1.4.

4.2.1.3 About Write Parameters

When a MRW disc is mounted and recognized by the drive, it shall set write speed and write parameters for best operation of the medium. This shall be done without host intervention. Furthermore, the current parameters of the Write Parameters Mode Page shall not be modified by the drive.

When a CD-RW or DVD+RW disc that does not have the MRW format is mounted and a FORMAT UNIT COMMAND is sent for the purpose of formatting the disc as MRW, the same rule applies.

Specifically, when specifying format type 24h, the host is not required to set Write Parameters prior to sending the FORMAT UNIT Command.

4.2.1.4 Writing During Format Process

Writing to the media during different format states sometimes requires different action by the drive. The cases are shown in Table 19.

Table 19 - Writing During different Format States

State of Format	Write Range	Action By Drive
Completed	All valid user space addresses	The host's data will be written as provided.
Not Complete and running	All valid user space addresses	The host's data shall be written as provided. Format state shall not be changed.
Not complete, not running	Valid user space addresses prior to temporary STA	The host's data shall be written as provided. Format state shall not be changed.
	Valid user space addresses at or beyond start of temporary STA. Note: This includes relocations into a spare area beyond the temporary STA.	The background format shall be restarted using parameters saved in the MTA structures. The BGformatRestarted Media Event shall be posted. The format state is now "Not Complete and Running", so the write shall proceed accordingly.

4.2.1.5 Recovering an Incomplete Format

The background format can be stopped in a controlled way as described in 4.2.1.2, above. An interface level RESET or loss of power can also stop a background format operation, but not in a controlled way. This can produce a disc that is partially formatted, however, it may also contain recoverable data.

A host operated recovery application can be produced in order to recover data from the disc. Since the defect management system may be corrupted, it is recommended that the READ CD MSF be used for data recovery on CD-MRW discs while READ DVD STRUCTURE command be used on DVD+MRW discs.

The *CD-MRW Defect Management & Physical Formatting* specification describes a method for check-pointing the background format progress. If the MTA is not corrupted, then a format restart will restart the formatting operation from the last check-point. If the MTA is corrupted and either the MIP or the MDT is unrecoverable, then a new format is required.

4.2.1.6 Reusing MRW Formatted Discs

A CD-MRW formatted disc is more permanent than other CD-RW media uses. It cannot be reused directly for other applications. The disc may be formatted in a different way that the MRW drive may support. The preferred method is by using the BLANK command to minimally blank the disc.

DVD+RW media must be formatted prior to any writing. In order to reuse a DVD+MRW disc in a different format, the FORMAT UNIT command with the appropriate parameters must be issued.

4.3 GET CONFIGURATION COMMAND

The presence of the MRW Feature adds a new structure into the host/drive interface: The MRW Feature Descriptor. Otherwise, the command operation is unchanged.

4.4 GET EVENT STATUS NOTIFICATION COMMAND

There is no need to modify the GET EVENT STATUS NOTIFICATION Command, however, a new Media Event is needed: Background Format Completed.

The data returned, with a class code 100b, is defined in Table 20.

Table 20 - 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 21.

Table 21 - 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 has been automatically restarted by the drive
7h – Fh	Reserved	

Since MRW drives are capable of generating more than one media event, MRW drives must be capable of queuing media events.

The Media Status byte is defined in Table 22.

Table 22 - 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 Drive. This bit is reported independently from the Door or Tray Open bit. If the 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 Drive to which the media status notification applies. For Drives that do not support multiple slots, this field shall be reserved.

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

4.5 INQUIRY COMMAND

The presence of the MRW Feature has no effect upon the host/drive interface. This command shall function as described in SPC-2.

4.6 MECHANISM STATUS COMMAND

The presence of the MRW Feature has no effect upon the host/drive interface. This command shall function as described in MMC-3.

4.7 MODE SELECT (10) COMMAND

The presence of the MRW Feature adds a new data structure into the host/drive interface. The new MRW Mode Page must be recognized and processed. In all other respects, this Command shall function as described in SPC-2.

4.8 MODE SENSE (10) COMMAND

The presence of the MRW Feature adds a new data structure into the host/drive interface. The new MRW Mode Page must be recognized and processed. In all other respects, this Command shall function as described in SPC-2.

4.9 PREVENT/ALLOW MEDIUM REMOVAL COMMAND

The presence of the MRW Feature has no effect upon the host/drive interface. This command shall function as described in MMC-3.

4.10 READ (10) COMMAND

When using this command, the host references the medium only by LBA. For MRW discs, the drive and the host must be aware of the LBA space referenced: DMA or GAA. The current LBA Space is determined by the setting of the LBA Space bit in the MRW Mode Page (See clause 5.5). In all other respects, this Command shall function as described in MMC-3.

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

When a MRW background format in progress, the drive shall respond to this command as if the format operation has completed.

In some instances, unexpected delays may be occur. If completion of the READ (10) requires more than 7 seconds, it is strongly recommended that the drive terminate the command with CHECK CONDITION status and set SK/ASC/ASCQ to NOT READY/OPERATION IN PROGRESS (02h/04h/07h).

4.11 READ (12) COMMAND

When using this command, the host references the medium only by LBA. For MRW discs, the drive and the host must be aware of the LBA space referenced: DMA or GAA. The current LBA Space is determined by the setting of the LBA Space bit in the MRW Mode Page (See clause 5.5). In all other respects, this Command shall function as described in MMC-3.

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

When a MRW background format in progress, the drive shall respond to this command as if the format operation has completed.

In some instances, unexpected delays may occur. If completion of the READ (12) requires more than 7 seconds, it is strongly recommended that the drive terminate the command with CHECK CONDITION status and set SK/ASC/ASCQ to NOT READY/OPERATION IN PROGRESS (02h/04h/07h).

Note to host implementers:

> MRW formats do not track stream written sectors. It is recommended that host systems track streamed written files independent of the drive. Some file systems support such a capability.

4.12 READ BUFFER CAPACITY COMMAND

The READ BUFFER CAPACITY command is described in MMC-3 as providing correct blank buffer length only for Disc-At-Once, Session-At-Once, and Track-At-Once. For devices that support MRW, this command shall provide accurate blank buffer length when a MRW formatted/formatting disc is present. Otherwise, the presence of the MRW Feature has no effect upon the host/drive interface.

4.13 READ CAPACITY

For MRW formatted/formatting media, capacity is reported based upon the LBA Space selected. The maximum addressable sector in the GAA has LBA = 1023 for both CD-MRW and DVD+MRW.

The maximum LBA on 12 cm DVD+MRW is 21FD1Fh or 1F051Fh, based upon sparing.

The maximum LBA on 8 cm DVD+MRW is 9DF0Fh.

The maximum LBA on CD-MRW is dependent upon the maximum start address for the final lead-out as specified in the lead-in ATIP.

4.14 READ CD COMMAND

When using this command, the host references the medium only by LBA. For MRW discs, the drive and the host must be aware of the LBA space referenced: DMA or GAA. The current LBA Space is determined by the setting of the LBA Space bit in the MRW Mode Page (See clause 5.5).

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

When a MRW background format in progress, the drive shall respond to this command as if the format has completed.

In some instances, unexpected delays may occur. If completion of the READ CD requires more than 7 seconds, it is strongly recommended that the drive terminate the command with CHECK CONDITION status and set SK/ASC/ASCQ to NOT READY/OPERATION IN PROGRESS (02h/04h/07h).

4.15 READ CD MSF

There is no real change to the operation of the READ CD MSF Command, however some clarification is necessary.

Table 23 - Read CD MSF Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code (B9h)							
1	Reserved			Expected Sector Type			Reserved	
2	Reserved							
3	Starting M Field							
4	Starting S Field							
5	Starting F Field							
6	Ending M Field							
7	Ending S Field							
8	Ending F Field							
9	Sync	Headers Code		User	EDC & ECC	Error Flags		Resvd
10	Reserved					Sub-channel Selection Bits		
11	Control							

The Starting MSF must begin not earlier than the start of the first lead-in. Reading prior to 00:00:00 is optional.

The Ending MSF must not end later than 1.5 minutes beyond the maximum start address of the last lead-out of the disc.

The Starting MSF and Ending MSF fields may represent any pair of MSF addresses which exist on the medium. The only requirement is that Ending MSF must lie physically at or later than Starting MSF.

Ending MSF references the first sector that is not to be read.

All other parameters are as defined in MMC-3.

Implementers Note: Reading across some CD structural boundaries may result in data errors.

4.16 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 MRW background format operation. There are 4 possible states. The appropriate value is placed in Disc Information Block in the DBit and Background Format Status fields.

Table 24 - Disc Information Block

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB) Disc Information Length							
1	(LSB)							
2	Reserved			Erasable	State of last Session		Disc Status	
3	Number of First Track on Disc							
4	Number of Sessions (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	Resvd	DBit	BG 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	Disc Application Code							
33	Number of OPC Table Entries							
34 - n	OPC Table Entries							

For MRW Formatted 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.
- Bits 0 and 1 of byte 7 represent BG Format Status. The value gives the Background Format Status of the mounted disc:

  00 Not a background formatted/formatting disc. For each disc that cannot be identified with background format status 01b, 10b, 0r 11b, background format status shall be set to 00b. For example, a blank disc (both physically blank and logically blank) the background format status is 00b.

  01 A background format was started but is not currently running and is not complete. This indicates that the session was closed prior to format completion. The unique identification is background format structures present, but TOC showing lead-out beginning prior to full capacity.

  10 A background format is in progress. A format has been started or restarted and is not yet completed.

  11 Background formatting is completed. When a completely formatted disc is mounted, background format status is set to 11b.

- If the disc is formatted MRW (BG Format Status = 01b, 10b, or 11b), then bit 2 of byte 7 (Dbit) is a copy of the “dirty bit” in the defect table. Otherwise (i.e. when BG Format Status = 00), Dbit 2 is cleared to zero.
- 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.

4.17 READ DVD STRUCTURE COMMAND

The READ DVD STRUCTURE command, Table 25, requests that the DVD Logical Unit transfer data from areas on the DVD Media to the host. There are several control structures on DVD media. Refer to MMC-3 for details on each Format documented there.

Table 25 – READ DVD STRUCTURE Command Descriptor Block

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

4.17.1 Mandatory Format Code Support

A DVD+RW drive shall support the format field codes shown in Table 26.

Table 26: Mandatory DVD+RW Format Codes

Format Code	Description	Reference
00h	Information in the DVD Lead-in area.	MMC-3
01h	The Copyright information from the DVD Lead-in area	MMC-3
03h	The BCA information on DVD media	MMC-3
04h	The Disc Manufacturing information from the DVD Lead-in area	MMC-3
30h	Disc Control Block identified by the Content Descriptor (DVD+(M)RW specific)	MMC-3
FFh	A list of DVD Structures present in the specified Layer	MMC-3

4.17.2 Optional Format Code 31h: Read MTA ECC Block

DVD+MRW introduces a new Format Code, 31h, for reading ECC blocks in the MTA. Support for Format Code 31h is optional since its only purpose is to aid in data recovery on media corrupted by an unexpected RESET or power-off.

If a drive supports Format Code 31h, it shall return data from ECC blocks within the MTA addressed by PSN. A specific ECC block may be read by placing its PSN in the Address field of the CDB. Valid PSNs are 02DE80h through 02EEBFh and 02EFC0h through 02EFFFh. If the Address field contains any other PSN, the command shall be terminated with CHECK CONDITION and sense data shall be set to ILLEGAL REQUEST/INVALID FIELD IN CDB. The Allocation Length field shall not be larger than 32 772. If the Allocation Length field is larger than 32 772, the command shall be terminated with CHECK CONDITION and sense data shall be set to ILLEGAL REQUEST/INVALID FIELD IN CDB.

The format of returned data for Format Code 31h is shown in Table 27.

Table 27 – READ DVD STRUCTURE Data Format (Format field = 31h)

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB) DVD STRUCTURE Data Length							
1								(LSB)
2	Reserved							
3	Reserved							
4 … 32 771	Addressed MTA ECC Block data							

4.18 READ FORMAT CAPACITIES COMMAND

The presence of the MRW Feature has no effect upon the host/drive interface. This command shall function as described in MMC-3.

When CD-RW or DVD+RW media is mounted, a MRW device shall report a Formattable Capacity Descriptor (Table 28) with Format Type = 24h.

Table 28 - Formattable Capacity Descriptor

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

When Format Type = 24h, the Number of Blocks field shall contain the maximum number of DMA addressable blocks for the currently mounted medium. The Type Dependent Parameter is not used and shall be cleared to zero.

4.19 READ TOC/PMA/ATIP COMMAND

The presence of the MRW Feature has no effect upon the host/drive interface when there is no MRW background format in progress. In that case, this command shall function as described in MMC-3. Note, however, track 1 shall be represented according to the special addressing of the MRW format.

4.19.1 TOC Form 0 - Legacy TOC

If the disc is MRW formatted or in progress with MRW formatting, form 0 of the TOC shall be reported as follows: One track, track number = 1, ADR = 0001b, and CONTROL = 0111b. The track start addresses are shown in Table 29.

Table 29 - TOC Form 0 for MRW

Media	LBA Space	MSF bit	Track 1 Start	Lead-out Start
CD-MRW	GAA	0	0	1024
		1	00:02:00	00:18:43
	DMA	0	0	C+1, where C is the LBA of the last user block of the last packet in the DMA.
		1	00:22:60	Regardless of the state of the MRW formatting process, only final state is reported. The absolute address of the final state link block separating the last DMA packet and the first STA packet is reported.
DVD+MRW	GAA	0	0	1024
		1	00:02:00	00:15:49
	DMA	0	0	C+1, where C is the LBA of the last user block of the last ECC block in the DMA.
		1	01:10:20	8 cm: 91h:08h:04h, 12 cm: FFh:3Bh:4Ah

4.19.2 TOC Form 1 - Multi-session TOC

If the disc is MRW formatted or in progress with MRW formatting, form 1 of the TOC shall be reported as follows: One session = 1, ADR = 0001b, CONTROL = 0111b, First track number in last session = 1, and the track 1 start address is given according to Table 29.

4.19.3 TOC Form 2 - Full TOC

If the disc is a CD-RW that is MRW formatted or in progress with MRW formatting, form 2 of the TOC shall be constructed to contain the values expected when formatting has completed.

If the disc is DVD+RW, TOC form 2 is not defined. The command shall be terminated with CHECK CONDITION status and sense shall be set to ILLEGAL REQUEST/INVALID FIELD IN CDB.

4.19.4 TOC Form 3 - PMA

If the disc is a CD-RW that is MRW formatted or in progress with MRW formatting, form 3 of the TOC shall be constructed to contain the values expected when formatting has completed.

If the disc is DVD+RW, TOC form 3 is not defined. The command shall be terminated with CHECK CONDITION status and sense shall be set to ILLEGAL REQUEST/INVALID FIELD IN CDB.

4.19.5 TOC Form 4 - ATIP

If the disc is a CD-RW that is MRW formatted or in progress with MRW formatting, there is no change to form 4 of the TOC.

If the disc is DVD+RW, TOC form 4 is not defined. The command shall be terminated with CHECK CONDITION status and sense shall be set to ILLEGAL REQUEST/INVALID FIELD IN CDB.

4.19.6 TOC Form 5 - CD-Text

CD-Text is valid only for audio discs and is therefore not supported for MRW discs. If the host requests TOC Form 5, the READ TOC/PMA/ATIP shall be terminated with CHECK CONDITION status and sense data shall be set to ILLEGAL REQUEST/INVALID FIELD IN CDB.

If the disc is DVD+RW, TOC form 5 is not defined. The command shall be terminated with CHECK CONDITION status and sense shall be set to ILLEGAL REQUEST/INVALID FIELD IN CDB.

4.20 READ TRACK INFORMATION COMMAND

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

When a MRW background format in progress, the drive shall respond to this command as if the format has completed. The content of the Track Descriptor Blocks is specified in Table 30.

Table 30 - TDB Content for CD-MRW Discs

TDB Field	Track 0 (Lead-in)	Track 1
Data Length	34	34
Track Number	0	1
Damage	0	0
Copy	0	0
Track Mode	0111h	0111h
RT	1	1
Blank	0	0
Packet	0	1
FP	0	1
Data Mode	2	2
LRA_V	0	0
NWA_V	0	0
Track Start Address	CD-MRW: ATIP start time of lead-in converted to LBA (negative) DVD+MRW: FFFFDE80h	00000000h
Next Writable Address	N/A	N/A
Free Blocks	0	0
Fixed Packet Size	N/A	32
Track Size	CD-MRW: 450 000 - Track Start Address+150 DVD+MRW: 8575	Value from Read Capacity Command
Last Recorded Address	NA	NA

4.21 REQUEST SENSE

The presence of the MRW Feature has no effect upon the host/drive interface when there is no MRW background format in progress (i.e. format progress reporting). In that case, this command shall function as described in SPC2.

New sense codes are needed for the MRW 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 5Dh. The ASCQ values of 80h through 0FEh are only for vendor unique reports.

Table 31 - SMART Oriented Sense Codes

Sense Key	ASC	ASCQ	Meaning
03	32h	00	No defect spares are available, relocation required
01	5Dh	01	No defect spares are available, no relocation required.
01	5Dh	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 Fault/Failure Reporting Page.

4.22 SEND OPC INFORMATION COMMAND

The presence of the MRW Feature has no effect upon the host/drive interface. This command shall function as described in MMC-3.

4.23 SET CD SPEED COMMAND

MRW The presence of the MRW Feature has no effect upon the host/drive interface. This command shall function as described in MMC-3.

4.24 START/STOP UNIT COMMAND

The presence of the MRW Feature has a small effect upon the host/drive interface. When a MRW background format is in progress and this command is issued requesting a media spin-down (Start = 0), the MM device 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).

4.25 SYNCHRONIZE CACHE COMMAND

The presence of the MRW Feature has no effect upon the host/drive interface. This command shall function as described in MMC-3.

4.26 TEST UNIT READY COMMAND

The presence of the MRW Feature affects the host/drive interface during background format. While background format is in progress, execution of the TEST UNIT READY command will cause sense data set to NO SENSE, FORMAT IN PROGRESS. Furthermore, the sense key specific data is set to reflect a format progress indication.

4.27 VERIFY (10) COMMAND

The host references the medium only by LBA when using this command. For MRW discs, the drive and the host must be aware of the LBA space referenced: DMA or GAA. The current LBA Space is determined by the setting of the LBA Space bit in the MRW Mode Page (See clause 5.5).

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

When a MRW background format in progress, the drive shall respond to this command as if the format has completed.

4.28 WRITE (10) COMMAND

The host references the medium only by LBA when using this command. For MRW discs, the drive and the host must be aware of the LBA space referenced: DMA or GAA. The current LBA Space is determined by the setting of the LBA Space bit in the MRW Mode Page (See clause 5.5).

Since the host may be able to send data at significantly higher speeds than the drive is able to write, it is always possible that write data may overrun the drive's buffer. In the event that the interface is ATAPI, this action will insure that the interface is not made unavailable for an extended period of time. The Host should use the READ BUFFER CAPACITY command to avoid this condition.

If the Host does not use the READ BUFFER CAPACITY command to avoid the buffer overrun condition, the drive may implement another mechanism to avoid the problem. If the drive detects that a WRITE (10) command will overrun the buffer, it may terminate the command with CHECK CONDITION status and set SK/ASC/ASCQ to NOT READY/LONG WRITE IN PROGRESS (02h/04h/08h).

4.29 WRITE (12) COMMAND

The host references the medium only by LBA when using this command. For MRW discs, the drive and the host must be aware of the LBA space referenced: DMA or GAA. The current LBA Space is determined by the setting of the LBA Space bit in the MRW Mode Page (See 5.5). In all other respects, this Command shall function as described in MMC-3.

Since the host may be able to send data at significantly higher speeds than the drive is able to write, it is always possible that write data may overrun the drive's buffer. In the event that the interface is ATAPI, this action will insure that the interface is not made unavailable for an extended period of time. The Host should use the READ BUFFER CAPACITY command to avoid this condition.

If the Host does not use the READ BUFFER CAPACITY command to avoid the buffer overrun condition, the drive may implement another mechanism to avoid the problem. If the drive detects that a WRITE (12) command will overrun the buffer, it may terminate the command with CHECK CONDITION status and set SK/ASC/ASCQ to NOT READY/LONG WRITE IN PROGRESS (02h/04h/08h).

4.30 WRITE and VERIFY (10) COMMAND

The host references the medium only by LBA when using this command. For MRW discs, the drive and the host must be aware of the LBA space referenced: DMA or GAA. The current LBA Space is determined by the setting of the LBA Space bit in the MRW Mode Page (See 5.5). In all other respects, this Command shall function as described in SBC.

5 MODE PAGES

MRW compliance requires that the device support several mode pages according to the reported feature list. These mode pages are listed in Table 32.

Table 32 - Mandatory Mode Pages for MRW Compliance

Mode Page	Page Code	Associated Feature(s)
Capabilities & Mechanical Status Page	2Ah	Legacy - no associated features
CD Device Parameters Page	0Dh	Legacy - no associated features
Fault/Failure Reporting Control Page	1Ch	SMART
Read/Write Error Recovery Page	01h	Random Readable, Random Writable, Defect Management
MRW Mode Page	03h	MRW
Power Condition Mode Page	1Ah	Power Management
Time-out and Protect Mode Page	1Dh	Time-out

5.1 Capabilities & Mechanical Status Page

The presence of the MRW Feature has no effect upon the host/drive interface with respect to this mode page. This mode page shall be processed as described in MMC-3.

5.2 CD Device Parameters Page

The presence of the MRW Feature has no effect upon the host/drive interface with respect to this mode page. This mode page shall be processed as described in MMC-3.

5.3 Fault/Failure Reporting Page

The Fault/Failure Reporting Page defines the methods used by the drive to control the reporting and the operations of specific informational exception conditions. This page shall apply only to informational exceptions that report CHECK CONDITION Status with sense data set to RECOVERED ERROR/FAILURE PREDICTION THRESHOLD EXCEEDED.

MM devices that do not support the SMART Feature shall not implement this mode page. MM devices that support writing the MRW format shall support the SMART Feature and may support this mode page.

When implemented, this mode page shall be processed as described in MMC-3.

5.4 Read/Write Error Recovery Parameters Page

The default values for ARRE and AWRE are 0 and 1 respectively. The use of this mode page for the MRW format on CD-RW is defined in MMC-3. The meanings of the parameters are not changed when applied to the MRW format on CD-RW and DVD+RW media.

5.5 MRW Mode Page

The MRW Mode Page (Table 33) provides a method by which the host can control the special features of a MRW drive.

Table 33 - MRW Mode Page

Bit / Byte	7	6	5	4	3	2	1	0
0	PS	Resvd	Page Code (03h)					
1	Page Length (06h)							
2	Reserved							
3	Reserved							LBA Space
4	Reserved							
5	Reserved							
6	Reserved							
7	Reserved							

The Page Code is documented in MMC-3 as 03h. Earlier versions may have used the vendor unique Page Code 2Ch. The use of Page Code = 2Ch is obsolete.

If the currently mounted medium is a MRW disc, then the value of LBA Space takes on the following meanings:

0b the drive shall reference the DMA for all LBA space reads and writes.

1b the drive shall reference the GAA for all LBA space reads and writes.

After power-on, the LBA Space value shall be cleared to zero. After a reset, the LBA Space value shall be cleared to zero. After a new medium is mounted, the LBA Space value shall be cleared to zero. This assures that the default LBA Space is always the DMA.

Whenever the host changes the LBA Space bit, the drive shall generate a Morph Event to indicate that the currency of features has changed.

5.6 Power Condition Mode Page

The presence of the MRW Feature has no effect upon the host/drive interface with respect to this mode page. This mode page shall be processed as described in MMC-3.

5.7 Time-Out And Protect Mode Page

The presence of the MRW Feature has no effect upon the host/drive interface with respect to this mode page. This mode page shall be processed as described in MMC-3.

5.8 Write Parameters Mode Page

The MRW device shall not use the Write Parameters Mode Page values for operations on a MRW disc. When a MRW disc is mounted and recognized by the drive, it shall set write speed and Write Parameters as appropriate for the medium. This shall be done without host intervention. Furthermore, the current parameters of the Write Parameters Mode Page shall not be modified by the drive.

As always, the host is free to change the Write Parameters Mode Page. MRW disc operation shall not be affected by changes to the Write Parameters Mode Page.

6 USING MRW MEDIUM

6.1 Using CD-MRW

This medium could be mounted in several system combinations: drive and host software. Of course, when all parties are aware of MRW formatted CD-RW media, then there should be no misunderstandings. There is an installed base of drives and software that will recognize this medium differently. Each combination is highlighted here. The greatest attention is given to host and drive interaction when the two components are both Mount Rainier capable.

COMBINATIONS		SOFTWARE	
		Legacy Software System	MRW Aware Software System
HARDWARE	Legacy CD-ROM drive (Multi-read capable)	1A	1B
	MRW Compliant CD-ROM drive	2A	2B
	Legacy CD-RW drive (at least MMC1)	3A	3B
	MRW Compliant CD-RW drive	4A	4B

The Legacy hardware cannot be “too old”. There are some minimal requirements:

- Drives must be minimally compliant with OSTA Multi-read in order to read CD-RW medium.
- Both CD-ROM and CD-RW Drives must be minimally compliant with MMC1.
- A DVD-ROM drive, which meets the first 2 requirements when CD-RW medium is mounted, may be viewed as an acceptable legacy CD-ROM drive.

The Legacy software must be presumed to be maximally capable with its companion hardware:

- In the case of reading, the legacy system software is capable of reading information stored in standard file systems (e.g. ISO9660, UDF, Joliet).

Note: It is only for the sake of completeness that we describe what might happen in cases 1A, 1B, 3A, and 3B. Nothing can be done within this document to make the legacy situations operate better. That work has been done in the format definition document: MRW Defect Management & Physical Formatting revision 1.0

6.1.1 Combinations 1A, 1B: Legacy CD-ROM Drive

The legacy CD-ROM drive will see a MRW disc as having a single, closed session that contains a single fixed packet track with length 32 packets. This drive sees this disc as having a single LBA space that begins at LBA = 0 (00:02:00). The LBAs continue upward, following method 2 addressing (according to Orange Book).

6.1.1.1 With Legacy Software

If no file system was placed within the GAA, then the host shall declare that this disc is not initialized in any recognizable way.

If some file system, recognizable by the system software was placed within the GAA, then it exists entirely within the GAA and makes no references into the DMA. No relocations have been made within the GAA, so there is no loss. The file system within the GAA may contain automatic run software that can provide some special function for the user. Minimally, this shall contain information as described in the CD-MRW DM & PF.

6.1.1.2 With Mount Rainier Aware System Software

Note that software which can recognize and read MRW from a legacy drive must operate differently than software which expects a MRW capable drive:

In the first case, the system software must perform address translations and defect insertions

In the second case, all LBA translations and defect replacements are already done by the drive.

6.1.2 Combinations 2A, 2B: MRW Compliant CD-ROM Drive

When the drive is capable of correctly reading a MRW disc, the system software will initially see only the LBA Space defined by the DMA. Both legacy and MRW system software will see only the file system installed in the DMA.

The primary difference with a read-only system is GAA access. The legacy software is unaware of the existence of the GAA and will not know how to address it. The MRW compliant system software will be able to switch addressing to the GAA.

6.1.3 Combinations 3A, 3B: Legacy (MMC1) CD-RW Drive

The legacy CD-RW drive is unaware of the MRW format and will present the disc to the host as a single session with one fixed packet written track in which the packet size is 32 and the block type is mode 2, form 1.

6.1.3.1 With Legacy System Software

See 3.1.1. With this combination: this drive can write and the legacy system software knows how to ask it to write.

6.1.3.2 With Mount Rainier System Software

See 3.1.2. In this case, the Mount Rainier aware software is aware of the unit's inability to perform defect management and sector-addressable writes, and shall force read-only access to the medium.

6.1.4 Combinations 4A, 4B: MRW Compliant CD-RW drive

The most important of these combinations is the case where the system software is Mount Rainier aware.

6.1.4.1 With Legacy System Software

Since the system software is not aware of how to enable writing, the drive effectively becomes a CD-RW drive.

6.1.4.2 With MRW Aware System Software

Since this represents the future, a great deal of attention needs to be given to how the drive should implement the updated MMC and how the system software can use the command set to fully utilize the MRW format. This is described from the host perspective.

6.1.4.2.1 Determining the Format State of a New Media

When a new medium is mounted, a media event is generated. This event is typically discovered by polling with the Get Event Status Notification Command (GESN).

6.1.4.2.1.1 Case: Discovering that the Media is Formatted/Formatting as a MRW Disc

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 CD-RW Profile and MRW Features as current.

The READ DISC INFORMATION Command is issued.

It is discovered that the MRW format status is non-zero.

If formatting was started earlier and needs restarting, then the status is 01b.

If formatting was started earlier and is still running, then the status is 10b.

If formatting has completed, then the status is 11b.

6.1.4.2.1.2 Case: Discovering Blank 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 CD-RW Profile as current and MRW Feature as not current or not supported.

The READ DISC INFORMATION Command is issued.

It is discovered that the media is RW, BLANK, and the MRW state is 00b.

We may now conclude that a format is required before this medium may be used as a MRW disc.

6.1.4.2.1.3 Case: Discovering Non-Blank Media which is not a MRW disc

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 CD-RW Profile as current and MRW Feature as not current or not supported.

The READ DISC INFORMATION Command is issued.

It is discovered that the media is RW, not BLANK, and the MRW state is 00b.

We now conclude that a new format is required before this medium may be used as a MRW CD-RW disc.

When the time arises to access a disc for writing, we now know the answer to the question: Must we format this disc?

6.1.4.2.2 Doing the Format

If it is determined that the currently mounted medium requires formatting before it may be used, and the user desires to format the medium, then:

The parameter list for a FORMAT UNIT Command is initialized for Format Type 24h, MRW. We prefer to have the IMMED bit cleared to zero. The FORMAT UNIT Command is then issued. The FORMAT UNIT Command should not terminate until the track 1 PMA entry, the track 1 pre-gap, the GAA and the first SA have been written. This assures no waiting for additional action before writes are accepted. The total elapsed time for a drive with 4x write capability is less than 10 seconds.

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. For a 4x writing system, the medium will be ejected within 1 minute after the user's media removal request was noted.

6.1.4.2.2.1 Writing User Data to the Medium During Background Format

Once the FORMAT UNIT Command has completed, the host may issue WRITE(10) commands for the purpose of initializing the logical volume (e.g. writing initial file system structures). That is, the host is not required to perform any special functions or sequences of functions in order to write to the medium. But note: When reading this medium Read(10) and Read(12) commands are guaranteed to be accepted. The host must check the CD READ feature to determine if the READ CD and/or READ CD MSF commands are supported.

Note that in order to write the GAA, the MRW Mode Page must be written for addressing that area.

6.1.4.2.2.2 Completing a Format

Suppose that a disc was mounted and our medium identification discovered a disc with incomplete background format. We may issue a new FORMAT UNIT Command with the Format Descriptor that indicates that we only wish to continue the background format. There are good reasons to NOT do that.

Suppose a format has begun or a format restart is requested, then sometime after the background part of the format has begun, a CLOSE SESSION is requested in preparation for medium eject. The time required to stop the background format and then close the disc can be up to 30 seconds.

It is possible that a partially formatted disc is mounted only for reading. The host knows best when to restart BG format, so the host must initiate the BG format restart.

6.1.4.2.2.3 Early Eject

Above, it was noted that the host is in charge of when a restart format is started. We must clearly specify that it is very much the job of the host to assure that the disc is ejected in a usable state. For this reason the drive must not take independent action to stop the formatting or close the session. However, the drive is the last place when formats can be protected, so the drive is responsible to disallow improper action. The drive will simply disallow media spin-down or eject when a background format is in progress. The behaviour is described in section 4.2.1.1.

6.2 Using DVD+MRW

Host usage of the DVD+MRW format as a data interchange disc is more like a removable magnetic medium than the streamed character of most CD and DVD formats. There are differences due to the multi-use capability of the DVD+RW media.

6.2.1 Determining the Format State of a New Media

When a new medium is mounted, a media event is generated. Polling with the Get Event Status Notification Command (GESN) typically discovers this event.

6.2.1.1 Case: Discovering that the Media is Formatted/Formatting as a MRW Disc

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 and MRW Features as current.

The READ DISC INFORMATION Command is issued.

It is discovered that the Background format status is non-zero.

If formatting was started earlier and needs restarting, then the status is 01b.

If formatting was started earlier and is still running, then the status is 10b.

If formatting has completed, then the status is 11b.

6.2.1.2 Case: Discovering Blank 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 and MRW Feature as not current or not supported.

The READ DISC INFORMATION Command is issued.

It is discovered that the media is RW, BLANK, and the MRW state is 00b.

We may now conclude that a format is required before this medium may be used as a MRW disc.

6.2.1.3 Case: Discovering Non-Blank Media which is not a MRW disc

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 and MRW Feature as not current or not supported.

The READ DISC INFORMATION Command is issued.

It is discovered that the media is RW and not BLANK.

We now conclude that a new format is required before this medium may be used as a MRW disc.

6.2.2 Formatting

If it is determined that the currently mounted medium requires formatting before it may be used, and the user desires to format the medium, then:

The parameter list for a FORMAT UNIT Command is initialized for Format Type 24h, MRW. We prefer to have the IMMED bit cleared to zero. The FORMAT UNIT Command is then issued. The FORMAT UNIT Command shall not terminate until the MTA and the GAA have been initialized. 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.

6.2.2.1 Writing User Data to the Medium During Background Format

Once the FORMAT UNIT Command has completed, the host may issue WRITE commands for the purpose of initializing the logical volume (e.g. writing initial file system structures). That is, the host is not required to perform any special functions or sequences of functions in order to write to the medium.

Note that in order to write the GAA, the MRW Mode Page must be written for addressing that area.

6.2.2.2 Reading User Data from the Medium During Background Format

Whenever the host requests information that reports capacity in any way, the drive shall respond as if the format had completed. For this reason, all addresses within the range of the currently active MRW address space shall be made to appear accessible by the host.

For each requested sector that has already been written either by the host or the format process, the drive shall return the written data.

For each requested sector that has not yet been written by either the format process or the host (since the format process began) the drive shall return data as if the format process had written the sector.

6.2.2.3 Completing a Format

Suppose that a disc was mounted and our medium identification discovered a disc with incomplete background format. We may issue a new FORMAT UNIT Command with the Format Descriptor that indicates that we only wish to continue the background format. There are good reasons to NOT do that.

Suppose a format has begun or a format restart is requested, then sometime after the background part of the format has begun, a CLOSE SESSION is requested in preparation for medium eject. The time required to stop the background format and then close the disc can be up to 30 seconds.

It is possible that a partially formatted disc is mounted only for reading. The host knows best when to restart BG format, so the host must initiate the BG format restart.

6.2.2.4 Early Eject

Above, it was noted that the host is in charge of when a restart format is started. We must clearly specify that it is very much the job of the host to assure that the disc is ejected in a usable state. For this reason the drive must not take independent action to stop the formatting or close the session. However, the drive is the last place when formats can be protected, so the drive is responsible to disallow improper action. The drive will simply disallow media spin-down or eject when a background format is in progress.

6.2.3 Accessing the Media

Once the formatting process has reached the point that the background format status is either "format in progress" regardless of the running condition, the entire address space of the currently addressed MRW Address space is available to the host. So, reading and writing after the format has completed is no different than reading and writing during the format process.

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