CD-RW

Multi-Media Command Set Modifications for the Mount Rainier RW Format

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1 INTRODUCTION

The Mount Rainier Initiative is a plan for the simplification of CD-R/RW devices and media usage. A new CD-RW medium format with requirements for support of defect management by the device is defined in the Mount Rainier document: *CD-RW* Defect Management & Physical Formatting. This document refers to the new format as simply, Mount Rainier RW.

The Multi-Media Command set (MMC) must be modified in order to support this new format in such a way that the device has behaviour common to removable medium, random access, fixed block devices. The bulk of this document is dedicated to detailing the changes to the MMC. The baseline for changes is MMC2. The target for changes is MMC3.

Standards typically offer many options for one general behavior. The simplification goal demands that the number of options be made minimal. So, we wish to present a single host system method for using this new format.

1.1 REFERENCES

Current MMC2 references apply. The following are additions for the MMC3 standard.

Mount Rainier RW Defect Management & Physical Formatting revision 1.0, Mount Rainier Promoters Group, September 2000

Multi-Media Command Set Modifications, revision 1.0, Mount Rainier Promoters Group, September 2000

SCSI Primary Command Set - 2 (SPC-2) [NCITS T10/1236D]

SFF-8090I Mt Fuji Multi-Media Commands, Version 4, March 2000

1.2 ABBREVIATIONS AND DEFINITIONS

The following are additions to the MMC3 standard.

Data Area (DA)

A Mount Rainier RW disc stores user data in these zones of the program area. With the exception of the last DA, each DA contains 136 packets. The last DA contains only the remaining undedicated packets in the sequence of

Defect Managed Area (DMA)

A Mount Rainier RW disc contains a logical address space that is completely covered by the defect management system of the Mount Rainier RW format. This logical address space is the Defect Managed Area.

General Application Area (GAA)

When a CD-RW disc is formatted as a Mount Rainier RW disc, the GAA consists of the first 32 packets in the program area. This area is not covered by the Mount Rainier defect management mechanism.

Main Defect Table (MDT)

A Mount Rainier RW disc stores its defect mappings and other format management information in this structure that is written in the disc lead-in.

Main Table Area (MTA)

This is the disc area in which the MDT is packet written.

Spare Area (SA)

Each DA is preceded by an associated 8 packet zone which is reserved as the primary spares space for the DA that it precedes. Each of these is a Spares Area.

Secondary Defect Table (SDT)

The Mount Rainier RW format requires a back-up copy of the MDT in the program area of the disc. This back-up copy is the SDT.

Secondary Table Area (STA)

This is the disc area in which the SDT is packet written. 34 packets are reserved for this area.

2 MMC MODIFICATIONS

The changes required to MMC (version 2) are somewhat layered:

- Model section:

  An addition to the CD Model is needed in order to describe the new Mount Rainier RW format and its use.

- Features and Profiles section:

  The Mount Rainier compliant CD-RW drive will claim the Removable Disk Profile. That profile requires the Formattable and Defect Management Features.

  A new feature is required to claim recognition and compliance with the Mount Rainier RW format. The SMART feature is made mandatory in order to provide compatibility other, similar devices.

- Changes to commands section:

- The READ CAPACITY, READ-10, READ-12, READ CD, WRITE-10, WRITE-12, WRITE AND VERIFY and READ CD Commands reference sectors only by LBA. A Mount Rainier RW disc has two addressable areas. So, although each of these commands essentially operates as before, both the drive and the host must be aware of the current address space.
- The READ FORMAT CAPACITIES Command will be given a new format type (and descriptor) for the Mount Rainier RW disc.
- The FORMAT UNIT Command must be expanded to include this new format type. Background formatting is an automatic feature included with this new format type. Since we must make the media available to the user prior to format completion, we shall need a suspension mechanism and a restarting mechanism.
- The CLOSE TRACK/SESSION Command will be expanded in order to provide a special case for a background format suspend function.
- The GET EVENT STATUS NOTIFICATION Command will be assigned a new Media Class Event: Background Format Completed.
- The WRITE AND VERIFY Command is mandatory for Mount Rainier compliant drives

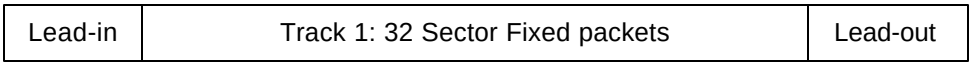
- Changes to mode pages section:

- The READ/WRITE Error Recovery Mode Page has no real changes, but its use by CD-RW drives is changing with the Mount Rainier RW format.
- The Mount Rainier RW Mode Page is new. At this time it carries only the LBA Space bit. This bit identifies the current LBA space for the drive.
- The WRITE PARAMETERS Mode Page has a large number of parameters. When a Mount Rainier RW disc is mounted, the drive shall automatically set all parameters to specific default values. We'll need to define those defaults.
- The Fault/Failure Reporting Page is a optionally present since the SMART feature allows for fault monitoring parameter adjustments by the host. Defaults are well defined.

2.1 THE MOUNT RAINIER RW MODEL

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

Figure 1: Track/Session Structure of a Mount Rainier RW Disc

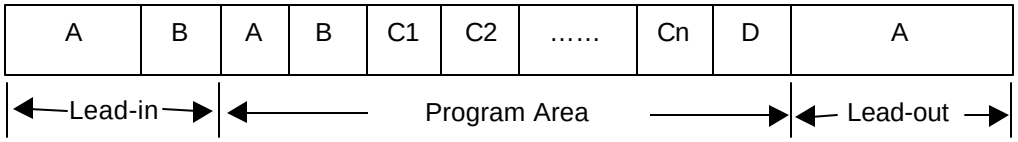


The differences are subtle.

2.1.1 Additional Structure

The Mount Rainier RW disc does have this format, but the *Mount Rainier RW Defect Management & Physical Formatting* requires additional features, built upon the basic format (Figure 2).

Figure 2: The Additional Structure



Lead-in, Part A	TOC, no change
Lead-in, Part B	TOC (in sub-channel) Q along with main defect management table (MT) in main channel. This is a big change. Prior to Mount Rainier RW, the lead-in has always been recorded track-at-once. With this new format, it is recorded as fixed packets. The MT use begins with the packet that precedes the pre-gap. When needed, the MT use area grows backward toward the disc center.
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 spares 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	Secondary DM maps: 34 packets reserved for secondary copies of the DM maps.
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 – 32 – 34 = P – 66. 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 pre-Mount Rainier RW disc.

The GAA is available for compatibility with older systems. The GAA LBA space is 0, 1, 2, 3, …, 1023d. Note that LBAs for the GAA exactly match LBAs for a similarly formatted pre-Mount Rainier RW disc.

2.1.2 Addressing

When method 2 addressing is used, the LBA of the first sector of the DMA is at the pre-Mount Rainier RW LBA of (32 + 8)*32 = 1280d. The following table shows the most inequities with pre-Mount Rainier RW LBA:

Pre-Mount Rainier RW LBA	Mount Rainier RW LBA
0	GAA 0
1	GAA 1
2	GAA 2
.	.
.	.
1023	GAA 1023

Pre-Mount Rainier RW LBA	Mount Rainier RW LBA
1280	DMA 0
1281	DMA 1
1282	DMA 2
.	.
.	.
5631	DMA 4351

Pre-Mount Rainier RW LBA	Mount Rainier RW LBA
4608	DMA 4352
4609	DMA 4353
4610	DMA 4354
.	.
.	.
8959	DMA 8703

There is a small problem: there are two LBA spaces where we formerly had only one. How does the host tell the drive which LBA space to use? There is a Mount Rainier RW Mode Page used for that selection.

The host may toggle between address spaces (DMA and GAA) by changing the drive's reference in the Mount Rainier RW Mode Page.

2.1.3 Host Requests/Drive Responses

The host may view the Mount Rainier RW disc as a removable magnetic medium with a 2048 byte sector size. This means that the random read capability of MMC is to be maintained and expanded to include the Mount Rainier RW disc.

Additionally, random write capability must be added specifically for the Mount Rainier RW disc. Within the drive, only the writing of 32 sector fixed packets is allowed. MMC1 and MMC2 drives share this restriction with their hosts. When Mount Rainier RW disc is present, the Mount Rainier RW compliant drive must not share this restriction with its host. This is a simple matter of implementing a read/modify/write for packets.

2.2 FEATURE AND PROFILE CHANGES

2.2.1 A New Feature: Mount Rainier RW Feature

We have a new drive feature: support for the Mount Rainier RW Feature. So, we'll need a new feature descriptor. It follows:

Table 1: Mount Rainier RW Feature Descriptor

Bit / Byte	7	6	5	4	3	2	1	0
0	Feature Code = 0028h							
1								
2	Reserved		Feature Version = 0000b				Persistent	Current
3	Additional Length = 4							
4	Reserved							Write
5	Reserved							
6	Reserved							
7	Reserved							

The presence of the Mount Rainier RW Feature indicates that the drive is capable of reading a CD-RW disc with the Mount Rainier RW format.

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

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

Note: The MMC2 references above carry the following meanings:

Since CD-RW medium is removable, Persistent is cleared to zero. When Current = 0, either no disc is mounted or the disc currently mounted is not a Mount Rainier RW disc. When Current = 1, a disc is mounted and it is a Mount Rainier RW disc.

The Additional Length field shall be set to 04h.

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

If the Write bit is set to one, then the drive is also capable of formatting CD-RW discs in the Mount Rainier RW format and is capable of writing CD-RW discs that have been Mount Rainier RW formatted. When the Write bit is set to one, then the drive must list all features required of the CD-RW Profile as well as the Random Write Feature.

Table 2: Mount Rainier RW Feature Commands

Op Code	Command Description	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	Always
2Ah	Write-10	Only when Write = 1
2Eh	Write and Verify-10	Only when Write = 1
2Fh	Verify-10	Always
B9h	Read CD MSF	Always
25h	Read Capacity	Always
23h	Read Format Capacities	Always

The Mount Rainier RW Mode Page is required.

2.2.2 Feature Code Reservation

In order to provide for expansion for format definitions in future Mount Rainier actions, we shall reserve feature codes 0029h through 002Ch.

2.2.3 The SMART Feature

This Feature identifies a drive that implements Self Monitoring Analysis and Reporting Technology (SMART). The SMART is present to give the host early warning about impending failures. In the case of the Mount Rainier compliant drive, the failure prediction is primarily oriented toward CD-RW 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 Mount Rainier compliant drives. The Fault/Failure Reporting Page (1Ch) is optional.

Table 3: 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 defined as in MMC2 sub-clause 5.2.2. This bit shall be set to zero if the medium is removable.

The Current bit shall be defined as in MMC2 sub-clause 5.2.3.

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.

2.2.4 Profiles: Including the Mount Rainier RW Features

A CD-RW device that reports the Mount Rainier RW Descriptor, is still a CD-RW device as defined by the MMC2 profiles, so its profile is essentially unchanged. This means that the Mount Rainier initiative does not define any new profiles. Our host must be aware of the extra feature in order to recognize and use the Mount Rainier capabilities.

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

Note: It might seem reasonable to recommend that the MMC3 redefine the CD-ROM and CD-RW profiles to include the Mount Rainier RW feature. That is not necessary. Once the Mount Rainier RW Feature becomes an expectation of the marketplace, the feature shall likewise be an expected requirement of the CD-RW profile.

2.3 COMMANDS

For a drive that reports the Mount Rainier RW feature with Write capability, the commands listed in Table 4 require additional description in support of the Mount Rainier RW format:

Table 4: Commands Affected by Mount Rainier Support

COMMAND	UNIQUE BEHAVIOUR
Close Track/Session (5Bh)	Used for stopping a Mount Rainier RW background format operation and leaving the disc in an identifiable state.
Format Unit (04h)	Support of the Mount Rainier RW format descriptor together with background formatting is a new requirement for this feature.
Get Event/Status Notification (4Ah)	GESN has an additional media event for reporting the completion of a background format of a Mount Rainier RW disc.
Read-10 (28h) Read-12 (A8h) Read Capacity (25h) Read CD (BEh) Write-10 (2Ah) Write and Verify-10 (2Eh) Verify-10 (2Fh)	Each of these are used to access the medium only by logical block address (LBA). Mount Rainier RW medium has two possible LBA Spaces. The Mount Rainier RW Mode Page identifies the current LBA Space for each of the commands listed above. Each of these commands must attach their execution to the LBA Space thus identified.
Read CD MSF (B9h)	must extend its required reference range into the lead-in.
Start / Stop Unit (1Bh)	If background formatting is in progress, this command shall be terminated with a CHECK CONDITION and sense data shall be set to NOT READY, FORMAT IN PROGRESS (02/04/04). This shall occur regardless of prevent status.
Read Format Capacities (23h)	requires an additional format descriptor for the formatting a Mount Rainier RW disc.

2.3.1 CLOSE TRACK/SESSION COMMAND

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

Table 5: Close Track/Session Command Descriptor Block

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

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

The Session and Track bits have the following meanings:

Session = 0, Track = 0

Reserved, not valid.

Session = 0, Track = 1

Close the track associated with the track number in the CDB. For CD, If this is:

- a blank reserved track, the CD-RW Drive shall pad to the entire track according to the write Parameters Mode Page. If the Write Parameters Mode Page is inconsistent with the PMA, this command shall be terminated with a CHECK CONDITION status and the sense data shall be set to ILLEGAL REQUEST, ILLEGAL MODE FOR THIS TRACK .
- a partially written reserved track, the CD-RW Drive shall pad according to the track TDB.
- the invisible track, the CD-RW Drive shall pad according to the Write Parameters Mode Page to the minimum length of 4 seconds. No other padding is to be done.

In all pad cases, Main Channel in the pad sectors shall be zero filled.

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

Session = 1, Track = 0

Close the last session. If there is no background format in progress:

If not all Tracks in the last Session are closed, the CD-RW Drive shall terminate this command with CHECK CONDITION Status and sense data shall be set to ILLEGAL REQUEST, SESSION FIXATION ERROR –INCOMPLETE TRACK IN SESSION. The inclusion and format of a Mode 5, point B0 is dependent upon the Multi-Session field in the Write Parameters Mode Page. If the last session is non-existent or empty, the media shall not be written. This shall not be considered an error.

If a Mount Rainier RW background format is in progress, the format operation shall be stopped and the disc shall be structured for removal according to Mount Rainier RW.

Implementers Note: When write speed is 4x, this operation should require less than 1 minute execution time.

Session = 1, Track = 1

Reserved, not valid.

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

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

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

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

During the Close Track operation, the CD-RW Drive shall respond to commands as follows:

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

2.3.2 FORMAT UNIT COMMAND

The FORMAT UNIT Command (Table 6) formats a medium into host addressable logical blocks per the host defined options. The medium may be certified and control structures created for the management of the medium and defects. There is no guarantee that the medium will not be altered.

Table 6: Format Unit Command Descriptor Block

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

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

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

Format Code is used by the device to identify the format descriptor from the host. Format Codes are defined for CD-RW in Table 7.

Table 7: Format Descriptor Included

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

Parameter data from the host is structured as shown in Table 8.

Table 8: Format Unit Parameter List

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

A Mount Rainier compliant CD-RW drive shall support Format Code 1 and optionally support Format Code 7 and requires 12 parameter bytes: a format list header and a single format descriptor.

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

Table 9: Format List Header

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

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

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

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 0 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.

2.3.2.1 Format Code 111b

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

Table 10: CD-RW Format Descriptor

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

Grow = 0, Session = 0

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

Grow = 0, Session = 1

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

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

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

2.3.2.2 Format Code 001b

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

Table 11: Format Descriptor

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

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

Format Type = 00h, Full Format, N/A for CD-R/RW medium

This type is defined for magnetic medium and is not allowed for CD-RW medium.

Format Types = 01h – 03h, Reserved

Format Type = 04h, Zone reformat, N/A for CD-R/RW medium

This type is defined for DVD-RAM and is not allowed for CD-RW medium.

Format Type = 05h, Zone Format, N/A for CD-R/RW medium

This type is defined for diskette and is not allowed for CD-RW medium.

Format Types = 06h – 0Fh, Reserved

Format Type = 10h, CD-RW Full Format, Obsolete (Optional for CD-RW medium)

Formatting to create a session on CD-RW media is specified. The created session shall become the only session on the medium. The Number of Blocks field specifies the number of addressable blocks for the new session and the Type Dependent Parameter field specifies the Fixed Packet Size. Both parameters may be adjusted to values less than or equal to the values reported by the READ FORMAT CAPACITIES Command. The CD-RW Drive shall round the Number of Blocks up to be an integral multiple of the packet size.

Format Type = 11h, CD-RW Grow Session, Obsolete (Optional for CD-RW medium)

Formatting to expand the last session of a CD-RW media is specified. The Number of Blocks field specifies the number of addressable blocks to be enlarged and the Type Dependent Parameter field specifies the Block Length.

Format Type = 12h, CD-RW Add Session, Obsolete (Optional for CD-RW medium)

Formatting to add a new session to a CD-RW media is specified. The Number of Blocks field specifies the number of addressable blocks for the new session and the Type Dependent Parameter field specifies the Fixed Packet Size. Both parameters may be adjusted to values less than or equal to the values reported by the READ FORMAT CAPACITIES Command.

Format Type = 13h, Reserved

Format Types = 24h, CD-RW Full Format with Defect management, Mandatory for the Mount Rainier RW feature.

The Type Dependent Parameter has the meaning of “New format” when it has the value 000000b. The Type Dependent Parameter has the meaning of “Restart format” when it has the value 000001b.

For a New Format operation, the medium format shall be performed to create a single track, single session of fixed packets of size = 32, mode 2 form 1 data. Defect management tables are initialized as a part of the formatting process. The bulk of this format is performed in background. The host may suspend the format operation by issuing the CLOSE TRACK/SESSION Command.

For a Restart Format operation, the CD-RW Drive shall continue a suspended background format. If there is no suspended background format to continue, the CD-RW Drive shall terminate the command with CHECK CONDITION status and set sense data to ILLEGAL REQUEST, COMMAND SEQUENCE ERROR.

When a new format is indicated, there are 3 cases, based upon current medium status:

Current Disc Status	Minimum Format Action
Physically Blank	Write entire surface format, verify only Mount Rainier RW structures
Written, but not Mount Rainier RW Formatted (includes logically blank)	Write format, verify surface
Mount Rainier RW formatted	Verify surface

Format Types = 25h – 27h, Reserved for Mount Rainier expansion.

Format Types = 28h – 3Fh, Reserved

2.3.2.3 Background Formatting of Format Type 24h

If the IMMED bit is cleared to zero, formatting proceeds:

1. A PMA entry is written for the single track,
2. The pre-gap of the first track is written.
3. The GAA is initialized.
4. The first SA is initialized.

Once these 4 functions are complete, the Format Unit Command will terminate with GOOD status and continue the format in background. At this point, the disc is available for write access. This initial recording action requires less than 10 seconds when 4x writing speed is used.

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

Regardless of the setting of IMMED, once the common part of the background formatting operation has begun, the response to a TEST UNIT READY Command shall be: the command shall be terminated with GOOD status and sense data shall be set to NO SENSE, FORMAT IN PROGRESS (00/04/04), unless an error has occurred. The sense key specific bytes (Table 12) shall be set as a progress indicator.

Table 12: Sense Key Specific Bytes in Sense Data

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

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

Once the background format operation has completed, the CD-RW drive shall post a Background Format Completed Media Event. The response to a TEST UNIT READY Command shall then be: the command shall be terminated with GOOD status and sense data shall be set to NO SENSE, NO ADDITIONAL SENSE, NO ADDITIONAL SENSE QUALIFIER, and SKSV shall be cleared to zero.

If a format is executing in background:

- The formatting process may be stopped only by issuing the CLOSE TRACK/SESSION Command. See section 2.3.1 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 CD-RW Drive shall terminate the command with CHECK CONDITION status and set sense data to NOT READY, LOGICAL UNIT NOT READY, FORMAT IN PROGRESS (02/04/04). Example: START/STOP UNIT Command is issued with Start = 0.
- If the host/drive physical interface provides a command layer with commands which can cause the medium to spin down, then those commands will be terminated with the appropriate error status. For example if the interface is ATA and the command is IDLE or SLEEP, then the command shall be terminated with the status register ERROR bit set to true.
- If any other command is issued to the CD-RW drive, it shall be executed normally.

Whenever a CD-RW disc is mounted, the CD-RW drive shall examine the disc structures. The state of formatting is reported in the Disc Information Block (see 2.3.7).

2.3.3 GET EVENT STATUS NOTIFICATION COMMAND

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

The data returned, with a class code 100b, is defined in Table 13.

Table 13: Media Event Descriptor

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

The Media Event Code is defined in Table 14.

Table 14: Media Event Codes

Code	Event	Description
0h	NoEvent	Media status is unchanged
1h	EjectRequest	The CD-RW Drive has received a request from the user (usually through a mechanical switch on the CD-RW Drive) to eject the specified slot or media.
2h	NewMedia	The specified slot (or the CD-RW Drive) has received new media and is ready to access it.
3h	MediaRemoval	The media has been removed from the specified slot (or the CD-RW 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 CD-RW Drive's tray) be loaded.
5h	BGformatCompleted	A background format has completed
6h – Fh	Reserved	

The Media Status byte is defined in Table 15.

Table 15: Media Status Byte

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

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

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

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

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

2.3.4 READ-10, READ-12, READ CD, and WRITE/VERIFY-10 COMMANDS

The host references the medium only by LBA when using the READ-10, READ-12, READ CD, VERIFY, and WRITE AND VERIFY-10 commands. For Mount Rainier RW disc, 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 Mount Rainier RW Mode Page (See2.4.3).

2.3.5 READ CD MSF

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

Table 16: 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.

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 which is not to be read.

All other parameters are as defined in MMC-2.

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

2.3.6 READ CAPACITY

The READ CAPACITY command (Table 17) provides a means for the Host to request information regarding the capacity of the currently mounted medium. This command may not report the correct capacity of the recorded data for CD-R, CD-RW and DVD-R media that does not have a Lead-out in the last Session. The capacity reported is further restricted to referenced LBA space when the mounted medium is Mount Rainier RW formatted.

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

Table 17: READ CAPACITY Command Descriptor Block

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

Eight bytes of READ CAPACITY response data (Table 18) shall be returned in response to the command. The returned Logical Block Address is defined in Table 19. The Block Length shall be reported, in bytes, as 2048d.

Table 18: READ CAPACITY Response Data

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

Table 19: Response LBA Values

LBA in CDB	PMI	LBA in Response
= 0	0	User area capacity: If the mounted medium is not a Mount Rainier RW disc, the last logical block shall be determined by converting the last recorded Lead-out to an LBA and subtracting one. If the resulting address points to a run out block (because the session was recorded with packets or track at once in data mode), the CD-RW Drive shall subtract 2 from the LBA to point to the actual last user data block. If no complete session exists on the medium, this field shall be set to zero. If the mounted medium is a Mount Rainier RW disc, then the value returned data is the LBA that represents the last block of the currently referenced LBA space.
≠ 0	0	The CD-RW Drive shall terminate the command with CHECK CONDITION status and set sense codes to ILLEGAL REQUEST, LBA OUT OF RANGE
= 0	1	The CD-RW Drive shall terminate the command with CHECK CONDITION status and set sense codes to ILLEGAL REQUEST, INVALID FIELD IN CDB.

2.3.7 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 MMC2 shall remain unchanged.

Additional information is needed. We need to know the state of the Mount Rainier RW background format operation. There are 4 possible states. The appropriate value is placed in Disc Information Block in the DBit and Mount Rainier RW Status fields.

Table 20: Disc Information Block

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB) Disc Information							
1	Length							(LSB)
2	Reserved			Erasable	State of last Session		Disc Status	
3	Number of First Track on Disc							
4	Number of Sessions (LSB)							
5	First Track Number in Last Session (LSB)							
6	Last Track Number in Last Session (LSB)							
7	DID_V	DBC_V	URU	Resvd		DBit	Mount Rainier RW 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)							
13	Disc							
14	Identification							
15								(LSB)
16	(MSB)							
17	Last Session Lead-in Start Time							
18	MSF							
19								(LSB)
20	(MSB)							
21	Last Possible Start Time for Start of Lead-out							
22	MSF							
23								(LSB)
24	(MSB)							
...	Disc Bar Code							
31								(LSB)
32	Reserved							
33	Number of OPC Table Entries							
34 - n	OPC Table Entries							

The Mount Rainier RW status is represented by bits 0 and 1 of byte 7. The value gives the Mount Rainier RW format status of the mounted disc:

00 Not a Mount Rainier RW format. For each disc which cannot be identified as a Mount Rainier RW format with status 01b, 10b, 0r 11b, Mount Rainier RW status shall be set to 00b. For example, a blank disc (both physically blank and logically blank) the Mount Rainier RW status is 00b.

01 Mount Rainier RW background format was started but is not currently running and is not complete. This indicates that the session was closed, thereby writing a valid MDT in the lead-in. The unique identification is: MDT present, but TOC showing lead-out beginning prior to full capacity.

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

11 Mount Rainier RW formatting completed. When a completely Mount Rainier RW formatted disc is mounted, Mount Rainier RW status is set to 11b.

If the disc is formatted as a Mount Rainier RW CD-RW disc (state = 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 Mount Rainier RW status = 00), Dbit 2 is cleared to zero.

2.3.8 READ FORMAT CAPACITIES COMMAND

The READ FORMAT CAPACITIES command (Table 21) allows the Host to request a list of the possible format capacities for an installed (and potentially) random-Writable media. This command also has the capability to report the capacity for a media when it is installed. If the command is required, by an implemented Feature it shall function independently of the state of that Feature's Current bit.

Table 21: READ FORMAT CAPACITIES Command Descriptor Block

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

The Allocation Length field specifies the maximum number of bytes that a Host has allocated for returned data. An Allocation Length of zero indicates that no data shall be transferred. This condition shall not be considered as an error. The CD-R/RW drive shall terminate the data transfer when Allocation Length bytes have been transferred or when all available data have been transferred to the Host, whatever is less. The returned data format is shown in Table 22..

Table 22: Read Format Capacities Data Format

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

The Capacity List Header is shown in Table 23. The Capacity List Length specifies the length in bytes of the Capacity Descriptors that follow. Each Capacity Descriptor is eight bytes in length, making the Capacity List Length equal to eight times the number of descriptors. Values of n * 8 are valid. Although it is possible that 64 descriptors are supported, we do not expect that any drive will support so many.

Table 23: Capacity List Header

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

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

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

Table 24: Current/Maximum Capacity Descriptor

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

Table 25: Descriptor Types

Descriptor Type	Description
00b	Reserved
01b	Unformatted Media. The reported value is for the maximum formatted capacity for this media. For CD-RW medium, the value reported is the maximum possible when using Format Type 10h.
10b	Formatted Media. The reported value is the current media's capacity. This is the number of user addressable blocks. When the media does not have a complete session it shall be reported as "No Media Present" with Descriptor Type = 11b.
11b	No Media Present. The reported value is for the maximum capacity of a media that the CD-R/RW drive is capable of reading.

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

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

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

24h, when the disc is formatted according the OB-III with Defect management. The descriptor shall contain the maximum number of addressable user blocks. The Type Dependent Parameter contains the DMA size in packets.

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

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

Table 26: Formattable Capacity Descriptor

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

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

Format Type = 00h, Full Format, N/A for CD-R/RW medium

This type is defined for magnetic medium and is not allowed for CD-RW medium.

Format Types = 01h – 03h, Reserved

Format Type = 04h, Zone reformat, N/A for CD-R/RW medium

This type is defined for DVD-RAM and is not allowed for CD-RW medium.

Format Type = 05h, Zone Format, N/A for CD-R/RW medium

This type is defined for diskette and is not allowed for CD-RW medium.

Format Types = 06h – 0Fh, Reserved

Format Type = 10h, CD-RW Full Format, Obsolete (Optional for CD-RW medium)

The descriptor shall contain the maximum number of addressable blocks and maximum packet size that can be used to fully format CD-RW media. The packet size and number of addressable blocks may be adjusted downward by the Host before sending this descriptor back via the FORMAT UNIT command. The Type Dependent Parameter is the Fixed Packet Size in sectors.

Format Type = 11h, CD-RW Grow Session, Obsolete (Optional for CD-RW medium)

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

Format Type = 12h, CD-RW Grow Session, Obsolete (Optional for CD-RW medium)

The descriptor shall contain the maximum number of addressable blocks and the maximum packet size that can be used to add a new session to a CD-RW media. The packet size and number of addressable blocks may be adjusted downward by the Host before sending this descriptor back via the FORMAT UNIT command. The Type Dependent Parameter is the Fixed Packet Size in sectors.

Format Type = 13h – 23h, Reserved

Format Type = 24h, CD-RW Full Format with Defect management, Mandatory for the Mount Rainier RW Feature. The descriptor shall contain the maximum number of DMA addressable blocks. The Type Dependent Parameter is not used and shall be cleared to zero.

Format Types = 25h – 27 are reserved for future Mount Rainier expansion.

Format Types = 28h - 3Fh, Reserved

2.3.9 WRITE-10 and WRITE/VERIFY-10 Commands

The host references the medium only by LBA when using the WRITE-10 and WRITE/VERIFY-10 commands. For Mount Rainier RW disc, 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 Mount Rainier RW Mode Page (See 2.4.3).

The WRITE-10 Command shall function as described in MMC2. In the case that the disc is Mount Rainier RW formatted and the LBA is negative, the command shall be terminated with a CHECK CONDITION because writing in the lead-in is allowed only as a non-incremental operation.

2.4 MODE PAGE CHANGES

Mount Rainier RW compliance requires that the device support several mode pages:

MODE PAGE	ORIGINAL DEFINITION	Mount Rainier REFINEMENTS
Fault/Failure Reporting Page (1Ch)	SPC2	√
Mount Rainier RW (2Ch)	Mount Rainier	√
Read/Write Error Recovery (01h)	SBC-1, MMC2	√
Write Parameters (05h)	MMC1	√

2.4.1 The 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 only apply to informational exception that report CHECK CONDITION Status, 1/5D/XX FAILURE PREDICTION THRESHOLD EXCEEDED to the Host.

Informational exception conditions may occur as the result of vendor specific events within a drive. An informational exception condition may occur asynchronously to any Commands issued by a Host.

Table 27: Fault/Failure Reporting Page Format

Bit / Byte	7	6	5	4	3	2	1	0
0	PS	Resv	Page Code (1Ch)					
1	Page Length (1Ah)							
2	Perf	Reserved		EWasc	DExcept	Test	Resv	LogErr
3	Reserved				MRIE			
4	(MSB)							
5	Interval Timer							
6								
7								(LSB)
8	(MSB)							
9	Report Count							
10								
11								(LSB)

The Parameters Savable (PS) bit is only used with the MODE SENSE (10) Command. This bit is reserved with the MODE SELECT (10) Command. A PS bit of one indicates that the drive is capable of saving the Page in a non-volatile vendor-specific location.

A Performance (Perf) bit of zero indicates that informational exception operations that are the cause of delays are acceptable. A Perf bit of one indicates the drive shall not cause delays while doing informational exception operations. A Perf bit set to one may cause the drive to disable some or all of the informational exception operations, thereby limiting the reporting of informational exception conditions. The default value for Perf is zero.

An enable warning sense code (EWasc) bit of zero indicates the drive shall disable reporting of the WARNING Sense Code. The MRIE field is ignored when DExcept is set to one and EWasc is set to zero. A EWasc bit of one indicates WARNING Sense Code reporting shall be enabled. The method for reporting the warning when the EWasc bit is set to one is determined from the Method of Reporting Informational Exceptions (MRIE) field. The default value for EWasc is zero.

A disable exception control (DExcept) bit of zero indicates informational exception operations shall be enabled. The reporting of informational exception conditions when the DExcept bit is set to zero is determined from the MRIE field. A DExcept bit of one indicates the drive shall disable all information exception operations. The MRIE field is ignored when DExcept is set to one and EWasc is set to zero. The default value for DExcept is zero.

A Test bit of one shall create a false drive failure at the next interval time (as specified by the Interval timer field), if the DExcept bit is not set. When the Te s t bit is one, the MRIE and Report Count fields shall apply as if the Test bit were zero. The false drive failure shall be reported with CHECK CONDITION Status, 1/5D/FF FAILURE PREDICTION THRESHOLD EXCEEDED (FALSE). If both the Test and the DExcept bits are one, the drive shall terminate the MODE SELECT (10) Command with CHECK CONDITION Status, 5/26/00 INVALID FIELD IN PARAMETER LIST. A Test bit of zero shall instruct the drive not to generate any false drive failure notifications. The default value for Test is zero.

The LogErr bit is vendor specific. The default value for LogErr is zero.

The Method of Reporting Informational Exceptions field (MRIE) indicates the methods that shall be used by the drive to report informational exception conditions. The priority of reporting multiple information exceptions is vendor specific. The default value for MRIE is 4h.

Table 28: Method of Reporting Informational Exceptions (MRIE) field

MRIE	Description
0h	No reporting of informational exception condition: This method instructs the drive to not report information exception conditions.
1h – 3h	Reserved
4h	Unconditionally generate recovered error: This method instructs the drive to report informational exception conditions, regardless of the value of the PER bit of the Read/Write Error Recovery mode page, by returning a CHECK CONDITION status. If the TEST bit equals zero, the status may be returned on any command after the informational exception condition occurs. If the TEST bit equals one, the status shall be returned on the next command that is normally capable of returning an informational exception condition when the TEST bit equals zero. The sense key shall be set to RECOVERED ERROR and the additional sense code shall indicate the cause of the informational exception condition. The command that has the CHECK CONDITION shall complete without error before any informational exception condition may be reported.
5h - Bh	Reserved
Ch - Fh	Vendor Unique

The Interval Timer field indicates the period in 100 millisecond increments that a informational exception condition has occurred. The drive shall not report informational exception conditions more frequently than the time specified by the Interval Timer field and as soon as possible after the timer interval has elapsed. After the informational exception condition has been reported the interval timer

shall be restarted. A value of zero or FFFFFFFFh in the Interval Timer field shall indicate the timer interval is vendor specific. The default value for the Interval Timer field is 6000d.

The Report Count field indicates the number of times to report an informational exception condition to the Host. A value of zero in the Report Count field indicates there is no limit on the number of times the drive shall report an informational exception condition. The default value of this field shall be zero. The default value for the Report Count field is zero.

2.4.2 Read/Write Error Recovery Parameters Page

This mode page is already required by MMC2, but the defect management switches are not currently applicable to CD-RW drives. With the Mount Rainier RW format, these bits now have meaning.

Table 29: Read/Write Error Recovery Parameters Page

Bit / Byte	7	6	5	4	3	2	1	0
0	PS	Resvd	Page Code (01h)					
1	Page Length (0Ah)							
2	Error Recovery Parameter							
	ARRE	AWRE	TB	TC	Resvd	PER	DTE	DCR
3	Read Retry Count							
4	Reserved							
5	Reserved							
6	Reserved							
7	Reserved							
8	Write Retry Count							
9	Reserved							
10	Recovery Time							
11	Limit (0)							

When the mounted medium is Mount Rainier RW formatted CD-RW and ARRE is set to 1, bad sectors will be relocated automatically by the CD-RW drive upon drive defined “read failure”. When ARRE is cleared to 0, no sectors will be relocated due to a drive defined “read failure”.

When the mounted medium is Mount Rainier RW formatted CD-RW and AWRE is set to 1, bad sectors will be relocated automatically by the CD-RW drive upon drive defined “write failure”. When AWRE is cleared to 0, no sectors will be relocated due to a drive defined “write failure”.

The default values for the bits are: ARRE = 0, AWRE = 1.

2.4.3 Mount Rainier RW Mode Page

The Mount Rainier RW Mode Page (Table 30) provides a method by which the host can control the special features of a Mount Rainier RW CD-RW drive.

Table 30: Mount Rainier RW Mode Page

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

If the currently mounted medium is a Mount Rainier RW 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.

2.4.4 Write Parameters Mode Page

When a Mount Rainier RW disc is mounted and recognized by the CD-RW drive, it shall set write speed and Write Parameters to match the medium. This shall be done without host intervention.

For a Mount Rainer RW disc, the Write Speed shall be set to the maximum allowed by the media/drive combination. The Write Parameters Mode Page shall be set according to Table 31.

Table 31: Write Parameters Defaulting for Format Type 24h

Parameter	Defaulted Value	Meaning
BUFE	0b	Buffer under-run protected for sequential recording. Not sequential recording
LS_V	0b	Link size field is not valid.
Test Write	0b	Not test writing.
Write Type	0000b	Writing Packets.
Multisession	00b	No B0 pointer for next session.
FP	1b	Packet recording is fixed packets.
Copy	0b	Data is not a copy.
Track Mode	0111b	Track is incrementally recorded data and not copy protected.
Data Block Type	0Ah	Data block is 2048 user bytes. Data shall be written as mode 2 form 1 sectors.
Link Size	00h	No entry required.
Host Application Code	00h	Usable only with general purpose discs.
Session Format	20h	The format for this session (disc) is CD-ROM XA.
Packet Size	20h	The packet size is 32 sectors.
Audio Pause Length	150d	Not really applicable to data discs.
MCN	0	MCN shall not be considered present. The entire field shall be zero filled.
ISRC	16 bytes: 00h	ISRC is not allowed on data tracks.
Sub-header bytes	00h, 00h, 00h, 00h	Mode 2 form 1 sectors. No CD-i or XA specific data.

As always, the host is free to change the Write Parameters Mode Page. And, as always, write will be inhibited if any parameter is inconsistent with the current format of medium.

2.5 NEW SENSE CODES

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

Table 32: SMART Oriented Sense Codes

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

3 Using Mount Rainier RW Medium

This medium could be mounted in several system combinations: drive and host software. Of course, when all parties are aware of Mount Rainier RW 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	Mount Rainier RW Aware Software System
H A R D	Legacy CD-ROM drive (Multi-read capable)	1A	1B
	Mount Rainier RW Compliant CD-ROM drive	2A	2B
W A R E	Legacy CD-RW drive (at least MMC1)	3A	3B
	Mount Rainier RW 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 1.1, 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: Mount Rainier RW Defect Management & Physical Formatting revision 1.0

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

The legacy CD-ROM drive will see a Mount Rainier RW 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).

3.1.1 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 should provide information to the user about how to make use of the disc.

3.1.2 With Mount Rainier Aware System Software

Note that software which can recognize and read Mount Rainier RW from a legacy drive must operate differently than software which expects a Mount Rainier RW 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.

3.2 Combinations 2A, 2B: Mount Rainier RW Compliant CD-ROM Drive

When the drive is capable of correctly reading a Mount Rainier RW disc, the system software will initially see only the LBA Space defined by the DMA. Both legacy and Mount Rainier RW 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 Mount Rainier RW compliant system software will be able to switch addressing to the GAA.

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

The legacy CD-RW drive is unaware of the Mount Rainier RW 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.

3.3.1 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.

3.3.2 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 should force read-only access to the medium.

3.4 Combinations 4A, 4B: Mount Rainier RW Compliant CD-RW drive

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

3.4.1 With Legacy System Software

Since the system software is not aware of how to enable writing, the drive effectively becomes a CD-ROM drive. See 3.2.

3.4.2 With Mount Rainier RW 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 Mount Rainier RW format. This is described from the host perspective.

3.4.2.1 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).

3.4.2.1.1 Case: Discovering that the Media is Formatted/Formatting as a Mount Rainier RW 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 Mount Rainier RW Features as current.

The READ DISC INFORMATION Command is issued.

It is discovered that the Mount Rainier RW 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.

3.4.2.1.2 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 Mount Rainier RW 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 Mount Rainier RW state is 00b.

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

3.4.2.1.3 Case: Discovering Non-Blank Media which is not a Mount Rainier RW 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 Mount Rainier RW 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 Mount Rainier RW state is 00b.

We now conclude that a new format is required before this medium may be used as a Mount Rainier RW 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?

3.4.2.2 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, Mount Rainier RW. 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.

3.4.2.2.1 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 Mount Rainier RW Mode Page must be written for addressing that area.

3.4.2.2.2 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.

3.4.2.2.3 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 2.3.2.3.