TEXEL DM-XX28
CD-ROM DRIVE
SCSI INTERFACE MANUAL

REVISION 1.23 *June 28, 1993*

MODELS

DM-3028
(INTERNAL MODEL)

DM-5028
(EXTERNAL MODEL)

TEXEL AMERICA, INC.

TEXEL DM xx28 CD-ROM SCSI INTERFACE MANUAL

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This document is intended for software development of TEXEL CD-ROM driver software. An operations manual which includes specifications and instructions on use of the CD-ROM drive, is also available.

[PRENOTE] Inactivity Timer Multiplier Values in this manual are different from those specified in the SCSI ANSI standard.

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1.0 Preface

This document details the implementation of a SCSI command set used for a CD-ROM device. This implementation complies with the ANSI X3.131-1986 standard. In addition, several of the concepts proposed in the X3T9.2 technical commitee have been fully implemented for SCSI-2 compliancy. The Common Command Set (CCS) document for direct-access devices have also been incorporated. Extensions to the SCSI CCS interface includes audio control via proprietary command set.

This implementation represents the best information available to TEXEL Engineering at the time of writing. There is continuing work in the x3t9.2 committee to develop a SCSI-2 standard that incorporates CD-ROM commands and extensions to the original SCSI standard. It is TEXEL Engineering's intention to comply with the proposed SCSI-2 document at the earliest feasible date. At the time of this document, it is expected that most of the current implementation shall comply with SCSI-2.

2.0 Introduction

This document covers the TEXEL DM-3028 and DM-5028 CD-ROM drives. The DM-3028 is an internal half height CD-ROM device which embeds a drive, a SCSI controller and audio circuitry. The DM-5024 is an external version of the DM-3028. Not only SCSI commands but also SCSI-2 commands which relate to the audio function are supported in this model. All commands supported are described in alphabetic order in this document. In this revision, the operating definition can be switched by CHANGE DEFINITION Command from SCSI-2 to CCS. These CCS commands are also incorporated in this document.

3.0 Physical Characteristics

The TEXEL SCSI controller uses a single-ended, asynchronous SCSI interface (53c80 SCSI controller) that complies with the physical characteristics of ANSI X3.131-1986, Section 4.0 (physical characteristics). Please refer to this standard for detailed information.

4.0 Logical Characteristics

The logical characteristics of the drive controller comply with ANSI X3.131-1986 for a single-ended, asynchronous implementation. The drive controller supports disconnect/ reselect. Several additional logical characteristics are discussed here to aid in understanding the operation of the drive and controller.

4.1 Conditions

This section describes certain conditions as they relate to the operation of the drive and the interface.

4.1.1 Power-on Condition

The power-on condition occurs when power is first applied to the unit. The drive controller performs power-on diagnostics. If a caddy is inserted, the drive attempts to read the table of contents. For the duration of the power-on diagnostics condition the drive controller returns a BUSY status. If a failure in power-on diagnostics occurs, the drive controller returns CHECK CONDITION STATUS. If after the caddy is inserted the the drive controller shall return a check condition for any of the following conditions:

* The caddy does not seat properly
* The Optical Head Assembly is unable to focus on the media
* The drive is unable to achieve a servo lock on the media
* The table of contents cannot be recovered form the media

4.1.2 Reset Condition

The reset condition occurs whenever the RST signal is asserted, or a BUS DEVICE RESET message is received. Additionally, if the an unrecoverable error occurs within drive's processor, the drive may also reset it'self.

4.1.3 Unit Attention Condition

The unit attention condition occurs following a power-on condition, a reset condition, insertion of a caddy (with the successful recovery of the table of contents), or the receipt of a MODE SELECT(6) command from another initiator.

The unit attention condition persists for each device until the initiator issues a command to the logical unit for which the drive controller returned a CHECK CONDITION status. If the next command from that initiator to the logical unit (following the CHECK CONDITION status) is REQUEST SENSE, the UNIT ATTENTION sense key is returned. If any command other than REQUEST SENSE is received, the unit attention condition is lost.

If more than one unit attention condition occurs the unit attention condition with the highest priority will be reported. The priority is as follows:

1) Power On / Reset
2) Not Ready To Ready Transition (media change)
3) MODE SELECT(6) command issued from another initiator

If an INQUIRY command is received from an initiator with a pending unit attention condition, the controller shall perform the INQUIRY command and will not clear the unit attention condition.

If a REQUEST SENSE command is received from an initiator with a pending unit attention condition, then the controller discards any pending sense data, reports UNIT ATTENTION sense key, and clears the unit attention condition for that initiator. The additional sense code is set to the appropriate value.

If a STOP UNIT command (with LoEj set) is received from the initiator with a pending unit attention condition, the controller performs the command and does not clear the unit attention condition.

If an initiator issues a command other than INQUIRY, REQUEST SENSE, or STOP UNIT (with LoEj set) while a unit attention condition exists for that initiator, the controller terminates the command with a CHECK CONDITION status.

4.1.4 Ready Condition/Not Ready Condition

The Ready condition occurs after a caddy is inserted and the table of contents has been recovered from the disc.

A Not Ready condition occurs for the following reasons:

1) There is no caddy inserted.

2) The drive is unable to load or unload the caddy.

3) The drive is unable to recover the table of contents.

4) The controller has issued an Eject Command to the drive. Reinstalling the media clears this condition.

5) The controller cannot select the drive. (This can only occur if the controller was previously able to select the drive.)

A check condition status shall be returned for the drive not ready condition only for commands that require or imply a disc access. The following commands shall not return a check condition status for the not ready condition. The value in parenthesis is the command code.

1)	INQUIRY	(12h)	6)	STOP UNIT with LoEj bit set to one	(1Bh)
2)	MODE SELECT (6)	(15h)	7)	ALLOW MEDIA REMOVAL	(1Eh)
3)	RESERVE	(16h)	8)	READ BUFFER	(3Ch)
4)	RELEASE	(17h)	9)	WRITE BUFFER	(3Bh)
5)	MODE SENSE (6)	(1Ah)			

The following commands shall return a check condition status for the not ready condition. The value in parenthesis is the command code.

1)	TEST UNIT READY	(00h)
2)	REZERO UNIT	(01h)
3)	READ (6)	(08h)
4)	SEEK (6)	(0Bh)
5)	START UNIT with Start bit set	(1Bh)
6)	RECEIVE DIAGNOSTIC RESULTS	(1Ch)
7)	SEND DIAGNOSTIC	(1Dh)
8)	PREVENT MEDIA REMOVAL	(1Eh)
9)	READ CD-ROM CAPACITY	(25h)
10)	READ (10)	(28h)
11)	SEEK (10)	(2Bh)
12)	VERIFY (10)	(2Fh)
13)	READ SUB-CHANNEL	(42h)
14)	READ TOC	(43h)
15)	READ HEADER	(44h)
16)	PLAY AUDIO (10)	(45h)
17)	PLAY AUDIO MSF	(47h)
18)	PLAY AUDIO TRACK/INDEX	(48h)
19)	PAUSE/RESUME	(4Bh)
20)	READ TOC	(C1h)
21)	READ SUB-CHANNEL	(C2h)
22)	READ HEADER	(C3h)
23)	PLAYBACK STATUS	(C4h)
24)	PAUSE	(C5h)
25)	PLAY TRACK	(C6h)
26)	PLAY MSF	(C7h)
27)	PLAY AUDIO	(C8h)
28)	PLAYBACK CONTROL	(C9h)

4.1.5 ATTENTION Condition

The ATTENTION condition allows an initiator to inform the drive's controller that the initiator has a message ready. The drive's controller may get this message by performing a MESSAGE OUT phase.

The initiator creates the ATTENTION condition by asserting ATN at any time except during the ARBITRATION or BUS FREE phases.

The initiator asserts the ATN signal before releasing ACK for the last byte transferred in a bus phase for the ATTENTION condition to be honored before transitioning to a new bus phase. An ATN asserted later may not be honored until a later bus phase and even then, may not result in the expected action. The drive's controller responds with a MESSAGE OUT phase as follows:

1. If ATN occurs during a COMMAND phase, MESSAGE OUT occurs after the transfer of all command descriptor block bytes has been completed.

2. If ATN occurs during a DATA phase, MESSAGE OUT occurs at the controller's convenience on a logical block boundary. The initiator must continue the REQ/ACK handshakes until it detects the phase change.

3. If ATN occurs during a STATUS phase, MESSAGE OUT occurs only after the status byte has been acknowledged by the initiator.

4. If ATN occurs during a MESSAGE IN phase, MESSAGE OUT phase occurs after the current MESSAGE IN byte has been acknowledged by the initiator.

5. If ATN occurs during a selection phase and before the initiator releases the BSY signal, MESSAGE OUT occurs immediately after that SELECTION phase.

6. If ATN occurs during a RESELECTION phase, MESSAGE OUT occurs after the controller has successfully set it's IDENTIFY for that RESELECTION phase.

The initiator shall keep ATN asserted if more than one byte is to be transferred. The initiator may negate the ATN signal at any time except while the ACK signal is asserted during a MESSAGE OUT phase. Normally, the initiator negates ATN while REQ are true and ACK are false during the last REQ/ACK handshake of the MESSAGE OUT phase.

4.2 Command Descriptor Block

The Command Descriptor Block (CDB) is a packet of six or ten bytes sent from the host computer during a command phase that requests the drive's controller to perform some operation. The common parts of the CDB are described here.

4.2.1 Operation Code

The operation code is the first byte of the CDB and indicates whether six or ten bytes are being sent. Each command has a unique operation code.

4.2.2 Relative Address Bit

The relative address bit is applicable to some ten byte commands. The DM-xx28 CD-ROM SCSI implementation does not currently support relative addressing.

4.2.3 Starting Logical Address

The starting logical address specifies the logical block at which the requested read, verify or play operation is to begin. Not all CDB's have starting logical addresses.

4.2.4 Transfer Length

The transfer length specifies the number of logical blocks to be transferred. A transfer length value of zero has special meaning in some commands. The size of the logical blocks can be set using the MODE SELECT (6) command.

4.2.5. Parameter Length

The parameter length specifies the exact number of bytes of sense data that the host transfers to the controller.

4.2.6. Allocation Length

The allocation length specifies the maximum number of bytes that the initiator has allocated for returned sense data. An allocation length of zero indicates that no sense data shall be transferred. This condition is not considered an error. The controller terminates the DATA IN phase when allocation length bytes have transferred or when all available sense data have transferred to the initiator, whichever is less.

4.2.7 Flag and Link Bits

A Link Bit set to one (1) indicates that the initiator requests a link to the next command upon successful completion of the current command. If the link bit is set to one (1), the controller returns an INTERMEDIATE status upon successful termination of the command. The message sent depends on the flag bit.

The link bit set to zero (0) indicates that the initiator does not want the command linked. If the link bit is set to zero (0), the flag bit shall be set to zero (0).

If the link bit is set to one (1) and the flag bit is set to zero (0), the controller sends a LINKED COMMAND COMPLETE message if the current command completes successfully.

If the link bit is set to one (1) and flag bit is to one (1), the controller ends the LINKED COMMAND COMPLETE (WITH FLAG) message, only if the current command completes successfully.

4.3 Command Processing

Upon normal command completion (successful or unsuccessful), the drive's controller returns a status byte to the initiator. Since most error and exception conditions cannot be adequately described with a single status byte, one status code, CHECK CONDITION, indicates that additional information is available. The initiator may issue a REQUEST SENSE command to retrieve this additional information.

An initiator should never send a second command to a logical unit until the command in progress is terminated. The command is normally terminated with a COMMAND COMPLETE message, but termination may result because of other events such as the RESET condition.

If the controller receives a selection from an initiator that has a command in progress (i.e., the controller has disconnected) the controller aborts the first command and does not perform the second command. A CHECK CONDITION status is returned. The sense key is set to ABORTED COMMAND, and the additional sense code is set to OVERLAPPED COMMANDS ATTEMPTED.

The occurrence of the initiator sending a second command to a logical unit with a command in progress by the same initiator is considered a catastrophic failure from the drive controller's viewpoint.

4.4 Handling of Message Phase

The message phase is a term that references either a MESSAGE IN, or a MESSAGE OUT phase. Multiple messages may be sent during either phase. The first byte transferred in either of these phases shall be either a single-byte message or the first byte of a multiple-byte message. Multiple-byte messages shall be wholly contained within a single message phase.

4.4.1. MESSAGE IN Phase

The MESSAGE IN phase allows the target to request that message(s) be sent to the initiator from the controller. The controller asserts C/D, I/O, and MSG during the REQ/ACK handshake(s) of this phase.

4.4.2. MESSAGE OUT Phase

The MESSAGE OUT phase allows the controller to request that message(s) be sent from the initiator to the controller. The controller may invoke this phase at its convenience in response to the ATTENTION condition created by the initiator.

The controller asserts C/D and MSG and negates I/O during the REQ/ACK handshake(s) of this phase. The controller handshakes a byte(s) in this phase until ATN goes false, unless an error occurs.

If the controller detects one or more parity error(s) on the message byte(s) received, it may indicate a desire to retry the message(s) by asserting REQ after detecting ATN has gone false and prior to changing to any other phase. The initiator, upon detecting this condition, shall re-send all of previous message byte(s) in the same order as previously sent during this phase. When re-sending more that one message byte, the initiator shall assert ATN prior to asserting ACK on the first byte and shall maintain ATN asserted until the last byte is sent.

The controller acts on messages received as long as no parity error is detected. However, the controller ignores all remaining messages sent under one ATN condition if a parity error is detected. The sequence of messages must be re-sent by an initiator because the target detected a parity error. The target does not act on any message which it acted on the first time received.

If the target receives all of the message byte(s) successfully (i.e., no parity errors), it indicates that it does not wish to retry by changing to any information transfer phase other than the MESSAGE OUT phase and transfering at least one byte. The target may also indicate that it has successfully received the message byte(s) by changing to the BUS FREE phase.

Table 4-1: Message Codes

Code	Description	Direction
00h	COMMAND COMPLETE	IN
02h	SAVE DATA POINTER	IN
03h	RESTORE POINTERS	IN
04h	DISCONNECT	OUT
05h	INITIAOR DETECTED ERROR	OUT
06h	ABORT	OUT
07h	MESSAGE REJECT	IN/OUT
08h	NO OPERATION	OUT
09h	MESSAGE PARITY ERROR	IN
0Ah	LINKED COMMAND COMPLETE	IN
0Bh	LINKED COMMAND COMPLETE(with FLAG)	IN
0Ch	BUS DEVICE RESET	OUT
80h-FFh	INDENTIFY	OUT

Key: In = Target to initiator, Out = Initiator to target

4.4.3 Messages

The single byte messages shown in **Table 4-1**, are deatailed below along with their code values and definitions.

COMMAND COMPLETE 00h. This message is sent from the controller to the initiator to indicate that the execution of a command (or series of linked commands) has terminated and valid status has been sent to the initiator. After successfully sending this message, the controller goes to the BUS FREE phase by releasing BSY. The controller will consider the message transmission to be successful when it detects the negation of ACK for the COMMAND COMPLETE message with the ATN signal false.

SAVE DATA POINTER 02h. This message is sent from the controller to direct the initiator to save a copy of the present active data pointer for the currently attached logical unit.

RESTORE POINTERS 03h. This message is sent from the controller to direct the initiator to restore the most recently saved pointers (for the currently attached logical unit) to the active state. Pointers to the command, data, and status locations for the logical unit shall be restored to the active Pointers. Command and status pointers shall be restored to the beginning of the present command and status areas. The data pointer shall be restored to the value at the beginning of the data area in the absence of a SAVE DATA POINTER massage or to the value at the point at which the last SAVE DATA POINTER message occurred for that logical unit.

DISCONNECT 04h. This message is sent from the drive's controller to inform the initiator that the present physical path is going to be broken (the target plans to disconnect by releasing BSY), but that a later reconnect shall be required to complete the current operation. This message shall not cause the initiator to save the data pointer. After successfully sending this message in, the drive's controller shall go to the BUS FREE phase by releasing BSY. The drive's controller considers the message transmission to be successful when it detects the negation of ACK for the DISCONNECT message with the ATN signal false. If DISCONNECT messages are used to break a long data transfer into two or more shorter transfers, a SAVE DATA POINTER shall be issued before each DISCONNECT message.

This message may also be sent from an initiator to the controller to instruct the drive's controller to disconnect from the SCSI bus. After the DISCONNECT message is received, the drive's controller switches to MESSAGE IN phase, sends the DISCONNECT message to the initiator preceded by SAVE DATA POINTER message, and then disconnects by releasing BSY. After releasing BSY, the drive's controller does not participate in another ARBITRATION phase for at least a disconnection delay. If the drive's controller cannot disconnect at the time when it receives the DISCONNECT message from the initiator, it shall respond by sending a MESSAGE REJECT message to the initiator.

INITIATOR DETECTED ERROR 05h. This message is sent from an initiator to inform the controller that an error (e.g., parity error) has occurred that does not preclude the drive's controller from retrying the operation. Although present pointer integrity is not assured, a RESTORE POINTERS message or a disconnect followed by a reconnect shall cause the pointers to be restored to their defined prior state.

ABORT 06h. This message is sent from the initiator to the drive's controller to clear the present operation. If a logical unit has been identified, all pending data and status for the issuing initiator from the affected logical unit shall be cleared, and the controller asserts a BUS FREE phase. Pending data and status for other initiators is not cleared. If a logical unit has not been identified, the controller asserts a BUS FREE phase. No status or ending message shall be sent for this operation. It is not an error to issue this message to a logical unit that is not currently performing an operation for the initiator.

MESSAGE REJECT 07h. This message is sent from either the initiator or controller to indicate that the last message it received was inappropriate or has not been implemented.

In order to indicate its intentions of sending this message, the initiator shall assert the ATN signal prior to its release of ACK for the REQ/ACK handshake of the message that is to be rejected. If the target receives this message under any other circumstance, it shall reject this message.

When the controller sends this message, it will change to MESSAGE IN phase and send this message prior to requesting additional message bytes from the initiator. This provides an interlock so that the initiator can determine which message is rejected.

NO OPERATION 08h. This message is sent from an initiator in response to the drive controller's request for a message when the initiator does not currently have any other valid message to send.

MESSAGE PARITY ERROR 09h. This message is sent from the initiator to the drive's controller to indicate that one or more bytes in the last message it received had a parity error.

In order to indicate its intentions of sending this message, the initiator shall assert the ATN signal prior to its release of the REQ/ACK handshake of the message that has the parity error. This provides an interlock so that the controller can determine which message has the parity error. If the controller receives this message under any other circumstance, it shall signal a catastrophic error condition by releasing the BSY signal without any further information transfer attempt.

LINKED COMMAND COMPLETE 0Ah. This message is sent from the controller to the initiator to indicate that the execution of a linked command has completed and that status has been sent. The initiator shall then set the pointers to the initial state for the next linked command.

LINKED COMMAND COMPLETE (WITH FLAG) 0Bh. This message is from the controller to an initiator to indicate that the execution of a linked command (with the flag bit set to one) has completed and that status has been sent. The initiator shall then set the pointers to the initial state of next linked command. Typically, this message is used to cause an interrupt in the initiator between two linked commands.

BUS DEVICE RESET 0Ch. This message is sent from an initiator to direct the controller to clear all current commands on that SCSI device. This message forces the SCSI device to an initial state with no operations pending for any initiator. Upon recognizing this message, the controller shall go to the BUS FREE phase.

IDENTIFY 80h to FFh. These messages are sent by either the initiator or the controller to establish the physical path connection between an initiator and controller for a particular logical unit. The logical unit number addresses one physical drive attached to the controller.

Bit 7. This bit shall be set to one to distinguish these messages from the other messages.

Bit 6. This bit is only set to one by the initiator to grant the privilege of disconnecting. If this bit is zero, the controller shall not disconnect. This bit is set to zero when the identify message is sent by the controller.

Bits 5-3. Reserved.

Bits 2-0. These bits specify the logical unit number in the controller.

Only one logical number shall be identified for any one selection sequence; a second IDENTIFY message with a new logical unit number shall not be issued before the bus has been released (BUS FREE phase). The initiator may send one or more IDENTIFY messages during a selection sequence. However, the logical unit number in any additional IDENTIFY messages shall be the same as the logical unit number specified in the first IDENTIFY message sent by the initiator.

When sent from the controller to an initiator during reconnection, an implied RESTORE POINTERS message shall be performed by the initiator prior to completion of this message.

4.5 Handling of Status Phase

The drive's controller shall always follow the selection phase with a command phase. If exception handling requests a status phase, it occurs after the command phase. (Example: a reservation conflict or busy status.)

A status byte is sent from the controller to the initiator during the STATUS phase at the termination of each command unless the command is cleared by one of the following conditions:

* an ABORT message
* a BUS DEVICE RESET message
* An assertion of the RST signal
* Or by an unexpected BUS FREE condition.

4.5.1 Status Byte Description

GOOD (00h). This status indicates that the controller has successfully completed the command.

CHECK CONDITION (02h). This status indicates that an error, exception, or abnormal condition has caused the sense key or additional sense code to be set. The REQUEST SENSE command should be issued following a CHECK CONDITION status, to determine the nature of this condition.

BUSY (08h). This status indicates that the controller is busy. The controller is unable to perform a command from an otherwise acceptable initiator. The normal initiator recovery action is to issue the command again at a later time.

INTERMEDIATE (10h). This status indicates that a command in a series of linked commands has completed successfully. This status is returned for every linked command in a series of linked commands except the last command, unless an error, exception, or abnormal condition causes a CHECK CONDITION status or a RESERVATION CONFLICT status to be returned. If the intermediate status is not returned, the chain of linked commands is broken; and no further commands in the series are executed.

RESERVATION CONFLICT (18h). This status indicates that the initiator attempted to access a logical unit that is reserved for another SCSI ID. The normal initiator recovery action is to issue the command again at a later time.

4.6 Disc Compatibility

The CD-ROM drive is designed to work with any disc that meets the Sony-Philips "red-book" or "yellow-book" documents at the current revision level. The drive can read CD-ROM data discs in Mode One or Mode Two, digital audio discs (CD/A), and Mixed Mode audio/data-combined discs (i.e., some tracks are audio, some tracks are data).

It is recommended for the efficient performance of the interface that postgap areas be encoded as CD-ROM data in mode zero (0).

4.7 Disconnect/Reconnect

The Disconnect/Reconnect function provides an efficient method of utilizing the SCSI bus when two or more targets share the same bus. If the target is requested to perform a time consuming task that does not involve immediate transfer of data, it may disconnect from the bus so that the initiator can perform other task. The target may signal the initiator to reconnect when the data is ready for transfer.

The target must first recieve a disconnect privilage message from the initiator prior to performing a disconnect. The target needs to disconnect, it must first assert a disconnect message to the initiator.

Targets which break data transfers into multiple Disconnect/Reconnects shall end each connection with a Save Data Pointer - Disconnect message.

The Texel DM-xx28 series CD-ROM fully supports the Disconnect/Reconnect function as previously defined. However, the device does not support Mode Select, Page Code 2 parameters for Disconnect/Reconnect. Consequently, the drive shall perform a disconnect/Reconnect for every block of data transfered regardless of data buffer content..

4.8 TOC Recovery Strategy

The recovery of the TOC data is required before a logical unit is ready and data can be read from the disc. The TOC data is written several times in the area set up for TOC data. The exact number of repetitions depends on the number of tracks on a disc. The following TOC recovery strategy attempts to maximize the chance of recovering the TOC data.

The drive attempts to recover the TOC as soon as a caddy is successfully loaded. The maximum time to recover a TOC that is read without error is approximately five seconds. For a Kodak's multisession photo CD, the TOC recovery time depends on how many sessions exist on the disc.

Any command received during the TOC read operation shall be terminated with a CHECK CONDITION status. The sense key is set to NOT READY, and the additional sense code is set to TOC READ IN PROGESS.

If the drive reaches the end of the TOC data area without successfully recovering the TOC data, the controller responds to all subsequent commands that imply a disc access with a CHECK CONDITION status (see 4.1.4). The sense key is set to NOT READY and the additional sense code is set to UNABLE TO RECOVER TOC.

4.8.1 TOC Recovery Strategy For Multiple Sessions

Initially, the CD-ROM format was designed to allow only one recorded session. With Kodak's multi-session photo-CD, additional recording sessions may be appended after the last recording session. However, to accomplish this, each consecutive session must append the TOC of the last recorded session. Therefore, the last session shall contain the TOC data of all previous sessions on the disc.

The Texel DM-xx28 series drive recognizes multiple sessions by verifying the disc is a Mode 2, Form 1 (CD-ROM X/A) format. If the X/A format is recognized, the TOC is read and drive attempts to read past the last recorded track known as the Lead-Out area. If the drive detects a Lead-In area after the Lead-out, then it knows that another session exist. If it does exist, the TOC of this session is read and the drive attempts to read past the last Lead out indicated by the newly read TOC. This process continues until the drive cannot detect any additional sessions on the disc. The drive then uses only the concatenated TOC data found in the last session.

The TOC data of the additional sessions may be accessed by the initiator by setting the applicable bits in the control byte of the READ TOC command (43h).

Although this implementation is effective, the DM-xx28 can only distinguish multiple sessions if the disc is recorded in an X/A format. Multi-session disc written in the Form 1 formats shall not be recognized as multi-session. Consequently, the drive shall handle this type of media as a single session disc. Further developement of the DM-xx28 firmware may include a means of verifying media recorded as an orange disc format (writable CD-ROM).

4.9 Audio Playback Implementation Rules

The rules for audio playback operations:

1) The starting audio address must be specified before a playback operation can occur. The controller sets the ending audio address (if any audio tracks exist on the disc) to the address of the next track index minus one block. If a playback operation is requested and no audio tracks exist, the playback operation is terminated with CHECK CONDITION status. The sense key is set to ILLEGAL REQUEST and the additional sense code is set to AUDIO ADDRESS NOT VALID.

2) The audio addresses are valid until a reset condition, a media change occurs, or until another command is received with a new audio address.

3) The audio addresses must be within an audio track. If the audio address is not within an audio track the command is terminated with a CHECK CONDITION status. The sense key is set to ILLEGAL REQUEST and the additional sense code is set to ILLEGAL MODE FOR THIS TRACK.

4) If a change in bit one of the control is detected, the playback operation is terminated with a CHECK CONDITION status. The sense key is set to ILLEGAL REQUEST and the additional sense code is set to END OF USER AREA ENCOUNTERED ON THIS TRACK.

If any of the following conditions occur and the drive has not detected the ending audio address, audio play operation continues on to the next track:

a) An index equals zero is detected (i.e., pre-gap detected).

b) A track number change is detected (i.e., lead-out).

The ending audio address may be set while audio play is in progress. If the ending address requested is not greater than the current address the audio play operation stops and the drive enters the hold track state.

5) The audio play operation is not interrupted by the following commands received by the drive controller. The value (xxh) in parentheses is the command code in hexadecimal.

TEST UNIT READY	**READ CD-ROM CAPACITY**
REQUEST SENSE	**WRITE BUFFER**
INQUIRY	**READ BUFFER**
RESERVE	**READ TOC (C1h)**
RELEASE	**READ TOC (43h)**
MODE SELECT (6)	**READ SUB-CHANNEL (C2h)**
MODE SENSE (6)	**READ SUB-CHANNEL (42h) with Sub Channel**
RECEIVE DIAGNOSTIC RESULTS	**Data Format field 01h**
PLAYBACK STATUS	**PAUSE with Pause bit = 0**

The actual starting audio address is within four q-subcode addresses of the requested starting audio address. This increases the reliability of reading the q-subcode address. The current audio plays through even if it misses the q-subcode address.

5.1 CD-ROM Model

-DEVELOPERS NOTE-

The model described is based on CD-ROM technology, however, the command set is designed to be usable by all Read Only devices via CCS. The model is provided as a means to understand the implementation of the command set. As such, the model description does not impose any mandatory requirements.

CD-ROM drives are designed to work with any disc that meets the Sony-Philips "red-book" or "yellow-book" documents. However, other similar formats exist that can also be read as well.

The CD-ROM disc has the same physical size and properties as the CD-AUDIO disc. The discs have two sizes, 120 millimeter and 80 millimeter diameter. These correspond to 5-1/4 inch and 3-1/2 inch footprint drives.

The disc is single sided, containing approximately 600 megabytes of data or 74 minutes of audio in the larger diameter. The exact total capacity is dependent on which mode of data format is employed. The smaller diameter disc has a capacity of 200 megabytes of data or 23 minutes of audio. Both form factors may contain a combination of audio and data, or mixed mode disc.

A disc may contain one to ninety-nine tracks. Each change in the type of information on the disc (audio or data) requires a change in track number. A disc containing both audio and data would have at least two tracks, one for audio and one for data.

A track has a minimum length of 300 sectors. The first track number on a disc may be any track number from one to ninety-nine. The following track numbers, if any, are in contiguous and ascending order.

A transition area occurs between each track. Seek operations can be performed to the transition area. However, the play operations cannot be performed in the transition area. The transition area is structured and the logical addressing sequence continues to increment through the transition area.

A Lead-In and Lead-Out area exist on all CD formats. This allows for overshoot during seek operations. Both of these areas are outside of the user defined space as reported in the READ CD-ROM CAPACITY data.

Each track can be subdivided by indexes. Every track has at least one index, and may have up to ninety-nine. The user information starts at index one within the track. The index numbers are contiguous and ascending in order.

Each disc has a table of contents (TOC). The TOC contains information on the number of tracks on a disc, and the starting location of the user information within the track. The starting location is given in MSF or LBA address format. The TOC also indicates which tracks are audio and which tracks are data. The data contained in the TOC does not include information to distinguish among CD-ROM Mode one, CD-I Form 1, XA Type 1 Form 1 and CD-ROM Mode 2 data.

The recovery of the TOC data is necessary before a drive is ready and data can be read from the disc. The TOC data is written several times in the area set up for TOC data. The exact number of repetitions depends on the number of tracks on a disc.

The drive attempts to recover the TOC as soon as a caddy is successfully loaded. The maximum time to recover a TOC that is read without error is approximately five seconds. However, a Photo CD may have multiple session and may take longer to read.

Each frame contains 588 bits. A frame must be EFM decoded by the drive before the bit stream contains recognizable data. Fourteen bits are used to represent each eight-bit byte. Three bits are added to each fourteen bits.

A block contains 98 frames.

FRAME BYTES

1 (24 + 3) Synchronization		
1 (14 + 3) Sub-Channels	--->	1 eight-bit sub-channel P,Q,R,S,T,U,V,W
24 (14 + 3) Data Symbols	--->	24 eight-bit bytes of data
8 (14 + 3) CIRC Symbols		Cross Interleaved Reed Solomon Error Correction Code
588 bits total		

The sub-channel byte is assigned one bit for each sub-channel. One byte contains a bit for sub-channels P,Q,R,S,T,U,V,W. Sub-channel P is used for audio muting control. Sub-channels R,S,T,U,V,W are not used in CD-ROM. Sub-channel Q contains the following:

2 bits Sync
4 bits Control
4 bits ADR
72 bits Sub-channel Q data (9 bytes)
16 bits CRC
---
98 bits total
(one bit from the sub-channel byte of each frame in a block)

The Sub-Channel Q data contains the following:

4 bits Reserved
4 bits Control Field
8 bits Track Number Field in bcd format
8 bits Index Number Field in bcd format
8 bits Relative Minute Field in bcd format
8 bits Relative Second Field in bcd format
8 bits Relative Frame Field in bcd format
8 bits Absolute Minute Field in bcd format
8 bits Absolute Second Field in bcd format
8 bits Absolute Frame Field in bcd format
---
72 bits total sub-channel Q data

The data symbols make up the block of data that is returned to the user during a read operation. A block of data is made up of 98 frames, so there are (98 x 24) 2352 bytes of data in a block. A block of data contains the following if the CD-ROM Mode field has a value of one:

12 bytes Synchronization
4 bytes CD-ROM data header
Absolute Minute Field in BCD format
Absolute Second Field in BCD format
Absolute Frame Field in BCD format
CD-ROM Mode Field
2048 bytes user defined data
4 bytes Error Detection Code
8 bytes zero
276 bytes Layered Error Correction Code

A block of data contains the following if the CD-ROM Mode field has a value of two:

12 bytes Synchronization
4 bytes CD-ROM data header
Absolute Minute Field in BCD format
Absolute Second Field in BCD format
Absolute Frame Field in BCD format
CD-ROM Mode Field
2336 bytes user defined data

-NOTE-

Many drives are capable of returning CD-ROM Mode one, CD-I From 1 or XA Type 1 Form 1 data in a CD-ROM Mode two format. This allows the user to investigate the error detection and error correction codes. However, if the data is encoded as CD-ROM Mode two it cannot be read as CD-ROM Mode one, CD-I Form 1 or XA Type 1 Form 1 data.

The address in the CD-ROM Header field is usually the same as the address in the sub-channel q data for a particular sector. However a tolerance of one second is allowed.

The address in the TOC for the start of user data in a track has a tolerance of 0 seconds.

5.2 CD-ROM Command Descriptions

The following table lists the commands implemented in the drive's controller. This list is sorted by alphabetical order. The command descriptions and nomenclature are also sorted in alphabetical order.

Table 5-1: Implemented Commands

Command Name	Command Code	Type	Section
CHANGE DEFINITION	40h	O	5.2.1.
INQUIRY	12h	M	5.2.2.
MODE SELECT (6)	15h	M	5.2.3.
MODE SENSE (6)	1Ah	M	5.2.4.
PAUSE	C5h	V	5.2.5.
PAUSE / RESUME	4Bh	O	5.2.6.
PLAY AUDIO	C8h	V	5.2.7.
PLAY AUDIO (10)	45h	O	5.2.8.
PLAY AUDIO MSF	47h	O	5.2.9.
PLAY AUDIO TRACK/INDEX	48h	O	5.2.11.
PLAY TRACK	C8h	V	5.2.12.
PLAYBACK CONTROL	C9h	V	5.2.13.
PLAYBACK STATUS	C4h	V	5.2.14.
PREVENT/ALLOW MEDIA REMOVAL	1Eh	M	5.2.15.
READ (6)	08h	M	5.2.16.
READ BUFFER	3Ch	O	5.2.17.
READ CD-ROM CAPACITY	25h	M	5.2.18.
READ (10)	28h	M	5.2.19.
READ HEADER	C3h	V	5.2.20.
READ HEADER	44h	O	5.2.21.
READ SUB-CHANNEL	C2h	V	5.2.22.
READ SUB-CHANNEL	42h	O	5.2.23.
READ TOC	C1h	V	5.2.24.
READ TOC	43h	O	5.2.25.
RECEIVE DIAGNOSTIC RESULT	1Ch	O	5.2.26.
RELEASE	17h	M	5.2.27.
REQUEST SENSE	03h	M	5.2.28.
RESERVE	16h	M	5.2.29.
REZERO UNIT	01h	M	5.2.30.
SEEK (6)	0Bh	M	5.2.31.
SEEK (10)	2Bh	M	5.2.32.
SEND DIAGNOSTIC	1Dh	M	5.2.33.
SET ADDRESS FORMAT	C0h	V	5.2.34.
START / STOP UNIT	1Bh	M	5.2.35.
TEST UNIT READY	00h	M	5.2.36.
VERIFY (10)	2Fh	O	5.2.37.
WRITE BUFFER	3Bh	O	5.2.38.

M: Mandatory **O:** Optional **V:** Vendor Unique

5.2.1 *CHANGE DEFINITION Command (40h)*

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code (40h)							
1	Logical Unit Number			Reserved				
2	Reserved							
3	Rsvd	Definition Parameter						
4	Reserved							
5	Reserved							
6	Reserved							
7	Reserved							
8	Parameter Data Length (00h)							
9	Control Byte							

The CHANGE DEFINITION Command modifies the operating definition of the target with respect to commands for all initiators. The applicable operating definition is CCS and SCSI-2. The default operating definition is SCSI-2.

The definition parameter field is defined as follows:

Table 5-2: Definition Parameter

Value	Meaning of Definition Parameter
00h	Use Current Operating Definition
01h	Reserved
02h	CCS Operating Definition
03h	SCSI-2 Operating Definition
04h-7Dh	Reserved
7Eh	Normal Speed (CD-ROM Speed)
7Fh	Twice Speed (CD-ROM Speed)

The parameter length field must be zero because no parameter data is required.

5.2.2 *INQUIRY Command (12h)*

Byte \ Bit	7	6	5	4	3	2	1	0
0	Operation Code (12h)							
1	Logical Unit Number			Reserved				
2	Reserved							
3	Reserved							
4	Allocation Length							
5	Control Byte							

The INQUIRY command requests that information regarding parameters of the controller and its attached peripheral device be sent to the initiator.

The INQUIRY command will terminate with a BUSY status if the controller is performing either a power-on diagnostics or READ TOC.

The INQUIRY command will terminate with a CHECK CONDITION status when the controller has detected a catastrophic error.

If an INQUIRY command is received from an initiator with a pending unit attention condition (before the controller reports CHECK CONDITION status), the controller performs the INQUIRY command and does not clear the unit attention condition.

Table 5-3 : Inquiry Data

Bit / Byte	7	6	5	4	3	2	1	0
0	Peripheral Device Type (05h)							
1	RMB	Device-Type Qualifier						
2	ISO Version		ECMA Version			ANSI-Approved Version		
3	AENC	TrmIOP	Reserved			Response Data Format		
4	Additional Length (31h)							
5	Reserved							
6	Reserved							
7	Readr	Wbus32	Wbus16	Snyc	Linked	Rvd	CmdQue	SftRe
8	(MSB)							
15	Vendor Identification							(LSB)
16	(MSB)							
31	Product Identification							(LSB)
32	(MSB)							
35	Product Revision Level							(LSB)

The peripheral device type code is set to 05h, if the logical unit is present. If the logical unit is not present, the peripheral device type code is set to 7Fh.

The RMB bit is set to one because the disc is removable.

The device-type qualifier is set to zero.

The ANSI-Approved Version is set to 02h.

The response data format is set to one.

The Additional Length is set to 31h. If the allocation length of the command descriptor block is too small to transfer all of the parameters, the additional length is not adjusted to reflect the truncation.

The Vendor Identification field contains eight bytes of ASCII data identifying the vendor of the product as follows:

Byte	08	09	10	11	12	13	14	15
ASCII	T	E	X	E	L	sp	sp	sp
Code	54h	45h	58h	45h	4Ch	20h	20h	20h

Byte 8, Bit 3, indicates whether the device supports Linked commands. This bit should be set to one (1) indicating that the drive supports Linked commands.

The Product Identification field contains sixteen bytes of ASCII data defined as follows:

Byte	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
ASCII	C	D	-	R	O	M	sp	D	M	-	X	X	2	8	sp	sp
Code	43h	44h	2Dh	52h	4Fh	4Dh	20h	44h	4Dh	2Dh	58h	58h	32h	38h	20h	20h

The product revision level field contains four bytes of ASCII data which indicate the revision level of the controller firmware defined as follows:

Byte	32	33	34	35	
ASCII	x	.	x	x	**x - is lower case letter indicating revision**
Code	3xh	2Eh	3xh	6Yh	**Y - is corresponding hex code for letter**

Byte 32 - A value of three indicates that this is a production release of the firmware. A value of two indicates a beta test version of the firmware. A value of one indicates an engineering development version of the firmware.

Byte 33 - is a period.

Byte 34 - This byte indicates major revisions of, or additions to, the firmware. The value of this byte is from zero to nine. This always implies a change in the implementation documentation.

Byte 35 - This byte indicates minor changes to the firmware, i.e., bug fixes, corrections for misunderstandings, etc. There is usually no change required, or only a very minor change in the implementation document.

5.2.3 *MODE SELECT (6) Command (15h)*

Byte \ Bit	7	6	5	4	3	2	1	0
0	Operation Code (15h)							
1	Logical Unit Number			PF	Reserved			SP
2	Reserved							
3	Reserved							
4	Parameter List Length							
5	Control Byte							

The MODE SELECT (6) command provides a means for the initiator to specify media, logical unit, or peripheral device parameters to the drive's controller.

The target does not check the value of the PF bit.

The save parameters (SP) bit is set to zero because the CD-ROM cannot save parameters.

The parameter list length specifies the length in bytes of the MODE SELECT parameter list that is transferred from the initiator to the drive's controller. A parameter list length of zero indicates that no data is transferred. This condition is not considered as an error. The block descriptor and the pages which follow, if any, must be sent in their entirety. Truncation of a page due to an incorrect parameter list length is considered an error. In this situation, the command is terminated with a CHECK CONDITION status. The sense key is set to ILLEGAL REQUEST and the additional sense code is set to INVALID FIELD IN PARAMETER LIST.

The MODE SELECT parameter list contains a four-byte header, followed by zero or one eight-byte block descriptor, followed by zero or more pages.

Table 5-4: Mode Select Parameter List

Byte \ Bit	7	6	5	4	3	2	1	0
0	Peripheral Device Type (05h)							
1	Reserved							
2	Media Type							
3	Block Descriptor Length (00h or 08h)							
	Block Descriptor							
0	Reserved							
1	(00h)							
2	(00h)							
3	(00h)							
4	Reserved							
5	(MSB)							
6	Block Length							
7							(LSB)	
	Page(s)							
0	Reserved		Page(s)					
1	Page-Specific Parameter Length							
2	Page-Specific Parameter							
n								

The media type is set to zero to indicate that the default disc is a CD-ROM.

The block descriptor length shall be set to either 00h or 08h.

The block descriptor specifies the media characteristics for the whole disc.

The block length requests that the controller use the logical block length specified for data transfers. The controller accepts the block lengths as shown in Table 5-5. Any other value is considered an error. The command is terminated with a CHECK CONDITION status. The sense key is set to ILLEGAL REQUEST and the additional sense code is set to INVALID FIELD IN PARAMETER LIST. The block length is applicable to the whole disc except the audio tracks.

Table 5-5: Block Lengths for CD-ROM

Block Length		Description
256	256 bytes of user data	CD-ROM mode one, CD-I Form 1 or XA Type 1 Form 1 data required.
512	512 bytes of user data	CD-ROM mode one, CD-I Form 1 or XA Type 1 Form 1 data required.
1024	1024 bytes of user data	CD-ROM mode one, CD-I Form 1 or XA Type 1 Form 1 data required.
2048	2048 bytes of user data	CD-ROM mode one, CD-I Form 1 or XA Type 1 Form 1 data required.
2336		Can be specified for all types of CD-ROM data if L-EC is off .
2340		Can be specified for all types of CD-ROM data if L-EC is off. Block contains a 4 byte header, 2048 bytes of user data & 288 bytes ECC data.(Uncooked Mode)

A block length of 2336 or 2340 can be specified for all types of CD-ROM data. If a read operation is requested on a track that is CD-ROM mode two data and L-EC is not disabled, the command is terminated with a CHECK CONDITION status. The sense key is set to ILLEGAL REQUEST and the additional sense code set to ILLEGAL MODE FOR THIS TRACK.

Each page descriptor specifies parameters for the controller to use for subsequent operations on the specified logical unit. The page descriptors are specified in section 5.3. The parameter length field specifies the length in bytes of the parameters that follow for that page. The initiator shall set this value to the value that is returned in the parameter length field for the same page by the MODE SENSE (6) command. If this condition is not met, the controller terminates the command with a CHECK CONDITION status. The sense key is set to ILLEGAL REQUEST and the additional sense code is set to INVALID FIELD IN PARAMETER LIST.

5.2.4 *MODE SENSE (6) Command (1Ah)*

Byte \ Bit	7	6	5	4	3	2	1	0
0	Operation Code (1Ah)							
1	Logical Unit Number			Reserved				
2	PC		Page Code					
3	Reserved							
4	Allocation Length							
5	Control Byte							

The MODE SENSE (6) command provides a means for the drive controller to report parameters to the initiator. It is a complementary command to the MODE SELECT (6) command.

The page control (PC) field defines the type of parameter values to be returned as shown below.

Table 5-6: Page Control Bit Definition

DB(7)	DB(6)	Type of Parameter Values
0	0	Current Values
0	1	Changeable Values
1	0	Default Values
1	1	Default Values

5.2.4.1 Current Values

A PC field value of 0h requests the controller to return the current values for the page code specified. The current values returned are either the parameters set in the last successful MODE SELECT (6) command, or the default values if a MODE SELECT (6) command has not been executed.

5.2.4.2 Changeable Values

A PC field value of 1h requests the controller to return the changeable values for the page code specified. The page requested is returned with the bits that are allowed to be changed set to one (1). Parameter bits that are not changeable will be set to zero (0). If any part of a field is changeable, all bits in that field are set to one.

The page descriptors (as defined in this document) are always returned, even if no parameters are changeable within the page.

5.2.4.3 Default Values

A PC field value of 2h requests the controller to return the default values for the page code specified. The page requested is returned with the default parameters set.

The page code specifies which page or pages to return. The page codes are described in Section 5.3. If the page codes specified are not implemented, the command is terminated with a CHECK CONDITION status. The sense key is set to ILLEGAL REQUEST, and the additional sense code set to ILLEGAL VALUE IN CDB. If the page code is 3Fh, all implemented pages are requested to be returned by the controller. The pages are returned in ascending order.

The MODE SENSE parameter list contains a four-byte header, followed by one eight-byte block descriptor, followed by zero or more pages.

Table 5-7: Mode Sense Parameter List

Byte \ Bit	7	6	5	4	3	2	1	0
0	Peripheral Device Type (05h)							
1	Media Type							
2	Reserved							
3	Block Descriptor Length (00h or 08h)							
	Block Descriptor							
0	Reserved							
1	(MSB)							
2	Number of Blocks							
3							(LSB)	
4	Reserved							
5	(MSB)							
6	Block Length							
7							(LSB)	
	Page(s)							
0	Reserved		Page(s)					
1	Page-Specific Parameter Length							
2	Page-Specific Parameter							
n								

The media type is set to zero to indicate that the default disc is a CD-ROM.

The block descriptor length is set to 08h.

The block descriptor specifies the media characteristics for the whole disc.

The Number of Blocks field indicates the number of contiguous logical blocks that have the block length specified in the block descriptor. A value of zero indicates the whole disc has the block length specified.

The block length specifies, in bytes, the logical block size in use by the controller. This is applicable to the whole disc except those tracks that are audio. The default block length is 2048 and is returned if default values are requested. The current block length is returned if current values are requested. A block length of FFh FFh FFh is returned if changeable values are requested. See **Table 5-5** for valid values.

Pages are returned following the block descriptor. Each page has a header defining the page code and the page length. Following the header are the page length parameters. The page length value is the number of bytes that follow the page length byte and does not include the length of the header. The pages are defined in Section 5.3.

5.2.5 *PAUSE Command (C5h)*

Byte \ Bit	7	6	5	4	3	2	1	0
0	Operation Code (C5h)							
1	Logical Unit Number				Pause	Reserved		
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	Reserved							
8	Reserved							
9	Control Byte							

The PAUSE command requests that the target start/stop the current audio play operation.

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

5.2.6 *PAUSE / RESUME Command (4Bh)*

Byte \ Bit	7	6	5	4	3	2	1	0
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/RESUME command requests that the target start or stop the current audio play operation. This command is used with some commands, such as PLAY AUDIO commands, issued while the immediate bit of MODE SELECT PAGE CODE E is set to one.

A resume bit of zero (0) indicates that the drive enters the hold track state with the audio output muted after the current audio block is played. A resume bit of one (1) indicates that the drive releases the pause and begins playing at the block following the last block played.

This command is terminated with CHECK CONDITION status if the resume bit is zero and the audio play operation cannot be resumed (i.e., an audio play operation has not been requested, or the requested audio play operation has been completed). It shall not be considered an error to request a pause when a pause is already in effect, or to request a resume when a play operation is in progress.

5.2.7 *PLAY AUDIO Command (C8h)*

Byte \ Bit	7	6	5	4	3	2	1	0
0	Operation Code (C8h)							
1	Logical Unit Number			Reserved				
2	(MSB)							
3				Logical Block Address				
4								
5								(LSB)
6	Reserved							
7	(MSB)							
8				Transfer Length				(LSB)
9	Control Byte							

The PLAY AUDIO command requests that the target play audio starting at the specified logical block address for the specified transfer length. The audio is output as specified by the audio control parameters.

This command returns the status byte when the address requested is found. If the address is not found, or if the ready condition does not exist, or if the address is not within an audio track, a CHECK CONDITION status is returned and the appropriate sense key set.

If the transfer length is zero (0), this command seeks to the specified logical block address and enters the hold track state. If the drive is in a pause condition, issuing a PAUSE command with the pause bit set to zero will begin audio play.

5.2.8 *PLAY AUDIO (10) Command (45h)*

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

The PLAY AUDIO command requests that the target play audio starting at the specified logical block address for the specified transfer length. The audio is output as specified by the audio control parameters MODE SELECT, page code E.

The status returning condition depends on the Immd. bit of MODE SELECT, page code E. If the Immd. bit in the MODE SELECT page code E is set to one (1), the status byte is returned when the address requested is found. If the Immd. bit in MODE SELECT page code E is set to zero (0), the command returns the status byte when reading operations of data transfer length specified byte 7 and 8 above is completed, or if an error occurs.

If the address is not found, if the ready condition does not exist, or if the address is not within an audio track, a CHECK CONDITION status is returned and the appropriate sense key set.

If the transfer length is zero, this command seeks to the specified logical block address and enters the hold track state.
If any command related to audio operations are implemented, then the PLAY AUDIO command shall be implemented to allow a method for the initiator to determine if audio operations are supported. A target responding to a PLAY AUDIO command which has a transfer length of zero, a CHECK CONDITION status, and a sense key set to ILLEGAL REQUEST, does not support audio play operations.

The logical block address field specifies the logical block at which the audio play back operation shall begin.
The transfer length field specifies the number of contiguous logical blocks that shall be played. A transfer length field of zero indicates that no audio operation shall occur. This condition shall not be considered as an error. Any other value indicates the number of logical blocks that shall be played.

-NOTE-

A logical block length not equal to the sector size may cause the starting logical block address and the transfer length to be adjusted by the target. In most targets, a starting logical address within a sector causes the Audio Play to start at the beginning of that sector. Many targets play any partial audio sector found beyond the end of the requested transfer length.

-NOTE-

When the immediate bit in MODE SELECT PAGE E is set to one, the command will be terminated at the address specified by the starting logical block address. When it is set to zero, the command is terminated at the stop address, or an error causes the command to be terminated.

5.2.9 *PLAY AUDIO MSF Command (47h)*

Byte \ Bit	7	6	5	4	3	2	1	0
0	Operation Code (47h)							
1	Logical Unit Number			Reserved				
2	Reserved							
3	Starting Minutes							
4	Starting Seconds							
5	Starting Frame							
6	Ending Minutes							
7	Ending Seconds							
8	Ending Frame							
9	Control Byte							

The PLAY MSF command requests that the target output the audio signals starting at the specified starting address and continue the audio play operation until the specified ending address is detected. The audio signals are output as specified by the audio control parameters in MODE SELECT page code E. The number in these fields is hexadecimal.

The Starting minutes, seconds, and frames specify the starting address in absolute time. The Ending minutes, seconds, and frames specify the ending address in absolute time. If the ending address is less that the starting address a CHECK CONDITION status is returned. The sense key is set to ILLEGAL REQUEST and the additional sense code is set to ILLEGAL VALUE IN COMMAND DESCRIPTOR BLOCK.

The status returning condition depends on the Immd. bit of MODE SELECT page code E. The Immd. bit in MODE SELECT page code E of one (1) requests that this command return the status byte when the address requested is found. The Immd. bit in MODE SELECT page code E of zero (0) requests that this command return the status byte when reading the operation of data transfer length specified by byte 7 and 8 above is completed, or an error occurs.

If the address is not found, or if the ready condition does not exist, or if the address is not within an audio track, a CHECK CONDITION status is returned and the appropriate sense key set.

If the starting address equals the ending address, this command seeks to the specified address and enters the hold track state. If the drive is in a pause condition, issuing a PAUSE command with the pause bit set to zero will begin audio play.

5.2.10 *PLAY AUDIO TRACK/INDEX Command (48h)*

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

The PLAY TRACK/INDEX command requests that the target play audio starting at the specified starting track and index for the specified ending track and index. The audio is output as specified by the audio control parameters in MODE SELECT PAGE CODE E.

The starting track field specifies the track number of the starting audio track. The starting index field specifies the index number within the starting track at which the audio play operation shall begin. Valid values for the track are 1h to 63h (1 to 99) and for the index, only 1.

-NOTE-

The current firmware in the controller only supports a starting index of one.

The ending track field specifies the track number of the ending audio track. The ending index specifies the index number within the track after which the audio play operation shall stop. The ending track of FFh is valid, and the play operation continues until a lead-out, non-audio track, or an error is encountered.

-DEVELOPERS NOTE-

A typical audio track for music has only one index number (i.e., the number of indexes is equal to one). The number of indexes within a track is not obtainable from data in the table of contents.

The status returning condition depends on the Immd. bit of MODE SELECT page code E. The Immd. bit in MODE SELECT page code E of one (1), requests that this command return the status byte when the address requested is found. If the Immd. bit in MODE SELECT page code E is set to zero (0), the command returns the status byte when the reading operation of the data transfer length specified by byte 7 and 8 above is completed. If not, an error occurs.

If the address is not found, or if the ready condition does not exist, or if the address is not within an audio track, a CHECK CONDITION status is returned and the appropriate sense key set.

If the starting track is greater than the ending track, a check condition status will be returned. The sense key is set to ILLEGAL REQUEST. If both are equal, the play operation is executed on the one track only.

5.2.11 *PLAY MSF Command (C7h)*

Byte \ Bit	7	6	5	4	3	2	1	0
0	Operation Code (C7h)							
1	Logical Unit Number			Reserved				
2	Reserved							
3	Starting Minutes							
4	Starting Seconds							
5	Starting Frame							
6	Ending Minutes							
7	Ending Seconds							
8	Ending Frame							
9	Control Byte							

The PLAY MSF command requests that the target output the audio signals starting at the specified starting address and continue the audio play operation until the specified ending address is detected. The audio signals are output as specified by the audio control parameters.

The Starting minutes, seconds, and frames specify the starting address in absolute time. The Ending minutes, seconds, and frames specify the ending address in absolute time. If the ending address is less than the starting address a CHECK CONDITION status is returned. The sense key is set to ILLEGAL REQUEST and the additional sense code is set to ILLEGAL VALUE IN COMMAND DESCRIPTOR BLOCK.

This command returns a status byte when the address requested is found. If the address is not found, or if the ready condition does not exist, or if the address is not within an audio track, a CHECK CONDITION status is returned and the appropriate sense key set.

If the starting address equals the ending address, the command seeks to the specified address and enters the hold track state. If the drive is in a pause condition, issuing a PAUSE command with the pause bit set to zero will begin audio play.

5.2.12 *PLAY TRACK Command (C6h)*

Byte \ Bit	7	6	5	4	3	2	1	0
0	Operation Code (C6h)							
1	Logical Unit Number			Reserved				
2	Reserved							
3	Reserved							
4	Starting Track							
5	Starting Index							
6	Reserved							
7	Reserved							
8	number of Indexes							
9	Control Byte							

The PLAY TRACK command requests that the target play audio starting at the specified starting track and index for the specified number of indexes. The audio is output as specified by the audio control parameters.
The starting track field specifies the track number of the audio track. The starting index field specifies the index number within the starting track that begins the audio play operation.

-NOTE-

The current firmware in the controller only supports a starting index of one.

The number of indexes specifies the duration of the audio play operation. If the value in the number of indexes field exceeds the number of indexes within the track, the play operation continues until the end of the requested track. A value of FFh requests that the play operation continue until the lead-out track or a non-audio track is detected.

-DEVELOPERS NOTE-

A typical audio track for music has only one index number (i.e., the number of indexes is equal to one). The number of indexes within a track is not obtainable from data in the table of contents.

This command returns the status byte when the address requested is found. If the address is not found, if the ready condition does not exist, or if the address is not within an audio track, a CHECK CONDITION status is returned and the appropriate sense key set.

If the number of the starting address specified is the same as that of the ending address, the audio data on the track is output.

5.2.13 *PLAYBACK CONTROL Command (C9h)*

Byte \ Bit	7	6	5	4	3	2	1	0
0	Operation Code (C9h)							
1	Logical Unit Number			Reserved				
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	(MSB)			Parameter Length				
8								(LSB)
9	Control Byte							

The PLAYBACK CONTROL command requests that the target set the audio play as specified. If the drive is not in the ready condition, the command is terminated with a CHECK CONDITION status. The sense key is set to NOT READY and the appropriate additional sense code set.
The parameter length specifies the number of bytes of data to be sent during the data out phase.

Table 5-8: Audio Control Data Format

Byte \ Bit	7	6	5	4	3	2	1	0
0	Reserved							
1	Reserved							
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	Reserved							
8	Reserved							
9	Reserved							
10	Reserved				Channel 0 Output Selection			
11	Channel 0 Volume							
12	Reserved				Channel 1 Output Selection			
13	Channel 1 Volume							
14	Reserved				Channel 2 Output Selection			
15	Channel 2 Volume							
16	Reserved				Channel 3 Output Selection			
17	Channel 3 Volume							

The channel output selection specifies where the audio for that channel is output. Channel output selection and volume control of channel 0 and 1 is valid in this command. The valid values of volume control are 00h though FF in the channel volume field, and a value of zero indicates the output is muted and a value of FFh indicates maximum volume level. **Please note audio volume levels are not supported on the Texel DM-xx28.**

Output selections are defined as follows:

Table 5-9: Output Port Channel Selection

0 0 0 0	Output port muted
0 0 0 1	Connect audio channel 0 to this output port
0 0 1 0	Connect audio channel 1 to this output port
0 0 1 1	Connect audio channel 0 and 1 to this output port

-NOTE-

The current firmware supports only channel 0 and 1. Attempting to set channel to 2 or 3 results in the command being terminated with a CHECK CONDITION status. The sense key is set to ILLEGAL REQUEST.

5.2.14 *PLAYBACK STATUS Command (C4h)*

Byte \ Bit	7	6	5	4	3	2	1	0
0	Operation Code (C4h)							
1	Logical Unit Number			Reserved				
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	(MSB)			Allocation Length				
8								(LSB)
9	Control Byte							

The PLAYBACK STATUS command requests that the target return the status data of the current audio block.

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

Table 5-10: Audio Status Data Format

Byte \ Bit	7	6	5	4	3	2	1	0
0	Reserved							
1	Reserved							LBA MSF
2	Reserved							
3	(MSB)							
4	Audio Status Data Length							(LSB)
5	Reserved				Control			
6	(MSB)							
7	CD Address							
8								
9								(LSB)
10	Reserved				Channel 0 Output Selection			
11	Channel 0 Volume							
12	Reserved				Channel 1 Output Selection			
13	Channel 1 Volume							
14	Reserved				Channel 2 Output Selection			
15	Channel 2 Volume							
16	Reserved				Channel 3 Output Selection			
17	Channel 3 Volume							

The audio status bits are defined in **Table 5-10.** The LBA/MSF bit indicates the present state of the address format that is only applicable to TEXEL vendor unique commands (Group 6). The LBA/MSF bit set to zero (0) indicates that the controller return the specified address data in the format of the logical block address. The LBA/MSF bit set to one (1) indicates to the drive's controller that the data is in the MSF format address (See **Section 5.5.**). The default value of LBAMSF bit is zero.

Table 5-11: Audio Status Codes

Status	Description
00h	Audio play operation in progress
01h	Audio pause operation in progress
02h	Audio muting ON.
03h	Audio play operation has successfully completed
04h	Error occured during audio play operation
05h	Audio play operation not requested

The control bits are defined in **Table 5-25.**

The CD address field specifies the current address. The format of the address is determined by the LBA/MSF bit in the CDB 05 last issued SET ADDRESS FORMAT command. For checking the present state of the format, the LBA/MSF bit in the returned data of PLAYBACK STATUS command is available (See sections 5.2.14 and 5.2.34).

The channel output selection indicates where the audio channel is outputed. See **Table 5-9.** A channel may be output to more than one channel (i.e., channel one may be output to channels one and two).

The channel volume control indicates the relative volume level of the audio output. A value of zero indicates the output is muted, a value of FFh indicates maximum volume level. Please note that the DM-xx24 does not support audio volume levels.

5.2.15 *PREVENT / ALLOW MEDIA REMOVAL Command (1Eh)*

Byte \ Bit	7	6	5	4	3	2	1	0
0	Operation Code (1Eh)							
1	Logical Unit Number			Reserved				
2	Reserved							
3	Reserved							
4	Reserved							Prevent
5	Control Byte							

The PREVENT/ALLOW MEDIA REMOVAL command requests that the controller enable or disable the removal of the caddy in the drive.

A prevent bit of one inhibits the removal of the caddy by use of a command through the interface or by use of the eject button. The emergency release mechanism cannot be overridden. A prevent bit of zero allows removal of the caddy.

This prevention of caddy removal condition terminates upon receipt of a ALLOW MEDIA REMOVAL command (i.e., the prevent bit set to zero), or by the receipt of a BUS DEVICE RESET message from any initiator or by a reset condition.

If a PREVENT MEDIA REMOVAL command is issued without the drive being in the ready condition the command is terminated with a CHECK CONDITION status. The sense key will be set to NOT READY and the appropriate additional sense code will be set.

An ALLOW MEDIA REMOVAL command may be issued at any time by the initiator and shall not be considered an error.

5.2.16 *READ (6) Command (08h)*

Byte \ Bit	7	6	5	4	3	2	1	0
0	Operation Code (08h)							
1	Logical Unit Number			Reserved				
2	(MSB)							
	Logical Block Address							
3							(LSB)	
4	Transfer Length							
5	Control Byte							

The READ (6) command requests that the controller transfer data to the initiator. The data will be re-transferred in whole blocks without delays occurring during a block transfer on the bus. After completion of the read operation, the drive enters the hold track state for the duration of the inactivity time.

The logical block address specifies the logical block at which the read operation will begin.

The transfer length specifies the number of contiguous logical blocks of data to be transferred. A transfer length of zero indicates that 256 logical blocks will be transferred. Any other value indicates the number of logical blocks that are transferred.

This command can be terminated with a RESERVATION CONFLICT status, if any reservation conflict exists and no data is read.

This command is terminated with a CHECK CONDITION status for a number of reasons. The error recovery parameters determine when and how the data errors are reported. See Section 5.3.1.1. The data transfer may also be terminated with a CHECK CONDITION STATUS if any of the following events occur while a read operation is in progress. The sense key is set to ILLEGAL REQUEST and the additional sense code set to END OF USER AREA ENCOUNTERED ON THIS TRACK.

1) A mode zero is detected (i.e., post-gap detected).

2) An index equal to 0 is detected (i.e., pre-gap detected).

3) A track number change is detected (i.e., lead-out, mode one <-> mode two).

4) A change in bit one of the control field is detected.

If the logical block address requested is not within a data track, the command is terminated with a CHECK CONDITION status. The sense key is set to ILLEGAL REQUEST and the additional sense code set to ILLEGAL MODE FOR THIS TRACK.

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

5.2.17 *READ BUFFER Command (3Ch)*

Byte \ Bit	7	6	5	4	3	2	1	0
0	Operation Code (3Ch)							
1	Logical Unit Number			Reserved				Mode
2	Reserved							
3	(MSB)							
4	Buffer Offset							
5								(LSB)
6	(MSB)							
7	Transfer Length							
8								(LSB)
9	Control Byte							

The READ BUFFER command is used in conjunction with the WRITE BUFFER command as a diagnostic function for testing controller memory and the bus integrity. This command will not alter the media.

The function of this command and the meaning of fields within the command descriptor block depend on the contents of the mode field. A mode field value of zero (0) indicates that the buffer offset is zero. A mode field value of one (1) indicates that the buffer offset is valid and data will be placed in the buffer with that offset.

The buffer offset is the byte offset within the buffer where the data is retrieved. If the controller is unable to accept the specified buffer offset, it returns a CHECK CONDITION status and sets the sense key to ILLEGAL REQUEST.

The data to be transferred is preceded by a four-byte READ header.

Table 5-12: Read Buffer Header

Byte \ Bit	7	6	5	4	3	2	1	0
0	Reserved							
1	(MSB)							
2	Available Length							
3							(LSB)	

5.2.18 *READ CD-ROM CAPACITY Command (25h)*

Byte \ Bit	7	6	5	4	3	2	1	0
0	Operation Code (25h)							
1	Logical Unit Number			Reserved				
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	Reserved							
8	Reserved							
9	Control Byte							

The READ CD-ROM CAPACITY command, creates a means for the initiator to request information regarding the capacity of the logical unit. The eight bytes of READ CD-ROM CAPACITY data are shown on the following page. The capacity is based on the starting address of the lead-out area minus one.

The eight bytes of READ CD-ROM CAPACITY data are shown below. The capacity is based on the starting address of the lead-out area minus one.

Table 5-13: Read Capacity Data

Byte	*Description*
0 to *3*	*(MSB) Logical Block Address (LSB)*
4 to *7*	*(MSB) Logical Block Address (LSB)*

The logical block address reports the address of the last user accessible block on the disc based on the block length specified in the MODE SELECT (6) command. The default block length is used if a MODE SELECT (6) command has not been issued.

The block length reported is based on the block size requested in the MODE SELECT (6) command. The default block length default is reported if a MODE SELECT (6) command has not been issued.

5.2.19 *READ (10) Command (28h)*

Byte \ Bit	7	6	5	4	3	2	1	0
0	Operation Code (28h)							
1	Logical Unit Number				Reserved			
2	(MSB)							
3	Logical Block Address							
4								
5							(LSB)	
6	Reserved							
7	(MSB)							
8	Transfer Length						(LSB)	
9	Control Byte							

The READ (10) command requests that the controller transfer data to the initiator. The data is transferred in whole blocks without delays occurring during a block transfer.

The logical block address specifies the logical block at which the read operation begins.

The transfer length specifies the number of contiguous logical blocks of data that is transferred. A transfer length of zero (0) indicates that no logical blocks will be transferred but the addressed drive will perform a seek operation to the specified address. This condition will not be considered as an error. Any other value indicates the number of logical block that will be transferred.

See the READ (6) command for the exception handling description.

5.2.20 *READ HEADER Command (C3h)*

Byte \ Bit	7	6	5	4	3	2	1	0
0	Operation Code (C3h)							
1	Logical Unit Number				Reserved			
2	(MSB)							
3				Logical Block Address				
4								
5							(LSB)	
6	Reserved							
7	(MSB)							
8				Allocation Length			(LSB)	
9	Control Byte							

The READ HEADER command requests that the target return the CD-ROM data header for the specified logical block.

See the READ (6) command for exception handling. If the logical block size is less than the physical block size the CD-ROM data header will be returned for the physical block which contains the logical block requested.

Table 5-14: Header Data Format

Byte \ Bit	7	6	5	4	3	2	1	0
0	*Absolute Minute*							
1	*Absolute Second*							
2	*Absolute Frame*							
3	*CD-ROM Mode*							

The absolute minutes, seconds and frame fields specify the physical location from the beginning of the disc.

The CD-ROM Mode field specifies the CD-ROM mode of the physical block.

5.2.21 *READ HEADER Command (44h)*

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

The READ HEADER command requests that the target return the CD-ROM data header for the specified logical block. If the block size is smaller than 2048 bytes, the header data of the block including the specified logical block address is returned. See the READ (6) command for exception handling.

The logical block address field specifies the logical block at which the read header operation shall begin.

The address format returned is specified by the MSF bit as follows.

- o If MSF bit is equal to 1, it is minutes, seconds and frames format.
- o If MSF bit is equal to 0, it is the logical block address format.

The CD-ROM data header format returned is defined as follows:

Table 5-15: Header Data Format

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

The CD-ROM Data Mode field shall return the requested logical block data mode format which is defined as follows:

Table 5-16: Logical Block Data Mode Format

CD-ROM Mode	User Data Field Contents (2048 bytes)	Auxiliary Field Contents (288 bytes)
00h	All bytes zero	All bytes zero
01h	User Data	EDC, L-EC symbols
02h	User Data	User Data
03h to FFh	Reserved	Reserved

5.2.22 *READ SUB-CHANNEL Command (C2h)*

Byte \ Bit	7	6	5	4	3	2	1	0
0	Operation Code (C2h)							
1	Logical Unit Number			Reserved				
2	Reserved		Sub Q	Reserved				
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	(MSB)							
8	Allocation Length							(LSB)
9	Control Byte							

The READ SUB-CHANNEL command requests that the target return the requested sub-channel data of the current block. The format of the address is determined by the LBA/MSF bit in the CDB of last issued SET ADDRESS FORMAT command. For checking the present state of the format, the LBA/MSF bit in the returned data of PLAYBACK STATUS command is available *(See 5.2.14. and 5.2.34).*

The Sub Q bit set to one (1) requests the target return the Q sub-channel data. The Sub Q bit set at zero (0) requests that no data be returned.

-NOTE-

The other bits in this byte are reserved for use in requesting other sub-channel data. The bits occur in the sub-channel in P Q R S T U V W order. At present, returning data from the other sub-channels is not permitted by the media standards.

Table 5-17: Sub-Channel Q Data MSF Format

Byte \ Bit	7	6	5	4	3	2	1	0
0	Reserved				Control			
1	Track Number							
2	Index Number							
3	Relative Minute							
4	Relative Second							
5	Relative Frame							
6	Absolute Minute							
7	Absolute Second							
8	Absolute Frame							

The control bits for Byte 0 are defined in **Table 5-25.**
The Track Number in Byte 1 specifies the current track number.
The Index Number in Byte 2 specifies the index number in the current track.

The relative minutes, seconds and frame fields specify the relative physical location at the beginning of the current track.

The absolute minutes, seconds and frame fields specify the absolute physical location at the beginning of the disc.

Table 5-18: Sub-Channel Q Data LBA Format

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

The control bits in Byte 0 are defined in Table 5-25.

The Track Number in Byte 1 specifies the current track number.

The Index Number in Byte 2 specifies the index number in the current track.

The relative CD address returns the equivalent logical address of the relative physical location at the beginning of the current track.

The absolute CD address returns the equivalent logical address of the absolute physical location at the beginning of the disc. If the first track on the disc is CD-ROM data the logical address returned is adjusted for the two second offset.

5.2.23 *READ SUB-CHANNEL Command (42h)*

Byte \ Bit	7	6	5	4	3	2	1	0
0	Operation Code (42h)							
1	Logical Unit Number			Reserved			MSF	Reserved
2	Reserved	Sub Q	Reserved					
3	Sub Channel Data Format							
4	Reserved							
5	Reserved							
6	Track Number							
7	(MSB)							
8	Allocation Length							(LSB)
9	Control Byte							

The READ SUB-CHANNEL command requests that the target return the requested sub-channel data of the current block plus the state of audio play operation.

An explaination of the MSF field is discussed below:

- If MSF bit equal to 1, it is minutes, seconds and frames format.
- If MSF bit equal to 0, it is the logical block address format (LBA).

A Sub Q bit set to one requests the target to return the Q sub-channel data. A Sub Q bit set to zero requests that no sub-channel data be returned. This shall not be considered an error.

The Sub Channel data format combinations are presented in table 5-19.

Table 5-19: Sub Channel Data Formats

Format Code	Returned Data
00h	Sub-Q Channel data
01h	CD-ROM Current Position
02h	Media Catalog Number (UPC/Bar Code)
03h	Track International-Standard Recording Code
04h - EFh	Reserved
F0h - FFh	Not Used

The Track Number field specifies the track from which ISRC data is read. This field must have a value between 01h and 63h (99BCD), and is valid only when the Sub Channel Data Format is set to 03h. In this case, the target returns ISRC data for this track.

The READ SUB-CHANNEL command data formats *(refer to Tables 5-20,5-22,and 5-23)* all consist of a four Byte header followed by a sub-channel data block. The header contains the audio status Byte and the sub-channel data length field. If the SUB-Q bit is zero, the target shall not return the sub-channel data block, in this this case the sub-channel data length is 0.

Table 5-20: Sub-Q Data Format

Byte \ Bit	7	6	5	4	3	2	1	0
Sub-Channel Data Header								
0	*Reserved*							
1	*Audio Status*							
2	*(MSB)*							
to	*Sub-Channel Data Length*							
3								*(LSB)*
Sub Channel Data Block								
4	*Sub Channel Data Format (00h)*							
5	*ADR*				*Control*			
6	*Track Number*							
7	*Index Number*							
8	*(MSB)*							
to	*Absolute CD-ROM Address*							
11								*(LSB)*
12	*(MSB)*							
to	*Track Relative CD-ROM Address*							
15								*(LSB)*
16	*MCVal*			*Reserved*				
17	*(MSB)*							
to	*Media Catalog Number (UPC/Bar Code)*							
31								*(LSB)*
32	*TCVal*			*Reserved*				
33	*(MSB)*							
to	*Track International Standard Recording Code (ISRC)*							
47								*(LSB)*

The audio status field indicates the status of audio play operation. The audio values are defined in table 5-21. Audio status values greater than zero are returned only to the initiator that requested the last audio play operation. Audio status values 13h and 14h return information on previous audio operationsl; they are returned only once after the condition has occured. If another audio play operation is not requested, the audio status returned for subsequent READ SUB-CHANNEL commands is 15h.

Table 5-21: Audio Status Codes

Status	Description
00h	Audio Status Byte Not Supported or Not Valid
11h	Audio Play Operation In Progress
12h	Audio Play Operation Paused
13h	Audio Play Operation Successfully Completed
14h	Audio Play Operation Stopped Due To An Error
15h	No Current Audio Status To Return

The Sub-Channel data length specifies the length in bytes of the following sub-channel data block. A sub-channel data length of zero indicates that no sub-channel data block is included in the returned data.

-Developers Note-

Usual values for Sub-channel data lengths are 0, 12, 20, 28 and 55 bytes.
Sub-channel data length does not include the Sub-Channel Header.

The sub-Q channel data block consists of control data (bytes 4-5), current position data (bytes 6-15) and indentification data (bytes 16-47). The control data and current position data is obtained from the Q sub-channel information of the current block. Identification data may be reported that was obtained from a previous block. The following apply:

1) If an audio play is proceeding in the background, position data for the last sector played shall be reported.

2) In other cases, for instances after a READ command, the target may either report position data for the last sector processed for that operation or may report position data from the sector at the current read head position.

-Developers Note-

When the type of information encoded in the Q sub-channel of the current sector is the media catalog number or ISRC; the track, index, and address field should be extrapolated from the previous sector.

The ADR field gives the type of information encoded in the Q sub-Channel of this block, as shown in **Table 5-22.**

Table 5-22: ADR Sub-Channel Q Field Codes

Status	Description
00h	Sub-Channel Q mode Information Not Supplied
01h	Sub-Channel Q Encodes current Position Data (i.e. Track, Index, Absolute Address, Relative Address)
02h	Sub-Channel Q Encodes Media Catalog Number
03h	Sub-Channel Q Encodes Media Catalog Number
04h - 0Fh	Reserved

The Control bits are defined in **Table 5-23**.

Table 5-23: Sub-Channel Q Control Bits

Bits	Equals Zero	Equals One
0	Audio Without Pre-emphasis	Audio With Pre-emphasis
1	Digital Copy Prohibited	Digital Copy Permitted
2	Audio Track	Data Track
3	Two Channel Audio	Four Channel Audio

The track number specifies the current track number.

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

The absolute CD-ROM address field gives the current location relative to the logical beginning of the media. If the MSF bit is set to zero, this field is a logical block address. If the MSF bit is one, this field is an absolute MSF address.

The track relative CD-ROM address field gives the current location relative to the logical beginning of the current track. If the MSF bit is zero, this field is a track relative logical block address. If the MSF bit is one, this field is the relative MSF address from the Q sub-channel.

A media catalog valid (MCVal) bit of one indicates that the media catalog number field is valid. A MCVal bit of zero indicates that the media catalog number field is not valid. For additional information of the MCVal bit, refer to section 13.2.10 of the ANSI SCSI-2 specification manual.

The track code valid (TCVal) bit of one indicates that the track ISRC field is valid. A TCVal bit of zero indicates that the track International-Standard-Recording-Code (ISRC) field is not valid.

The track ISRC field contains the indentifying number of this media according to the ISRC standards expressed in ASCII.

Table 5-24: CD-ROM Current Position Data Format

Byte \ Bit	7	6	5	4	3	2	1	0
Sub-Channel Data Header								
0	*Reserved*							
1	*Audio Status*							
2	*(MSB)*		*Sub-Channel Data Length*					
3								*(LSB)*
CD-ROM Current Position Data Block								
4	*Sub Channel Data Format code (01h)*							
5	*ADR*					*Control*		
6	*Track Number*							
7	*Index Number*							
8	*(MSB)*							
to			*Absolute CD-ROM Address*					
11								*(LSB)*
12	*(MSB)*							
to			*Track Relative CD-ROM Address*					
15								*(LSB)*

Table 5-25: Media Catalog Number Data Format

Byte \ Bit	7	6	5	4	3	2	1	0
	Sub-Channel Data Header							
0	*Reserved*							
1	*Audio Status*							
2	*(MSB)*							
to	*Sub-Channel Data Length*							
3								*(LSB)*
	Media Catalog Number Data Block							
4	*Sub Channel Data Format code (02h)*							
5	*Reserved*							
6	*Reserved*							
7	*Reserved*							
8	*MCVal*	*Reserved*						
9	*(MSB)*							
to	*Media Catalog Number (UPC/Bar Code)*							
15								*(LSB)*

If the media Catalog Number data is found, the MCVal bit is set to one. If MCN data is not detected, the MCVal bit is set to zero to indicate the Media Catalog Number field is invalid.

-Developers Note-

Media catalog Number data returned by this command with Sub-channel Data format field 02h may be from any block which has UPC/Bar Code Q sub-channel data. (This code is constant anywhere in every applicable disc.)

5.2.24 *READ TOC Command (C1h)*

Byte \ Bit	7	6	5	4	3	2	1	0
0	Operation Code (C1h)							
1	Logical Unit Number			Reserved				
2	Reserved							
3	Reserved							
4	Reserved							
5	Track Number							
6	Reserved							
7	(MSB)			Allocation Length				
8								(LSB)
9	Control Byte							

The READ TOC command requests the transfer of the table of contents (TOC) data to the initiator.

The track number field specifies the first track number for which the TOC data will be returned. The data is returned in contiguous ascending order.

If the track number field is zero or is not valid for the disc inserted, the command will be terminated with a CHECK CONDITION status. The sense key is set to ILLEGAL REQUEST. The additional sense code is set to ILLEGAL VALUE IN CDB.

Table 5-26: TOC Data Format

Byte \ Bit	7	6	5	4	3	2	1	0
0	(MSB)							
1				Sub-Channel Data Length				(LSB)
2				First Track Number				
3				Last Track Number				
				TOC Track Descriptor				
0				Track Number				
1		Reserved				Control		
2	(MSB)							
3				CD Address				
4								
5								(LSB)

The starting track field specifies the starting track number for which the TOC data will be returned. The data is returned in contiguous, ascending order. Valid values for the starting track field are 1h to 63h. A value of AAh requests that the starting address of the lead out area be returned.

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 format of the address is determined by the LBA/MSF bit in the CDB of the last issued SET ADDRESS FORMAT command. For checking the present state of the format, LBA/MSF bit in the returned data of PLAYBACK STATUS command is available (See 5.2.14 and 5.2.34).

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 602d (025Ah).

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

DEVELOPERS NOTE

A disc may start at any track number. The track numbers between the first track number and the last track number are 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 the CD address that follows.

The control field indicates the attributes of the track. These are defined in **Table 5-27**.

Table 5-27: Definition of Control Field Bits

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

5.2.25 *READ TOC Command (43h)*

Byte \ Bit	7	6	5	4	3	2	1	0
0	Operation Code (43h)							
1	Logical Unit Number			Reserved			MSF	Reserved
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	Starting Track			(Ignored for Multi-session)				
7	(MSB)							
8	Allocation Length (0Ch)							(LSB)
9	Control Byte (Use bit 6 (40h) to request the last session address)							

-NOTE-

It is important that the application does not issue this command directly (i.e., bypassing the device driver). Future drives may not support all formats as defined in the Format field.

The READ TOC command requests the target to transfer table of contents (TOC) data to the initiator.
The Kodak Multi-Session format requires modification to SCSI-2 specifications. This modification affects Byte 6 which indicates the starting session number. Byte 9 reserves bits 6 and 7 for issuing the format mode. This mode is as follows:

Format
(bits 6,7)

(00) Same definition as in SCSI-2. The Start Track/Session Number field specifies starting track number for which the data is returned. For multi-session Photo CD, this command returns the TOC data for all sessions.

(01) This format returns the first session number, last session number and last session starting address.
In this format, the Starting Track/Session Number field is reserved and should be set to 00h.

-Note-

This format provides the host to access the last session starting address quickly.

(10) This format returns all Q subcodes data in the lead in(TOC) area starting from a specified session number as specified in the Session Number field. In this mode, the drive supports pointers as listed below:

Pointer:
A0, A1, A2,
Tracks:
B0, B1, B2, B3, B4 and C0

(11) Reserved.

The starting track field specifies the starting track number for which the TOC data will be returned. The data is returned in contiguous, ascending order. Valid values for the starting track field are (00h) to (63h). A value of (AAh) requests that the starting address of the Lead-Out area be returned. If this is zero, the Table Of Contents' (TOC) data will begin with the first track on the disc.

If the track number field is not valid for the disc inserted, the command will be terminated with a CHECK CONDITION status. The sense key is set to ILLEGAL REQUEST. The additional sense code is set to ILLEGAL VALUE IN CDB.

For Format = 00b, this returned data of the READ TOC Command is defined as follows:

Table 5-28: TOC Data Format

Byte	Bit 7	6	5	4	3	2	1	0
0	(MSB)							
1				TOC Data Length				(LSB)
2				First Track Number				
3				Last Track Number				
				TOC Track Descriptor(s)				
0				Reserved				
1		Reserved				Control		
2				Track Number				
3				Reserved				
4	(MSB)							
to				Absolute CD-ROM Address				
7								(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 format of the CD address is determined by the MSF bit in the CDB.

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 the TOC data length field itself.

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

-DEVELOPERS NOTE-

A disc may start at any track number greater than zero. The track numbers between the first track number and the last track number are in contiguous ascending order, except for the lead-out track which has a track number of AAh.

The ADR field is defined in the Read Q Sub-Channel command. The control field indicates the attributes of the track. It is defined in the Read Q Sub-Channel command.

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

The absolute CD-ROM address contains the address of the first block with user information for that number as from the table of contents. An MSF bit of zero indicates that the absolute CD-ROM address field contains a logical block address. An MSF bit of one indicates the absolute CD-ROM address field contains a MSF address.

-DEVELOPERS NOTE-

The starting logical block address value recovered from the TOC has a tolerance of zero for data track and plus or minus 75 CD sectors for audio tracks. This tolerance is multiplied by a factor dependent on the logical block length.

For Format = 01b, the returned data of READ TOC Command is defined as follows:

Table 5-29: TOC Data With Format Field = 01b

Byte \ Bit	7	6	5	4	3	2	1	0
0	(MSB)							
1				TOC Data Length (08h)				(LSB)
2	First Track Number indicates the first session number							
3	Last Track Number indicates the last session number							
	TOC Track Descriptor(s)							
0 *	Reserved							
1 *	Address				Control			
2 *	Track Number							
3 *	Reserved							
4 to 7	(MSB) Address to last written session. Address type determined By the MSF bit at Byte 1 of the READ TOC Command Block. Last PVD (Primary Volume Descriptor) -(10h) (LSB)							

* Bytes 0, 1, 2, and 3 are all reserved

For Format = 10b, the returned data of READ TOC Command is defined as follows:

Table 5-30: TOC Data With Format Field = 10b

Byte \ Bit	7	6	5	4	3	2	1	0
0	(MSB)							
	TOC Data Length							
1								(LSB)
2	First Track Number							
3	Last Track Number							
	TOC Track Descriptor(s)							
0	Session Number							
1	ADR				Control			
2	Byte 1 or TNO							
3	Byte 2 or Point							
4	Byte 3 or Min							
5	Byte 4 or Sec							
6	Byte 5 or Frame							
7	Byte 6 or Zero							
8	Byte 7 or PMin							
9	Byte 8 or PSec							
10	Byte 9 or PFrame							

For Format field of 10b, the drive should return TOC data for all Q-subcode modes (adr field) in the lead in area. (Note: Currently defined Q-Subcode modes are 1 and 5.)

The First Session Number is equal to the Last Session Number for a single session disc.

The returned TOC data are arranged in ascending order of the ADR field, and then in ascending order of the POINT field within the ADR field.

Table 5-31: Definition of Control Field Bits

Bit	Equals One	Equals Zero
0	With pre-emphasis	without pre-emphasis
1	Digital copy permitted	Digital copy prohibited
2	Data track	Audio track
3	Four channel	Two channel

The absolute CD-ROM address contains the address of the first block with user information for that track number as read from the table of contents. An MSF bit of zero indicates that the absolute CD-ROM address field contains a logical block address. An MSF bit of one indicates the absolute CD-ROM address field contains a MSF address.

5.2.26 RECEIVE DIAGNOSTIC RESULTS Command (1Ch)

Byte \ Bit	7	6	5	4	3	2	1	0
0	Operation Code (1Ch)							
1	Logical Unit Number			Reserved				
2	Reserved							
3	(MSB)							
4	Allocation Length						(LSB)	
5	Control Byte							

The RECEIVE DIAGNOSTIC RESULTS command requests analysis data be sent to the initiator after completion of a SEND DIAGNOSTIC command.

The RECEIVE DIAGNOSTIC data contains an eight-byte parameter list defined as follows:

Table 5-32: Receive Diagnostic Data

Byte \ Bit	7	6	5	4	3	2	1	0
0	*Reserved*							
1	*Parameter Length*							
2	*ROM Diagnostic*							
3	*ROM Diagnostic*							
4	*Data Buffer Diagnostic*							
5	*Interface Diagnostic*							
6	*Reserved*							
7	*Reserved*							

The parameter length specifies the length in bytes of the following SEND DIAGNOSTIC parameters. The sense data length does not include itself.

A value of zero in any field indicates that the diagnostic, if requested, passed.

If the ROM Diagnostic field is set to one, it indicates that the controller ROM has failed. If the ROM Diagnostic field is set to two, it indicates that the drive control ROM has failed.

If the RAM Diagnostic field is set to one, it indicates that the controller RAM has failed. If the RAM Diagnostic field is set to two, it indicates that the drive control RAM has failed.

If the Data Buffer Diagnostic field is set to one, it indicates that the controller data buffer has failed.
If the Data Buffer Diagnostic field is set to two, it indicates that the drive control data buffer has failed.
If the Data Buffer Diagnostic field is set to four, it indicates that the drive control error RAM has failed.
If the Interface Diagnostic field is set to one, it indicates that the controller - drive control interface has failed.
If the Interface Diagnostic field is set to two, it indicates that the drive control - mechanism control interface has failed.

5.2.27 *RELEASE Command (17h)*

Byte \ Bit	7	6	5	4	3	2	1	0
0	Operation Code (17h)							
1	Logical Unit Number			3rdPty	Third Party Device ID			Reserved
2	Reserved							
3	Reserved							
4	Reserved							
5	Control Byte							

The RELEASE command is used to release previously reserved logical units. It is not an error for an initiator to attempt to release a reservation that is not currently active. In this case, the controller returns GOOD status without altering any other reservation.

This command causes the controller to terminate the logical unit reservation from the initiator. The third-party release for the RELEASE command allows an initiator to release a logical unit reserved using third-party reservation.

If the third-party (3rdPty) bit is zero, then the third-party release option is not requested. If the 3rdPty bit is one, the controller will release the specified logical unit only if the reservation was made using the third-party reservation option by the initiator that is requesting the release for the same initiator as specified in the third-party ID field.

5.2.28 *REQUEST SENSE Command (03h)*

Byte \ Bit	7	6	5	4	3	2	1	0
0	Operation Code (03h)							
1	Logical Unit Number			Reserved				
2	Reserved							
3	Reserved							
4	Allocation Length							
5	Control Byte							

The REQUEST SENSE command requests that the controller transfer sense data to the initiator.

The sense data will be valid after a CHECK CONDITION status has been returned on the previous command. This sense data will be preserved by the controller for the initiator until:

1) It is retrieved by a REQUEST SENSE command from that initiator;

2) The receipt of another command for the same logical unit from that initiator;

3) A reset condition occurs.

-NOTE-

The sense data will be cleared upon receipt of any subsequent command for the same logical unit from the initiator that was returned the CHECK CONDITION status. See Section 4.1.3.

The REQUEST SENSE command returns the CHECK CONDITION status only to report catastrophic errors for the REQUEST SENSE command. Following a catastrophic error on a REQUEST SENSE command, sense data may be invalid. For example:

1) A reserved bit is set in the command descriptor block.

2) An unrecovered parity error occurs on the bus.

3) A controller malfunction prevents return of the sense data.

If an error occurs during the execution of the REQUEST SENSE command, but it is not catastrophic, the controller will return the sense data with GOOD status.

Table 5-33: Error Code 70h Sense Data Format

Byte	Bit 7	6	5	4	3	2	1	0
0	Valid	Error Code (70h)						
1	Reserved							
2	Reserved				Control			
3 TO 6	(MSB) Information Bytes (LSB)							
7	Additional Sense Length (8h)							
8 to 11	(MSB) Command Specific Information Bytes (LSB)							
12	Additional Sense Code							
13	Additional Sense Code Qualifier							
14	Reserved							
15	Reserved							

A valid bit of zero indicates that the information bytes are not defined. A valid bit of one indicates the information bytes contain valid information as defined in this document.

The sense keys are described in **Table 5-30**. The additional sense codes and additional sense code qualifier are described in Section 5.4.

The contents of the information bytes are command specific and are defined under the appropriate command description. Unless specified otherwise, these bytes contain the unsigned logical block address associated with the sense key.

The additional sense length specifies the number of additional sense bytes to follow. If the allocation length of the command descriptor block is too small to transfer all of the additional sense bytes, the additional sense length is not adjusted to reflect the truncation.

The contents of the command specific information bytes are defined under the appropriate command description.

Table 5-34: Sense Key Descriptions

NO SENSE (0h). Indicates that there is no specific sense key information to be reported for the designated logical unit.

RECOVERED ERROR (1h). Indicates that the last command completed successfully with some recovery action performed by the controller. Details may be determinable by examining the additional sense bytes and the information bytes. *(See Section 5.3.1.1.)*

NOT READY (2h). Indicates that the logical unit addressed is not accessible. Operator intervention may be required to correct this condition.

MEDIA ERROR (3h). Indicates that the command terminated with a unrecovered error condition that was probably caused by a flaw in the media or an error in the recorded data. This sense key may also be returned if the controller is unable to distinguish between a flaw in the media and a specific hardware failure (sense key 4h). *(See Section 5.3.1.1.)*

HARDWARE ERROR (4h). Indicates that the controller detected a unrecoverable hardware failure (for example, controller failure, device failure, parity error, etc.) while performing the command or during a self test.

ILLEGAL REQUEST (5h). Indicates that there was an illegal parameter in the command descriptor block or in the additional parameters supplied as data for some commands. If the controller detects an invalid parameter in the command descriptor block, then it will terminate the command without altering the media. If the controller detects an invalid parameter in the additional parameters supplied as data, then the controller may have already altered the media.

UNIT ATTENTION (6h). Indicates that the removable media may have been changed or the controller has been reset. *(See 4.1.3.)*

ABORTED COMMAND (Bh). Indicates that the controller aborted the command. The initiator may be able to recover by trying the command again.

5.2.29 *RESERVE Command (16h)*

Byte \ Bit	7	6	5	4	3	2	1	0
0	Operation Code (16h)							
1	Logical Unit Number			3rdPty	Third Party Device ID			Reserved
2	Reserved							
3	Reserved							
4	Reserved							
5	Control Byte							

The RESERVE command is used to reserve logical units for the use of the initiator. The third-party reservation allows logical units to be reserved for another specified initiator. The RESERVE and RELEASE commands provide the basic mechanism for contention resolution in multiple-initiator systems.

This command requests that the entire logical unit be reserved for the exclusive use of the initiator until the reservation is superseded by another valid RESERVE command from the initiator that made the reservation, or until released by a RELEASE command from the same initiator that made the reservation, by a BUS DEVICE RESET message from any initiator, by a "hard" RESET condition, or by a power off/on cycle. A logical unit reservation is not granted if the logical unit is reserved by another initiator. It is permissible for an initiator to reserve a logical unit that is currently reserved by that initiator.

If the logical unit, or any extent within the logical unit, is reserved for another initiator, the controller responds by returning a RESERVATION CONFLICT status.

If, after honoring the reservation, any other initiator then subsequently attempts to perform any command on the reserved logical unit other than an INQUIRY or a REQUEST SENSE command, the command will be rejected with RESERVATION CONFLICT status.

The third-party reservation for the RESERVE command allows an initiator to reserve a logical unit for another initiator.

If the third-party (3rdPty) bit is zero, then the third-party reservation option is not requested. If the 3rdPty bit is one, then the specified logical unit will be reserved for the initiator specified in the third-party device ID field. The controller will preserve the reservation until it is superseded by another valid RESERVE command from the initiator that made the reservation or until it is released by the same initiator, by a BUS DEVICE RESET message from any initiator, or a reset condition. The controller will ignore any attempt to release the reservation made by any other initiator.

An initiator that holds a current reservation may modify that reservation by issuing another RESERVE command to the same logical unit. The superseding RESERVE command will release the previous reservation when the new reservation request is granted. The current reservation will not be modified if the new reservation request cannot be granted. If the superseding reservation cannot be granted because of conflicts with a previous active reservation (other than the reservation being superseded), then the controller will return RESERVATION CONFLICT status.

5.2.30 *REZERO UNIT Command (01h)*

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code (01h)							
1	Logical Unit Number			Reserved				
2	Reserved							
3	Reserved							
4	Reserved							
5	Control Byte							

The REZERO UNIT command requests that the controller position the optical pick-up at logical block address zero and enter the hold track state for the duration of the inactivity time. If the disconnect privilege is granted, the controller disconnects before performing the seek operation.

If the ready condition does not exist, a CHECK CONDITION status is returned and the appropriate additional sense code set.

The MODE SELECT (6) parameters will not be changed.

5.2.31 *SEEK (6) Command (0Bh)*

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code (0Bh)							
1	Logical Unit Number			(MSB)				
2	Logical Block Address							
3								(LSB)
4	Reserved							
5	Control Byte							

The SEEK (6) command requests that the controller position the optical pickup at the logical block address specified and enter the hold track state for the duration of the inactivity time.

A seek operation may be requested to any logical block address that is less than or equal to that reported by a READ CD-ROM CAPACITY command. If the logical block address is within a data track, then the address will be verified against the header address. If the logical block address is within an audio track, it is first converted into a Q sub-channel address and the seek is performed to that address. The Q sub-channel address has a tolerance of +/- 75 blocks.
If the disconnect privilege is granted, the controller will disconnect before performing the seek operation.
If the ready condition does not exist, a CHECK CONDITION status is returned and the appropriate additional sense code set.

If the logical block address requested exceeds that reported by the READ CD-ROM 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.
If the drive is unable to complete the seek operation, a CHECK CONDITION status is returned. The sense key is set to MEDIA ERROR and the additional sense code is set to ERROR OCCURRED DURING SEEK OPERATION.

5.2.32 *SEEK (10) Command (2Bh)*

Byte \ Bit	7	6	5	4	3	2	1	0
0	Operation Code (2Bh)							
1	Logical Unit Number			Reserved				
2	(MSB)							
3	Logical Block Address							
4								
5							(LSB)	
6	Reserved							
7	Reserved							
8	Reserved							
9	Control Byte							

The SEEK(10) command requests that the controller position the optical pick-up at the logical block address specified and enter the hold track state for the duration of the inactivity time.

See the SEEK (6) command for further definition and exception handling.

5.2.33 *SEND DIAGNOSTIC Command (1Dh)*

Byte \ Bit	7	6	5	4	3	2	1	0
0	Operation Code (1Dh)							
1	Logical Unit Number			Reserved		SelfTest	Reserved	
2	Reserved							
3	(MSB)							
4	Parameter List Length							(LSB)
5	Control Byte							

The SEND DIAGNOSTIC command requests the controller to perform diagnostic tests on itself, on the attached peripheral devices, or on both. Except when the self-test bit is one, this command is usually followed by a RECEIVE DIAGNOSTIC RESULTS command.

A self-test bit of one directs the controller to complete its default self-test. If the self-test is requested, the parameter list length shall be set to zero. If the self-test bit is set to one and the parameter list length is not zero, the command will be terminated with CHECK CONDITION status. The sense key is set to ILLEGAL REQUEST and the additional sense code set to INVALID VALUE IN CDB. The controller will not disconnect during self-test.

If the self-test does not fail, the command will be terminated with a GOOD status; otherwise, the command will be terminated with CHECK CONDITION status and the sense key will be set to HARDWARE ERROR.

The parameter list length specifies the length in bytes of the parameter list that will be transferred during the DATA OUT phase. A parameter list length of zero indicates that no data is transferred. This condition will not be considered as an error.

If the self-test is not requested, the controller returns a GOOD status upon receiving a valid command descriptor block and parameter list. The parameter list length is set to eight, only if user specified diagnostics are requested. The results of the diagnostic test are returned to the initiator by a RECEIVE DIAGNOSTICS RESULTS command.

The SEND DIAGNOSTIC data contains an eight-byte parameter list defined as follows.

Table 5-35: Send Diagnostic Data

Byte \ Bit	7	6	5	4	3	2	1	0
0	*Reserved*							
1	*Parameter Length*							
2	*ROM Diagnostic*							
3	*RAM Diagnostic*							
4	*Interface Diagnostic*							
5	*Reserved*							
6	*Reserved*							
7	*Reserved*							

The parameter length specifies the length in bytes of the following SEND DIAGNOSTIC parameters. The sense data length does not include itself.

The ROM Diagnostic field, if zero, requests diagnostics not be performed on the ROM. The ROM Diagnostic field, if one, requests that diagnostics be performed on the controller. The ROM Diagnostic field, if two, requests that diagnostics be performed on the drive control.

The RAM Diagnostic field, if zero, requests that diagnostics not be performed on the RAM. The RAM Diagnostic field, if one, requests that diagnostics be performed on the controller. The RAM Diagnostic field, if two, requests that diagnostics be performed on the drive control. The Data Buffer Diagnostic field, if zero, requests that diagnostics not be performed on the data buffer. The Data Buffer Diagnostic field, if one, requests that diagnostics be performed on the controller. The Data Buffer Diagnostic field, if two, requests that diagnostics be performed on the drive control data buffer. The Data Buffer Diagnostic field, if four, requests that diagnostics be performed on the drive control data error buffer.

The Interface Diagnostic field, if zero, requests that diagnostics not be performed on the interfaces. The Interface Diagnostic field, if one, requests that diagnostics be performed on the controller - drive control interface. The Interface Diagnostic field, if two, requests that diagnostics be performed on the drive control - mechanism control interface.

5.3.34 *SET ADDRESS FORMAT Command (C0h)*

Byte \ Bit	7	6	5	4	3	2	1	0
0	Operation Code (C0h)							
1	Logical Unit Number			Reserved				
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	Reserved							
8	Reserved							LbaMsf
9	Control Byte							

The SET ADDRESS FORMAT command modifies the address format of the specified bytes in the returned data. This command (Group 6) is unique to TEXEL.

The LBA/MSF bit set to zero modifies the format to the logical block address. The LBAMSF bit set to one modifies the format to the MSF address *(See section 5.5)*. This modification is only applicable to TEXEL vendor unique commands. The present state of the format is available for review by returning PLAYBACK STATUS command *(See section 5.2.14)*.

5.2.35 *START / STOP UNIT Command (1Bh)*

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code (1Bh)							
1	Logical Unit Number			Reserved			Immed	
2	Reserved							
3	Reserved							
4	Reserved						LoEj	Start
5	Control Byte							

The START/STOP UNIT command requests that the controller enable or disable the logical unit for further operations.

An immediate (Immed.) bit of one indicates that status will be returned as soon as the operation is initiated. An Immed. bit of zero indicates that status will be returned after the operation is completed.

A load/eject (LoEj) bit of zero indicates that no action is to be taken regarding loading or ejecting the disc. A LoEj bit of one indicates that the disc is to be unloaded if the start bit is zero.

A start bit of one requests the logical unit be made ready for use. A start bit of zero requests that the logical unit be stopped.

LoEj	Start	Description
0	0	spin down the disc, optical pick-up is not moved
0	1	spin up the disc, seek to last address requested
1	0	spin down the disc, eject caddy
1	1	not supported

If a PREVENT MEDIA REMOVAL command has been issued, a request to eject the disc will be terminated with a CHECK CONDITION status. The sense key will be set to ILLEGAL REQUEST, and the additional sense code set to PREVENT BIT SET.

5.2.36 *TEST UNIT READY Command (00h)*

Byte \ Bit	7	6	5	4	3	2	1	0
0	Operation Code (00h)							
1	Logical Unit Number			Reserved				
2	Reserved							
3	Reserved							
4	Reserved							
5	Control Byte							

The TEST UNIT READY command provides a means to check if the logical unit is in the ready condition. This is not a request for a self test.

If the ready condition does not exist, a CHECK CONDITION status will be returned and the appropriate additional sense code set.

5.2.37 VERIFY (10) Command (2Fh)

Byte \ Bit	7	6	5	4	3	2	1	0
0	Operation Code (2Fh)							
1	Logical Unit Number			Reserved				
2	(MSB)							
3	Logical Block Address							
4								
5							(LSB)	
6	Reserved							
7	(MSB)							
8	Verification Length						(LSB)	
9	Control Byte							

The VERIFY (10) command requests that the drive controller verify the data on the disc based on the error recovery parameter settings. This command operates the same as a READ (10) command except the data is not transferred to the initiator. The verification is performed according to the settings of the verification page *(See Section 5.3.1.3)*

The logical block address specifies the logical block at which the verify operation will begin.

The verification length specifies the number of contiguous logical blocks of data that will be verified. A verification length of zero indicates that no logical blocks will be verified but the addressed drive will perform a seek operation to the specified address. This condition will not be considered as an error. Any other value indicates the number of logical blocks that will be verified.

See the READ (6) command for exception handling description.

5.2.38 *WRITE BUFFER Command (3Bh)*

Byte \ Bit	7	6	5	4	3	2	1	0
0	Operation Code (3Bh)							
1	Logical Unit Number			Reserved			Mode	
2	(MSB)							
3				Buffer Offset				
4								(LSB)
5				Reserved				
6	(MSB)							
7				Transfer Length				
8								(LSB)
9				Control Byte				

The WRITE BUFFER command is used in conjunction with the READ BUFFER command as a diagnostic function for testing controller memory and the bus integrity. This command will not alter the media.
The function of this command and the meaning of fields within command descriptor block depend on the contents of the mode field. A mode field value of zero indicates that the buffer offset is zero. A mode field value of one indicates that the buffer offset is valid and the data is placed in the buffer with that offset.

The buffer offset is the byte offset within the buffer where the data will be scored. If the controller is unable to accept the specified buffer offset, it will return CHECK CONDITION status. The sense key is set to ILLEGAL REQUEST and the additional sense code is set to ILLEGAL VALUE IN CDB.

The data to be transferred is preceded by a four-byte header. The header consists of all reserved bytes. The transfer length specifies the maximum number of bytes that will be transferred during the DATA OUT phase. This number includes four bytes of WRITE BUFFER header, so the data length to be stored in the controller's buffer is transfer length minus four. If the transfer length minus four exceeds the capacity of the buffer the controller will return a CHECK CONDITION status. The sense key is set to ILLEGAL REQUEST and the additional sense code is set to ILLEGAL VALUE IN CDB.

If the buffer offset plus the transfer length minus four exceeds the buffer capacity, the controller will return a CHECK CONDITION status. The sense key is set to ILLEGAL REQUEST and the additional sense code is set to ILLEGAL VALUE IN CDB.

Table 5-36: Write Buffer Header

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

The WRITE BUFFER header is sent as part of the data transfer phase to the controller. The purpose is to make the READ BUFFER and WRITE BUFFER transfers equivalent in byte count.

5.3 CD-ROM Page Descriptions

5.3.1 MODE SELECT Pages

Table 5-37: Page Codes

Page Code	Description
01h	Read Error Recovery Parameters
02h	Disconnect/Reconnect Control Parameters
07h	Verify Error Recovery Parameters
0Dh	CD-ROM Parameters
0Eh	CD-ROM Audio Control Parameters

5.3.1.1 Page Code One

Table 5-38: Page Code One: Read Error Recovery Parameters

Byte \ Bit	7	6	5	4	3	2	1	0
0	Reserved			Page Code (01h)				
1	Parameter Length (06h)							
2	Error Recovery							
3	Read Retry Count							
4	Reserved							
5	Reserved							
6	Reserved							
7	Reserved							

The implementation of error recovery procedures for CD-ROM devices is markedly different than those used for magnetic media disc drives. At least one level of error correction (i.e., CIRC) is required to unscramble the data stream. Therefore, the performance of the drive may differ substantially from what would be expected by sending the same error recovery parameters to a magnetic media device.

The correlation of the error recovery parameter and the bit settings defined in common command set document is given in **Table 5-39**. The error recovery parameter is defined in **Tables 5-40, 5-41, 5-42, 5-43, 5-44** and **5-45**. If the error recovery parameter is set to any other value 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 VALUE IN PARAMETER LIST.

The Read Retry Count field specifies the number of times that the controller will attempt its read recovery algorithm. The default value is one.

Table 5-39: Error Recovery Byte Bit Settings

Bit / Byte / 2 / Value	7	6	5	4	3	2	1	0
			TB	RC		PER	DTE	DCR
00			0	0		0	0	0
01			0	0		0	0	1
04			0	0		1	0	0
05			0	0		1	0	1
06			0	0		1	1	0
07			0	0		1	1	1
20			1	0		0	0	0
21			1	0		0	0	1
24			1	0		1	0	0
25			1	0		1	0	1
26			1	0		1	1	0
27			1	0		1	1	1
10			0	1		0	0	0
11			0	1		0	0	1
14			0	1		1	0	0
15			0	1		1	0	1

A CIRC recovered data error is defined as a block for which the C2PO flag was set, but on subsequent read operations it was not. The number of subsequent read operations is limited to the read retry count. Layered error correction is not used.

A CIRC unrecovered data error is defined as a block for which the C2PO flag was set on all read operations up to the read retry count. Only read retries are used; layered error correction is not used.

An L-EC recovered data error is defined as a block for which the C2PO flag was asserted but the layered error correction was able to correct the block within the read retry count.

An L-EC uncorrectable data error is defined as a block which could not be corrected by layered error correction within the read retry count.

The error recovery procedures in **Table 5-39, 5-40**, and **5-44** are applicable only to CD-ROM mode one, CD-I Form 1 or XA Type Form 1 data. If one of the these error recovery parameters is specified and CD-ROM mode two data is detected, the read operation will be terminated with a CHECK CONDITION status. Additionally, the sense key is set to ILLEGAL MODE FOR THIS TRACK.

Table 5-40: Error Recovery Procedures - CD-ROM Mode One Data

Error Recovery Description
00h This is the default setting of the error recovery parameter on or when a power-on reset condition occurs. The maximum error recovery procedures are used. Only L-EC uncorrectable data errors are reported. If an L-EC uncorrectable data error occurs, data transfer is terminated with a CHECK CONDITION status. The sense key is set to MEDIA ERROR and the additional sense code is set to L-EC UNCORRECTABLE DATA ERROR. The information bytes are set to the address of the last block transferred to the initiator plus one.
04h The maximum error recovery procedures are used. L-EC recovered data errors are reported. If an L-EC recovered data error occurs, data transfer is not terminated. However, when the data transfer has completed a CHECK CONDITION status is reported. The sense key is set to RECOVERED ERROR and the additional sense code is set to L-EC RECOVERED DATA ERROR. The information bytes are set to the address of the last block for which an L-EC recovered data error was detected. If an L-EC uncorrectable data occurs, data transfer is terminated and CHECK CONDITION status is reported. The block with the error is not transferred. The sense key is set to MEDIA ERROR and the additional sense code is set to L-EC UNCORRECTABLE DATA ERROR. The information bytes are set to the address of the last block on which an L-EC uncorrectable error was detected.
06h The maximum error recovery procedures are used. L-EC recovered data errors are reported. If an L-EC recovered data error occurs, data transfer is terminated with a CHECK CONDITION status. The sense key is set to RECOVERED ERROR and the additional sense code is set to L-EC RECOVERED DATA ERROR. The information bytes are set to the address of the last block transferred to the initiator plus one. If an L-EC uncorrectable data error occurs, data transfer is terminated with a CHECK CONDITION status. The sense key is set to MEDIA ERROR and the additional sense code is set to L-EC UNCORRECTABLE DATA ERROR. The information bytes are set to the address of the first block on which an L-EC uncorrectable error was detected.

Table 5-41: Error Recovery Procedures For- CD-ROM Mode One, CD-I Form 1 or XA Type Form 1 Data

Error Recovery Description
20h The maximum error recovery procedures are used. Only L-EC uncorrectable data errors are reported. If an L-EC uncorrectable data error occurs, data transfer is terminated with a CHECK CONDITION status. The block with the error is transferred. The sense key is set to MEDIA ERROR and the additional sense code is set to L-EC UNCORRECTABLE DATA ERROR. The information bytes are set to the address of the last block for which an L-EC uncorrectable data error was detected.
24h The maximum error recovery procedures available are used. Recovered data errors are reported. If a recovered data error occurs, data transfer is not terminated. However, when the data transfer has completed, CHECK CONDITION status is reported. The sense key is set to RECOVERED ERROR. The information bytes give the address of the last block where a recovered data error was detected. If a data error occurs which is uncorrectable with the ECC information available on the media, data transfer is terminated and CHECK CONDITION status is reported. The block with the error is transferred. The sense key is set to MEDIA ERROR. The information bytes give the address of the block where the uncorrectable error was detected.
26h The maximum error recovery procedures are used. L-EC recovered data errors are reported. If an L-EC recovered data error occurs, data transfer is not terminated. However, when the data transfer has completed a CHECK CONDITION status is reported. The sense key is set to RECOVERED ERROR and the additional sense code is set to L-EC RECOVERED DATA ERROR. The information bytes are set to the address of the last block transferred. If an L-EC uncorrectable data error occurs, data transfer is terminated with a CHECK CONDITION status after the L-EC uncorrectable block is transferred. The sense key is set to MEDIA ERROR and the additional sense code is set to L-EC UNCORRECTABLE DATA ERROR. The information bytes are set to the address of the block on which an the L-EC uncorrectable error occurred.

Table 5-42: Error Recovery Procedures - All Types of CD-ROM Data

Error Recovery Description
01h Only retries of the read operation are used (layer error correction is not used). Only CIRC unrecovered data errors are reported. If an CIRC unrecovered data error occurs, data transfer is terminated with a CHECK CONDITION status. The sense key is set to MEDIA ERROR and the additional sense code is set to CIRC UNRECOVERED DATA ERROR. The information bytes are set to the address of the last block transferred to the initiator plus one. **05h** Only retries of the read operation are used (layer error correction is not used). CIRC recovered data errors are reported. If a CIRC recovered data error occurs, data transfer is not terminated. However, when the data transfer has completed a CHECK CONDITION status is reported. The sense key is set to RECOVERED ERROR and the additional sense code is set to CIRC RECOVERED DATA ERROR. The information bytes are set to the address of the last block for which an CIRC recovered data error was detected. If a CIRC unrecovered data error occurs, data transfer is terminated and CHECK CONDITION status is reported. The block with the error is not transferred. The sense key is set to MEDIA ERROR and the additional sense code is set to CIRC UNRECOVERED DATA ERROR. The information bytes are set to the address of the last block on which an CIRC unrecovered error was detected. **07h** Only retries of read operation are used (layer error correction is not used). CIRC recovered data errors are reported. If a CIRC recovered data error occurs data transfer is terminated with a CHECK CONDITION status. The sense key is set to RECOVERED ERROR and the additional sense code is set to CIRC RECOVERED DATA ERROR. The information bytes are set to the address of the last block transferred to the initiator plus one. If a CIRC unrecovered data error occurs, data transfer is terminated with a CHECK CONDITION status. The sense key is set to MEDIA ERROR and the additional sense code is set to CIRC UNRECOVERED DATA ERROR. The information bytes are set to the address of the first block on which an CIRC unrecovered error was detected.

Table 5-43: Error Recovery Procedures - All Types of CD-ROM Data

Error Recovery Description
21h Only retries of the read operation are used (layer error correction is not used). Only CIRC unrecovered data errors are reported. If a CIRC unrecovered data error occurs, data transfer is terminated with a CHECK CONDITION status. The block with the error is transferred. The sense key is set to MEDIA ERROR and the additional sense code is set to CIRC UNRECOVERED DATA ERROR. The information bytes are set to the address of the last block for which a CIRC unrecovered data error was detected.
25h Only retries of the read operation and CIRC are used (layered error correction is not used). Recovered data errors are reported. If a recovered data error occurs, data transfer is not terminated. However, when the data transfer has completed CHECK CONDITION status is reported. The sense key is set to RECOVERED ERROR. The information bytes give the address of the last block where a CIRC recovered data error was detected. If an unrecovered data error occurs data transfer is terminated and CHECK CONDITION status is reported. The block with the error is transferred. The sense key is set to MEDIA ERROR. The information bytes give the address of the block where the unrecovered error was detected.
27h Only retries of the read operation are used (layer error correction is not used). CIRC recovered data errors are reported. If a CIRC recovered data error occurs, data transfer is not terminated. However, when the data transfer has completed a CHECK CONDITION status is reported. The sense key is set to RECOVERED ERROR and the additional sense code is set to CIRC RECOVERED DATA ERROR. The information bytes are set to the address of the last block for which a CIRC recovered data error was detected. If an CIRC unrecovered data error occurs, data transfer is terminated with a CHECK CONDITION status after the CIRC unrecovered block is transferred. The sense key is set to MEDIA ERROR and the additional sense code is set to CIRC UNRECOVERED DATA ERROR. The information bytes are set to the address of the block on which the CIRC unrecovered error occurred.

Table 5-44: Error Recovery Procedures - CD-ROM Mode One, CD-I Form 1 or XA 1 Form 1 Data

Error Recovery Description
10h The maximum error recovery procedures are used. If a L-EC uncorrectable error occurs, data transfer is not terminated. However, when the data transfer has completed, CHECK CONDITION status is reported. The sense key is set to MEDIA ERROR. Recovered errors are not reported.
14h The maximum error recovery procedures are used. L-EC recovered data errors are reported. If a recovered data error occurs, data transfer is not terminated. However, when the data transfer has completed, CHECK CONDITION status is reported. The sense key is set to RECOVERED ERROR. If a data error occurs which is uncorrectable with the ECC information available on the media, data transfer is not terminated. However, when the data transfer has completed, a CHECK CONDITION status is reported. The sense key is set to MEDIA ERROR.

Table 5-45: Error Recovery Procedures - All Types of CD-ROM Data

Error Recovery Description
11h Only retries of the read operation and CIRC are used (layered error correction is not used). Only CIRC unrecovered data error are reported. If a CIRC unrecovered data error occurs, data transfer is not terminated. However, when the data transfer has completed, CHECK CONDITION status is reported. The sense key is set to MEDIA ERROR. Recovered errors are not reported.
15h Only retries of the read operation and CIRC are used (layered error correction is not used). Recovered data errors are reported. If a recovered data error occurs, data transfer is not terminated. However, when the data transfer has completed, CHECK CONDITION status is reported. The sense key is set to RECOVERED ERROR. If an unrecovered data error occurs, data transfer is not terminated. However, when the data transfer has completed, CHECK CONDITION status is reported. The sense key is set to MEDIA ERROR.

5.3.1.2 Page Code Two

The DM-xx28 does not support Page Code Two

5.3.1.3 Page Code Seven

Table 5-48: Page Code Seven: Verify Error Recovery Parameters

Byte \ Bit	7	6	5	4	3	2	1	0
0	Reserved		Page Code (07h)					
1	Parameter Length (06h)							
2	Error Recovery							
3	Verify Retry Count							
4	Reserved							
5	Reserved							
6	Reserved							
7	Reserved							

The implementation of error recovery procedures for verification operations is the same as for read operations on CD-ROM devices.

5.3.1.4 Page Code D

Table 5-49: Page Code D: CD-ROM Parameters

Byte \ Bit	7	6	5	4	3	2	1	0
0	PS	Rsvd	Page Code (0Dh)					
1	Parameter Length (06h)							
2	Reserved							
3	Reserved				Inactivity Timer Multiplier			
4	Number of MSF-S Units per MSF-M Unit (3Ch)							
5								
6	Number of MSF-F Units per MSF-S Unit (4Bh)							
7								

The paremeters savable (PS) bit is only used with the MODE SENSE command. This bit is reserved with the MODE SELECT command. A PS bit of one indicates that the target is capable of saving the page in a non-volatile vendor specific location.

The inactivity timer multiplier specifies the length of time that the drive shall remain in the hold track state after completion of a seek or read operation (See **Table 5-49**).

-Developers Note-

Higher values in this parameter may have an adverse effect on the drive MTBF, in some implementation.

Table 5-50: Inactivity Timer Multiplier Values

Inactivity Multiplier	Timer Minimum Time in Hold Track State	Inactivity Timer Multiplier	Minimum Time in Hold Track State
0h	infinite	8h	16 minutes
1h	2 minutes	9h	18 minutes
2h	4 minutes	Ah	20 minutes
3h	6 minutes	Bh	22 minutes
4h	8 minutes	Ch	24 minutes
5h	10 minutes	Dh	26 minutes
6h	12 minutes	Eh	28 minutes
7h	14 minutes	Fh	30 minutes

The number of S Units per M unit field gives the ratio of these MSF address values. For media conforming to the CD-ROM and CD-DA standard, this value is 60(=3Ch).

The number of F Units per S Units field gives the ratio of these MSF address values. For media conforming to the CD-ROM and CD-DA standard, this value is 75(=4Bh).

5.3.1.5 Page Code E

Table 5-51: Page Code E: CD-ROM Audio Control Parameters

Byte \ Bit	7	6	5	4	3	2	1	0
0	Reserved		Page Code (0Eh)					
1	Parameter Length (0Eh)							
2	Reserved					Immd	Reserved	
3 to 7	Reserved							
8	Reserved				Channel 0 Output Selection (1h)*			
9	Channel 0 Volume (FFh)*							
10	Reserved				Channel 1 Output Selection (2h)*			
11	Channel 1 Volume (FFh)*							
12	Reserved				Channel 2 Output Selection (0h)*			
13	Channel 2 Volume (00h)*							
14	Reserved				Channel 3 Output Selection (0h)*			
15	Channel 3 Volume (00h)*							

* Default value

If Immd(Immediate) bit is set to one, the command shall be terminated at the moment when the seek operation in audio commands of Group 2, such as play audio, is completed. If this bit is set to zero, the command shall not be terminated until the end address is found or an error occurs. Values in parentheses are default values.

Value 00 must be specified in ch.2 and ch.3 (byte 12 through 15) of the audio control parameters. If not, the command will be terminated with a CHECK CONDITION status.

Please see **Table 5-9** in Section 5.2.13. about Channel Output Selection.

5.3.2 MODE SENSE Pages

Table 5-52: Page Codes

Page Code	Description
01h	Read Error Recovery Parameters
02h	Disconnect/Recovery Control Parameters
07h	Verify Error Recovery Parameters
0Dh	CD-ROM Parameters
0Eh	CD-ROM Audio Control Parameters
3Fh	Return All Implemented Pages

The MODE SENSE pages have the same format as MODE SELECT pages. The meanings of the fields within a page are the same. The difference is that MODE SENSE settings are reported instead of being requested.

5.4 CD-ROM Additional Sense Codes & Additional Sense Code Qualifier

The following tables list the additional sense codes and additional sense code qualifier reported in Byte (12) and (13) of the REQUEST SENSE data.

Table 5-53: Additional Sense Code (ASC) and Additional Sense Code Qualifier (ASCQ) Descriptions

For Sense Key **NO SENSE (0h):**

ASC	ASCQ	Description
00	00	NO ADDITIONAL SENSE INFORMATION

For Sense Key **RECOVERED ERROR (1h):**

ASC	ASCQ	Description
18	03	RECOVERED DATA WITH CIRC
18	04	RECOVERED DATA WITH L-EC

For Sense Key **NOT READY (2h):**

ASC	ASCQ	Description
04	00	LOGICAL UNIT NOT READY, CAUSE NOT REPORTABLE
3A	00	MEDIA NOT PRESENT
57	00	UNABLE TO RECOVER TABLE-OF-CONTENTS
53	00	MEDIA LOAD/EJECT FAILED
04	01	LOGICAL UNIT IS IN PROGRESS OF BECOMING READY (TABLE-OF-CONTENTS READ IN PROGRESS)

For Sense Key **MEDIA ERROR (3h):**

ASC	ASCQ	Description
02	00	NO SEEK COMPLETE
11	05	L-EC UNCORRECTABLE ERROR (L-EC CODES PRESENT AND L-EC ON)
11	06	CIRC UNRECOVERED ERROR (L-EC UNAVAILABLE OR OFF)
00	14	AUDIO PLAY OPERATION STOPPED DUE TO ERROR

For Sense Key **HARDWARE ERROR (4h):**

ASC	ASCQ	Description
08	00	LOGICAL UNIT COMMUNICATION FAILURE
09	01	TRACKING SERVO FAILURE
40	00	DIAGNOSTIC FAILURE ON COMPONENT 0 (INTERNAL BUS FAILURE)
44	00	INTERNAL TARGET FAILURE
47	00	SCSI PARITY ERROR
09	02	FOCUS SERVO FAILURE
09	03	SPINDLE SERVO FAILURE
B6	00	MEDIA LOAD MECHANISM FAILED

For Sense Key **ILLEGAL REQUEST (5h):**

ASC	ASCQ	Description
20	00	INVALID COMMAND OPERATION CODE
21	00	LOGICAL BLOCK ADDRESS OUT OF RANGE
24	00	INVALID FIELD IN CDB
25	00	LOGICAL UNIT NOT SUPPORTED
26	00	INVALID FIELD IN PARAMETER LIST
53	02	MEDIA REMOVAL PREVENT
81	00	LOGICAL UNIT IS RESERVED
63	00	END OF USER AREA ENCOUNTERED ON THIS TRACK
64	00	ILLEGAL MODE FOR THIS TRACK
85	00	AUDIO ADDRESS NOT VALID

For Sense Key **UNIT ATTENTION (6h):**

ASC	ASCQ	Description
28	00	NOT READY TO READY TRANSITION
29	00	POWER ON, RESET OR BUS DEVICE RESET OCCURRED
2A	01	MODE PARAMETER CHANGED

For Sense Key **ABORTED COMMAND (Bh):**

ASC	ASCQ	Description
43	00	MESSAGE ERROR
45	00	SELECT/RESELECT FAILURE
48	00	INITIATOR DETECTED ERROR MESSAGE RECEIVED
49	00	INVALID MESSAGE ERROR
4E	00	OVERLAPPED COMMAND ATTEMPTED
B9	00	AUDIO PLAY OPERATION ABORTED

5.5 CD-ROM Glossary

Absolute MSF Address - The address encoded in the sub-channel (and header of CD-ROM) which is the elapsed time from the start of disc.

Block - A block commonly refers to the data contained in one frame. However, threre are other meanings attached to this term within the world of compact disc.

CD-ROM - Compact Disc Read Only Memory. The CD-ROM was developed by N.V. Philips & Sony Corporation. The 'RED BOOK' and 'YELLOW BOOK' documents describe the media.

Control Field - Four bits in the Q sub-channel data that indicate whether the track is CD-ROM or CD-AUDIO. If the track is CD-AUDIO then three bits are used to indicate use of pre-emphasis, copy protection, and whether the audio is two or four channel.

Frame - One frame is equal to 1/75 second of elapsed time.

Hold Track State - When the drive enters the hold track state the optical pick-up jumps one track towards the inside of the disc at the specified Sub-Q address. The optical pick-up traces the groove of the disc until detecting the address and again jumps one track towards the inside of the disc.

LBA Address - Logical Block Address determines a point on the physical disk.

MSF Address - Determines an address on the disc using the minutes, seconds and frame number format. All three must be specified to determine a physical location on the disc.

Sub-Channel - The signal from the compact disc consists of a main channel and a sub-channel. The sub-channel is divided into three parts. The P sub-channel is part one and is used with CD-Audio. The Q sub-channel is part three and contains useful information, such as the control field and MSF address. The R, S, T, U, V and W sub-channels collectively are treated as part three.

TNO - Track Number. A disc has logical segments which are called tracks. The track numbers range from one to ninety-nine. The data within a track are always of the same type. A track can contain either CD-ROM or CD-AUDIO data. A disc can start at any track number.

TOC - The Table of Contents has information on the type of each track and the starting address of the user data in a tracks. This information is encoded in the Sub-Q channel during the lead-in area of the compact disc.

Relative MSF Address - The address encoded in the sub-channel which is the elapsed time from the start of a track.

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END OF DOCUMENT

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