Double Layer DVD+R Multi-Media Command Set Description

Version 0.45

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1 Scope

Double Layer DVD+R (DVD+R Double Layer) is a DVD media type that requires special device behavior when recording in order that the written media is acceptable to and readable by DVD read-only devices. This document describes the set of multi-media commands that allow a host to utilize the capabilities of the DVD+R Double Layer drive.

This document is created to match the structure of MMC-4:

1. Scope – This section
2. References – A list of documents that may be needed by the reader for the correct understanding of this document.
3. Definitions, Symbols, Abbreviations, and Conventions – A glossary of terminology in this document
4. Multi-Media Device Models – Modeling for the various media oriented behaviors that the host may witness from the device provides an overview of internal drive operation to the host application developer.
5. Commands for Multi-media Devices – Commands are described from the host's point of view.
6. Mode Parameters for Multi-media Devices – Inputs required by the drive are not always a part of a command. Inputs associated with mode of operation are readable and sometimes writable.

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2 References

2.1.1 Approved References

The following are approved ANSI, approved international and approved regional publications (ISO, IEC, CEN/CENELEC, and ITUT), and may be obtained from the international and regional organizations that control them.

ANSI NCITS.351:2001	SCSI-3 Primary Commands (SPC-2)
ANSI INCITS 360:2002	SCSI-3 MultiMedia Command Set 3 (MMC-3)
ANSI NCITS.306:1998	SCSI-3 Block Command Set (SBC)
ANSI NCITS.361:2002	AT Attachment with Packet Interface 6 (ATA/ATAPI-6)
ECMA 167, 3rd Edition	Volume and File Structure for Write-Once and Rewritable Media using Non-Sequential Recording for Information Interchange
ECMA 337	120 mm 4.7GB and 80 mm 1.46 GB DVD ReWritable Disc (DVD+RW)

INCITS T10/1416D	SCSI Primary Command Set - 3 (SPC-3)
INCITS T10/1417D	SCSI Block Command Set - 2 (SBC-2)
INCITS T10/1467D	SCSI Serial Bus Protocol - 3 (SBP-3)
INCITS T13/1532D	AT Attachment with Packet Interface 7 (ATA/ATAPI-7)
T13/e03104r0	Serial ATA: High Speed Serialized AT Attachment

2.1.2 References Under Development

At the time of publication, the following referenced standards were still under development. For information on the current status of the document, or regarding availability, contact the relevant standards body or other organization as indicated.

INCITS T10/1416D	SCSI Primary Command Set - 3 (SPC-3)
INCITS T10/1417D	SCSI Block Command Set - 2 (SBC-2)
INCITS T13/1532D	AT Attachment with Packet Interface 7 (ATA/ATAPI-7)
INCITS T10/1545D	SCSI-3 MultiMedia Command Set 4 (MMC-4)

For more information on the current status of the above documents, contact INCITS Secretariat, 1250 Eye Street, NW Suite 200, Washington, DC 20005, Phone Number (202) 737-8888. To obtain copies of these documents, contact Global Engineering at (303) 792-2181 or INCITS Secretariat.

2.2 Other References

The following are published by the DVD+RW Alliance and are available from Philips Electronics, NV:

DVD+RW 4.7 Gbytes Basic Formats Specifications, Version 1.2, December 2002

DVD+R 4.7 Gbytes Basic Formats Specifications, Version 1.11, December 2002

DVD+R Double Layer, 8.5 Gbytes Basic Format Specifications, Version 0.89a, December 2003

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3 Definitions, Symbols, Abbreviations, and Conventions

3.1 Terms

3.1.1 DVD+R Double Layer

Double Layer DVD+R

3.1.2 Layer Jump

When the OPU is focused on and tracking on Lx (x = 0, 1), the function of re-focusing the OPU onto Lx^{-} and tracking on Lx^{-} is a Layer Jump.

3.1.3 L0 Middle Zone

Once the middle zone locations have been established, the middle zone part on L0 "closes" data zone recording on L0.

3.1.4 L1 Middle Zone

Once the middle zone locations have been established, the middle zone part on L1 provides an "Intro" to data zone recording on L1.

3.1.5 Opposite Track Path (OTP)

An opposite track path DVD is dual layer disc. The Layer 0 groove begins at the inner radius with a Lead in, followed by a user area, and finishes with a Middle area. The Layer 1 groove begins at the outer radius with a Middle area, followed by a user area, and finishes with a lead-out.

3.1.6 Parallel Track Path (PTP)

A parallel track path DVD is a dual layer disc that has a Lead in, user area and Lead-out in each layer respectively. The ID sector number in each layer increases to its respective Lead-out in parallel.

3.1.7 Recording Unit (RUN)

A RUN shall consist of an integer number $(M \geq 1)$ of sets of 16 Physical Sectors, each from a single ECC Block. The M ECC Blocks shall be preceded by 8 Channel bits, which are meant to reduce possible influences of inaccuracies of the linking point, while the last 8 Channel bits of the last Physical Sector shall be discarded at recording.

3.2 Abbreviations

DVD-RO	DVD Read-only
L0	Layer zero
L1	Layer one
OTP	Opposite Track Path
PTP	Parallel Track Path
RUN	Recording Unit

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4 DVD+R Double Layer Models

The DVD+R double layer medium is DVD+R medium with two recording layers physically constructed in order to permit recorded media that is compatible with DVD readers and players.

4.1 Physical Overview

The physical disc and the physical structure of each layer of the DVD+R double layer are unchanged from single layer DVD+R. The mechanism used to connect the two layers into an 8.5 GB user addressable storage area is logical.

For details on the physical characteristics of DVD+R double layer media, see *DVD+R Double Layer, 8.5 Gbytes Basic Format Specifications*.

4.2 Logical Overview

4.2.1 Double Layer DVD

Dual layer DVD-ROM has two versions: Parallel Track Path (PTP) and Opposite Track Path (OTP) as shown in Figure 1 and Figure 2.

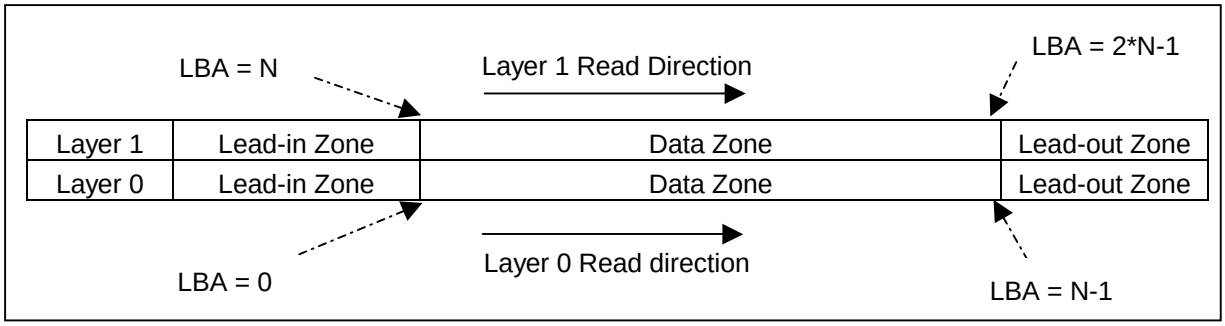

Figure 1 – Double Layer DVD-ROM, PTP

The PTP version is constructed as 2 independent volumes with grooves that have a similar, mirrored spiral. There are two lead-in zones, two data zones, and two lead-out zones. These volumes are logically merged by appending the L1 data zone to the L0 data zone. A disc with a data zone capacity of N in each layer has a LBA space of 2N sectors, ranging from 0 to 2N-1.

If K_0-1 and K_0 are sequential sectors in L0, the access time from K_0-1 to K_0 is very small. Similarly, if K_1-1 and K_1 are sequential sectors in L1, the access time from K_1-1 to K_1 is very small. However, the access time from sector N-1 (in L0) to sector N (in L1) is a layer jump, plus a near maximum distance seek, plus latency. If the data is streamed, as in DVD-Video, maintaining a consistent data rate may require a very large read-ahead buffer.

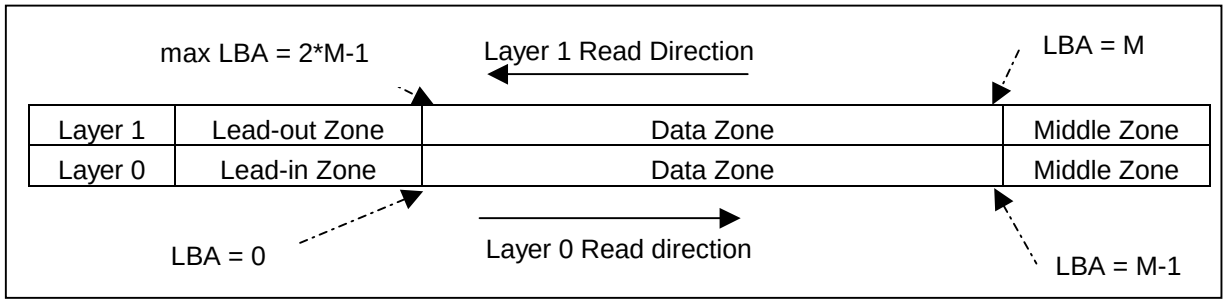

Figure 2 – Double Layer DVD-ROM, OTP

The OTP version is constructed with parallel grooves that have data recorded in opposite directions. The L0 spiral runs from inner radius to outer radius while the L1 spiral runs from outer radius to inner radius. Unlike PTP, the OTP disc has one lead-in, one lead-out, and two middle zones. The middle zone is present as a layer-jumping zone when streaming through data that crosses the layer boundary. These volumes are logically merged by appending the L1 data zone to the L0 data zone. A disc with a data zone capacity of M in each layer has a LBA space of 2M sectors, ranging from 0 to 2M-1.

If K_0-1 and K_0 are sequential sectors in L0, the access time from K_0-1 to K_0 is very small. Similarly, if K_1-1 and K_1 are sequential sectors in L1, the access time from K_1-1 to K_1 is very small. Unlike the PTP disc, the access time from sector M-1 (in L0) to sector M (in L1) is a latency, plus a layer jump, plus a small seek, plus a latency. This access is small enough that maintaining a consistent data stream rate can be achieved through the drive's read-ahead buffer.

Due to the access time differences in the two methods for constructing double layer discs, OTP is preferred. Double Layer DVD+R (DVD+R Double Layer) is constructed to be recorded only as an OTP disc.

4.2.2 The DVD+R Double Layer Information Zones

The Information zones are organized as a sequence of independently recorded units called ECC blocks.

The definition of the ECC block has only small changes from the single layer DVD+R. The DVD+R ECC block is defined according to the DVD-ROM standard. A DVD+R data sector contains 2 064 bytes, 2 048 bytes of main data and 16 bytes of additional information.

The logical layout of a DVD+R data sector is shown in Figure 3.

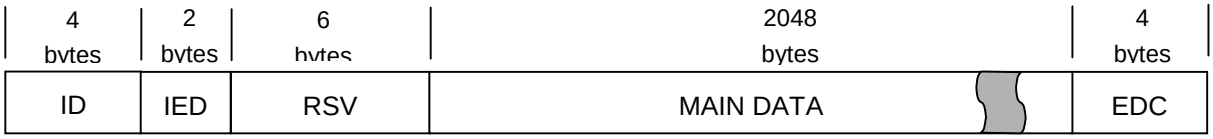

Figure 3 – Logical Layout of a DVD+R Data Sector

ID is a field that identifies the sector

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

RSV is reserved and must be recorded with zeros.

MAIN DATA contains 2048 bytes and has 2 possible sources. The source is determined by the reference: *DVD+R Double Layer 8.5 Gbytes Basic Format Specifications.* Except for format management overheads, the host is the source of Main Data for the part of the Information Zone called the Data Zone. For all other areas, the drive must generate the Main Data from information provided by the host according to the format requirements of *DVD+R Double Layer 8.5 Gbytes Basic Format Specifications.*

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

The ID field is viewed as a 32 bit field as shown in Figure 4.

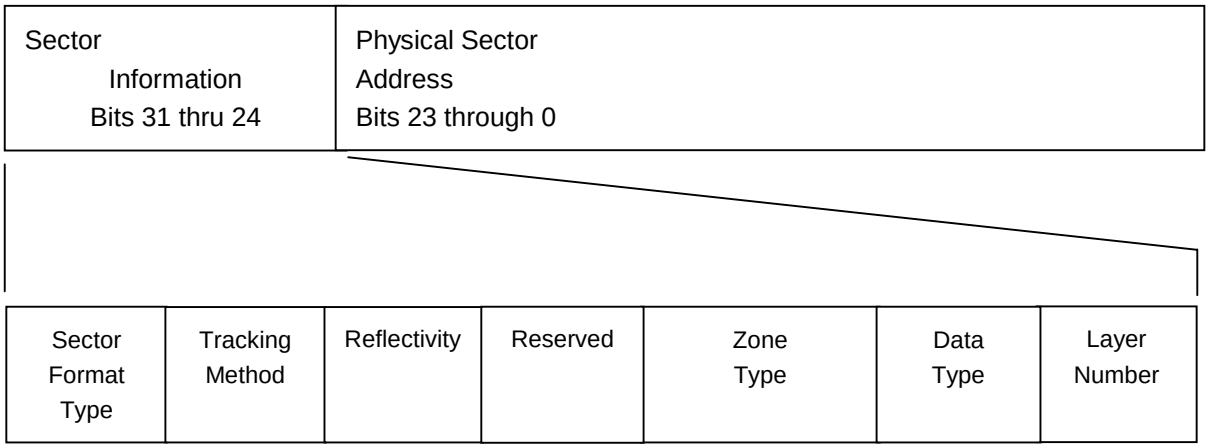

Figure 4 - ID Field Details

Sector Format Type (Bit 31)	is set to ZERO, indicating a CLD format
Tracking Method (Bit 30)	is set to ZERO, indicating pit tracking
Reflectivity (Bit 29)	is set to ONE indicating that the reflectivity is less than 40 %
Reserved (Bit 28)	is set to ZERO
Zone Type (Bits 27 and 26)	is valued as: 00 when the sector is in the Data Zone (this includes session intro and session closure areas) 01 when the sector is in the Disc Lead-in 10 when the sector is in the Disc Lead-out 11 when the sector in the middle zone
Data Type (Bit 25)	is set to ZERO, indicating read-only media
Layer Number (Bit 24)	is set to ZERO when the sector is on layer 0 Is set to ONE when the sector is on layer 1

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

A 2064 byte sector is divided into 12 rows of 172 bytes each. Main data is scrambled similar to CD-ROM sectors. 16 sequential DVD sectors are packed into 192 rows, each with 172 bytes. Error correction for the ECC block is unchanged from the DVD standard.

4.3 Double Layer DVD+R

4.3.1 Physical Addressing

DVD-RO devices typically are unable to maintain tracking over blank areas. So, in order to maximize playback compatibility with DVD-RO devices, there is one recording restriction:

> If the DVD-RO device is tracking on a recorded area on Lx (x = 0, 1) and a layer jump is required, the jump must land in a recorded area on Lx^{-}.

Consequently, when a disc is finalized, the band of recording in Layer 0 must be matched by a radially equivalent band of recording on layer 1. The size of this band is large enough to cover any layer offset.

The simplest written structure (single session, single fragment) appears as in Figure 5.

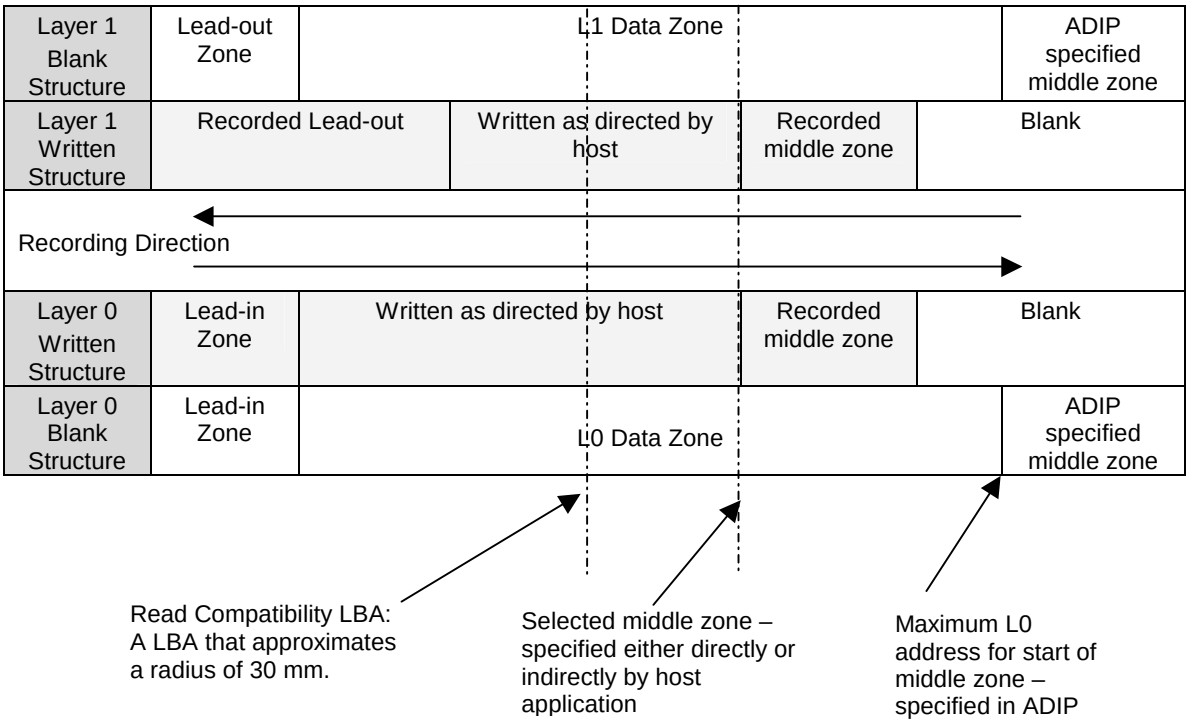

Figure 5 – Blank and Recorded Structure of a DVD+R Double Layer Disc

4.3.2 Recording on DVD+R Double Layer

Data is recorded sequentially from the beginning of the L0 data zone until the start of the L0 Middle Zone. Recording continues from the end of the L1 Middle Zone until the end of the L1 data zone. A DVD+R Double Layer disc may contain multiple sessions, each consisting of one or more fragments.

Information in the lead-in ADIP contains the last possible start address for the L0 middle zone. If the disc is blank, the default maximum L0 data zone size is defined by that address. The Host may request to change the L0 middle zone start address to a smaller address (using the SEND DVD STRUCTURE command) prior to or during L0 recording.

Figure 6 shows an example of a multi-session disc. Note that the recorded middle zone may occur prior to the ADIP specified last possible middle zone start address. Note also that a session is permitted to cross layer boundaries.

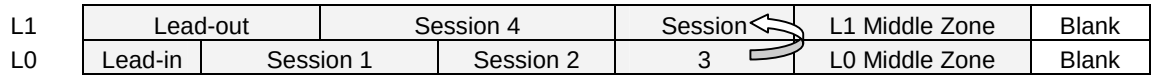

Figure 6 – Example of a DVD+R Double Layer Disc

4.3.2.1 Session Structure

The session structure is identical to DVD+R.

4.3.2.2 Single Layer Recording

A DVD+R Double Layer disc may be recorded as a single layer disc. However, maximum compatibility is obtained when both layers are recorded. If the disc is closed prior to any recording on layer 1, the middle zones should be recorded as middle zone and the remainder of layer 1 should be recorded as lead-out. See Figure 7.

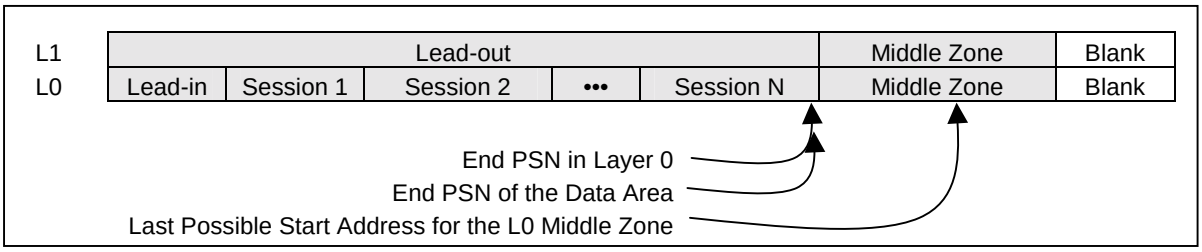

Figure 7 – Preferred Single Layer Recording

4.3.2.3 Double Layer Recording: Crossing the Layers

When a layer switch is required at the selected end of L0, recording begins on L1 with 4 run-in blocks in the L1 middle zone preceding user data. See Figure 8.

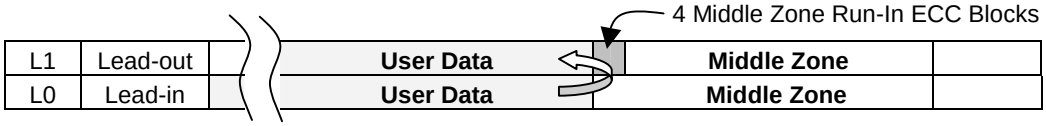

Figure 8 – Run-in ECC Blocks in L1 Middle Zone

Since DVD+R Double Layer format follows the DVD+R format, there is only one additional pre-condition prior to crossing the layers: Crossing the layers must occur at an ECC block boundary in an unrecorded area.

A typical example of crossing the layers during recording is shown Figure 9. In this case, fragment 4 is the incomplete fragment and is written sequentially. When a write command requires more capacity than remains on layer 0, the write continues on layer 1 after 4 run-in blocks have been written into the L1 middle zone. The Middle Zones shall be recorded

completely when the Session that contains the layer crossing position is closed or when the disc is finalized, whichever of the two happens first.

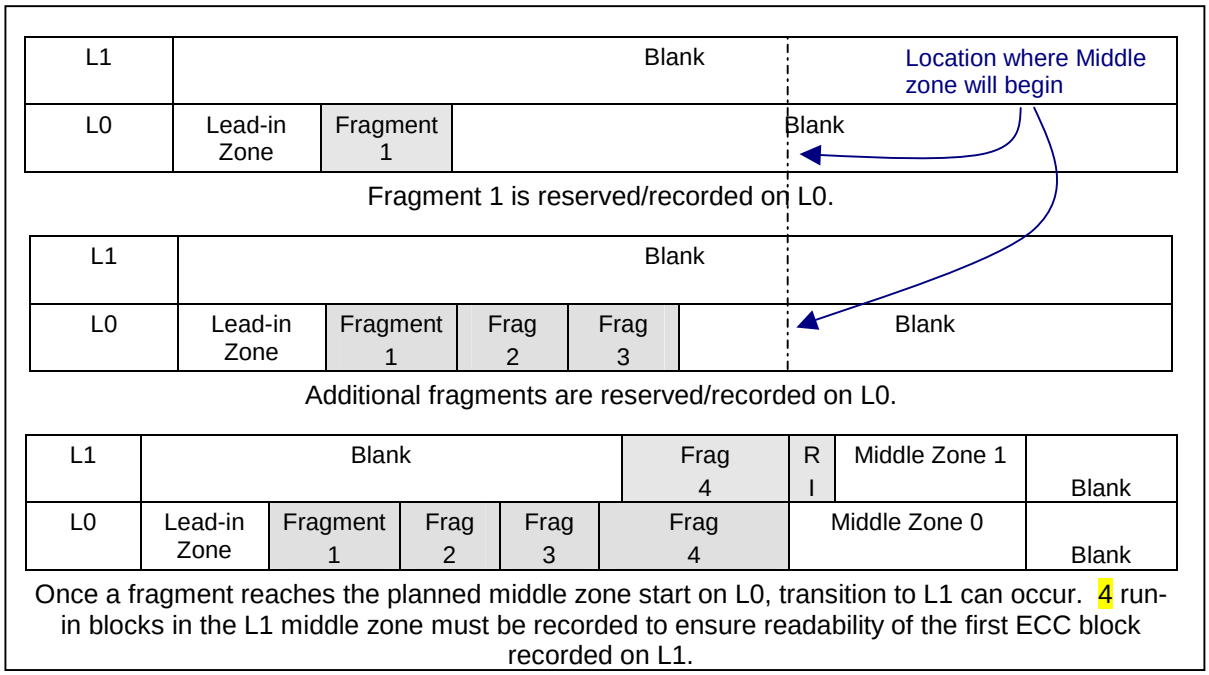

Figure 9 – Example: Crossing the Layers During Recording

Other cases of layer transition are always governed by the DVD+R format. Examples are shown in Table 1.

Table 1 – Examples of Layer Transitions

Situation	Content of the First ECC Block written in the L1 User Data Area
The Intro of a session ends exactly at the end of the L0 user data area.	The first ECC block of the first fragment of the session
A fragment that is not the last fragment ends exactly at the end of the L0 user data area.	The fragment dividing run-in ECC block that appears prior to the next fragment
A run-in ECC block that divides two fragments is exactly the last ECC block of the L0 user data area.	The first ECC block of the next fragment of the session
The last fragment of a session ends exactly at the end of the L0 user data area.	The first ECC block of the session closure. Note: The closure is written when the session is closed. Consequently, both middle zones are also written at this time.
The closure of a session ends exactly at the end of the L0 user data area.	The first ECC block of the Intro of the next session. Note: In this case both middle zones should be written when the session in question is closed. It is permitted to defer writing

5 Features and Profiles for Multi-Media Devices

5.1 Feature Descriptions

5.1.1 The DVD+R Double Layer Feature

The presence of the DVD+R Double Layer Feature indicates that the drive is capable of reading a recorded DVD+R Double Layer disc that is written according to *DVD+R Double Layer 8.5 GB Basic Format Specifications.* The DVD+R Double Layer Feature descriptor is shown in Table 2.

Table 2 - DVD+R Double Layer Feature Descriptor

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			Feature Code = 003Bh				
1								(LSB)
2	Reserved			Version			Persistent	Current
3	Additional Length							
4	Reserved							Write
5	Reserved							
6	Reserved							
7	Reserved							

The Version field shall be set to 0h.

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

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

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

The Additional Length field shall be set to 04h.

If Write is zero, then no DVD+R Double Layer write capability is claimed.

If Write is one, then the drive claims the ability to write DVD+R Double Layer.

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

If a drive reports this feature with the Current bit set to one, Table 3 shows commands that shall be supported based upon the setting of the Write bit.

Table 3 - Command Support Required by the DVD+R Double Layer Feature

Op Code	Write Bit	Command Description	Reference
5Bh	1	Close Track/Session	6.2
28h	-	Read (10)	6.11
AAh	-	Read (12)	6.12
51h	-	Read Disc Information	6.15
ADh	-	Read DVD STRUCTURE (format field values 20h an FFh)	6.16
52h	-	Read Track Information	6.18
53h	1	Reserve Track	6.20
BFh	1	Send DVD Structure (format field value 20h)	6.21
54h	1	Send OPC Information	6.22
35h	1	Synchronize Cache	6.26
2Ah	1	Write (10)	6.28
AAh	1	Write (12)	6.29

The DVD+R Double Layer Feature does not require the use of the Write Parameters Mode Page.

Note: If the Write Parameters Mode Page is supported for other media types, the drive must accept valid mode selects to the Write Parameters Mode Page. The Host must be aware that the drive will always ignore the Write Parameters Mode Page when the DVD+R Double Layer Feature is current.

5.2 Profile Descriptions

5.2.1 Profile 2Bh: DVD+R Double Layer

Drives identifying Profile 002B as current shall support the features listed in Table 4.

Table 4 - Mandatory Features for DVD+R Double Layer

Feature Number	Feature Name	Description
0000h	Profile List	A list of all Profiles supported by the device
0001h	Core	Mandatory behavior for all devices
0002h	Morphing	Device changes operational behavior upon events external to the Host
0003h	Removable Medium	The medium may be removed from the device
0010h	Random Readable, PP=1	Read ability for storage devices with random addressing
001Fh	DVD Read	The ability to read DVD specific structures
0100h	Power Management	Host and device directed power management
003Bh	DVD+R Double Layer	Support for reading and optionally writing DVD+R Double Layer Media and formats
0105h	Timeout	Ability to respond to all commands within a specific time
0107h	Real-time Streaming	Ability to read and write using Host requested performance parameters
010Ah	DCBs	The ability to read and optionally write DCBs.

Table 5 shows the decomposition of the profile into features and features into commands and mode pages.

Table 5 – DVD+R Double Layer Profile Decomposition

DVD+R Double Layer Profile	Core Feature	Get Configuration Command, Get Event Status Notification Command, Inquiry Command, Mode Select (10) Command, Mode Sense (10) Command, Request Sense Command, Test Unit Ready Command
	Morphing Feature	Get Configuration Command, Get Event Status Notification Command, Prevent Allow Medium Removal Command
	Removable Medium Feature	Mechanism Status Command, Prevent Allow Medium Removal Command, Start Stop Unit Command
	Random Readable Feature	Read Capacity Command, Read (10) Command, Read/Write Error Recovery Mode Page
	DVD Read Feature	Read (10) Command, Read DVD Structure Command, Read TOC/PMA/ATIP Command
	DVD+R Double Layer Feature	Close Track/Session, Read Disc Information, Read DVD Structure, Read Track Information, Reserve Track, Send DVD Structure, Synchronize Cache, Write (10), Write (12)
	Power Management Feature	Get Event Status Notification Command, Start Stop Unit Command, Power Condition Page
	Timeout Feature	Timeout and Protect Mode Page
	Real-time Streaming Feature	Get Performance Command, Read (12) Command, Set Read-Ahead Command, Set CD Speed Command[C], Set Streaming Command, Write (12) Command[C]
	DCBs	Read DVD Structure Command, Send DVD Structure Command

[C] marks a feature conditional command or mode page. All other commands and mode pages are mandatory.

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6 Commands for Multi-Media Devices

6.1 Overview

The commands described in this clause are defined uniquely for Multi-Media Drives or have a unique behavior when executed by a Multi-Media Drive.

The commands described in this clause are listed in Table 6. MMC-4 is the primary reference for the command descriptions. For a given command, modified/additional behavior necessary for the support of DVD+R Double Layer is described in the specified sub-clause.

Table 6 – Commands for Multi-Media Drives

Command Name	Op Code	Reference
CLOSE TRACK/SESSION	5Bh	6.2
GET CONFIGURATION	46h	6.3
GET EVENT STATUS NOTIFICATION	4Ah	6.4
GET PERFORMANCE	ACh	6.5
INQUIRY	12h	6.6
MECHANISM STATUS	BDh	6.7
MODE SELECT (10)	55h	6.8
MODE SENSE (10)	5Ah	6.9
PREVENT ALLOW MEDIUM REMOVAL	1Eh	6.10
READ (10)	28h	6.11
READ (12)	A8h	6.12
READ BUFFER CAPACITY	5Ch	6.13
READ CAPACITY	25h	6.14
READ DISC INFORMATION	51h	6.15
READ DVD STRUCTURE	ADh	6.16
READ TOC/PMA/ATIP	43h	6.17
READ TRACK INFORMATION	52h	6.18
REQUEST SENSE	03h	6.19
RESERVE TRACK	53h	6.20
SEND DVD STRUCTURE	BFh	6.21
SEND OPC INFORMATION	54h	6.22
SET READ AHEAD	A7h	6.23
SET STREAMING	B6h	6.24
START STOP UNIT	1Bh	6.25
SYNCHRONIZE CACHE	35h	6.26
TEST UNIT READY	00h	6.27
WRITE (10)	2Ah	6.28
WRITE (12)	AAh	6.29

6.2 CLOSE TRACK SESSION Command

The CLOSE TRACK SESSION Command (Table 7) allows closure of either a track or a session. The command description that follows is specific to DVD+R Double Layer. For other media types and formats, refer to MMC-4.

Table 7 – 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.

Track Number is the number of the Logical Track is to be closed. For DVD+R Double Layer, this is a fragment number.

The specific functioning of the CLOSE TRACK SESSION command is defined according to the 3-bit close function code. The Close Function codes for DVD+R Double Layer are defined in Table 8.

Table 8 - CLOSE TRACK SESSION functions for DVD+R Double Layer

Close Function	Description
000b	Reserved
001b	Close the fragment associated with the fragment number in the CDB as follows: If the current fragment is reserved and blank or partially written, the DVD+R Double Layer Drive shall pad the fragment to its defined length. User data areas in all pad sectors shall be zero filled. If the fragment being closed is the invisible fragment and the invisible fragment is not blank, then a new DCB shall be appended into the Session Identification Zone defining the existence of the fragment. If the fragment being closed is the invisible fragment and the invisible fragment is blank, then the command shall be terminated with GOOD status and sense data shall be set to NO SENSE/NO ADDITIONAL INFORMATION.
010b	Close the last session. If not all Fragments in the last Session are closed, the DVD+R Double Layer 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. If the LBA of the last ECC block of the session closure is greater than or equal to the LBA of the last ECC block on L0, then both middle zones shall be recorded. If, upon completion of the closure, less than 65 ECC blocks would remain in disc capacity, the drive shall finalize the disc.
011b	Reserved
100b	Reserved
101b	Close Last Incomplete Session and Finalize the Disc Case 1: L1 is blank Once this close function has been executed, no more writing to the disc is allowed. Complete all pending writes. Verify that all fragments are closed. If not all fragments in the last Session are closed, the 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. Write last session closure and encode as lead-out. Write last session intro. Write middle zone on L0 until at least 30 mm. Write L1 middle zone. Write L1 lead-out until complete under L0 lead-in. Note: Writing order may vary. Case 2: L1 contains user data Complete all pending writes. Verify that all fragments are closed. Write a lead-out that is long enough to be completely present under the disc lead-in. If the middle zones have not been written, write the middle zones. Write the last session intro.
110b	Reserved
111b	Reserved

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

a) In response to all commands except REQUEST SENSE, INQUIRY, GET CONFIGURATION, GET EVENT STATUS NOTIFICATION, and TEST UNIT READY, the Logical Unit shall return CHECK CONDITION status and set SK/ASC/ASCQ to NOT READY/LOGICAL UNIT NOT READY/OPERATION IN PROGRESS.

b) In response to the TEST UNIT READY command, the Logical Unit should return CHECK CONDITION status and set SK/ASC/ASCQ to NOT READY/LOGICAL UNIT NOT READY/OPERATION IN PROGRESS. Some legacy implementations allowed for a GOOD status response to a TEST UNIT READY command. This behavior is not recommended.

c) In response to the INQUIRY, GET CONFIGURATION, GET EVENT STATUS NOTIFICATION commands, the Logical Unit shall respond as commanded.

d) In response to the REQUEST SENSE command, unless an error has occurred, the Logical Unit shall return with SK/ASC/ASCQ values set to NOT READY/LOGICAL UNIT NOT READY/LONG WRITE IN PROGRESS or NOT READY/LOGICAL UNIT NOT READY/OPERATION IN PROGRESS, with the sense key specific bytes set for progress indication.

Due to the potentially long close session times, progress indication is required when the CLOSE TRACK SESSION command is issued with the IMMED bit set to one.

The progress indication field (Table 9) in sense data represents a fractional amount of completion in which the returned value is the numerator that has 65 536 (10000h) as its denominator. The progress indication shall be based upon the total operation. While the close is in progress, SKSV shall be set to one. Once the close operation has completed, progress reporting shall cease and SKSV shall be set to zero.

Table 9 – Progress Indication in Sense Data

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

6.3 GET CONFIGURATION Command

The Core Feature requires that this command be implemented. The DVD+R Double Layer Profile includes the Core Feature. From the Host's perspective, use of this command requires no special behavior from a Drive when the DVD+R Double Layer Feature is current.

See MMC-4 at this sub-clause number for a description of this command.

6.4 GET EVENT STATUS NOTIFICATION Command

The Core Feature requires that this command be implemented. The DVD+R Double Layer Profile includes the Core Feature. From the Host's perspective, use of this command requires no special behavior from a Drive when the DVD+R Double Layer Feature is current.

See MMC-4 at this sub-clause number for a description of this command.

6.5 GET PERFORMANCE Command

The Real-time Streaming Feature requires that this command be implemented. The DVD+R Double Layer Profile includes the Real-time Streaming Feature. From the Host's perspective, use of this command requires no special behavior from a Drive when the DVD+R Double Layer Feature is current.

Note that there is a performance change at the layer boundary.

See MMC-4 at this sub-clause number for a description of this command.

6.6 INQUIRY Command

The Core Feature requires that this command be implemented. The DVD+R Double Layer Profile includes the Core Feature. From the Host's perspective, use of this command requires no special behavior from a Drive when the DVD+R Double Layer Feature is current.

See MMC-4 at this sub-clause number for a description of this command.

6.7 MECHANISM STATUS Command

The Core Feature requires that this command be implemented. The DVD+R Double Layer Profile includes the Core Feature. From the Host's perspective, use of this command requires no special behavior from a Drive when the DVD+R Double Layer Feature is current.

See MMC-4 at this sub-clause number for a description of this command.

6.8 MODE SELECT (10) Command

The Core Feature requires that this command be implemented. The DVD+R Double Layer Profile includes the Core Feature. From the Host's perspective, use of this command requires no special behavior from a Drive when the DVD+R Double Layer Feature is current.

See MMC-4 at this sub-clause number for a description of this command.

6.9 MODE SENSE (10) Command

The Core Feature requires that this command be implemented. The DVD+R Double Layer Profile includes the Core Feature. From the Host's perspective, use of this command requires no special behavior from a Drive when the DVD+R Double Layer Feature is current.

See MMC-4 at this sub-clause number for a description of this command.

6.10 PREVENT ALLOW MEDIUM REMOVAL Command

The Removable Media Feature requires that this command be implemented. The DVD+R Double Layer Profile includes the Removable Media Feature. From the Host's perspective, use of this command requires no special behavior from a Drive when the DVD+R Double Layer Feature is current.

See MMC-4 at this sub-clause number for a description of this command.

6.11 READ (10) Command

The Random Readable Feature requires that this command be implemented. The DVD+R Double Layer Profile includes the Random Readable Feature. From the Host's perspective, use of this command requires no special behavior from a Drive when the DVD+R Double Layer Feature is current.

See MMC-4 at this sub-clause number for a description of this command.

6.12 READ (12) Command

The DVD Read Feature requires that this command be implemented. The DVD+R Double Layer Profile includes the DVD Read Feature. From the Host's perspective, use of this command requires no special behavior from a Drive when the DVD+R Double Layer Feature is current.

See MMC-4 at this sub-clause number for a description of this command.

6.13 READ BUFFER CAPACITY Command

The Real-time Streaming Feature requires that this command be implemented. The DVD+R Double Layer Profile includes the Real-time Streaming Feature. From the Host's perspective, use of this command requires no special behavior from a Drive when the DVD+R Double Layer Feature is current.

See MMC-4 at this sub-clause number for a description of this command.

6.14 READ CAPACITY Command

The Random Readable Feature requires that this command be implemented. The DVD+R Double Layer Profile includes the Random Readable Feature. From the Host's perspective, use of this command requires no special behavior from a Drive when the DVD+R Double Layer Feature is current.

The Logical Unit must report only the capacity of closed sessions. Consequently, a disc has a capacity of zero until the first session is closed.

See MMC-4 at this sub-clause number for a description of this command.

6.15 READ DISC INFORMATION Command

The Read Disc Information Command (the CDB is unchanged and thus not shown) returns detailed information about the medium. This information is returned in the Disc Information Block.

All fields currently defined in MMC-4 shall remain unchanged.

Table 10 - 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	DAC_V	Reserved		Background Format Status	
8	Disc Type							
9	Number of Sessions (MSB)							
10	First Track Number in Last Session (MSB)							
11	Last Track Number in Last Session (MSB)							
12	(MSB) Disc Identification							
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 DVD+R Double Layer 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 cleared to zero,
- State of last Session shall be according to the MMC-4 definition for DVD+R,
- Disc Status shall be according to the MMC-4 definition for DVD+R,
- Number of First Track on Disc shall be set to 1,
- Number of Sessions is the actual number of sessions on the medium - including the open session, if it exists,
- First Track Number in Last Session is equal to the number of the last session,
- Last Track Number in Last Session is exactly the last track number in the last session,
- 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.
- Background Format Status shall be cleared to zero,
- Disc Type shall be set to 00h,
- Disc Identification is unique to CD. For DVD+R Double Layer, this field shall be cleared to zero,
- Last Session Lead-in Start Time shall be reported as a LBA,
- Last Possible Start Time for Start of Lead-out shall be reported as a LBA,
- 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.
- The OPC Table Entry for a speed shall be attached only if the OPC Values for at least one of layers is known. Otherwise no OPC Table Entry shall be returned. If the values are known for only one layer, then the table entry for the other layer shall be present, but zero filled. If a speed X OPC Table entry for Layer 0 is present in the list, then the speed X Layer 1 OPC Table entry must appear later in the list.

  The Number of OPC Table Entries field shall be 2 x the number of writing speeds supported for writable double layer media.

  Examples of the attached OPC Table for DVD+R Double Layer are shown in Table 11.

Table 11 - Example 1 of OPC Table Entry for DVD+R Double Layer Media

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			Speed (in kBps) representing 2.4x				
1								(LSB)
2	OPC Values for Layer 0							
…								
7								
8	(MSB)			Speed (in kBps) representing 1x				
9								(LSB)
10	OPC Values for Layer 0							
…								
15								
16	(MSB)			Speed (in kBps) representing 2.4x				
17								(LSB)
18	OPC Values for Layer 1							
…								
23								
24	(MSB)			Speed (in kBps) representing 1x				
25								(LSB)
26	OPC Values for Layer 1							
…								
31								

Table 12 - Example 1 of OPC Table Entry for DVD+R Double Layer Media

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			Speed (in kBps) representing 2.4x				
1								(LSB)
2	OPC Values for Layer 0							
…								
7								
8	(MSB)			Speed (in kBps) representing 2.4x				
9								(LSB)
10	OPC Values for Layer 1							
…								
15								
16	(MSB)			Speed (in kBps) representing 1x				
17								(LSB)
18	OPC Values for Layer 0							
…								
23								
24	(MSB)			Speed (in kBps) representing 1x				
25								(LSB)
26	OPC Values for Layer 1							
…								
31								

6.16 READ DVD STRUCTURE Command

The READ DVD STRUCTURE command requests that the Logical Unit transfer data from areas on the DVD Media to the Initiator.

Table 13 – READ DVD STRUCTURE Command Descriptor Block

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

According to the DVD+R Double Layer Profile, the READ DVD STRUCTURE command implementation shall implement format code values 0, 1, 3, 4, 20h, 30h and FFh.

Format code 20h (DVD+R Double Layer Layer Boundary Information) is unique to DVD+R Double Layer.

When the Format code is not 20h, see MMC-4 for CDB parameter definitions and specific execution descriptions. When format code is 20h, CDB parameter definitions are given in Table 14.

Table 14 – Parameter Definitions for Format Code = 20h

Format Code	Layer Field Usage	Address Field Usage	Description
20h	Reserved	Reserved	When the DVD+R Double Layer Feature is current, the data returned identifies the layer boundary information.

Table 15 – DVD+R Double Layer Recording Information

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			DVD STRUCTURE Data Length				
1								(LSB)
2	Reserved							
3	Reserved							
DVD+R Double Layer Recording Information (Format field = 20h)								
0	Init Status	Reserved						
1	Reserved							
2	Reserved							
3	Reserved							
4	(MSB)							
5	L0 Data Zone Capacity							
6								
7								(LSB)

Init Status specifies the ability of the Initiator to change Data Zone Capacity.

When Init Status is zero, L0 Data Zone Capacity has not been specified and shall default to the capacity specified in lead-in ADIP. The host may specify a smaller value by using the SEND DVD STRUCTURE command with format code = 20h.

When Init Status is one, L0 Data Zone Capacity has been specified and may not be changed.

If the DVD+R Double Layer disc is completely blank, Init Status shall be set to Zero.

L0 Data Zone Capacity is the number of data zone sectors available for recording on L0. The disc shall provide exactly the same capacity in ECC blocks on each layer. Consequently, this value shall be an integral multiple of 16. The capacity of L0 is the number of sectors between the end of the disc lead-in and the first sector of the middle zone. When no L0 Data Zone Capacity has been selected, the reported capacity shall be based upon the lead-in ADIP.

6.17 READ TOC/PMA/ATIP Command

The DVD Read Feature requires that this command be implemented. The DVD+R Double Layer Profile includes the DVD Read Feature. When the media present is not DVD+R Double Layer recorded media, MMC-4 should be consulted.

The Read TOC Command reports track information only for closed sessions. If no sessions are recorded and closed, this command shall be terminated with CHECK CONDITION status and sense bytes SK/ASC/ASCQ shall be set to ILLEGAL REQUEST/INVALID FIELD IN CDB.

All TOC forms shall be reported as for DVD+R.

6.17.1 TOC Form 0

Due to track merging, TOC form 0 reports each closed session as a track. Since DVD+R/R Double Layer supports at most 127 sessions, TOC form 0 may have at most 127 track descriptors. Thus, the maximum size of returned data for TOC form 0 is 1 020 (i.e. 4 + 8*127).

The TOC form 0 format is presented to the host as shown in Table 16:

Table 16 - TOC Form 0 Format

TOC Header								
Bit **Byte**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	(MSB) TOC Data Length							
1								(LSB)
2	Number of First Closed Session on disc (=01h)							
3	Number of Last Closed Session on Disc							
Track Descriptor Format								
0	Reserved							
1	ADR				CTL			
2	Session Number							
3	Reserved							
4	(MSB) Session Start Address (Address of first sector of user data in session)							
5								
6								
7								(LSB)

If the host requests this TOC form for a disc that has no closed sessions, the drive shall terminate the READ TOC/PMA/ATIP command with CHECK CONDITION status and set sense data to ILLEGAL REQUEST/INVALID PARAMETER IN CDB.

If the MSF (TIME) bit in the CDB is set to zero, then the Address field (bytes 4 - 7) shall contain the LBA of the first sector of the first user ECC block of the session.

If the MSF (TIME bit in the CDB is set to one, then the Address field (bytes 4 - 7) shall contain an MSF representation of the LBA. When LBA is less than 1 152 000d, M,S and F are selected so that:

LBA = MIN (4500*M + 75*S + F - 150. Otherwise, M, S, and F shall be selected as 0FFh, 3Bh, and 4Ah.

6.17.2 TOC Form 1

The TOC form 1 format for DVD+R/R Double Layer is as follows:

TOC Header								
Byte \ **Bit**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	(MSB) TOC Data Length							
1								(LSB)
2	Number of First Closed Session on Disc (01h)							
3	Number of Last Closed Session on Disc							
Track Descriptor Format								
0	Reserved							
1	ADR				CTL			
2	Number of Last Closed Session on Disc							
3	Reserved							
4	(MSB) Session Start Address (Address of first sector of user data in session)							
5								
6								
7								(LSB)

If the MSF (TIME) bit in the CDB is set to zero, then the Address field (bytes 4 - 7) shall contain the LBA of the first sector of the first user ECC block of the session.

If the MSF (TIME bit in the CDB is set to one, then the Address field (bytes 4 - 7) shall contain an MSF representation of the LBA. When LBA is less than 1 152 000d, M,S and F are selected so that:

LBA = MIN (4500*M + 75*S + F - 150. Otherwise, M, S, and F shall be selected as 0FFh, 3Bh, and 4Ah.

6.17.3 TOC Form 2

TOC form 2 is not defined for DVD+R media. If the host requests this TOC form, the drive shall terminate the READ TOC/PMA/ATIP command with CHECK CONDITION status and set sense data to ILLEGAL REQUEST/INVALID PARAMETER IN CDB.

6.17.4 TOC Form 3

TOC form 3 is not defined for DVD+R media. If the host requests this TOC form, the drive shall terminate the READ TOC/PMA/ATIP command with CHECK CONDITION status and set sense data to ILLEGAL REQUEST/INVALID PARAMETER IN CDB.

6.17.5 TOC Form 4

TOC form 4 is not defined for DVD+R media. If the host requests this TOC form, the drive shall terminate the READ TOC/PMA/ATIP command with CHECK CONDITION status and set sense data to ILLEGAL REQUEST/INVALID PARAMETER IN CDB.

6.17.6 TOC Form 5

TOC form 5 is not defined for DVD+R media. If the host requests this TOC form, the drive shall terminate the READ TOC/PMA/ATIP command with CHECK CONDITION status and set sense data to ILLEGAL REQUEST/INVALID PARAMETER IN CDB.

6.18 READ TRACK INFORMATION Command

The Read Track Information Command (the CDB is unchanged and thus not shown) returns detailed information about the medium. This information is returned in the Track Information Block (Table 17).

Table 17 - Track Information Block

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB) Data Length							
1								(LSB)
2	Track Number (LSB)							
3	Session Number (LSB)							
4	Reserved							
5	Reserved		Damage	Copy	Track Mode			
6	RT	Blank	Packet	Fixed	Data Mode			
7	Reserved						LRA_V	NWA_V
8	(MSB) Track Start Address							
...								
11								(LSB)
12	(MSB) Next Writable Address							
...								
15								(LSB)
16	(MSB) Free Blocks							
...								
19								(LSB)
20	(MSB) Packet Size/Blocking Factor							
...								
23								(LSB)
24	(MSB) Track Size							
...								
27								(LSB)
28	(MSB) Last Recorded Address							
...								
31								(LSB)
32	Track Number (MSB)							
33	Session Number (MSB)							
34	Reserved							
35	Reserved							
36	(MSB) Read Compatibility LBA							
37								
38								
39								(LSB)

For DVD+R Double Layer:

- Data Length shall be set to 34 (22h).
- Track Number shall be reported according the DVD+R reporting rules: track merging in closed sessions with a maximum of 127 sessions.
- Session Number shall be set according to MMC-4.
- Damage has no meaning for DVD+R Double Layer and shall be cleared to zero.
- Copy has no meaning for DVD+R Double Layer and shall be cleared to zero.
- Track Mode shall be set to 7h.
- RT shall be set according to MMC-4.
- Blank shall be set according to MMC-4.
- Packet has no meaning for DVD+R Double Layer and shall be cleared to zero.
- FP has no meaning for DVD+R Double Layer and shall be cleared to zero.
- Data Mode shall be set to 1.
- LRA_V shall be cleared to zero.
- NWA_V shall be set according to MMC-4.
- Track Start Address is set to the first user data sector of the session if the session is closed. Otherwise, it shall be set according to MMC-4.
- Next Writable Address shall be set according to MMC-4.
- Free Blocks shall be set according to MMC-4.
- Packet Size/Blocking Factor shall be set to10h.
- Track Size shall be equal to session data zone size if the session is closed. Otherwise, it shall be set according to MMC-4.
- Last Recorded Address shall be cleared to zeros.
- If the track is the invisible track (i.e. RT=0), the Read Compatibility LBA shall be present. Read Compatibility LBA is an approximation of a logical block address at or beyond a 30mm disc radius on L0. The host may use this address as a minimal pad limit prior to closing the current session in order to maximize compatibility with read-only devices. The host may also use this address as a lower limit for the Layer Jump address.

6.19 REQUEST SENSE Command

The Core Feature requires that this command be implemented. The DVD+R Double Layer Profile includes the Core Feature.

Due to the potentially long close session times, progress indication is required when the CLOSE TACK SESSION command is issued with the IMMED bit set to one.

See MMC-4 at this sub-clause number for a description of this command.

6.20 RESERVE TRACK Command

Fragment reservation on DVD+R Double Layer is identical to fragment reservation on DVD+R.

This command operates in an equivalent way to the function described for CD in MMC-4, with some small exceptions:

Reservation Length is given as a count of 2 KB sectors. If this number is not an integral multiple of 16, then the drive shall increase the value to the next integral multiple of 16. This is the value used by the drive. A track always begins with the first sector of an ECC block. A run-in ECC block shall be written between any two tracks within a session just prior to writing the first ECC block of the following track. The run-in ECC block does not belong to either track.

6.21 SEND DVD STRUCTURE Command

A new Format Number (20h, DVD+R Double Layer Recording Information) is available when the DVD+R Double Layer feature is current with write capability.

Table 18 – SEND DVD STRUCTURE CDB Parameters

Format Code	Layer Field Usage	Address Field Usage	Description
20h	Reserved	Reserved	When the DVD+R Double Layer Feature is current, the host shall L0 Data Zone Capacity.

Table 19 – DVD+R Double Layer Recording Information

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			DVD STRUCTURE Data Length				
1								(LSB)
2	Reserved							
3	Reserved							
DVD+R Double Layer Recording Information (Format field = 20h)								
0	Reserved							
1	Reserved							
2	Reserved							
3	Reserved							
4	(MSB)							
5				L0 Data Zone Capacity				
6								
7								(LSB)

The host may specify the L0 Data Zone Capacity at a value greater than zero. The value shall be selected large enough such that it represents 30 mm of recording on layer 0 (see Read Compatibility LBA, sub-clause 6.18). The last user data zone LBA in L0 is L0 Data Zone Capacity – 1.

If the value of L0 Data Zone Capacity is not an integral multiple of 16, then the value shall be rounded up to the next integral multiple of 16. If the rounded L0 Data Zone Capacity value is greater than available capacity in L0, or the value represents less than 30mm of recording, then the command shall be terminated with CHECK CONDITION status and sense bytes SK/ASC/ASCQ shall be set to ILLEGAL REQUEST/INVALID FIELD IN PARAMETER BLOCK. If Data Zone Capacity has already been established by a previous SEND DVD STRUCTURE command with format code = 20h, then the command shall be terminated with CHECK CONDITION status and sense bytes SK/ASC/ASCQ shall be set to ILLEGAL REQUEST/INVALID FIELD IN PARAMETER BLOCK.

See 4.3.2.3 for a description of how the layer transitions operate.

6.22 SEND OPC INFORMATION Command

The SEND OPC INFORMATION command descriptor block (Table 20) allows the Host to request that the drive perform Optimum Power Calibration (OPC) on the currently mounted medium.

Table 20 – SEND OPC INFORMATION Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code (54h)							
1	Reserved					Exclude0	Exclude1	DoOpc
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	(MSB) Parameter List Length							
8								(LSB)
9	Control							

If DoOpc is set to one, the drive shall perform an OPC operation to set the OPC values for the current speed. These OPC values shall become current. When DoOpc is set to one, the Parameter List Length field is ignored.

If DoOpc is set to zero, the Logical Unit shall transfer the Parameter List and attempt to set OPC values to those in the Parameter List.

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

Table 21 shows the behaviour given various combinations of control bits from byte 1.

Table 21 – Drive Action with Combinations of DoOPC, Exclude0, and Exclude1

DoOpc	Exclude0	Exclude1	Drive Response
1	0	0	Perform OPC operation on each layer to set OPC values for current media speed.
1	0	1	Perform OPC operation only on layer 0 to set OPC values for current media speed.
1	1	0	Perform OPC operation only on layer 1 to set OPC values for current media speed.
1	1	1	No operation
0	0	0	Perform OPC operation on each layer using OPC values supplied in parameter data.
0	0	1	Perform OPC operation only on layer 0 using OPC values supplied in parameter data.
0	1	0	Perform OPC operation only on layer 1 using OPC values supplied in parameter data.
0	1	1	No operation

If the mounted media is not DVD+R Double Layer and either Exclude0 or Exclude1 is non-zero, then the command shall be terminated with CHECK CONDITION status and sense bytes SK/ASC/ASCQ shall be set to ILLEGAL REQUEST/INVALID FIELD IN CDB.

Parameter List Length is the number of bytes in the OPC Table that shall be received by the drive.

The OPC Table is a sequence of OPC entries where each entry is uniquely associated with a recording speed.

An OPC Table entry (Table 22) is 8 bytes in length.

Table 22 – OPC Table Entry

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			Speed in kB per second				
1								(LSB)
2	OPC Values							
3								
...								
7								

Speed shall be in kB per second (k = 1000).

The OPC values are 6 bytes per OPC calibration area. The values are vendor specific.

If each byte of the OPC values field is zero, then the drive shall assume that no values for the specified speed are available.

The OPC Table Entry for a speed shall be included only if the OPC Values for at least one of layers is known. Otherwise no OPC Table Entry shall be returned. If the values are known for only one layer, then the table entry for the other layer shall be present, but zero filled. If a speed X OPC Table entry for Layer 0 is present in the list, then the speed X Layer 1 OPC Table entry must appear later in the list.

The Number of OPC Table Entries field shall be 2 x the number of writing speeds supported for writable double layer media.

Examples of the attached OPC Table for DVD+R Double Layer are shown in Table 11 and Table 12.

If only one layer is to be calibrated (i.e. Exclude0 = 1 or Exclude1 = 1), the drive shall ignore the parameters associated with the excluded layer.

6.23 SET READ AHEAD Command

The Real-time Streaming Feature requires that this command be implemented. The DVD+R Double Layer Profile includes the Real-time Streaming Feature. From the Host's perspective, use of this command requires no special behavior from a Drive when the DVD+R Double Layer Feature is current.

See MMC-4 at this sub-clause number for a description of this command.

6.24 SET STREAMING Command

The Real-time Streaming Feature requires that this command be implemented. The DVD+R Double Layer Profile includes the Real-time Streaming Feature. From the Host's perspective, use of this command requires no special behavior from a Drive when the DVD+R Double Layer Feature is current.

See MMC-4 at this sub-clause number for a description of this command.

6.25 START STOP UNIT Command

The Removable Media Feature requires that this command be implemented. The DVD+R Double Layer Profile includes the Removable Media Feature. From the Host's perspective, use of this command requires no special behavior from a Drive when the DVD+R Double Layer Feature is current.

See MMC-4 at this sub-clause number for a description of this command.

6.26 SYNCHRONIZE CACHE Command

From the Host's perspective this command shall perform no differently than with DVD+R. The command may have a longer execution time when the synchronization occurs across layers.

6.27 TEST UNIT READY Command

The Core Feature requires that this command be implemented. The DVD+R Double Layer Profile includes the Core Feature. From the Host's perspective, use of this command requires no special behavior from a Drive when the DVD+R Double Layer Feature is current.

See MMC-4 at this sub-clause number for a description of this command.

6.28 WRITE (10) Command

From the Host's perspective this command shall perform no differently than with DVD+R.

6.29 WRITE (12) Command

From the Host's perspective this command shall perform no differently than with DVD+R.

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7 Mode Parameters for Multi-Media Devices

7.1 Mode Parameter List

The presence of the DVD+R Double Layer Profile causes no change in either the Mode Parameter List or Mode Parameter List Header.

See MMC-4 at this sub-clause number for a description of this mode page.

7.2 Mode Pages

7.2.1 Read/Write Error Recovery Parameters Mode Page (Page Code 01h)

The Random Readable Feature requires that this mode page be implemented. The DVD+R Double Layer Profile includes the Random Readable Feature. From the Host's perspective, use of this mode page requires no special behavior from a Drive when the DVD+R Double Layer Feature is current.

See MMC-4 at this sub-clause number for a description of this mode page.

7.2.2 Power Condition Page (Page Code 1Ah)

The Power Management Feature requires that this mode page be implemented. The DVD+R Double Layer Profile includes the Power Management Feature. From the Host's perspective, use of this mode page requires no special behavior from a Drive when the DVD+R Double Layer Feature is current.

See MMC-4 at this sub-clause number for a description of this mode page.

7.2.3 Timeout and Protect Page (Page Code 1Dh)

The Timeout Feature requires that this mode page be implemented. The DVD+R Double Layer Profile includes the Timeout Feature. From the Host's perspective, use of this mode page requires no special behavior from a Drive when the DVD+R Double Layer Feature is current. The Initiator should note that the Group 1 and Group 2 minimum timeout values are larger than those for DVD+R.

See MMC-4 at this sub-clause number for a description of this mode page.

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Annex A Using DVD+R Double Layer

The command set has two viewpoints: the Initiator's view of the drive/media combination and reality as known by the Logical Unit. This annex presents an Initiator's viewpoint.

A.1 Features and Profiles for DVD+R Double Layer

A.1.1 Features

The Initiator must be able to determine that the Logical Unit is capable of reading DVD+R Double Layer formats. It is also important to determine that the Logical Unit can/cannot write DVD+R Double Layer formats. A single feature is used for that purpose, similar to the DVD+R feature, but not the DVD+R Feature.

For reading, a DVD+R Double Layer disc has the appearance of a DVD+R disc. The only difference is the disc capacity (4.7 GB for DVD+R versus 8.5 GB for DVD+R Double Layer).

In the case of writing, the only difference that DVD+R Double Layer has with DVD+R is the two-layer construction. Closing a DVD+R Double Layer disc can require quite a lot of time. For this reason, the Initiator has an additional capability with DVD+R Double Layer – the total capacity can be restricted in order to minimize the disc closing time.

A.1.2 Profiles

Since the complete DVD+R Double Layer command set is different from the DVD+R command set, a new DVD+R Double Layer profile is necessary. Although the DVD+R command set can be used for DVD+R Double Layer recording, full control and efficient use can only be realized with the DVD+R Double Layer command set.

A profile has no technical value to either the Logical Unit or the Initiator. It's intent is to create a minimal list of behaviors for the device. Some applications use a current profile to select a unique icon for the device/media combination.

A.2 Recording a DVD+R Double Layer Disc

The DVD+R session format can be used on DVD+R Double Layer. A Single Session with exactly one fragment is suitable for authoring and disc backup. Multiple sessions with the possibility of reserving and closing fragments provides incremental recording.

A.2.1 Performing OPC

OPC can be a time consuming function. It becomes twice as long when both layers must be calibrated. The host may distribute the OPC overhead by performing OPC on layer 0 only and later on layer 1 only.

A.2.2 Recording DAO

If the Initiator can construct a disc image on a HDD, the disc can be recorded in a Disc-At-Once way. This is the simplest method for the Initiator:

1. Mount a blank DVD+R Double Layer; wait for READY.
2. Calculate the image size. If it is less than 8.5 GB, notify the Logical Unit of the optimal L0 Data Zone Capacity (1/2 image size) via the SEND DVD STRUCTURE command, format code = 20h.
3. Read the HDD image; write to the DVD+R Double Layer beginning with LBA 0.
4. Close the disc.

A.2.3 Fragmented Recording

The purpose of fragmented recording in multiple sessions is typically an incremental build where the final capacity is not known.

If a fragmented recording application exists for DVD+R, that application can be used with DVD+R Double Layer. If there is a reason to restrict the final disc capacity, that can be done by using the SEND DVD STRUCTURE command with format code = 20h. Otherwise the application requires no changes.

A.3 Special Considerations

A.3.1 Group 1 Timeout

The DVD+R Double Layer disc has a LBA, N, such that N is on L0 and N+1 is on L1. A write command may begin at the first sector of the ECC block that contains N and with a length of 32. If this command is issued with the FUA bit set to one, then the first ECC block will be written on L0, a layer jump shall be performed and then the second ECC block shall be written on L1. This requires more time than a 2 ECC block write in which both ECC blocks are on the same layer. This must be reflected in the Group 1 timeout value in the Timeout and Protect Mode Page.

A.3.2 Group 2 Timeout

In order that the disc be read compatible with DVD-RO devices, both layers must be recorded to a radial position that includes overlapping intro (on L1) and closure (on L0) that are large enough to cover the groove tolerance. Consequently, closing a disc when no or only a small amount of L1 has been recorded requires a great deal of time. This must be reflected in the Group 2 timeout value in the Timeout and Protect Mode Page.