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## 13. Read-Only Direct Access Devices

## 13.1. Model for Read-Only Direct Access Devices

## 13.1.1. CD-ROM Addressing

The formats written on the CD-ROM and CD Audio disks require special addressing considerations.

These disks may contain either audio information, data or a mixture of the two. Table 13-1 shows the layout of a mixed mode disk to illustrate the correspondence between the logical addresses reported across the SCSI interface and the physical Minutes / Seconds / Frames location information encoded in the media.

The CD-ROM physical format provides 2340 bytes per frame (or in more usual terminology, sector.) For most data applications, 2048 bytes are used for user data, 4 bytes for a header field and 288 bytes - the auxiliary field - for ECC. The auxiliary field may also be used for user data. A CD-ROM drive may return to the host 2048, 2336 or 2340 bytes from each data frame. These block lengths correspond to user data field only, user data plus auxiliary data, or the 4 byte header plus the two other fields.

This same area of the CD-ROM or CD audio media may store 1/75th second of audio information.

Logical addressing of CD-ROM information may select block sizes of 256, 512 or 1024 bytes in addition to the full frame values of 2048, 2336 and 2340. The smaller logical block lengths map 8, 4 or 2 logical blocks to the 2048 byte user data area of each physical frame. These mappings apply to all frames on the media.

The device locates information on a CD-ROM media by translating the Logical Block Address into a physical M/S/F location. This function is identical, in principle, to the translation to Cylinder/Head/Sector that takes place when addressing a typical magnetic direct access device.

The translation from M/S/F to Logical Block Address is:

$$LBA = (((((M * 60) + S) * 75) + F) - 150) * Blks\_per\_Frame$$

where M == Minutes value from M/S/F address,  
S == Seconds value from M/S/F address,  
F == Frames value from M/S/F address,  
150 == frames in 2 seconds, and  
Blks\_per\_frame is 1 if the block length is 2048, 2336 or 2340,  
2 if the block length is 1024,  
4 if the block length is 512, or  
8 if the block length is 256 bytes.

Data frames are always addressed by their Logical Block address relative to the first addressable block on the media which is located at M/S/F location 00/02/00. This block is referred to as the logical beginning of the media, LBA zero.

Audio frames may be addressed with an absolute logical block address plus two other means dependent on track, index, and track relative M/S/F location. This additional addressing information is encoded in a reserved (Q-sub-channel) area of each frame.

A track may be viewed as a partition of the CD address space. All information frames of a track are required to be of the same type (Audio/Data) and mode. The information tracks of a CD media are consecutive values between 1 and 99. However, the first information track may have a number greater than 1.

The lead-in area of the media is track zero. The lead-out area is track 0AAh. These tracks are not addressable. The sub-channel area of the lead-in track contains a Table of Contents (TOC) for the media.

The Table of Contents gives the absolute M/S/F locations of the first information frame of each track. Control information (audio/data, mode of audio recording, etc.) for each track is also given in the TOC. The M/S/F locations of the beginning of data tracks in the TOC are required to be accurate, however, these values for audio tracks have a tolerance of plus or minus one second. Information from the TOC can be used to reply to a Read Capacity command. When this is done the drive implementer should consider the possible tolerances and return a Read Capacity value which allows access to all information frames.

An index is a partition of a track. Pre-gap areas are encoded with an index value of zero. The first information frame of a track will have index 1. Consecutive values up to 99 are permitted. Index information is not found in the TOC. Not all frames carry index data (the requirement is 9 out of 10). A frame without an index value is presumed to have the same index as the preceding frame.

Tracks and indexes are not defined to be any particular length. A CD media may be created with a single information track with a single index or with 99 information tracks each with 99 indexes.

Areas of the CD media may be set aside as track and information type separations. When adjacent tracks are of the same type, the separator area (called pause, audio silence, pre-gap or post-gap) is optional. Table 13-1 shows the possible arrangements. The required lengths are given as minimum values.

The sub-channel location information of each frame includes a relative M/S/F value giving the distance from the first information frame of the track. On the media this value decreases during the pre-gap area (frames with index values of 0) and increases for the rest of the track. Over the SCSI interface this is converted to a relative logical address. It is monotonic over a track and pre-gap areas will return negative values.

Table 13-1: Example Mixed Mode CD-ROM Disk Layout

Logical Addresses given assume a Block Length of 2048, 2336 or 2340 bytes. For Block Lengths of 1024, 512 or 256 multiply all values given in the SCSI Addressing columns by 2, 4 or 8 respectively.

Block Description	SCSI Addressing		Sub-channel Information					Data Header
	Logical Address (decimal)	Track Relative Logical Address	Absolute M/S/F Address (1)	Track and Index	Track Relative M/S/F Address	Frame is Info or is Pause	Mode Audio or Data	Data Block Mode (2)
Lead-In Area (3)	---	---	---	0/-	---	---	Audio	---
Pre-gap (3)	---	---	00/00/00	1/0	00/02/00	Pause	Data	Null
1st Trk Data	0000 (5)	0	00/02/00 (4)	1/1	00/00/00	Info	Data	ECC
2nd Trk Data	6000 (5)	0	01/22/00 (4)	2/1	00/00/00	Info	Data	ECC
	7500	1500	01/42/00	2/2	00/20/00	Info	Data	ECC
Post-gap	9000	3000	02/02/00	2/3	00/40/00	Pause	Data	Null
Pause- Silence	9150	-150 (9)	02/04/00	3/0	00/02/00 (8)	Pause	Audio	---
3rd Trk Audio	9300 (7)	0	02/04/00 (6)	3/1	00/00/00	Info	Audio	---
	11400	2250	02/34/00	3/2	00/30/00	Info	Audio	---
Track 4 Audio	21975 (7)	0	04/53/00 (6)	4/1	00/00/00	Info	Audio	---
Pre-gap Part 1	30000	-225 (9)	06/40/00	5/0	00/03/00	Pause	Audio	---
Pre-gap Part 2	30075	-150	06/41/00	5/0	00/02/00	Pause	Data	Null
Track 5 Data	30225	0	06/43/00	5/1	00/00/00	Info	Data	ECC
Last Info	263999 (10)	233774	58/39/74	5/1	51/56/74	Info	Data	ECC
Post-gap	---	233775	58/40/00	5/2	51/57/00	Pause	Data	Null
Lead-out track	264000 (11)	0	58/42/00 (12)	AA/1 (13)	00/00/00	Pause	Audio	---

## Notes for Table 13-1:

- (1) Absolute M/S/F Address repeated in the header field of data blocks.
- (2) The data block mode is stored in the header of data tracks. This indicates that the block is part of a data pre-gap or post-gap (Null), that this is a data block using the auxiliary field for ECC symbols (ECC), or that this is a data block using the auxiliary field for data.
- (3) Table of Contents information is stored in the sub-channel of Lead-In Area. The lead-in area is coded as track zero. Track zero and the initial 2 second pre-gap (or audio pause) are not accessible with SCSI logical addressing.
- (4) Value stored in Table of Contents with zero tolerance.
- (5) Exact value returned by Read TOC command.
- (6) Value stored in Table of Contents plus or minus 1 second.
- (7) Value returned by Read TOC command plus or minus 75 blocks.
- (8) Track relative M/S/F value decreases from  $\geq 2$  Sec to 0 in pre-gap areas.
- (9) Track relative Logical addresses are negative in the pre-gap areas. Pre-gap areas have index values of zero.
- (10) Minimum value returned by Read Capacity - Exact value depends on encoding of this track and the lead out track and whether this is derived from the TOC data.
- (11) Value returned by Read TOC command - exact if lead-out track is coded as Audio, or plus or minus 75 blocks if coded as Data.
- (12) Value stored in Table of Contents - exact if lead-out track is coded as Audio, or plus or minus 75 blocks if coded as Data.
- (13) Lead-out track number is defined as 0AAh.

## 13.1.2. CD Audio Error Reporting

Audio playback operations started with the Immediate bit set in the audio control mode are terminated by the CD player without notification to the initiator. Error termination of these operations will be reported to the initiating host by returning immediate CHECK CONDITION status to the next command (except for REQUEST SENSE and INQUIRY.) Other SCSI initiators should not receive CHECK CONDITION status due to audio playback error terminations (but may receive BUSY status terminations if the device does not implement independent Sense Data storage.)

## 13.2. Command Descriptions for Read-Only Devices

Table 13-2: Command Summary for Read-Only Devices

Command Name	Operation Code	Type	Section
INQUIRY	12h	M	7
MODE SELECT	15h	O	7
MODE SELECT EXTENDED	55h	O	7
MODE SENSE	1Ah	O	7
MODE SENSE EXTENDED	5Ah	O	7
PAUSE/RESUME	4Bh	O	
PLAY AUDIO - LBA (GROUP 2)	46h	O	
PLAY AUDIO - LBA (GROUP 5)	A6h	O	
PLAY - TRACK RELATIVE (GROUP 2)	47h	O	
PLAY - TRACK RELATIVE (GROUP 5)	A7h	O	
PLAY AUDIO TRACK/INDEX	48h	O	
PLAYBACK STOP	4Ch	O	
PREVENT/ALLOW MEDIUM REMOVAL	1Eh	O	15
READ	08h	M	15
READ BUFFER	3Ch	O	7
READ CAPACITY	25h	M	7
READ CD STATE	45h	O	
READ EXTENDED	28h	M	15
READ HEADER	44h	O	
READ LOG	1Fh	O	7
READ TOC	43h	O	
RECEIVE DIAGNOSTIC RESULTS	1Ch	O	7
RELEASE	17h	M	15
REQUEST SENSE	03h	M	7
RESERVE	16h	M	15
REZERO UNIT	01h	O	15
SCAN CD FOR TRACK/INDEX	41h	O	
SCAN CD - TRACK RELATIVE	42h	O	
SEEK	0Bh	O	15
SEEK EXTENDED	2Bh	O	15
SENSE AUDIO CONTROL	4Ah		
SEND DIAGNOSTIC	1Dh	M	7
SET AUDIO CONTROL	49h		
START/STOP UNIT	1Bh	O	15
TEST UNIT READY	00h	M	7
VERIFY	2Fh	O	15
WRITE BUFFER	3Bh	O	7

## READ Command Additions

[The following paragraphs are added to the READ command in Section 15.]

The READ command will be terminated with a CHECK CONDITION status for a number of reasons. The error recovery parameters determine when and how the data errors are reported. The data transfer will also be terminated with CHECK CONDITION Status if any of the following events occur while a read operation is in progress.

Special error situations for Read Only Direct Access / CD-ROM devices. The sense key will be set to BLANK CHECK and the additional sense code set to END OF USER AREA ENCOUNTERED ON THIS TRACK.

- 1) A post-gap area is encountered. (i.e. a data block with CD-ROM mode 0.)
- 2) A pre-gap area is encountered. (i.e. a block with index equal to 0.)
- 3) The information type (data vs. audio) changes.

If the logical block address requested is not within a data track the command will be terminated with a CHECK CONDITION status. The sense key will be set to ILLEGAL REQUEST and the additional sense code set to ILLEGAL MODE FOR THIS TRACK. This applies to mixed-mode and CD audio media.

If the logical block address plus the transfer length requested exceeds that reported by the READ CAPACITY data a CHECK CONDITION status will be returned. The sense key is set to ILLEGAL REQUEST and the additional sense code is set to LOGICAL BLOCK ADDRESS NOT VALID.

## 13.2.1. PAUSE Command

Peripheral Device Type: Read-Only (CD-ROM)

Operation Code Type: Optional

Table 13-3: PAUSE Command

Bit:	7	6	5	4	3	2	1	0
Byte:								
0	Operation Code (4Bh)							
1	Logical Unit Number				Reserved			
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	Reserved							
8	Reserved							Resume
9	Control Byte							

The PAUSE command requests that the device start/stop the current audio playback operation. This command is used with PLAY AUDIO commands issued while the Immediate bit of the Audio Control Mode is a one.

A Resume bit of zero causes the drive to enter the hold track state with the audio output muted after the current audio block is played. A Resume bit of one indicates the drive will release the pause and begin play at the block following the last block played.

## 13.2.2. PLAYBACK AUDIO - LBA Command

Peripheral Device Type: Read-Only (CD-ROM)  
Operation Code Type: Optional

Table 13-4: PLAYBACK AUDIO - LBA Command (Group 2)

Bit	7	6	5	4	3	2	1	0
Byte								
0	Operation Code (46h)							
1	Logical Unit Number			Reserved				RelAdr
2	(MSB)							
3								
4	Starting Logical Block Address							
5	(LSB)							
6	Reserved							
7	(MSB)							
8	Transfer Length				(LSB)			
9	Control Byte							

105 The PLAY AUDIO - LBA command requests that the device begin an audio playback operation. The playback is to start with the audio frame with the specified Logical Block Address.

Implementors Note: If the Logical Block Length is less than 2048, more than one logical block address will map to a single audio frame. Any of the logical addresses that map to a physical frame will cause playback to start with that frame.

The playback operation is to continue until Transfer Length Logical Blocks of audio data are played. Partial audio frames are not played.

The requested playback operation will be repeated and/or be terminated or repeated early based on the Repeat and Continue bits of the current Audio Control Mode.

If the immediate bit of the current Audio Control Mode is a zero, the requested playback operation terminates before the command completes. If the immediate bit is a one, the command returns the ending status byte and COMMAND COMPLETE message when the playback operation has started.

If the starting address is not found, if the address is not within an audio track, or if the drive is not ready, a CHECK CONDITION status will be returned and the appropriate sense key set.

## 13.2.2.1. PLAY AUDIO - LBA Command (Group 5)

Peripheral Device Type: Read-Only (CD-ROM)  
Operation Code Type: Optional

Table 13-5: PLAY AUDIO - LBA Command (Group 5)

Bit	7	6	5	4	3	2	1	0
Byte								
0	Operation Code (A6h)							
1	Logical Unit Number			Reserved				RelAdr
2	(MSB)							
3	Logical Block Address							
4								
5								
6	(MSB)							
7	Transfer Length							
8								
9								
10	Reserved							
11	Control Byte							

The Group 5 version of the PLAY AUDIO - LBA command requests that the device begin an audio playback operation. The operation is the same as the Group 2 command described above. The Group 5 format allows a longer Transfer Length.

## 13.2.3. PLAY - TRACK RELATIVE Command

Peripheral Device Type: Read-Only (CD-ROM)  
Operation Code Type: Optional

Table 13-6: PLAY - TRACK RELATIVE (Group 2) Command

Bit	7	6	5	4	3	2	1	0
Byte								
0	Operation Code (47h)							
1	Logical Unit Number				Reserved			
2	(MSB)							
3								
4	Track Relative Logical Block Address							
5	(LSB)							
6	Starting Track							
7	(MSB)							
8	Transfer Length							
9	(LSB)							
	Control Byte							

The PLAY - TRACK RELATIVE command requests that the device begin an audio playback operation. The playback is to start with the audio block within the specified starting track with a track relative M/S/F value translated from the specified Track Relative Logical Block Address. A negative value can be used to specify a starting location in the pause area (optionally present) at the beginning of an audio track.

Implementers Note: Tolerances in the TOC track starting location should not affect the starting point of this command. However, the delay before starting the operation may be increased if the TOC is not accurate.

The playback operation is to continue until Transfer Length Logical Blocks of audio data are played. Partial blocks of audio data are not played.

The requested playback operation will be repeated and/or be terminated or repeated early based on the Repeat and Continue bits of the current Audio Control Mode.

If the immediate bit of the current Audio Control Mode is a zero, the requested playback operation terminates before the command completes. If the Immediate bit is a one, the command returns the ending status byte and COMMAND COMPLETE message when the playback operation has started.

If the starting address is not found, if the address is not within an audio

track, or if the drive is not ready, a CHECK CONDITION status will be returned and the appropriate sense key set.

## 13.2.3.1. PLAY - TRACK RELATIVE (Group 5)

Peripheral Device Type: Read-Only (CD-ROM)  
Operation Code Type: Optional

Table 13-7: PLAY - TRACK RELATIVE (Group 5) Command

Bit	7	6	5	4	3	2	1	0
Byte								
0	Operation Code (A7h)							
1	Logical Unit Number				Reserved			
2	(MSB)							
3	Track Relative Logical Block Address							
4								
5								
6	(MSB)							
7	Transfer Length							
8								
9								
10	Starting Track							
11	Control Byte							

The Group 5 version of PLAY - TRACK RELATIVE command requests that the device begin an audio playback operation. The operation is the same as the Group 2 command described above. The Group 5 format allows a longer Transfer Length.



## 13.2.4. PLAY AUDIO TRACK / INDEX Command

Peripheral Device Type: Read-Only (CD-ROM)  
Operation Code Type: Optional

Table 13-8: PLAY AUDIO TRACK / INDEX Command

Bit	7	6	5	4	3	2	1	0
Byte								
0	Operation Code (48h)							
1	Logical Unit Number			Reserved				
2	Starting Track							
3	Starting Index							
4	Last Track							
5	Last Index							
6	Reserved							
7	Reserved							
8	Reserved							
9	Control Byte							

The PLAY AUDIO TRACK / INDEX command requests that the device start an audio playback operation. Playback begins with the first audio frame with the Starting Track and Starting Index values. The playback operation will continue until the last audio frame with track and index values less than or equal to the Last Track and Last Index.

Valid values for Starting Track and Last Track are 1 to 99. Valid values for Starting Index and Last Index are 0 to 99. A Starting Index value of 0 is equivalent to an index value of one. This specifies that playback is to start with the first audio frame of the track following the (optional) pause. A Last Index value of 0 is equivalent to a last index value of 99. The playback continues through the last frame of the track.

If the Starting Index is greater than the largest index value on the Starting Track and the Continue bit of the Audio Control Mode is a zero, the playback will not begin and the command will complete with a CHECK CONDITION. If the Continue bit is set, the playback operation will start at the beginning of the next track. This situation is not an error.

If the Last Track is greater than the last information track on the media, this will cause the playback to continue until the last track is complete. This is not considered an error. If the Repeat bit of the Audio Control Mode is set the playback will be repeated.

If the Last Index is greater than the largest value on the Last Track, the playback will continue until this track is complete then terminate. This is not considered an error. If Repeat is set the playback will be repeated.

The requested playback operation will be repeated and/or be terminated or repeated early based on the Repeat and Continue bits of the current Audio Control Mode.

If the immediate bit of the current Audio Control Mode is a zero, the requested playback operation terminates before the command completes. If the Immediate bit is a one, the command returns the ending status byte and COMMAND COMPLETE message when the playback operation has started.

If the starting address is not found, if the address is not within an audio track, or if the drive is not ready, a CHECK CONDITION status will be returned and the appropriate sense key set.

Implementers Note: Tolerances in the TOC track starting location should not affect the starting point of this command. However, the delay before starting the operation may be increased if the TOC is not accurate.

## 13.2.5. PLAYBACK STOP Command

Peripheral Device Type: Read-Only (CD-ROM)  
Operation Code Type: Optional

Table 13-9: PLAYBACK STOP Command

Bit:	7	6	5	4	3	2	1	0
Byte:								
0	Operation Code (48h)							
1	Logical Unit Number				Reserved			
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	Reserved							
8	Reserved							
9	Control Byte							

808  
The PLAYBACK STOP command requests that the device stop an audio playback operation. The audio outputs will be muted, and the device will enter a hold track state with no operation in progress. This command is used with PLAY AUDIO commands issued while the Immediate bit of the Audio Control Mode is a one.

## 13.2.6. READ CD STATE Command

Peripheral Device Type: Read-Only (CD-ROM)  
Operation Code Type: Optional

Table 13-10: READ CD STATE Command

Bit	7	6	5	4	3	2	1	0
Byte								
0	Operation Code (45h)							
1	Logical Unit Number				Reserved			
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	(MSB)	Allocation Length						(LSB)
8								
9	Control Byte							

The READ CD STATE command requests that the device return the state of the CD-ROM drive including the sub-channel data of the current block.

The allocation length will specify the number of bytes that the initiator has allocated for returned data. An allocation length of zero indicates that no data will be transferred. Any other value indicates the maximum number of bytes that will be transferred. The controller terminates the DATA IN phase when allocation length bytes have been transferred or when all available data have been transferred to the initiator, whichever is less.

If the drive is not in the ready condition the command will be terminated with a CHECK CONDITION status. The sense key will be set to NOT READY and the appropriate additional sense code set.



Table 13-11: CD STATE Format

Bit	7	6	5	4	3	2	1	0
Byte								
0	CD Player Status							
1	Reserved				Control			
2	Track Number							
3	Index Number							
4	(MSB)	Absolute Logical Block Address						
7		Absolute Logical Block Address						(LSB)
8	(MSB)	Track Relative Logical Block Address						
11		Track Relative Logical Block Address						(LSB)

The CD Player Status indicates the current state of the drive. CD Player Status values are defined in Table 13-\_\_.

Table 13-12: CD Player Status

Status	Description
00h	No drive operation in progress
02h	Audio play operation in progress.
03h	Audio pause state in effect.

Note: All other values for this byte are reserved.

The following information is obtained from the sub-channel information of the current block. (For the purpose of returning this location information, frames with Q-Channel data modes other than (ADR =) 1 may be ignored.)

The control bits are defined in Table 13-\_\_.

The Track Number specifies the current track number.

The Index Number specifies the index number in the current track.

The Absolute Logical Block Address field specifies the current location relative to the logical beginning of the media.

The Track Relative field specifies the current location relative to the logical beginning of the current track. This will be a negative value, expressed as a twos complement number, if the current block is in the pre-gap area of a track.

## 13.2.7. READ HEADER Command

Peripheral Device Type: Read-Only (CD-ROM)  
Operation Code Type: Optional

Table 13-13: READ HEADER Command

Bit	7	6	5	4	3	2	1	0
Byte								
0	Operation Code (44h)							
1	Logical Unit Number				Reserved			RelAdr
2	(MSB)							
3								
4	Logical Block Address							
5								
6	(LSB)							
7	Reserved							
8	(MSB)							
9	Allocation Length							
	(LSB)							
9	Control Byte							

The READ HEADER command requests that the device return the CD-ROM data block address header of the requested logical block.

The allocation length will specify the number of bytes that the initiator has allocated for returned data. An allocation length of zero indicates that no data will be transferred. Any other value indicates the maximum number of bytes that will be transferred. The controller terminates the DATA IN phase when allocation length bytes have been transferred or when all available data have been transferred to the initiator, whichever is less.

See the READ command for exception handling. If the logical block size is less than 2048 bytes, it will be mapped into the appropriate physical block from which the data would have been read.

Table 13-14: Header Data Format

Bit:	7	6	5	4	3	2	1	0
Byte:	-----							
0	CD-ROM Mode							
1	Reserved							
3	-----							
4	(MSB)	Absolute Logical Block Address						
7	Absolute Logical Block Address						(LSB)	
	-----							

The CD-ROM Mode field specifies the CD-ROM mode of the logical blocks in this physical block. The values in this field are defined in Table 13-15.

The Absolute Logical Block Address field specifies the LBA of the first logical block in the physical block relative to the logical beginning of the media.

Table 13-15: Definition of CD-ROM Mode

Mode	User Data Field (2048 bytes)	Auxiliary Field (288 bytes)
0	All bytes zero	All bytes zero
1	User Data	ECC symbols
2	User Data	User Data

Note: Values greater than 2 are prohibited.

## 13.2.8. READ TOC Command

Peripheral Device Type: Read-Only (CD-ROM)  
Operation Code Type: Optional

Table 13-16: READ TOC Command

Bit:	7	6	5	4	3	2	1	0
Byte:								
0	Operation Code (43h)							
1	Logical Unit Number				Reserved			
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	Track Number							
7	(MSB)	Allocation Length						(LSB)
8								
9	Control Byte							

The READ TOC command transfers data from the table of contents (TOC) on the CD media. The data is returned in format specified in Table 13-17 TOC Data Format.

The track number field specifies the starting track number for which the data will be returned. If this value is zero, the Table of Contents data will begin with the first track on the media. The data is returned in contiguous ascending order.

If the track number field is not valid for the current media the command shall be terminated with a CHECK CONDITION status. The sense key shall be set to ILLEGAL REQUEST and the additional sense code set to ILLEGAL VALUE IN CDB.

The allocation length specifies the number of bytes that the initiator has allocated for returned data. An allocation length of zero indicates that no data will be transferred. Any other value indicates the maximum number of bytes that will be transferred. The controller terminates the DATA IN phase when allocation length bytes have been transferred or when all available data have been transferred to the initiator, whichever is less. The maximum TOC data length possible is 804 bytes.

Table 13-17: TOC Data Format

0	(MSB)	TOC Data Length	
1			(LSB)
2		First Track Number	
3		Last Track Number	
TOC Track Descriptor			
0		Reserved	
1	Reserved		Control
2		Track Number	
3		Reserved	
4	(MSB)	Starting Logical Block Address	
7		Starting Logical Block Address	(LSB)

The TOC data returned is a four byte header followed by one or more (up to 100) TOC track descriptors. The last track descriptor is for the lead-out area.

The TOC data length specifies the length in bytes of the available table of contents data. The value of TOC data length does not include itself. The maximum value is 802d (0322h). This value is not modified when the Allocation length is insufficient to return all the TOC data available.

The first track number field indicates the first track number in the table of contents.

Implementers note: The first track number is not required to be one. A disk may start at any valid track number. The track numbers between the first track number and the last track number are required to be in contiguous ascending order.

The last track number field indicates the last track number in the table of contents before the lead-out track number.

The track number field indicates the track number for which the data in the TOC track descriptor is valid.

A Track Number value of 0AAh will be supplied for the lead-out track.

The control field indicates the attributes of the track. These are defined in Table 13-18.

Table 13-18: Definition of Control Bits

Bit	equal one	equal zero
0	Audio with pre-emphasis	Audio without pre-emphasis
1	Digital copy permitted	Digital copy prohibited
2	Data track	Audio track
3	Four channel audio	Two channel audio

The Starting Logical Block Address field gives the location of the initial information block for the referenced track as read from the TOC data.

Implementors Note: The Starting Logical Block Address value recovered from the TOC has a tolerance of zero for data tracks and plus or minus 75 CD frames for audio tracks. This tolerance is multiplied by 1, 2, 4, or 8 Blocks per Frame depending on the Logical Block Length.

### 13.2.9. SCAN CD FOR TRACK / INDEX Command

Peripheral Device Type: Read-Only (CD-ROM)

Operation Code Type: Optional

Table 13-19: SCAN CD FOR TRACK / INDEX Command

Bit	7	6	5	4	3	2	1	0
Byte								
0	Operation Code (41h)							
1	Logical Unit Number			Reserved				
2	Track							
3	Index							
4	Reserved							
5	Reserved							
6	Reserved							
7	Reserved							
8	Reserved							
9	Control Byte							

The SCAN CD FOR TRACK / INDEX command requests that the device seek to the requested location and enter a hold track mode. The first Logical Block Address that maps to a CD frame with the requested Track and Index will be

stored.

A succeeding command with the Relative Address bit set will use the resulting Logical Block Address as a base address.

Valid values for Track are 1 to 99. Valid values for Index are 0 to 99. An Index value of 0 is equivalent to an index value of one. This specifies that the first frame of the track following the (optional) pause is to be found.

If the Index is greater than the largest index value on the Track the command will complete with a CHECK CONDITION.

If the requested location is not found, or if the drive is not ready, a CHECK CONDITION status will be returned and the appropriate sense key set.

#### [ ILLEGAL REQUEST or BLANK CHECK ?? ]

Implementers Note: Tolerances in the TOC track starting location should not affect the resulting location. However, the delay before the seek operation completes may be increased if the TOC is not accurate.

#### 13.2.10. SCAN CD - TRACK RELATIVE Command

Peripheral Device Type: Read-Only (CD-ROM)  
Operation Code Type: Optional

Table 13-20: SCAN CD - TRACK RELATIVE Command

Bit	7	6	5	4	3	2	1	0
Byte								
0	Operation Code (42h)							
1	Logical Unit Number				Reserved			
2	(MSB)							
3	Track Relative Logical Block Address							
4								
5								
6	Track							
7	Reserved							
8	Reserved							
9	Control Byte							

The SCAN CD - TRACK RELATIVE command requests that the device seek to the requested location and enter a hold track mode. A Logical Block Address will be stored for use as a base address for a subsequent command with the Relative

Address bit set.

The Logical Block Address result will be an LBA within a CD frame within the specified Track where the frame's track relative M/S/F address matches the value translated from the specified Track Relative Logical Block Address (modulo Blocks per frame.) Any remainder in the Track Relative LBA to M/S/F address translation is to be added to the first LBA of the CD frame.

A negative Track Relative LBA value can be used to specify a location in the pre-gap or pause area at the beginning of a track.

Valid values for Track are 1 to 99.

Implementers Note: Tolerances in the TOC track starting location should not affect the starting point of this command. However, the delay before starting the operation may be increased if the TOC is not accurate.

If the starting address is not found, or if the drive is not ready, a CHECK CONDITION status will be returned and the appropriate sense key set.

#### 13.2.11. SENSE AUDIO CONTROL Command

Peripheral Device Type: Read-Only (CD-ROM)  
Operation Code Type: Optional

Table 13-21: SENSE AUDIO CONTROL Command

Bit:	7	6	5	4	3	2	1	0
Byte:								
0	Operation Code (4Ah)							
1	Logical Unit Number			Reserved				
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	(MSB)							
8	Allocation Length							(LSB)
9	Control Byte							

The SENSE AUDIO CONTROL command requests that the device return the current audio operation controls.

The allocation length will specify the number of bytes that the initiator has allocated for returned data. An allocation length of zero indicates that no data will be transferred. Any other value indicates the maximum number of bytes that will be transferred. The controller terminates the DATA IN phase when allocation length bytes have been transferred or when all available data have been transferred to the initiator, whichever is less.

The data format returned by this command is the same as the SET AUDIO CONTROL command. See section 13.2.\_\_\_\_.

### 13.2.12. SET AUDIO CONTROL Command

Peripheral Device Type: Read-Only (CD-ROM)  
Operation Code Type: Optional

Table 13-22: PLAYBACK CONTROL Command

Bit	7	6	5	4	3	2	1	0
Byte								
0	Operation Code (49h)							
1	Logical Unit Number			Reserved				
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	(MSB)							
8	Parameter Length				(LSB)			
9	Control Byte							

The SET AUDIO CONTROL command requests that the device select the specified modes and controls for subsequent PLAY AUDIO commands and any current audio playback operation.

The parameter length specifies the number of bytes of data to be sent during the data out phase. Controls specified by bytes beyond the allocation length will not be modified.

Table 13-23: Audio Control Data Format

Bit	7	6	5	4	3	2	1	0
Byte								
0	Audio Control Mode							
1	Reserved							
3	Reserved							
4	Reserved				Output Port 0 Channel Selection			
5	Output Port 0 Volume							
6	Reserved				Output Port 1 Channel Selection			
7	Output Port 1 Volume							
8	Reserved				Output Port 2 Channel Selection			
9	Output Port 2 Volume							
10	Reserved				Output Port 3 Channel Selection			
11	Output Port 3 Volume							

The audio control mode field is defined in Table 13-\_\_\_\_.

The output port channel selection specifies the audio channels from the disk to which this output port should be connected. See Table 13-\_\_\_\_. Only one channel may be connected to an output port. More than one output port may be connected to an audio channel. (For instance, channel one may be connected to both output to ports zero and one.)

The channel volume control indicates the relative volume level for this audio output port. A value of zero indicates the output is muted, a value of FFh indicates maximum volume level.

Implementors Note: If volume controls are implemented, the default volume level should be no more than 25% of the maximum level (i.e. no more than 6.25% of the maximum output power.)

Table 13-24: Audio Control Mode

Bit	Value	Definition
=====		
Immediate Bit		
0	0	PLAY AUDIO commands will not send completion status until the operation is terminated.
	1	PLAY AUDIO commands will send completion status as soon as the playback operation has been started.
Continue Bit		
1	0	Audio playback operations will stop when the transfer length is satisfied. Multiple tracks will be played as necessary. Periods encoded as audio pause/silence at the beginning of tracks, (index 0,) will also be played.
	1	Audio playback operations will terminate when the beginning of a following track is encountered. This situation is not considered an error for the purposes of the repeat bit. If the repeat bit is zero, sense data with a BLANK CHECK sense key is posted.
Repeat Bit		
2	0	Audio playback operations requested by a PLAY AUDIO command will occur once and the operation will terminate.
	1	The audio playback operations requested by a PLAY AUDIO command will be repeated until terminated by the PLAYBACK STOP command, by an error, by an ABORT or a BUS DEVICE RESET message, or by a hard reset condition. Note that if this bit is 1 and the immediate bit is 0 a hard reset may be needed to stop the playback.
=====		

Table 13-25: Output Port Channel Selection

0000	output port muted
0001	connect channel 0 to this output port
0010	connect channel 1 to this output port
0100	connect channel 2 to this output port
1000	connect channel 3 to this output port

### 13.3. Mode Select Pages for Read Only Direct Access Devices

### 13.4. Error Codes for Read Only Direct Access Devices

### 13.5. Glossary for Read Only Direct Access Devices

#### 13.5.1. CD-ROM Terminology.

Blocks per Frame -- The number of Logical Blocks read from each CD physical frame. The value depends on the Logical Block Length as defined by Mode Select. The value for blocks per frame is

- 1 if the block length is 2048, 2336 or 2340,
- 2 if the block length is 1024,
- 4 if the block length is 512, and
- 8 if the block length is 256 bytes.

M/S/F Address

Output Port

Track

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END OF DOCUMENT  
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