Seagate

Viper 200

LTO Tape Drive

SCSI Interface Manual

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Manufacturing Part Number: 100109647, Rev. B

Publication Number T001, Rev. C; February, 2001

Important Information About This Manual

Contents

Introduction

The Seagate LTO drives are designed for computer environments requiring high performance, ultra-high capacity data storage. LTO drives are available in 5.25-inch internal configurations or as an external subsystem.

Seagate LTO drives contain an embedded Small Computer Systems Interface (SCSI) controller. These drives provide synchronous or asynchronous SCSI and a high speed burst synchronous data transfer rate of 80 Mbytes per second. The internal drive is tailored for easy installation in today's computers and the full-featured embedded SCSI controller facilitates easy integration into a variety of systems.

About This Manual

The information in this manual applies specifically to the Viper 200 drive. For drive-specific installation and operational information, including SCSI connection information, refer to the Installation Guide or Product Description Manual for the specific model of your drive.

SCSI Interface Overview

The Seagate LTO drives are designed to operate with the Small Computer System Interface (SCSI) bus. This chapter discusses SCSI bus operation as it pertains to drive functions.

SCSI is a standard interface established to support peripheral equipment such as printers, tape drives, magnetic disks, optical disks for microcomputers and other computer systems. The SCSI bus can support up to sixteen devices consisting of any multiple of host adapters and peripheral devices.

The Seagate LTO drives comply with SCSI-2 and SCSI-3 specifications. In a few cases, vendor unique features are available. These features are compatible with the SCSI standards.

The interface is a sixteen-port daisy-chained bus using twenty-seven signal lines: eighteen data-bit signal lines and nine control lines. The eighteen data-bit lines are made up of two pairs of eight data signal lines and one parity bit line. The remaining nine lines provide control and status signals to coordinate data transfer operations between the host controller and the selected drive.

The drives have an internal SCSI controller integrated into the drive electronics. Each device ID on the SCSI bus may drive up to 16 logical units (LUN). Seagate LTO drives support only LUN 0.

ANSI SCSI Bus Standards

In addition to the information presented in this manual, we recommend that you review the applicable SCSI-3 standards before writing host software drivers. Also, see the conformance statements, which are given in the Product Description Manual for the each model of LTO drive.

Cabling and Connectors

The cabling requirements and pin assignments for the SCSI connector for the internal drive models are given in the respective installation guide and Product Description Manual for each model of LTO drive.

SCSI Conformance

General features

The Viper 200 supports the following:

- Disconnect/reconnect, arbitration (required in SCSI-2 and SCSI-3)
- LVD and single-ended drivers
- Both single and multi-initiator systems
- Fixed and variable block transfer lengths
- Hard reset
- Synchronous data transfers
- Parity implemented (switch option)
- Space blocks, filemarks and EOD
- Log Sense and Log Select for managing soft error reporting

Interface standards conformance

The Small Computer System Interface is described in standards including several versions and a number of individual documents. The original Small Computer System Interface Standard, X3.131-1986, is referred to herein as SCSI-1. SCSI-1 was revised resulting in the Small Computer System Interface – 2 (X3.131-1994), referred to herein as SCSI-2. The set of SCSI-3 standards are collectively referred to as SCSI-3. The applicable SCSI-3 standards are as follows:

SCSI-3 Architecture Model (SAM) X3.270: 1996
SCSI Architecture Model - 2 (SAM-2) in development
SCSI-3 Parallel Interface Amendment (SPI Amnd) X3.253/AM1: 1998
SCSI Parallel Interface - 2 (SPI-2) X3.302: 1999
SCSI Parallel Interface - 3 (SPI-3) in development
SCSI-3 Primary Commands (SPC) Status: X3.301: 1997
SCSI Primary Commands - 2 (SPC-2) in development
SCSI-3 Medium Changer Commands (SMC) NCITS.314: 1998
SCSI-3 Stream Commands (SSC) in development

The term SCSI is used wherever it is not necessary to distinguish between the versions of SCSI.

LTO Conformance

Seagate LTO drives conform to the requirements of the *Generation 1 SCSI Common Command Set Advisory Document* (AU1-SCSI) for Ultrium format devices.

Strategy

Reset Condition

When a reset is issued to the tape drive, the SCSI bus clears all uncompleted commands, releases all SCSI device reservations, sets the tape drive to default modes, and returns to the Bus Free phase.

Unit Attention Condition

The Unit Attention condition in the tape drive typically results from the following conditions:

- A Reset was previously issued to the drive.
- The drive has just been powered on.
- A cartridge has been inserted.
- A log exception condition occurred.
- The mode pages have been changed.
- The cartridge has been loaded or unloaded to the Hold position, and the Medium Auxiliary Memory (MAM) is accessible.

The Unit Attention Condition persists for each Initiator until that Initiator issues a command other than Inquiry for which the tape drive returns with a Check Condition Status. If the next command from that Initiator following the Check Condition Status is Request Sense, then the unit attention sense key is returned.

If the Inquiry Command is received from an Initiator with a pending Unit Attention Condition before the tape drive reports Check Condition Status, the tape drive performs the Inquiry Command and does not clear the Unit Attention Condition.

If the Request Sense Command is received from an Initiator with a pending Unit Attention Condition before the tape drive reports Check Condition Status, the tape drive reports unit attention sense key and clears the Unit Attention Condition for that Initiator.

Contingent Allegiance Condition

The Contingent Allegiance condition shall exist following the return of Check Condition and may exist following an unexpected disconnect. The contingent allegiance condition shall be preserved for the I T x nexus until it is cleared. The contingent allegiance condition shall be cleared upon the generation of a hard reset condition or by an Abort message, a Bus Device Reset message, or any subsequent command for the I T x nexus. While the contingent allegiance condition exists the drive shall preserve the sense data for the initiator.

While the contingent allegiance condition exists, the drive shall respond to any other requests for access to the logical unit from another initiator with a Busy status. Execution of queued commands shall be suspended until the Contingent Allegiance condition is cleared.

Buffered Mode

Buffered Mode allows the most efficient operation of a tape drive. The drive defaults to Buffered mode. In this mode, the drive signals Command Complete when all requested data for a Write command has been transferred from the host to the tape drive buffer. This mode provides data to maintain operation while the host readies a new Write Command.

If an error occurs in writing data to the tape after the tape drive signals Command Complete, an error status is sent on the next Command issued.

Immediate Function

For Initiators that do not support the disconnect feature, the Immediate bit provides a means of releasing the bus while the drive is busy completing a function such as repositioning the tape. If a command is sent by the Initiator after a previous Immediate Command was accepted, the drive continues the Immediate Function it is currently performing and may disconnect, execute, or reject the new command depending on the new command.

An immediate bit of zero means that the status is returned to the Initiator when the operation is completed. (For example, the status is returned when the tape has been repositioned.) An Immediate bit of one means that the status is returned to the Initiator as soon as the function is started.

Residual Length Function

When performing a Write command, the drive returns a Good Status and Command Completion Message when the last byte requested by the command is placed in the Data Buffer, rather than when it is written onto tape. If an error occurs while data is being written onto tape, the drive calculates the Residual Length and places this value in the information bytes of the Sense Data Block. Also, the Residual Length functions for other commands, such as Read.

Residual Length is calculated by: RL = TL - AL

Where:

AL (Actual Length) =	Blocks transferred from the host to the tape drive across the SCSI bus.
TL (Transfer Length) =	The Transfer Length from bytes 2-4 of the Write command (Request Transfer Length).
RL (Residual Length) =	The amount of blocks or bytes not written to tape.

Disconnect/Reconnect Function

When the drive is performing a task not requiring communication with the Initiator or when the tape drive determines that a relatively long time has passed with no bus activity, it disconnects from the SCSI bus. Examples are:

- When rewinding the tape.
- When writing to the tape and the buffer is full.
- When reading from the tape and the buffer is empty.
- When spacing, locating, or generally performing any tape motion when data cannot be transferred on the SCSI bus.

During the time the Target is disconnected for one of these functions, the bus is free for use by other devices. Both disconnect and reconnect are initiated by the Target.

If the tape drive is selected while disconnected, it only allows the following actions:

- If the command is from a different initiator or is from the same initiator but to a different LUN, the tape drive accepts the command and immediately disconnects if the command is a media-access command. If the new command is a Request Sense, Inquiry or Test Unit Ready, then the new command is executed immediately.
- Immediately following the selection, the Initiator may send the Identify, No Op, Abort, or Bus Device Reset messages to the drive.
- If the command is from the same initiator to the same LUN, the current command terminates with a Check Condition and an Abort Sense Key.

Early Warning Function

Early Warning on the Viper drive is a logical warning given when 64 megabytes of storage space remain on the tape. The position is calculated by the drive. When this physical position is reached on a tape, the following occurs.

1. Data transfers from the host are terminated at the next disconnect burst size boundary for SEW=1.

2. All data remaining in the drive buffer is written to the tape if SEW=1.

3. The command completes with a Check Condition and a 40h Sense data meaning EOM and no Sense Key.

4. Subsequent WRITE commands write data and complete with check condition with EOM Status and No Sense Key until the physical tape end is encountered.

Error Reporting

Soft errors are generally tape-quality related and occur more frequently during write operations than during read operations. Soft errors indicate repeated attempts by the drive to read or write data on the tape. Some soft errors are normal, but an increase in the usual count can indicate deteriorating tape quality. If the soft error count

remains higher than normal, use a cleaning cartridge to clean the read/write heads. If this procedure does not clear the problem, change to a new tape cartridge.

If a hard error (unrecoverable error) occurs during operation, the drive terminates operation immediately and returns a Check Condition. The Initiator should cease any further read or write functions and issue a Request Sense Command to determine the type of error.

When the drive detects a write error, it attempts to rewrite the data up to 128 times.

After the 128th attempt, the error is considered unrecoverable and the operation terminates. When a hard error is encountered, replace the tape with a new cartridge and repeat the function or clean the heads with a cleaning cartridge.

Variable and Fixed Mode Recording

The Viper drive can write either fixed or variable block sizes. The recording mode is determined by the Fixed bit in the SCSI Write and Read commands.

If the Fixed bit is set, the Mode Select command sets the size of the next block or multiple blocks to be written with the next Write command. When a Write command is issued with the Fixed bit set, the current block size is implemented. The transfer length specifies the number of blocks to be written with this size. If a Write command is issued with the Fixed bit set and the current block size set to 0, the Viper drive returns a Check Condition with Illegal Request Sense Key. When writing with the Fixed bit set, each Write command specifies the number of contiguous blocks to be written of a fixed size, resulting in fixed-mode blocks. If the Fixed bit is reset, then only one block can be written on the tape per SCSI Write command CDB. In that case, the Write command CDB transfer length specifies the size of the block to be written in bytes. With the Fixed bit reset, the current block size specified with the last Mode Select command is ignored.

Setting the block size to 0 in the Mode Select page descriptor is not required. Therefore, with the Fixed bit reset, each SCSI Write command may specify a different byte count, resulting in variable-mode blocks.

The host may switch between fixed and variable mode recording. By issuing the Mode Select command to specify different block sizes, blocks can be written to the tape with different block sizes in the fixed mode. Also, the host may change the block size after BOM, allowing on-the-fly block-size changes.

The Read command Fixed bit also specifies fixed or variable mode. When reading in variable mode, the host must know the size of the block to be read from the tape in advance in order to avoid causing the Viper drive to return a Check Condition with Incorrect Length indicated in the Sense data (ILI). Also, the data transfer may be truncated (cut off) when the recorded block does not match the transfer length in variable mode or the current block size in fixed mode.

The Read command includes a SILI bit to Suppress ILI Check conditions.

When the SILI bit is set, the host usually specifies the maximum block size before reading so that the data blocks are not truncated, and no Check Conditions are generated.

The SCSI Read Block Limits command returns the minimum and maximum block sizes that the Viper drive can support. The Block Limits data is not modified to reflect the current mode of writing—fixed or variable. The Block Limits returned data is not modified to reflect the current block size for the next fixed-mode Write. The Mode Sense command is used for that purpose.

Library Features

Auto Unload Mode

The Viper drive has an Auto Unload Mode that may be accessed via a Mode command to Mode Page 21h. Auto Unload mode allows the drive to be configured for Library systems or as a standalone drive. Auto Unload mode allows the drive to control how the tape is unloaded in automated environments. Auto Unload modes provide three options for tape unloading:

- Do Nothing – Stay at BOT or Stay SEATED.
- Unthread Only
- Unthread and unload

The list below provides examples of automation situations in which the ejection process may be controlled using the Auto Unload mode. These examples include not only normal power-on situations, but situations involving cleaning tapes, incompatible tapes and firmware tapes.

- Powering on or power cycling while the tape is inside the drive
- Cleaning tape has finished the cleaning cycle
- Unsupported data tape has been loaded
- Unsupported cleaning tape has been loaded
- Microcode download from a firmware tape
- Microcode download via the SCSI Write Buffer command while a tape is loaded

SCSI ID Modification

Tape libraries require that the SCSI ID of an installed tape drive can be changed without opening the library enclosure and changing address jumpers. To change the SCSI ID of the Viper drive, issue a Mode Select command to Mode Page 22h to change the Next Selection ID field to the desired SCSI ID. After you reset or cycle the power to the drive, it will begin responding to the new SCSI ID. The new ID will persist through additional resets and power cycles.

If the address jumpers are changed and the drive's power is cycled, the drive will respond to the new address on the jumpers. The value in the Next Selection ID field will be that on the jumpers, even though the field may have been changed immediately before the power cycle.

LUN 1 Command Forwarding

A tape library or autoloader containing a Viper can receive its SCSI commands via the Viper. This function is called "Command Forwarding" and is enabled via the "CmdFwd" field in the Interface Control mode page (22h). When enabled, commands received via the SCSI bus and addressed to LUN 1 are immediately transmitted to

the library via the RS-422 interface. The Viper acts as a bridge, passing commands, data, and status between the initiator and the library, as specified in the Library Interface Encapsulated SCSI Protocol Manual.

In SCSI Medium Changer terminology, the library or autoloader appears as an “independent medium changer,” because the tape drive and medium changer are at different LUNs. Medium changer commands addressed to LUN 0 are rejected with Check Condition and sense data of Illegal Request / Invalid Command Operation Code (05/20/00).

Because of the relatively slow communication on the RS-422 interface, the Viper will disconnect from the SCSI bus after receiving a command, after receiving data-out, and after sending status. Data-in and status are sent to the initiator without disconnecting between them.

If the link between the Viper and the library fails, a command will receive a status of Check Condition and sense data of Aborted Command / Logical Unit Communication Failure (0B/08/00).

If a SCSI bus reset is received, a target reset task management request is transmitted to the library.

When command forwarding is disabled in mode page 22h, commands addressed to LUN 1 will receive a status of Check Condition and sense data of Illegal Request / Logical Unit Not Supported (05/25/00).

After Command Forwarding is enabled or disabled, the drive will respond to the next command with a Check Condition and sense data of Unit Attention / Reported LUNs Data Has Changed (06/3F/0E).

SCSI Messages and Status Codes

SCSI Messages

The SCSI message codes, descriptions, and directions are given in the following table. Each of these SCSI messages are supported by the Seagate LTO drive.

Code	Description	Direction
00h	Command Complete	In
01h	Extended Message*	In/Out
02h	Save Data Pointers	In
03h	Restore Pointers	In
04h	Disconnect	In
05h	Initiator Detected Error	Out
06h	Abort	Out
07h	Message Reject	In/Out
08h	No Operation	Out
09h	Message Parity Error	Out
0Ch	Bus Device Reset	Out
23h	Ignore Wide Residue	In
80h+	Identify	In/Out

In = Drive to host

Out = Host to drive

* Only two extended messages are Supported: Synchronous Data Transfer Request and Wide Data Transfer Request.

Inbound messages

The following table lists drive to host SCSI messages and their definitions.

Message	Hex Code	Definition
Command Complete	00h	This message is sent by the drive at the end of the status phase to indicate that a command is complete. Once the message is sent, the drive releases the bus and goes to Bus Free
Disconnect	04h	This message is sent by the drive to indicate that it is about to disconnect from the bus and go to Bus Free. During a Data phase, it is always preceded by a Save Data Pointers message. If a Message Reject message is received in response to this message, then the disconnect is prevented.
Extended Message	01h	See page 11 for a description of extended message support
Identify	80h+	An Identify in message is sent to the initiator during reconnect to indicate which Logical Unit is reconnecting. The Disconnect Privilege and LUNTAR flags will both be clear
Ignore Wide Residue	23h	This message is sent by the drive to the initiator to indicate that a byte on a wide bus is not valid. This will be supported whenever a wide transfer is active.

Message	Hex Code	Definition
Message Reject	07h	This message is sent to the initiator when the message received by the drive is unsupported or inappropriate.
Restore Pointers	03h	This message causes the initiator to reset its data transfer pointers to the values they held when the last Save Data Pointers message was sent. It will be sent when a parity error is detected on the bus or when an Initiator Detected Error message is received in order to re-try the data phase.
Save Data Pointers	02h	This message instructs the initiator to save its current data transfer pointers for use with a subsequent Restore pointers message. This message will always be sent before a Disconnect message during data phases.

Outbound messages

The following table lists host to drive SCSI messages and their definitions.

Message	Hex Code	Definition
Abort	06h	An abort condition is generated. See Message exception handling on page 14.
Bus Device Reset	0Ch	A reset condition is generated. . See Message exception handling on page 14.
Extended Message	01h	See Extended messages on the following page for a description of extended message support
Identify	80h+	The Identify Out message is sent by the initiator to identify the Logical Unit to be accessed and to set Disconnect Privilege. The LUNTAR flag must be zero. The Identify Out message must be sent as the first thing after selection. If it is sent at any other time, the drive will respond with a message reject message and go to Bus Free.
Initiator Detected Error	05h	The initiator has detected an error in the data being sent in a Message Command, Data or Status phase. The drive will retry the data burst or message. If the message is received immediately after an Identify message or after the Command Complete message has been sent, the drive will go Bus Free.
Message Parity Error	09h	The initiator has detected a parity error in a message. The drive will retry the message. If the message is received during a Command, Data or Status phase, immediately after an Identify message or after the Command Complete message has been sent, the drive will go Bus Free.
Message Reject	07h	This message is sent when the initiator does not support a message sent by the drive or considers the message inappropriate. If the message being rejected is Disconnect, Synchronous Data Transfer Request or Wide Data Transfer Request, the operation continues without those features. For all other messages except Restore Pointers, the message is treated as an Abort message. If the message is received during a Command, Data or Status phase, immediately after an Identify message or after the command complete message has been sent, the drive will go Bus Free.
No Operation	08h	This message has no effect and is ignored.

Extended messages

The following table lists extended SCSI messages and their definitions.

Hex Code	Message	Definition
Synchronous Data Transfer Request	01h	The drive will never initiate a Synchronous data transfer negotiation, but will expect the initiator to do so. If the message is received after selection and before command phase, it will then go to Message In phase and respond with a valid response to complete the negotiation. If the message is received at any other time, a Message Reject is sent in response.
Wide Data Transfer Request	03h	The drive will never initiate a Wide Data Transfer negotiation, but will expect the initiator to do so. If the message is received after selection and before Command phase, it will then go to Message In phase and respond with a valid response to complete the negotiation. If the message is received at any other time, a Message Reject is sent in response.

Parity errors

The following table describes the operation for each of the possible cases of parity error.

State or Phase	Description
Bus Free State	The drive does not detect nor react to parity errors on the SCSI bus while the drive is in a bus free state.
Arbitration Phase	The drive does not detect nor react to parity errors on the SCSI bus while arbitration is being performed.
Selection Phase	The drive does not detect nor react to parity errors on the SCSI bus while the drive is being selected.
Selection, Message Out Phase (Identify Message)	If the drive detects a parity error while the host is sending an Identify message, the drive retries forever.
Reselection, Message In Phase (Identify Message)	If the drive is attempting to reconnect to the host and the host asserts ATN because it detected an error, the drive: ♦ Switches the host to the Message Out Phase. ♦ Waits for the host to send a 09 (Parity Error Message) ♦ The drive then performs the retry option by: ♦ Switching the host to the Message In Phase. ♦ Resending the Identify Message
Command Phase	If the drive detects a parity error while the host is transferring a CDB, the drive: ♦ Switches the host to Message In phase ♦ Sends Restore Data Pointers (03h) message ♦ Switches the host to Command phase to retry the command. ♦ If a parity error occurs on the retry the host: ♦ Terminates the transfer. ♦ Switches the host to the Status Phase and sends a Check Condition. ♦ Switches the host to the Message In Phase and sends a Command Complete. ♦ Sets the Sense Key = B and ASC/ASCQ = 47-00 (SCSI-2 only).

State or Phase	Description
Data In Phase	If the host detects a parity error while data is being transferred from the drive and asserts ATN, the drive: ♦ Terminates the transfer of data. ♦ Switches the host to the Message Out Phase. ♦ Waits for the host to send a 05 (Host Detected Error). ♦ Switches the host to the Status Phase and sends a Check Condition. ♦ Switches the host to the Message In Phase and sends a Command Complete. ♦ Sets the Sense Key = B and ASC/ASCQ = 48-00 (SCSI-2 only).
Data Out Phase	If the drive detects a parity error while the host is transferring data, the drive: ♦ Terminates the transfer of data. ♦ Switches the host to the Status Phase and sends a Check Condition. ♦ Switches the host to the Message In Phase and sends Command Complete. ♦ Sets the Sense Key = B and ASC/ASCQ = 47-00 (SCSI-2 only).
Status Phase	If the host is in the Status phase and detects an error in the status byte and asserts ATN, the drive: ♦ Switches the host to the Message Out Phase and waits for the host to send 05 (Initiator Detected Error). ♦ Switches the host to the Status Phase and sends a Check Condition. ♦ Target sends restore pointers and resends Status.
Message In Phase	If the host is in the Message In Phase and detects an error on a message bytes an asserts ATN, the drive: ♦ Switches the host to the Message Out Phase. ♦ Waits for the host to send 09 (Parity Error Message). ♦ Switches the host to the Message In Phase and resends the message.
Message Out Phase	♦ If the host is in the Message Out Phase and sends a message bytes and the drive detects a parity error, the drive retries forever.

An Initiator that accommodates disconnect/reconnect can indicate this capability to the tape drive during the Selection phase by asserting both its own Initiator SCSI ID bit as well as the tape drive's SCSI ID bit (allows the tape drive to know with which Initiator to reconnect). The Initiator must also assert ATN before exiting the Selection phase (prior to releasing SEL) and send an Identify message out of C0h to the tape drive. This sequence causes the drive to enter the Message-Out phase when the Selection phase completes.

The first message sent by the host after the Selection phase is an Identify message. Under normal conditions, the first message sent by the tape drive after a Reselection phase is also Identify. Under certain exceptional conditions, the host may send the Abort message or the Bus Device Reset message instead of Identify as the first message.

Message exception handling

Message exceptions are handled as described in the following tables. The numbers in the tables identify the actions that the drive takes when an exception under the identified conditions occurs. The actions are listed following the tables.

Phase During Which ATN is Raised

Message	Selection	Ident.	Cmd	Data in	Data out	Status	sdtr/wdtr
Abort (06h)	2	2	2	2	2	2	2
BDR (0Ch)	2	2	2	2	2	2	2
Identify (80h/C0h)	12	7, 11	7, 11	7, 11	7, 11	7, 11	7, 11
IDE (05h)	5	2	If Retry, 8, else 5	If Retry, 8, else 5	If Retry, 8, else 5	If Retry, 8, if Status, 2, if No Status, 5	If Retry, 4, else 5
Reject (07h)	5	2	2	2	2	2	1
Parity (09h)	5	2	11	11	11	11	If Retry, 4, else 5
NOP (08h)	5	9	9	9	9	9	If EOM, 9, else 4
SDTR	5	10	7, 11	7, 11	7, 11	7, 11	10
WDTR	5	10	7, 11	7, 11	7, 11	7, 11	10
Unrecognized or illegal	5	6	6	6	6	6	If EOM, 6, else 4

Message-In Byte During Which ATN is Raised

Message	SDP (02h)	Restore Pointers (03h)	Disconnect (04h)	Reject (07h)	Identify (80h)	CC (00h)	Ignore Wide Resi-due (23h)
Abort (06h)	2	2	2	2	2	2	2
BDR (0Ch)	2	2	2	2	2	2	2
Identify (80h/C0h)	7, 11	7, 11	7, 11	7, 11	7, 11	2	7, 11
IDE (05h)	If Retry, 4 else 5	If Status, 2, if No Status, 5	If Retry, 4, else 5	If Retry, 4, else 13	If retry, 4, else 5	2	If retry, 4, else 5
Reject (07h)	2	If Status, 2, if No Status, 5	1	2	2	2	2
Parity (09h)	If Retry, 4 else 5	If Status, 2, if No Status, 5	If Retry, 4, else 5	If Retry, 4, else 13	If Retry, 4, else 5	2	If Retry, 4, else 5
NOP (08h)	9	9	9	9	9	2	If EOM, 9, else 4
SDTR	7, 11	7, 11	7, 11	7,11	7, 11	2	7, 11
WDTR	7, 11	7, 11	7, 11	7,11	7, 11	2	7, 11
Unrecognized or illegal	6	6	6	6	6	2	If EOM, 6, else 4

Retry	Retry has not been exhausted	Status	Status has been reported
EOM	End of the message	No Status	Status has not been reported

Actions:

1. The Message Out Reject disables the feature and continues. In case of Message In Disconnect, the drive disables further “Disconnects” on the current command. In case of Message In SDTR, both the initiator and the drive go to asynchronous mode. In case of Message In WDTR, the drive goes to 8-bit data transfer mode.

2. The drive goes Bus Free by releasing BSY without sense data set up.

3. The Message Out Abort or Bus Device Reset will result in the drive going Bus Free and therefore abnormally terminating the command.

4. The drive re-sends the message.

5. The drive posts Check Condition status indicating an Aborted command.

6. The drive rejects the message by Message In Reject and continues its operation.

7. The drive rejects the message by Message In Reject.

8. The drive sends Message In Restore Pointers and retries if retry is not exhausted.

9. The drive ignores the message and continues.

10. The wide data transfer agreement is negotiated prior to negotiating the synchronous data transfer agreement.

11. The drive goes Bus Free by releasing BSY with sense data set up.

12. The drive continues the normal process.

13. If the drive is continuing an operation after sending a Message in Reject, the drive will post Check Condition status indicating an Aborted command (Action 5), if not, The drive will go Bus Free by releasing BSY without sense data set up (Action 2).

SCSI Commands

This chapter describes the SCSI commands for the LTO tape drive.

Command Set

The following table shows the SCSI commands for sequential access devices implemented by the drive.

Group	Code	Command	Page
0	00h	Test Unit Ready	116
0	01h	Rewind	110
0	03h	Request Sense	98
0	05h	Read Block Limits	79
0	06h	Park Unpark	79
0	08h	Read	73
0	0Ah	Write	120
0	10h	Write Filemarks	125
0	11h	Space	114
0	12h	Inquiry	22
0	13h	Verify	118
0	15h	Mode Select	42
2	55h	Mode Select	42
0	16h	Reserve Unit	108
0	17h	Release Unit	91
0	19h	Erase	20
0	1Ah	Mode Sense	64
2	5Ah	Mode Sense	64
0	1Bh	Load Unload	33
0	1Ch	Receive Diagnostic Results	89
0	1Dh	Send Diagnostic	111
0	1Eh	Prevent/Allow Medium Removal	70
0	0Bh	Set Capacity	112
1	2Bh	Locate	36
1	34h	Read Position	84
1	3Bh	Write Buffer	122
1	3Ch	Read Buffer	81
2	44h	Report Density Support	93
2	4Ch	Log Select	38
2	4Dh	Log Sense	42
2	56h	Reserve Unit	108
2	57h	Release Unit	91
3	A0h	Report LUNS	96

Conventions

The commands in this chapter are listed in alphabetical order. Each command is described, its Command Descriptor Block (CDB) illustrated, and the Completion Status is given. Bits and fields defined in the ANSI SCSI documents that are not used by the drive are not described in this document. Bits and fields that are supported by the drive are described.

Command Descriptor Blocks

A host makes request of the tape drive by sending a Command Descriptor Block (CDB). Some commands also require a parameter list. If the CDB or the parameter list contains an invalid parameter, the drive terminates the command, returning a Sense Key of Illegal Request, without altering the medium.

Command Descriptor Block Formats

SCSI six-byte Command Descriptor Blocks are arranged in the format shown in the following table.

	Bits							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Operation Code							
1	Ignored LUN			Command Dependent				
2	Command Dependent							
3	Command Dependent							
4	Command Dependent							
5	Control							

SCSI ten-byte Command Descriptor Blocks are arranged in the format shown in the following table.

	Bits							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Operation Code							
1	Ignored LUN			Command Dependent				
2	Command Dependent							
3	Command Dependent							
4	Command Dependent							
5	Command Dependent							
6	Command Dependent							
7	Command Dependent							
8	Command Dependent							
9	Control							

Field names that are centered represent fields that are at least one byte long. Field names that are left-aligned with a bit number are one or more bits long. The length is indicated by the beginning of the following field name, and by the Bits column in the Field Descriptions table, shown below.

Field Descriptions

Field	Byte	Bits	Description
Operation Code	0		The Operation Code is made up of the Group Code and the Command Code. See Operation Code Format, below.
Ignored Logical Unit	1	5-7	The LUN field is residual from the SCSI-1 days and is ignored.
Command Dependent	1 2-4 2-8	0-4	See the specific command.
Reserved			All reserved bits must be 0.
Control	Last		The Control byte is made up of the Vendor Unique, Flag and Link bits. See Control Format, below.

Fields that are one byte or longer have no entry in the Bits column.

Operation Code Format

	Bits							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Group Code			Command Code				

Field Descriptions

Field	Byte	Bits	Description
Group Code	0	5-7	The SCSI command group.
Command Code *	0	0-4	The SCSI command code.

NOTE: The Group Code and Command Code together make the Operation Code.

Control Byte Format

	Bits							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Last	Vendor Unique		Reserved				Flag	Link

Field Descriptions

Field	Byte	Bits	Description
Vendor Unique	Last	6-7	Not used, always 0.
Reserved	Last	2-5	All reserved bits must be 0.
Flag and Link bits	Last	0-1	These bits are not supported by the Viper drive.

Command Status

When the tape drive competes a command it responds with a status byte. The format of the status byte is shown below.

Status Byte Format

	Bits							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Reserved		Status Code					

Field Descriptions

Field	Byte	Bits	Description
Reserved	0	6-7	Always 0
Status Code *	0	0-5	The command status, as shown below.

Status Codes

Status codes for the Viper drives are shown in the following table.

Description	Value	When returned
Good Status	00h	The command completed without problems
Check Condition	02h	A problem occurred during command execution. The sense data should be examined to determine the nature of the problem.
Busy	08h	The drive is unable to accept the command at this time. This is only returned during the power on sequence or if there are commands from too many initiators outstanding.
Reservation Conflict	18h	This is returned if the drive is reserved for an initiator other than the one sending the command

ERASE

The Erase command marks the tape, from the current position to the end of tape, as erased.

Command Descriptor Block

	Bits							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Operation Code (19h)							
1	Ignored LUN			Reserved			Immed	Long
2	Reserved							
3	Reserved							
4	Reserved							
5	Control							

Field Descriptions

Field	Bytes	Bits	Description
Operation Code	0		The Operation Code for Erase is 19h.
Ignored Logical Unit	1	5-7	The LUN field is residual from the SCSI-1 days and is ignored.
Immed	1	1	0 = Status is not returned until the tape is erased. 1 = Status is returned as soon as the operation is initiated.
Long	1	0	0 = Short Erase is performed and EOD is recorded at the current tape position. 1 = Long data-security Erase is performed, and EOD is recorded from the current tape position to the end of the tape.
Reserved			All reserved bits must be 0.
Control			See Control Byte Format on page 18.

If the Immediate (Immed) flag is set to 1, then the drive validates the command and waits for any previous command from any host to complete including any immediate commands currently being processed and for any buffered data to be flushed to tape. It will then report a deferred error for any preceding command or buffered data if appropriate. If there is no deferred error, the drive reports good status and initiates the command. If the Immediate (Immed) flag is set to 0, status is not returned until after the command has completed.

If the Long bit is set, EOD is written at the current position. Data Set Separators are then written from EOD to the end of the medium to overwrite any data currently on the tape. If the Long bit is clear, then an EOD is written at the current position marking it as end of data.

Completion Status

<table>
<tr><th>Code</th><th>Message</th><th>Description</th></tr>
<tr><td>00h</td><td>Good Status</td><td>• The drive remains in any previously set modes.
• The drive is ready to perform any appropriate command.
Note: If Immed is 1, then Good Status only indicates that the command is valid.</td></tr>
<tr><td>02h</td><td>Check Condition</td><td>Use the Request Sense command to retrieve status information. Possible Sense Keys are:
<table>
<tr><th>Code</th><th>Message</th><th>Description</th></tr>
<tr><td>02h</td><td>Not Ready</td><td>No cartridge is in the drive.</td></tr>
<tr><td>04h</td><td>Hardware Error</td><td>Parity error on the SCSI bus or drive hardware failure detected.</td></tr>
<tr><td>05h</td><td>Illegal Request</td><td>Both the Immed bit and the Link bits are 1, or the Command Descriptor Block is invalid.</td></tr>
<tr><td>06h</td><td>Unit Attention</td><td>The cartridge was changed or the drive was reset prior to this command.</td></tr>
<tr><td>07h</td><td>Write Protect</td><td>The cartridge is write protected.</td></tr>
</table></td></tr>
</table>

INQUIRY

The Inquiry command requests that the drive return information about itself. If an Inquiry command is received from an Initiator with a pending Unit Attention Condition (before the drive reports Check Condition status), the drive performs the Inquiry command and does not clear the Unit Attention Condition.

Command Descriptor Block

	Bits							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Operation Code (12h)							
1	Ignored			Reserved				EVPD
2	Page Code							
3	Reserved							
4	Allocation Length							
5	Control							

Field Descriptions

Field	Bytes	Bits	Description
Operation Code	0		The Operation Code for Inquiry is 12h.
Ignored Logical Unit	1	5-7	The LUN field is residual from the SCSI-1 days and is ignored.
EVPD	1	0	0 = Requests Standard Inquiry Data. 1 = Requests data page specified by the Page Code.
Page Code	2		00h = Requests Supported Vital Product Data Page 80h = Requests Unit Serial Number Page 83h = Requests Device Identification Page C0h = Requests SCSI Firmware Revision Page C1h = Requests Servo Firmware Revision Page C2h = Requests Head Assembly Serial Number Page C3h = Requests Reel Motor 1 Serial Number Page C4h = Requests Reel Motor 2 Serial Number Page C5h = Requests Board Serial Number Page C6h = Requests Base Mechanical Serial Number Page DFh = Requests Drive Status Page
Allocation Length	4		Specifies the amount of data to be returned, in bytes. A value of 0 is a valid entry and returns no data. The drive transfers the number of bytes specified up to a maximum of 38h for Standard Inquiry.
Reserved			All reserved bits must be 0.
Control	5		See Control Byte Format on page 18.

If the Enable Vital Product Data (EVPD) flag is clear and the Page Code is zero, Standard Inquiry Data is returned. If the Enable Vital Product Data (EVPD) flag is set and the Page Code is zero, the Supported Vital Product Data Pages page is returned.

If the Enable Vital Product Data (EVPD) flag is set and the Page Code is not zero and there is a vendor defined Inquiry data page corresponding to that page code,

then that page is returned. Otherwise, Check Condition status is returned. The Sense Key is set to Invalid Request (5) and the additional Sense to Invalid Field in CDB (2400).

Standard Inquiry Data Page

	Bits							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Peripheral Qualifier			Peripheral Device Type				
1	RMB	Reserved						
2	Version							
3	AENC	Obsolete	NACA	HiSup	Response Data Format			
4	Additional Length							
5	Reserved							
6	Bque	EncSrv	VS	MuiltiP	MChngr	Obsolete		Adr16
7	RelAdr	Obsolete	WBs16	Sync	Linked	TransDis	CmdQ	VS
8 – 15	Vendor Identification							
16 – 31	Product Identification							
32 – 35	Product Revision Level							
36 – 55	Vendor Specific							

Field Descriptions

Field	Bytes	Bits	Description
Peripheral Qualifier	0	5-7	Always 000b.
Peripheral Device Type	0	0-4	Normally 01h to indicate a sequential access device. 7Fh indicates that a logical unit is not present. This value is returned when an invalid LUN was in the last Identify message.
RMB	1	7	Always 1, indicating Removable Media.
Version	2		Always 3
AENC	3	7	Always 0, indicating Asynchronous Event Notification Capability is not supported.
NACA	3	5	Always 0, indicating Normal ACA (NACA) is not supported.
HiSup	3	4	Always 0, indicating Hierarchical Support is not supported.
Response Data Format	3	0-3	Always 2, indicating support of the SCSI-2 standard.
Additional Length	4		Always 33h, indicating that 51 bytes of additional Inquiry command parameters follow, beginning in Byte 5. This value does not change if the Allocation Length in the CDB is too small or too large to accommodate the entire response.
Bque	6	7	Always 0, indicating Basic Queuing is not supported.
EncSrv	6	6	Always 0, indicating Enclosure Services is not supported.
VS	6	5	Always 0, indicating this feature is not supported.
MuiltiP	6	4	0 = Multiple Interface Ports not available (SCSI drives) 1 = Multiple Interface Ports are available (Fibre Channel drives).
MChngr	6	3	Always 0, indicating Medium Changer is not supported.
Adr16	6	0	0 = 16 Bit Address not available (non-SCSI drives) 1 = 16 Bit Address supported (SCSI drives only)
RelAdr	7	7	Always 0 because Relative Addressing is not supported.
WBs16	7	5	0 = Wide Bus16 not available (non-SCSI drives) 1 = Wide Bus16 supported (SCSI drives only)

Field	Bytes	Bits	Description
Sync	7	4	Always 1, indicating Synchronous Transfer is supported.
Linked	7	3	Always 0, indicating Linked Command is not supported.
TransDis	7	2	Always 0, indicating Transfer Disable is not supported.
CmdQ	7	1	Always 0, indicating Command Queuing is not supported.
VS	7	0	
Vendor Identification	8-15		8 bytes of ASCII data: “SEAGATE” followed by 1 space.
Product Identification	16-31		16 bytes of ASCII data: “ULTRIUM06242-XXX“.
Product Revision Level	32-35		4 bytes of ASCII data indicating the SCSI firmware version.
Vendor Specific	36-55		This field may contain additional vendor specific information.
Obsolete			Always 0
Reserved			Always 0

The Standard Inquiry Data is based on the SCSI 3 standard for Standard Inquiry Data. This allows for setting certain bits in byte 6 to indicate features that were non-standard in SCSI 2. The only supported SCSI 3 field is Multi Port (MultiP).

The Multi-Port (MultiP) flag is set if the device has multiple interface ports. Parallel SCSI devices will not have multiple interface ports and will have this flag clear. Fibre Channel devices will have multiple interface ports and will have this flag set.

The 16 Bit Address (Adr16) and Wide Bus 16 (WBs16) flags are set depending on whether the hardware supports these bus features. These flags are only valid for parallel SCSI and are clear for all other low level interfaces.

Supported Vital Product Data (VPD) Page (00h)

The Supported Vital Product Data Page lists the following eleven VPD pages including itself.

Supported Vital Product Data Inquiry Page

	Bits							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Peripheral Qualifier			Peripheral Device Type				
1	Page Code							
2	Reserved							
3	Page Length							
4	Supported Vital Product Data Page Code							
5	Unit Serial Number Page Code							
6	Device Identification Page Code							
7	SCSI Firmware Revision Page Code							
8	Servo Firmware Revision Page Code							
9	Head Assembly Serial Number Page Code							
10	Reel Motor 1 Serial Number Page Code							
11	Reel Motor 2 Serial Number Page Code							

	Bits							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
12	Board Serial Number Page Code							
13	Base Mechanical Serial Number Page Code							
14	Drive Status Page Code							

Field Descriptions

Field	Bytes	Bits	Description
Peripheral Qualifier	0	5-7	Always 000b.
Peripheral Device Type	0	0-4	Normally 01h to indicate a sequential access device. 7Fh indicates that a logical unit is not present. This value is returned when an invalid LUN was in the last Identify message, or the LUN field of the Identify CDB.
Page Code	1		Always 0, indicating the Supported Vital Product Data Inquiry Page
Reserved	2		Always 0
Page Length	3		Always 0Bh to indicate 11 listed pages.
Supported Vital Product Data Page Code	4		Always 00h, the page code of the Supported Vital Product Data Inquiry Page
Unit Serial Number Page Code	5		Always 80h, the page code of the Unit Serial Number Page
Device Identification Page Code	6		Always 83h, the page code of the Device Identification Page
SCSI Firmware Revision Page Code	7		Always C0h, the page code of the SCSI Firmware Revision Page
Servo Firmware Revision Page Code	8		Always C1h, the page code of the Servo Firmware Revision Page
Head Assembly Serial Number Page	9		Always C2h, the page code of the Head Assembly Serial Number Page.
Reel Motor 1 Serial Number Page	10		Always C3h, the page code of the Reel Motor 1 Serial Number Page.
Reel Motor 2 Serial Number Page	11		Always C4h, the page code of the Reel Motor 2 Serial Number Page.
Board Serial Number Page	12		Always C5h, the page code of the Board Serial Number Page.
Base Mechanical Serial Number Page	13		Always C6h, the page code of the Base Mechanical Serial Number Page.
Drive Status Page	14		Always DFh, the page code of the current drive and cartridge state.

Unit Serial Number Page (80h)

The Unit Serial Number Page contains a single value, which is a 12 byte ASCII string. The string, with the Vendor Identification and Product Identification fields in the standard Inquiry data, uniquely identifies the drive.

	Bits							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Peripheral Qualifier			Peripheral Device Type				

	Bits							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
1	Page code							
2	Reserved							
3	Page Length							
4-15	Drive Serial Number							

Field Descriptions

Field	Bytes	Bits	Description
Peripheral Qualifier	0	5-7	Always 000b.
Peripheral Device Type	0	0-4	Normally 01h to indicate a sequential access device. 7Fh indicates that a logical unit is not present. This value is returned when an invalid LUN is specified.
Page Code	1		Always 80h, indicating the Unit Serial Number Page
Reserved	2		Always 0
Page Length	3		Always 0Ch to indicate 12 additional bytes of data.
Drive Serial Number	4-15		12 bytes of ASCII data giving the unit serial number.

Device Identification Page (83h)

The Device Identification Page contains one or more device identification descriptors that uniquely identify the particular device.

	Bits							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Peripheral Qualifier			Peripheral Device Type				
1	Page code							
2	Reserved							
3	Page Length							
4-…	Identification Descriptor							
…-…	…							
…-*n*	Identification Descriptor							

Field Descriptions

Field	Bytes	Bits	Description
Peripheral Qualifier	0	5-7	Always 000b.
Peripheral Device Type	0	0-4	Normally 01h to indicate a sequential access device. 7Fh indicates that a logical unit is not present. This value is returned when an invalid LUN is specified.
Page Code	1		Always 83h, indicating the Device Identification Page
Reserved	2		Always 0
Page Length	3		*n*-3, indicating the total length of all Identification Descriptors following.
Identification Descriptor	4-n		One or more Identification Descriptor. See the Identification Descriptor data format below.

Identification Descriptor Data Format

	Bits							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Reserved				Code Set			
1	Reserved				Identifier Type			

	Bits							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
2	Reserved							
3	Identifier Length							
4-n	Identification Descriptor							

Field Descriptions

Field	Bytes	Bits	Description
Code Set	0	0-3	1 = Identification Descriptor contains binary data. 2 = Identification Descriptor contains ASCII data.
Identifier Type	1	0-3	1 = Identification Descriptor is Vendor ID and Product ID from Standard Inquiry Data Page, followed by Serial Number from the Unit Serial Number Page. 2 = Identification Descriptor is an IEEE Extended Unique Identifier. 3 = Identification Descriptor is the Fibre Channel 64 bit Name Identifier
Identifier Length	3		*n*-3, indicating the length of this Identification Descriptor.
Identification Descriptor	4-n		Binary or ASCII data (depending on Code Set).
Reserved			Always 0

Drive Component Revision Levels Pages (C0h, C1h)

The Drive Component Revision Levels Pages contain details of the revisions of each of the components of the drive. For any given product, if these pages are the same then the drive has been built with the same components and with the same manufacturing process.

	Bits							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Peripheral Qualifier			Peripheral Device Type				
1	Page Code							
2	Reserved							
3	Page Length							
4–29	Component							
30–48	Version							
49–72	Date							
73–95	Variant							

Field Descriptions

Field	Bytes	Bits	Description
Peripheral Qualifier	0	5-7	Always 000b.
Peripheral Device Type	0	0-4	01h, indicating a sequential access device.
Page Code	1		C0h = SCSI Firmware Revision Page C1h = Servo Firmware Revision Page
Reserved	2		Always 0
Page Length	3		Always 5Ch

Field	Bytes	Bits	Description
Compo-nent	4-29		26 bytes of ASCII data, identifying the component. "SCSI FIRMWARE " = SCSI Firmware Revision Page "SERVO FIRMWARE " = Servo Firmware Revision Page
Version	30-48		19 bytes of ASCII data, "XXXXXXXXXXXXXXXXX"
Date	49–72		24 bytes of ASCII data, "YYYY/MM/DD " YYYY = 4 digits of year MM = 2 digits of month DD = 2 digits of day
Variant	73–95		23 bytes of ASCII data, "XXXXXXXXXXXXXXXXXXXXX"

Drive Component Serial Number Page (C2h,C3h,C4h,C5h,C6h)

The Drive Component Serial Number Page contains a single value, which is a 12-byte ASCII string. The string, with the drive component fields in the standard Inquiry data, uniquely identifies the component.

	Bits						
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Peripheral Qualifier		Peripheral Device Type					
1	Page code							
2	Reserved							
3	Page Length							
4-15	Component Serial Number							

Field Descriptions

Field	Bytes	Bits	Description
Peripheral Qualifier	0	5-7	Always 000b.
Peripheral Device Type	0	0-4	Normally 01h to indicate a sequential access device.
Page Code	1		C2h, indicating the Head Assembly Serial Number Page C3h, indicating the Reel Motor 1 Serial Number Page C4h, indicating the Reel Motor 2 Serial Number Page C5h, Board Serial Number Page C6h, Base Mechanical Serial Number Page
Reserved	2		Always 0
Page Length	3		Always 0A to indicate 12 additional bytes of data.
Drive Serial Number	4-15		12 bytes of ASCII data giving the unit serial number.

Drive Status Page (DFh)

The Drive Status Page provides a snapshot of the current state of the drive and cartridge. It provides an extract of selected mode and log pages. The page code is DFh

	Bits							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Peripheral Qualifier			Peripheral Device Type				
1	Page Code							
2	Reserved							
3	Page Length							
4	Drive State							
5	CmdFwd		Alerts	Rsvd	NoRemov	Unit	Rsvd	Clean
6	Reserved				Lun1Cmd	AutoloadMode		
7	Reserved							
8	Cartridge Type							
9	Cartridge Format (0)							
10	Cartridge Capacity, MSB							
11	Cartridge Capacity, LSB							
12	Port A Transport Type							
13	Port A Selection ID, MSB							
14	Port A Selection ID							
15	Port A Selection ID, LSB							
16	Port B Transport Type							
17	Port B Selection ID, MSB							
18	Port B Selection ID							
19	Port B Selection ID, LSB							
20	Operating Hours Since Manufacture, MSB							
21	Operating Hours Since Manufacture							
22	Operating Hours Since Manufacture							
23	Operating Hours Since Manufacture, LSB							
24-31	Initiator ID							
32-63	Cartridge Serial Number							

Field Descriptions

Field	Bytes	Bits	Description
Peripheral Qualifier	0	5-7	Always 000b.
Peripheral Device Type	0	0-4	01h, indicating a sequential access device.
Page Code	1		Always DFh, indicating the Drive Status Page
Page Length	3		Always 3Ch
Drive State	4		Contains one of the values shown in the Drive State Field Values table below.
Cmd Fwd	5	6-7	0 = Command Forwarding is disabled. 1 = Command Forwarding is enabled. Command Forwarding is controlled by the Interface Control Mode Page
Alerts	5	5	0 = Alerts are disabled. 1 = Alerts are enabled. (Alerts are not implemented, so this field never has a value of 1.) Alerts would be controlled by the Interface Control Mode Page
NoRemov	5	3	0 = Removal of the cartridge is enabled 1 = Removal of the cartridge has been disabled with the Prevent/Allow Medium Removal command.

Field	Bytes	Bits	Description
Unit Rsvd	5	2	0 = The unit is not reserved. The Initiator Selection Address field is invalid. 1 = An initiator has reserved the device. The Initiator Selection Address field contains the Selection Address of the initiator.
BusReset	5	1	0 = No reset in process. 1 = Bus reset (or Fibre Channel LIP) is in process.
Clean	5	0	0 = Cleaning is not needed. 1 = Cleaning is needed.
Lun1Cmd	6	3	0 = No unforwarded command exists for LUN 1. 1 = One or more LUN 1 commands are awaiting forwarding via RS-422.
Autoload Mode	6	2-0	0 = Load and thread when cartridge is inserted 1 = Load and do not thread when cartridge is inserted 2 = Do not load when cartridge is inserted Autoload Mode is controlled by the Control Mode Page
Cartridge Type	8		Contains one of the values shown in the Cartridge Type Field Values table below.
Cartridge Format	9		Always 0, indicating an LTO tape cartridge.
Cartridge Capacity	10-11		Uncompressed capacity of the cartridge, in multiples of 10^9 bytes.
Port A Transport Type	12		The current transport type of Port A, as specified in the Interface Control Mode Page.
Port A Selection ID	13-15		The current drive address of Port A as specified in the Interface Control Mode Page.
Port B Transport Type	16		The current transport type of Port B, as specified in the Interface Control Mode Page. Zero in a Parallel SCSI drive.
Port B Selection ID	17-19		The current drive address of Port B, as specified in the Interface Control Mode Page. Zero in a Parallel SCSI drive.
Operating Hours Since Manufacture	20-23		Total number of hours of head-tape contact time.
Initiator ID	24-31		Identification of the initiator holding a reservation on the drive, when the Unit Rsvd field is one. If the interface is Parallel SCSI, then the least-significant byte contains the initiator's SCSI ID; if the interface is Fibre Channel, then the field contains the initiator's 64-bit world-wide ID. If Unit Rsvd is zero, then this field is zero.
Cartridge Serial Number	32-63		32 bytes of ASCII data, right-filled with blanks. This is the cartridge serial number as defined by attribute number 0201h of the SPC-2 Read Attribute command. [The SPC-2 Read Attribute command has not been implemented.]
Reserved			Always 0

As there is only one LTO format defined at this time, the Cartridge Format value is always zero. During insertion, the type of a data cartridge is unknown between the time the cartridge is seated and the drive completes winding to BOT; the length calculation takes place during winding.

Drive State Field Values

The Medium Auxiliary Memory (MAM) can be accessed only in the states indicated.

Value	State	Description	MAM Accessible
0	DRIVE EMPTY NOT READY	No cartridge in drive, but no commands may be issued or cartridge inserted.	N
1	DRIVE EMPTY READY	No cartridge in drive. Commands will be accepted and a cartridge may be inserted.	N
2	DRIVE MEDIA LOADABLE	Cartridge is in carrier and loading may be initiated by issuing a SCSI Load or a library LOAD CARTRIDGE command.	N
3	DRIVE LOADING	Drive is loading and threading the cartridge.	N
4	DRIVE LOADED HOLD	Drive is loaded to Hold point.	Y
5	DRIVE LOADED READY	Drive can accept non-status commands.	Y
6	DRIVE WRITING	Drive cannot accept non-status commands.	Y
7	DRIVE READING	Drive cannot accept non-status commands.	Y
8	DRIVE BUSY	Drive cannot accept non-status commands.	Y
9	DRIVE UNLOADING	Tape is being unthreaded and ejected.	Y
10	DRIVE MEDIA REMOVABLE	Cartridge has been ejected and is ready for extraction by the library.	N
11	DRIVE LOAD FAILED EJECTED	Loading failed and the cartridge was returned to the loadable/removable position.	N
12	DRIVE LOAD FAILED JAMMED	Loading failed and the drive is unable to eject the cartridge.	N
13	DRIVE LOAD FAILED HOLD	Loading failed and the cartridge is in the drive at the Hold position.	Y
14	DRIVE EJECT FAILED JAMMED	Ejection failed and the drive is unable to move the cartridge.	N
15	DRIVE EJECT FAILED HOLD	Ejection failed and the cartridge is in the drive at the Hold position.	Y
16	DRIVE STATE UNKNOWN.		N

Cartridge Type Field Values

Value	Meaning
0	Empty – no cartridge is present
1	Cleaning cartridge
2	Unknown data cartridge
3	Ultrium Type A data cartridge
4	Ultrium Type B data cartridge
5	Ultrium Type C data cartridge
6	Ultrium Type D data cartridge
7	Firmware cartridge

Completion Status

<table>
<tr><th>Code</th><th>Message</th><th>Description</th></tr>
<tr><td>00h</td><td>Good Status</td><td>♦ The tape is not moved; the current position is maintained.
♦ The drive remains in any previously set modes.
♦ The drive is ready to perform any appropriate command.</td></tr>
<tr><td>02h</td><td>Check Condition</td><td>Use the Request Sense command to retrieve status information. Possible Sense Keys are:
<table>
<tr><th>Code</th><th>Message</th><th>Description</th></tr>
<tr><td>02h</td><td>Not Ready</td><td>No cartridge is in the drive.</td></tr>
<tr><td>04h</td><td>Hardware Error</td><td>Parity error on the SCSI bus or drive hardware failure.</td></tr>
<tr><td>05h</td><td>Illegal Request</td><td>The Command Descriptor Block is invalid.</td></tr>
</table></td></tr>
</table>

LOAD UNLOAD

The Load Unload command may be used to load or unload a cartridge. This command may also be used to request that the retension function be performed.

Command Descriptor Block

	Bits							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Operation Code (1Bh)							
1	Ignored LUN			Reserved				Immed
2	Reserved							
3	Reserved							
4	Reserved				Hold	EOT	Reten	Load
5	Control							

Field Descriptions

Field	Bytes	Bits	Description
Operation Code	0		The Operation Code for the Load Unload command is 1Bh.
Ignored Logical Unit	1	5-7	The LUN field is residual from the SCSI-1 days and is ignored.
Immed	1	0	0 = Status is not returned until the operation has completed. 1 = Status is returned as soon as buffered data, filemarks have been written to the medium and the CDB has been validated.
Hold	4	3	1 = Requests that the medium be positioned to the Medium Auxiliary Memory Accessible position where the medium is seated into the drive but the tape is not threaded to BOT.
EOT	4	2	Not supported. Must be set to 0.
Reten	4	1	1 = Requests that the retension function be performed on medium.
Load	4	0	0 = requests that the medium be unloaded. 1 = requests that the medium be loaded.
Reserved			All reserved bits must be 0.
Control	5		See Control Byte Format on page 18.

The drive has three possible states where the medium may be positioned. The locations are:

- The Medium Loadable Position where the medium is inserted into the drive but has not been seated into the drive and the tape has not been threaded to BOT.
- The Medium Auxiliary Memory Accessible Position where the medium has been seated into the drive but the tape has not been threaded to BOT.
- The Medium Loaded And Ready Position where the medium has been seated into the drive and the tape has been threaded to BOT. The medium is ready to use.

Medium Loadable Position

Hold	Reten	Load	Description
0	0	0	No action taken, Good Status is returned.
0	0	1	Load the medium to the Loaded position. The medium will be ready at BOT.
0	1	0	Check condition, sense data 02/3A/03.
0	1	1	Load the medium to the Loaded position and perform the retension operation. The medium will be ready at BOT.
1	0	0	Load the medium to the Medium Auxiliary Memory Accessible position.
1	0	1	Load the medium to the Medium Auxiliary Memory Accessible position.
1	1	0	Check condition, sense data 02/3A/03.
1	1	1	Check condition, sense data 02/3A/03.

Medium Auxiliary Memory Accessible Position

Hold	Reten	Load	Description
0	0	0	Unload the medium to the Loadable position.
0	0	1	Load the medium to the Loaded position. The medium will be ready at BOT.
0	1	0	Check condition, sense data 02/3A/04.
0	1	1	Load the medium to the Loaded position and perform the retension operation. The medium will be ready at BOT.
1	0	0	No action taken, Good Status is returned.
1	0	1	No action taken, Good Status is returned.
1	1	0	Check condition, sense data 02/3A/04.
1	1	1	Check condition, sense data 02/3A/04.

Medium Loaded And Ready Position

Hold	Reten	Load	Description
0	0	0	Unload the medium to the Loadable position.
0	0	1	Rewind the medium to the Loaded position. The medium will be ready at BOT.
0	1	0	Perform the retension operation and unload the medium to the Loadable position.
0	1	1	Perform the retension operation. The medium will remain at the Loaded position ready at BOT.
1	0	0	Unload the medium to the Medium Auxiliary Memory Accessible position.
1	0	1	Unload the medium to the Medium Auxiliary Memory Accessible position.
1	1	0	Perform the retension operation and unload the medium to the Medium Auxiliary Memory Accessible position.
1	1	1	Perform the retension operation and unload the medium to the Medium Auxiliary Memory Accessible position.

If the Prevent Medium Removal state has been set using the Prevent Allow Medium Removal command and a Load Unload command is issued that requests the medium be unloaded to the Medium Loadable position, then a check condition status will be returned. The sense key will be set to Illegal Request(05) and the additional sense data will be set to Medium Removal Prevented (5302).

If the Immediate (Immed) flag is 1, then the drive validates the command and waits for any previous command from any host to complete, including any immediate commands currently being processed, and for any buffered data to be flushed to tape. It will then report a deferred error for any preceding command or buffered data if appropriate. If there is no deferred error, the drive reports good status and initiates the command. If the Immediate flag is 0, status is not returned until after the command has completed.

Completion Status

<table>
<tr><th>Code</th><th>Message</th><th>Description</th></tr>
<tr><td>00h</td><td>Good Status</td><td>♦ The tape is positioned as requested.
♦ The drive remains in any previously set modes.
♦ The drive is ready to perform any appropriate command.
Note: If IMMED is one, then Good status only indicated that the command is valid.</td></tr>
<tr><td>02h</td><td>Check Condition</td><td>Use the Request Sense command to retrieve status information. Possible Sense Keys are:
<table>
<tr><th>Code</th><th>Message</th><th>Description</th></tr>
<tr><td>02h</td><td>Not Ready</td><td>No cartridge is in the drive, cartridge is in the Loadable position or the cartridge is in the Medium Auxiliary Memory Accessible Position</td></tr>
<tr><td>04h</td><td>Hardware Error</td><td>Parity error on then SCSI bus, or drive hardware failure detected.</td></tr>
<tr><td>05h</td><td>Illegal Request</td><td>Medium Removal Prevention has been set, or the command Descriptor Block is invalid.</td></tr>
<tr><td>06h</td><td>Unit Attention</td><td>The cartridge was loaded or unloaded to the Medium Loadable, Medium Auxiliary Memory Accessible Or Medium Loaded at BOT positions.</td></tr>
</table></td></tr>
</table>

LOCATE

The Locate command moves to a specified position on the tape.

Before the locate operation is performed, all buffered data and filemarks are transferred to tape. On completion, the logical position is before the specified location.

Command Descriptor Block

	Bits							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Operation Code (2Bh)							
1	Ignored LUN			Reserved				Immed
2	Reserved							
3	Block Address, MSB							
4	Block Address							
5	Block Address							
6	Block Address, LSB							
7	Reserved							
8	Reserved							
9	Control							

Field Descriptions

Field	Bytes	Bits	Description
Operation Code	0		The operation code for Locate is 2Bh
Ignored Logical Unit	1	5-7	The LUN field is residual from the SCSI-1 days and is ignored.
Immed	1	0	0 = Status is not returned until the tape is positioned. 1 = Status is returned as soon as the operation is initiated.
Block Address	3-6		The logical block address of the block to which the tape is to be positioned. Block 0 is the first block on tape. The value indicates the total number of records and marks between BOT and the desired logical position.
Reserved			All reserved bits must be 0.
Control	5		See Control Byte Format on page 18.

The Locate command causes the logical position on tape to be set to the value indicated by the Block Address field. The value indicates the total number of records and marks between BOT and the desired logical position. A value of 0 will cause the tape to be positioned at BOT.

If the Immediate (Immed) flag is set to 1, then the drive validates the command and waits for any previous command from any host to complete including any immediate commands currently being processed and for any buffered data to be flushed to tape. It will then report a deferred error for any preceding command or buffered data if appropriate. If there is no deferred error, the drive reports good status and initiates the command. If the Immediate (Immed) flag is set to 0, status is not returned until after the command has completed.

Completion Status

<table>
<tr><th>Code</th><th>Message</th><th>Description</th></tr>
<tr><td>00h</td><td>Good Status</td><td>♦ The tape is positioned to the logical block address specified.
♦ The drive remains in any previously set mode.
♦ The drive is ready to perform any appropriate command.
Note: If Immed is 1, then Good Status only indicates that the command is valid.</td></tr>
<tr><td>02h</td><td>Check Condition</td><td>Use the Request Sense command to retrieve status information. Possible Sense Keys are:
<table>
<tr><th>Code</th><th>Message</th><th>Description</th></tr>
<tr><td>02h</td><td>Not Ready</td><td>No cartridge is in the drive.</td></tr>
<tr><td>04h</td><td>Hardware Error</td><td>Parity error on SCSI bus or drive hardware failure detected.</td></tr>
<tr><td>05h</td><td>Illegal Request</td><td>The Command Descriptor Block is invalid.</td></tr>
<tr><td>06h</td><td>Unit Attention</td><td>The cartridge was changed, or the drive was reset prior to this command.</td></tr>
<tr><td>08h</td><td>Blank Check</td><td>The drive encountered EOD.</td></tr>
</table></td></tr>
</table>

LOG SELECT

The Log Select and Log Sense commands work in conjunction to allow the host to control and obtain statistical information about cartridge usage and error rates. This information consists of counters of particular events.

The Log Select command is used to reset the log counters to their default values. A SCSI Bus Reset, Bus Device Reset, or cartridge loading is also used to reset these counters (of pages 02h, 03h, 0Ch, and 32h). Multiple pages are reset by a single Log Select command. Log Select affects pages 02h, 03h, 2Eh, and 32h only. See Log Sense for information about log pages and their format.

Command Descriptor Block

	Bits							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Operation Code (4Ch)							
1	Ignored LUN		Reserved			PCR	Reserved	
2	PC		Reserved					
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	Parameter List Length, MSB							
8	Parameter List Length, LSB							
9	Control							

Field Descriptions

Field	Bytes	Bits	Description
Operation Code	0		The Operation Code for Log Select is 4Ch
Ignored Logical Unit	1	5-7	The LUN field is residual from the SCSI-1 days and is ignored.
Parameter Code Reset (PCR)	1	1	0 = Reset values as specified by PC. Do not clear the DU (Disable Update, see **Log Parameter**) bits of the parameters of log pages 02h, 03h, 2Eh, and 32h. With page 2Eh log parameters are set to 0 only when PC = 11b. 1 = Reset log parameters on pages 02h, 03h, 2Eh, and 32h. All accumulated values are set to 0; all threshold values are set to maximums except page 2Eh. DU bits of the parameters of these log pages are also cleared.
Page Control (PC)	2	6-7	00b = Check Condition if Parameter List Length > 0. 01b = Check Condition if Parameter List Length > 0. 10b = All thresholds are set to maximums. Check Condition if Parameter List Length > 0. 11b = All accumulated values are set to 0. Check Condition if Parameter List Length > 0. This field is ignored if PCR is not 0.
Parameter List Length	7-8		Always 0. Specifies the length (in bytes) of the parameter list to be transferred during the Data Out phase. A 0 length indicates that no parameter data is to be transferred.
Reserved			All reserved bits must be 0.

Field	Bytes	Bits	Description
Control	9		See Control Byte Format on page 18.

Note: Pages 00h, 0Ch, 30h, and 31h cannot be reset by Log Select.

The drive does not maintain a separate set of log parameters for each initiator. Therefore, a Log Select command affects all initiators.

Note: The subsequent section discusses the Log Sense command. The log page codes and the log parameter codes are described in that section.

Log Pages

A log page is made up of a four-byte page header and one or more log parameters. A log parameter is made up of a four-byte parameter header and one or more associated parameter data bytes.

The following table shows the log page header format.

	Bits							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Reserved		Page Code					
1	Reserved							
2	Page Length, MSB							
3	Page Length, LSB							

Field Descriptions

Field	Bytes	Bits	Description
Page Code	0	0-5	Identifies the page.
Page Length	2-3		Indicates the length of log parameters (in bytes) which follow the page header.
Reserved			All reserved bits must be 0.

Log Parameter

The following table shows a typical log parameter format.

	Bits							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Parameter Code, MSB							
1	Parameter Code, LSB							
2	DU	DS	Reserved					
3	Parameter Length (n-3)							
4	Parameter Value							
n	Parameter Value							

Field Descriptions

Field	Bytes	Bits	Description
Parameter Code	0-1		Identifies the log parameter. Log Parameters are always in ascending order.

Disable Update (DU)	2	7	0 = Enables update of accumulated value when the corresponding event occurs. 1 = Disables update of all accumulated values within a log page when the corresponding event occurs. The drive sets this bit to indicate that the accumulated value of the parameter has reached its maximum value so that the drive can no longer increment any Parameter Values.
Disable Save (DS)	2	6	Always 1, indicating that the drive does not support Save Page in Log Sense and Log Select.
Parameter Length	3		n – 3, indicating the length of the Parameter Value.
Parameter Value	4 - n		Actual data.
Reserved			Always 0.

The parameter header contains a two-byte parameter code to identify the parameter, a Parameter Control byte, and a parameter length byte.

All of the bits in byte 2 of the Log Parameter are collectively referred to as the Parameter Control byte. The Parameter Control byte specifies counter controls.

The host specifies the Parameter Control byte to control

- Whether or not a counter is enabled.
- Whether or not a Check Condition is generated when a counter is incremented, and if so, how the Check Condition is generated.

Each Log Parameter contains only one control byte. This control byte is shared between the threshold and accumulated parameters. The Log Sense data reflects the current setting of the control byte for the parameter.

There are several logs of different formats that allow you to retrieve different drive parameters. The following logs are supported:

Log	**See Page**
Supported Log Pages Log	45
Write Error Counters Log	46
Read Error Counters Log	47
Sequential Access Device Log	47
Tape Alert Log	47
Tape Usage Log	48
Tape Capacity Log	48
Data Compression Log	49

Maximum Counts

The maximum value of each counter depends on the size of the counter in bytes. When the maximum count is reached, the DU bit in the Parameter Control byte for the counter is set to 1 for the Log Sense data indicating that the parameter is no longer to be updated by the drive because the maximum count has been reached and if RLEC (Report Log Exception Condition) bit in Mode Page 0Ah (Control Mode page) is set to 1, Recovered Error/Log Counter at Maximum (01/5B/02) is returned to host to inform of the log exception. Bytes 15-17 of the Request Sense data specify the page, MSB and LSB of the Parameter Code respectively, which caused the Log Exception.

When a counter reaches the maximum, the counter is no longer incremented. If a maximum value for the parameter size is reached, the count does NOT roll over and continue counting. When any counter of a page reaches maximum, all counters of that page are no longer incremented. A Log Select command can be issued for pages 02h, 03h, and 32h with the PCR bit set to reset the accumulated values and to allow counters to continue as normal. The DU bit of the affected parameter is also reset to zero. The same effect can be achieved by a SCSI Bus Reset, Bus Device Reset, or cartridge loading.

Completion Status

<table>
<tr><th>Code</th><th>Message</th><th>Description</th></tr>
<tr><td>00h</td><td>Good Status</td><td>• The drive is ready to perform any appropriate command.
• The affected log parameters are reset.
• The tape position is not changed.</td></tr>
<tr><td>02h</td><td>Check Condition</td><td>Use the Request Sense command to retrieve status information. Possible Sense Keys are:
<table>
<tr><th>Code</th><th>Message</th><th>Description</th></tr>
<tr><td>04h</td><td>Hardware Error</td><td>Parity error on the SCSI bus or drive hardware failure.</td></tr>
<tr><td>05h</td><td>Illegal Request</td><td>The Reserved bits are set or the Parameter List Length is not 0 in the Command Descriptor Block.</td></tr>
<tr><td>06h</td><td>Unit Attention</td><td>The cartridge was changed, or the drive was reset prior to this command.</td></tr>
</table>
</td></tr>
</table>

LOG SENSE

The Log Select and Log Sense commands work in conjunction to allow the host to control and obtain statistical information about cartridge usage and error rates. This information consists of counters of particular events.

Log Sense data is obtained by specifying a log page in the Page Code field of the Log Sense CDB. The host can request only one page of data with each Log Sense command. The available pages are found by reading the Supported Log Pages Log (00h).

Command Descriptor Block

	Bits							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Operation Code (4Dh)							
1	Ignored LUN			Reserved				
2	PC		Page Code					
3	Reserved							
4	Reserved							
5	Parameter Pointer, MSB							
6	Parameter Pointer, LSB							
7	Allocation Length, MSB							
8	Allocation Length, LSB							
9	Control							

Field Descriptions

Field	Bytes	Bits	Description
Operation Code	0		The Operation Code for Log Sense is 4Dh.
Ignored Logical Unit	1	5-7	The LUN field is residual from the SCSI-1 days and is ignored.
Page Control (PC)	2	6-7	00b = Requests Threshold values (always returns maximum possible values). 01b = Requests Accumulated values 10b = Requests Default threshold values (always returns maximum possible values). 11b = Requests Default accumulated values (always returns 0s).
Page Code	2	0-5	00h = Requests Supported Log Pages Log 02h = Requests Write Error Counters Log 03h = Requests Read Error Counters Log 0Ch = Requests Sequential Access Device Log 2Eh = Requests Tape Alert Log 30h = Requests Tape Usage Log 31h = Requests Tape Capacity Log 32h = Requests Data Compression Log
Parameter Pointer	5-6	7-0	Specifies the beginning parameter code to be returned to the initiator. All remaining parameter codes are returned in ascending order. This field is ignored for page code 00h.

Field	Bytes	Bits	Description
Allocation Length	7-8	7-0	The Allocation Length field specifies the maximum amount of memory space (in bytes), which the initiator has reserved for Log Sense data. The drive returns the number of bytes contained in the requested page, or the requested Allocation Length, whichever is less. If the Allocation Length is less than the actual page length, the transfer is truncated.
Reserved			All reserved bits must be 0.
Control	9		See Control Byte Format on page 18.

The Page Control (PC) field specifies the type of counters that the initiator is requesting. The value 01b is the most common page control setting. This requests the accumulated counts for the page to be returned. These counts reflect the current count of events since the last power-on cycle, SCSI bus Reset, Bus Device Reset, cartridge loading, or the last Log Select command that cleared the parameter values.

Accumulated values are incremented by the drive as an event occurs. For pages 02h, 03h, and 32h, these values can be cleared with all the above methods. For page 0Ch these values can be cleared with all the above methods except with Log Select.

Because the drive maintains the accumulated values in volatile memory, the values may be lost if a power cycle occurs.

The PC field is ignored for pages 00h, 0Ch, 2Eh, 30h, and 31h and the accumulated values are always returned except page 00h which has no accumulated values.

The Parameter Pointer Field

The Parameter Pointer field specifies the starting page that is to be transferred.

For example, if the page uses parameter codes 2 through 6 and the parameter pointer field is set to 3, then the drive returns parameters 3 through 6. Likewise, if the parameter pointer is set to 1, parameters 2 through 6 are returned.

If the Parameter Pointer field is set to 0, all parameters for that particular page are returned up to the maximum number of bytes specified in the allocation length.

Regardless of the starting parameter code specified in the Parameter Pointer field, the page header is always returned.

Log Pages

There are several logs of different formats that allow you to retrieve different drive parameters. The following logs are supported:

Log	See Page
Supported Log Pages Log	45
Write Error Counters Log	46
Read Error Counters Log	47
Sequential Access Device Log	47
Tape Alert Log	47

Log	See Page
Supported Log Pages Log	45
Tape Usage Log	48
Tape Capacity Log	48
Data Compression Log	49

Only one log page is transferred to the host with each Log Sense command. The Page Code field (Byte 2) of the CDB specifies the page to be transferred.

A four-byte page header precedes the parameter data for each page. The page header specifies the page code returned and the length of that page in bytes.

Following the page header are the log parameters. Each log parameter is a data structure that contains several description bytes followed by the parameter value itself.

Log Page Header
First Log Parameter
…
Last Log Parameter

Log Page Header is always returned.

Multiple Log Parameters are returned in each log page. The log parameters are returned in ascending order.

Log Page Header

	Bits							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Reserved		Page Code					
1	Reserved							
2	Page Length, MSB							
3	Page Length, LSB							

Field Descriptions

Field	Bytes	Bits	Description
Page Code	0	0-5	Identifies the page being returned.
Page Length	2-3		Indicates the length of the page in bytes that follow the page header. If the allocation length specified in the CDB is too small to transfer the entire requested page, this value is not adjusted to reflect the truncation. However, if the Parameter Pointer field specifies a starting parameter code other than zero, the page length is adjusted to indicate the number of bytes that follow the page header.
Reserved			All reserved bits must be 0.

Log Parameter

	Bits							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Parameter Code, MSB							
1	Parameter Code, LSB							
2	DU	DS	TSD	ETC	TMC		LBIN	LP
3	Parameter Length							
4 - n	Parameter Value							

Field Descriptions

Field	Bytes	Bits	Description
Parameter Code	0-1		Identifies the log parameter returned. Log Parameters are always returned in ascending order.
Disable Update (DU)	2	7	0 = Enables update of accumulated value when the corresponding event occurs. 1 = Disables update of all accumulated values within a log page when the corresponding event occurs. The drive sets this bit to indicate that the accumulated value of the parameter has reached its maximum value so that the drive can no longer increment any Parameter Values.
Disable Save (DS)	2	6	Always 1, indicating that the drive does not support Save Page in Log Sense and Log Select.
TSD	2	5	Always 0, indicating that Target Save Disable (TSD) is not supported.
ETC	2	4	Always 0, indicating that Enable Threshold Comparison (ETC) is not supported.
TMC	2	2-3	Always 0, indicating that Threshold Met Criteria (TMC) is not supported.
List Binary (LBIN)	2	1	Always 0, indicating that all log parameters are data counters.
List Parameter (LP)	2	0	Always 0, indicating that all log parameters are data counters.
Parameter Length	3		n – 3, indicating the length of the Parameter Value.
Parameter Value	4 – n		The Parameter Value is the actual data requested.
Reserved			Always 0.

Supported Log Pages Log (00h)

Page 00h indicates the log pages used by the drive. To determine the size of each page and of each parameter in the page, the individual page must be requested. Page 00h is unique in that the log parameters returned do not contain log parameter headers. All other pages return a log parameter header for each log parameter. Page 00h is valid only for the Log Sense command. When page 00h is requested, the four-byte page header is returned followed by the list of log pages—one byte for each log page. The list of log pages is returned in ascending order.

	Bits							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Reserved		Page Code (00h)					
1	Reserved							
2	Page Length, MSB							
3	Page Length, LSB (0Ah)							
4	Supported Log Pages Log (00h)							
5	Write Error Counters Log (02h)							
6	Read Error Counters Log (03h)							
7	Sequential Access Device Log (0Ch)							
8	Tape Alert Log (2Eh)							
9	Tape Usage Log (30h)							
10	Tape Capacity Log (31h)							
11	Data Compression Log (32h)							

	Bits							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
12	Vendor Unique Error Counters (3Ah)							
13	Drive Usage Log (3Ch)							

Field Descriptions

Field	Bytes	Bits	Description
Page Code	0	0-5	
Page Length	2-3		Always 0Ah, indicating the page length.
Supported Log Pages Log	4		Always 00h, the page code of the Supported Log Pages Log
Write Error Counters Log	5		Always 02h, the page code of the Write Error Counters Log
Read Error Counters Log	6		Always 03h, the page code of the Read Error Counters Log
Sequential Access Device Log	7		Always 0Ch, the page code of the Sequential Access Device Log
Tape Alert Log	8		Always 2Eh, the page code of the Tape Alert Log
Tape Usage Log	9		Always 30h, the page code of the Tape Usage Log
Tape Capacity Log	10		Always 31h, the page code of the Tape Capacity Log
Data Compression Log	11		Always 32h, the page code of the Data Compression Log
Reserved			Always 0.

Write Error Counters Log (02h)

The Write Error Counters Log records write errors. The parameters on this page can be reset to 0 with the Log Select command.

Page Code	Page Length
02h	38h

Parameter	Description	Length
0	Always 0.	4
1	Always 0.	4
2	Always 0.	4
3	Total errors corrected. This is total write retries less total unrecovered write errors.	4
4	Total times error correction processed. This is the total number of write retries.	4
5	Total bytes processed. The is the total data sets written.	4
6	Total unrecovered errors. This is the total unrecoverable write errors.	4

Read Error Counters Log (03h)

The Read Error Counters Log records read errors. The parameters on this page can be reset to 0 with the Log Select command.

Page Code	Page Length
03h	38h

Parameter	Description	Length
0	Always 0.	4
1	Always 0.	4
2	Always 0.	4
3	Total errors corrected. This is total read retries less total unrecovered read errors.	4
4	Total times error correction processed. This is the total number of read retries.	4
5	Total bytes processed. The is the total data sets read.	4
6	Total unrecovered errors. This is the total unrecoverable read errors.	4

Sequential Access Device Log (0Ch)

The Sequential Access Device Log tracks the flow of data to and from the drive. It also signals when drive cleaning is necessary.

Page Code	Page Length
0Ch	3Ch

Parameter	Description	Length
0000h	Number of data bytes received from application clients during Write Command operations. This is the number of bytes transferred over the SCSI interface before compression.	8
0001h	Number of data bytes written to the media as a result of Write Command operations, not counting ECC and formatting overhead. This is the number of data bytes transferred to media after compression.	8
0002h	Number of data bytes read from the media during Read command Operations, not counting ECC and formatting overhead. This is the number of data bytes transferred from media with compression.	8
0003h	Number of data bytes transferred to the initiator(s) during Read Command operations. This is the number of bytes transferred over the SCSI interface, after decompression.	8
0100h	Cleaning required. A non-zero value of the cleaning required parameter indicates that a condition requiring cleaning has been detected and a subsequent cleaning cycle has not been completed. The cleaning required parameter is persistent across hard resets and power cycles.	8

Tape Alert Log (2Eh)

The Tape Alert Log Page provides information about errors and the status of the drive and media.

Page Code	Page Length
2Eh	140h

All parameters are one byte long. Each parameter is either zero to indicate the corresponding condition has not occurred or one to indicate that the corresponding condition has occurred. The log page is used in conjunction with Information Exceptions Mode Page (1Ch) that controls the action taken by the drive when a flag is set and sets various other control mechanisms of the Tape Alert system. A flag is set whenever the condition for setting the flag exists. There are three types of flags, Informational, Warning, and Critical. The type of flag depends upon the severity of the condition that sets the flag. Flags are cleared on the following conditions:

- At drive power on
- When the TapeAlert Log page is read
- When specified corrective action has been taken (such as using a cleaning cartridge)
- On a SCSI bus reset or bus device reset message
- On Log Select reset (note that the recommended action on receiving Log Select for the TapeAlert Log page is to reject the command with an error).

Additional information regarding the Tape Alert system is found in the SCSI-3 Stream Commands (SSC) Standard and Tape Alert specification. The following is the list of flags (parameters) supported by the drive.

Parameter	Description	Type	Length
3	Hard Error	Warning	1
9	Write Protect	Critical	1
11	Cleaning media in drive	Informational	1
14	Unrecoverable snapped tape	Critical	1
15	Memory in Cartridge Failure	Warning	1
16	Forced Eject	Critical	1
17	Read Only Format	Warning	1
18	Tape Directory Corrupted on Load	Warning	1
20	Clean now	Critical	1
21	Clean periodic	Warning	1
22	Expired cleaning media	Critical	1
23	Invalid cleaning tape	Critical	1
30	Hardware A	Critical	1
31	Hardware B	Critical	1
32	Interface	Warning	1
34	Download Fault	Warning	1
51	Tape Directory Invalid at Unload	Warning	1

Tape Usage Log (30h)

The Tape Usage Log Page returns information about the current tape cartridge. These values are all read directly from the tape log. The Page Control, PC, field is ignored and accumulated values are always returned.

Page Code	Page Length
30h	5Ah

Parameter	Description	Length
1	Thread Count	4

Parameter	Description	Length
2	Total Data Sets Written	8
3	Total Write Retries	4
4	Total Unrecovered Write Errors	2
5	Total Suspended Writes	2
6	Total Fatal Suspended Writes	2
7	Total Data Sets Read	8
8	Total Read Retries	4
9	Total Unrecovered Read Errors	2
10	Reserved	2
11	Reserved	2
12	Total Suspended Append Writes	2

Tape Capacity Log (31h)

The Tape Capacity Log returns information about the tape capacity. All values are in millions of bytes (10^6) and assume no data compression. The Page Control, PC, field is ignored and accumulated values are always returned.

Page Code	Page Length
31h	20h

Parameter	Description	Length
1	Main partition remaining capacity	4
2	Always 0	4
3	Main partition maximum capacity	4
4	Always 0	4

Data Compression Log (32h)

The Data Compression Log records compression information. The parameters on this page can be reset to 0 with the Log Select command

Page Code	Page Length
32h	4Ch

Parameter	Description	Length
0	Read compression ratio in percent	2
1	Write compression ratio in percent	2
2	Millions of total bytes transferred to host	4
3	Remaining bytes of total bytes transferred to host	4
4	Millions of total bytes read from tape	4
5	Remaining bytes of total bytes read from tape	4
6	Millions of total bytes transferred from host	4
7	Remaining bytes of total bytes transferred from host	4
8	Millions of total bytes written to tape	4
9	Remaining bytes of total bytes written to tape	4

Parameters 2 through 9 occur as pairs each of which represents a total number of bytes (i.e., total number of bytes transferred to host as with Parameter 2 and 3 pair.)

The first four-byte parameter of a pair represents millions of bytes (10^6.) The second four-byte parameter of a pair represents the difference between the millions of bytes and the total number of bytes as a positive number in the range of 0 to 999,999. Thus the total number of bytes is the first four-byte parameter in bytes plus the second four-byte parameter. Parameters 0 and 1are in percent, i.e. 200 represents 200% compression. Compression ratios will be most accurate after 10^8 bytes have been read or written.

Completion Status

Code	Message	Description
00h	Good Status	• The drive is ready to perform any appropriate command. • The requested log page is returned. • The tape position is not changed.
02h	Check Condition	Use the Request Sense command to retrieve status information. Possible Sense Keys are:

Code	Message	Description
04h	Hardware Error	Parity error on the SCSI bus or drive hardware failure.
05h	Illegal Request	The Command Descriptor Block is invalid.
06h	Unit Attention	The cartridge was changed, or the drive was reset prior to this command.

MODE SELECT

The Mode Select command allows the host to assign device parameters to the drive.

After a power-on or SCSI reset condition, the drive sets its device parameters to the default values. By issuing a Mode Select command, the host can change the device parameters. The parameters are transferred to the drive as data formatted in a parameter list.

Parameters assigned by the Mode Select command remain in effect until the drive receives a subsequent Mode Select command or a reset. The Mode Select parameters are not unique to the initiator that assigned the parameters.

In multiple-initiator systems, all initiators that access the drive use the assigned parameters. However, when a Mode Select command changes parameters that apply to other initiators, the drive generates a Unit Attention condition for all initiators except the one that issued the Mode Select command. The Additional Sense Code and Additional Sense Code Qualifier are set to Mode Parameters Changed.

The Mode Select command immediately checks for invalid parameters or invalid combinations of parameters before executing. If an exception is found, the drive returns a Check Condition, and the request sense data is set to Illegal Request.

All Mode Select parameters may be rounded up or down, as appropriate. A Mode Sense command may be issued after a Mode Select command to determine which parameters have been rounded.

Command Descriptor Block

6-Byte Command Descriptor Block

	Bits							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Operation Code (15h)							
1	Ignored LUN			PF	Reserved			
2	Reserved							
3	Reserved							
4	Parameter List Length							
5	Control							

Field Descriptions

Field	Bytes	Bits	Description
Operation Code	1		The Operation Code for Mode Select is 15h.
Ignored Logical Unit	1	5-7	The LUN field is residual from the SCSI-1 days and is ignored.
PF	1	4	Always 1, indicating SCSI-2 format.
Parameter List Length	4		Specifies the number of bytes in the Mode Select parameter list to be transferred from the host to the drive. A value of 0 is a valid entry and indicates no data.
Reserved			All reserved bits must be 0.

Field	Bytes	Bits	Description
Control	5		See Control Byte Format on page 18.

A value in the Parameter List Length field that truncates a parameter list causes the drive to return a Check Condition, and the request sense data is set to Illegal Request.

10-Byte Command Descriptor Block

	Bits						
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Operation Code (55h)							
1	Ignored LUN			PF	Reserved			
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	Parameter List Length, MSB							
8	Parameter List Length, LSB							
9	Control							

Field Descriptions

Field	Bytes	Bits	Description
Operation Code	1		The Operation Code for Mode Select is 55h.
Ignored Logical Unit	1	5-7	The LUN field is residual from the SCSI-1 days and is ignored.
PF	1	4	Always 1, indicating SCSI-2 format.
Parameter List Length	7-8		Specifies the number of bytes in the Mode Select parameter list to be transferred from the host to the drive. A value of 0 is a valid entry and indicates no data.
Reserved			All reserved bits must be 0.
Control	9		See Control Byte Format on page 18.

A value in the Parameter List Length field that truncates a parameter list causes the drive to return a Check Condition, and the request sense data is set to Illegal Request.

Mode Select Parameters

The Mode Select parameter list, for both the 6-byte CDB and 10-byte CDB versions is in the following general format:

Mode Parameter Header	The Mode Parameter Header is required.
Block Descriptor	The Block Descriptor is optional.
Mode Parameter Pages	Zero or more Mode Parameter Pages may be included.

Mode Parameter Header

6-Byte CDB Mode Parameter Header

	Bits							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Mode Data Length							
1	Reserved							
2	WP	Buffered Mode		Speed				
3	Block Descriptor Length							

Field Descriptions

Field	Bytes	Bits	Description
Mode Data Length	0		Mode Select: Always 0. Mode Sense: The number of bytes of data available.
WP	2	7	Mode Select: Ignored. Mode Sense: 0 = The cartridge is not write protected. 1 = the cartridge is write protected.
Buffered Mode	2	4-6	0 = Unbuffered mode. 1 = Buffered mode (default).
Speed	2	0-3	This field indicates the tape speed. 0 = Default 3 = 2.077 m/sec (meter/second) 4 = 2.576 m/sec 5 = 3.097 m/sec 6 = 3.643 m/sec 7 = 4.153 m/sec
Block Descriptor Length	3		0 = No Block Descriptor follows. 8 = 8-byte Block Descriptor follows.
Reserved			All reserved bits must be 0.

When Buffered Mode is 1, a Write command is terminated when the data is transferred to the internal buffer of the drive. When Buffered Mode is 0 a Write command is not terminated until all data has been transferred to tape.

10-Byte CDB Mode Parameter Header

	Bits							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Mode Data Length, MSB							
1	Mode Data Length, LSB							
2	Reserved							
3	WP	Buffered Mode		Speed				
4	Reserved							
5	Reserved							
6	Block Descriptor Length, MSB							
7	Block Descriptor Length, LSB							

Field Descriptions

Field	Bytes	Bits	Description
Mode Data Length	0-1		Mode Select: Always 0. Mode Sense: The number of bytes of data available.
WP	3	7	Mode Select: Ignored. Mode Sense: 0 = The cartridge is not write protected. 1 = the cartridge is write protected.
Buffered Mode	3	4-6	0 = Unbuffered mode. 1 = Buffered mode (default).
Speed	3	0-3	This field indicates the tape speed. 0 = Default 3 = 2.077 m/sec (meter/second) 4 = 2.576 m/sec 5 = 3.097 m/sec 6 = 3.643 m/sec 7 = 4.153 m/sec
Block Descriptor Length	6-7		0 = No Block Descriptor follows. 8 = 8-byte Block Descriptor follows.
Reserved			All reserved bits must be 0.

When Buffered Mode is 1, a Write command is terminated when the data is transferred to the internal buffer of the drive. When Buffered Mode is 0 a Write command is not terminated until all data has been transferred to tape.

Block Descriptor

The following table presents the Parameter List block descriptor.

	Bits							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Density Code							
1	Reserved							
2	Reserved							
3	Reserved							
4	Reserved							
5	Block Length, MSB							
6	Block Length							
7	Block Length, LSB							

Field Descriptions

Field	Bytes	Bits	Description
Density Code	0		Identifies the format of the tape currently in the drive. Mode Select: 00h = Default of Ultrium 1 40h = Ultrium 1 7Fh = No-op Mode Sense: 00h = Default of Ultrium 1
Block Length	5-7		0 = Variable length block mode. The Fixed bit in Read and Write commands must be 0. 1 to FFFFFFh = The length of the fixed-length block to be read or written when the Fixed bit is set in a Read or Write command.
Reserved			All reserved bits must be 0.

Mode Parameter Pages

There are several mode parameter pages of different formats that allow you to set different drive parameters. The following mode parameter pages are supported:

Mode Parameter Page	See Page
Disconnect/Reconnect Page (02h)	55
Control Mode Page (0Ah)	56
Data Compression Control Page (0Fh)	57
Sequential Access Device Configuration Page (10h)	58
Information Exceptions Mode Page (1Ch)	59
Drive Capabilities Control Mode Page (21h)	60
Interface Control Mode Page (22h)	60

The following table shows the general format of a Mode Parameter Page.

	Bits							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Reserved		Page Code					
1	Additional Page Length							
2 - n	Mode Parameters							

Field Descriptions

Field	Bytes	Bits	Description
Page Code	0	0-5	02h = Disconnect/Reconnect Page 0Ah = Control Mode Page 0Fh = Data Compression Control Page 10h = Device Configuration Page 1Ch = Information Exceptions Page 21h = Drive Capabilities Control Mode Page 22h = Interface Control Page
Additional Page Length	1		Specifies the length (in bytes) of the Mode Parameters.
Mode Parameters	2-n		The mode parameters are specific to each mode parameter page and are described in the following sections.
Reserved			All reserved bits must be o.

If the initiator does not set the Additional Page Length field of the Mode Page to the value indicated in the Mode Page definition (for example, 10h for the Device Configuration Page), the drive terminates the Mode Select command and returns Check Condition status bytes with an Illegal Request sense key. The Additional Sense Code and Additional Sense Code Qualifier are set to Invalid Field in Parameter List.

Disconnect/Reconnect Page

The Disconnect/Reconnect page allows the host to set the maximum burst size for data transfer.

	Bits							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Reserved		Page Code (02h)					
1	Additional Page Length (0Eh)							

Byte	Bits 7	6	5	4	3	2	1	0
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	Reserved							
8	Reserved							
9	Reserved							
10	Maximum Burst Size, MSB							
11	Maximum Burst Size, LSB							
12	Reserved							
13	Reserved							
14	Reserved							
15	Reserved							

Field Descriptions

Field	Bytes	Bits	Description
Page Code	0	0-5	Always 02h, indicating the Disconnect/Reconnect Page
Additional Page Length	1		Always 0Eh, indicating that 14 parameter bytes follow the Page Length byte.
Maximum Burst Size	10-11		0 = No limit exists on the amount of data transferred per connection (default). The drive does not have to disconnect until all requested data is transferred. 1 to FFFFh = The maximum amount of data that the drive can transfer, in 512-byte increments, before disconnecting, if the initiator granted the disconnect capability.
Reserved			All reserved bits must be 0.

On read operations, the drive disconnects when the drive buffer is empty, even if the Allocation Length has not been satisfied. On write operations, the drive disconnects when the drive buffer is full, even if the Transfer Length has not been exhausted.

Control Mode Page

The Control Mode page specifies whether the drive generates a Check Condition when any log parameter reaches maximum. (Refer to the Log Select command and the Log Sense command.) It also specifies whether tagged queueing is used and the behavior of the drive autoload sequence.

Note: Autoload Mode persists across power cycles. Its new definition takes effect at the next cartridge insertion after Mode Select.

Byte	Bits 7	6	5	4	3	2	1	0
0	Reserved		Page Code (0Ah)					
1	Additional Page Length (06h)							
2	Reserved							RLEC
3	Reserved							DQUE
4	Reserved							
5	Reserved					Autoload Mode		

6	Reserved
7	Reserved

Field Descriptions

Field	Bytes	Bits	Description
Page Code	0	0-5	Always 0Ah, indicating the Control Mode Page.
Additional Page Length	1		Always 06h, indicating that 6 parameter bytes follow the Page Length byte.
RLEC	2	0	0 = Drive does not Report Log Exception Conditions (RLEC) (default). 1 = Drive Reports Log Exception Conditions (RLEC).
DQUE	3	0	Always 1, indicating that Tagged Queuing (DQUE) is disabled.
Auto Load Mode	5	0-2	000b = Load inserted medium for full access. 001b = Load inserted medium for medium auxiliary memory access only. 010b = Do not load inserted medium.
Reserved			All reserved bits must be 0.

Data Compression Control Page

The Data Compression Control Page specifies whether or not data is compressed during Write commands and whether or not data is decompressed during Read commands.

	Bits							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Reserved		Page Code (0Fh)					
1	Additional Page Length (0Eh)							
2	DCE	DCC	Reserved					
3	DDE	RED	Reserved					
4	Compression Algorithm, MSB							
5	Compression Algorithm							
6	Compression Algorithm							
7	Compression Algorithm, LSB							
8	Decompression Algorithm, MSB							
9	Decompression Algorithm							
10	Decompression Algorithm							
11	Decompression Algorithm, LSB							
12	Reserved							
13	Reserved							
14	Reserved							
15	Reserved							

Field Descriptions

Field	Bytes	Bits	Description
Page Code	0	0-5	Always 0Fh, indicating the Data Compression Control Page.
Additional Page Length	1		Always 0Eh, indicating that 14 parameter bytes follow the Page Length byte.

Field	Bytes	Bits	Description
DCE	2	7	0 = Data compression is disabled. 1 = Data Compression is Enabled (DCE) (default). The drive compresses data before writing to tape.
DCC	2	6	Always 1, indicating that the drive is Data Compression Capable (DCC).
DDE	3	7	0 = Data decompression is disabled. Compressed data is not decompressed before it is transferred to the host. 1 = Data Decompression is Enabled (DDE) (default). The drive decompresses compressed data before sending it to the host.
RED	3	5-6	Always 0, indicating that when DDE is 1 and drive is unable to decompress compressed data from tape, it should return Check Condition.
Compression Algorithm	4-7		0 = Data is not compressed before it is written to tape (even if DCE is 1). 1 = Default compression algorithm (default).
Decompression Algorithm	8-11		0 = No algorithm is selected. 1 = Default decompression algorithm is used (default).
Reserved			All reserved bits must be 0.

Sequential Access Device Configuration Page

The Device Configuration page specifies the appropriate sequential access device configuration. The following table illustrates this page.

	Bits							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Reserved		Page Code (10h)					
1	Additional Page Length (0Eh)							
2	Reserved	CAP	CAF	Active Format				
3	Active Partition							
4	Write Buffer Full Ratio							
5	Read Buffer Empty Ratio							
6	Write Delay Time, MSB							
7	Write Delay Time, LSB							
8	DBR	BIS	RSmk	AVC	SOCF		RBO	REW
9	Gap Size							
10	EOD Defined			EEG	SEW	Reserved		
11	Buffer Size at Early Warning, MSB							
12	Buffer Size at Early Warning							
13	Buffer Size at Early Warning, LSB							
14	Select Data Compression Algorithm							
15	Reserved							

Field Descriptions

Field	Bytes	Bits	Description
Page Code	0	0-5	10h, indicating the Sequential Access Device Configuration Page.
Additional Page Length	1		Always 0Eh, indicating that 14 parameter bytes follow the Page Length byte.
CAP	2	6	Always 0, indicating that multiple partitions are not supported
CAF	2	5	Always 0, indicating that changing formats is not supported

Field	Bytes	Bits	Description
Active Format	2	0-4	Always 0, indicating that changing formats is not supported
Active Partition	3		Always 0, indicating that multiple partitions are not supported
Write Buffer Full Ratio	4		Always 0, indicating that buffer management is handled by the drive.
Read Buffer Empty Ratio	5		Always 0, indicating that buffer management is handled by the drive.
Write Delay time	6-7		For a WRITE command, the Write Delay Time field indicates to the drive how long in 100 millisecond increments, to delay writing buffered data to tape after the last WRITE command.
DBR	8	7	Always 0, indicating that Data Buffer Recovery is not supported.
BIS	8	6	Always 1, indicating that Block Identifiers are Supported
RSmk	8	5	Always 0, indicating that Report Set Marks is not supported.
AVC	8	4	Always 0, indicating that Automatic Velocity Control is managed by the drive.
SOCF	8	2-3	Always 0, indicating that Stop On Consecutive Filemarks is not supported.
RBO	8	1	Always 0, indicating that Recover Buffer Order is not supported.
REW	8	0	Always 0, indicating that Report Early Warning for Read type commands is not supported.
Gap Size	9		Always 0, indicating that there is no concept of inter-block gaps in the LTO format.
EOD Defined	10	5-7	Always 0, indicating the logical unit's default EOD definition.
EEG	10	4	Always 1, indicating that EOD generation is always enabled.
SEW	10	3	1 = In the Early Warning Zone the drive operates in unbuffered mode (default). 0 = The Buffered Mode set in the Mode Select Parameter Header controls drive buffering in the Early Warning Zone.
Buffer Size at Early Warning	11-13		Always 0, indicating that this cannot be set.
Select Data Compression Algorithm	14		0 = Use pass through mode; do not compress data (not recommended). 1 = Use default auto-compression scheme (recommended default)
Reserved			All reserved bits must be 0.

Information Exceptions Mode Page

The Information Exceptions Mode Page controls exception reporting via the TapeAlert log page.

	Bits							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Reserved		Page Code (1Ch)					
1	Page Length (0Ah)							
2	Perf	Reserved			DExcept	Test	Reserved	LogErr
3	Reserved				MRIE			
4	Interval Timer, MSB							
5	Interval Timer							
6	Interval Timer							
7	Interval Timer, LSB							
8	Test Flag Number, MSB							

9	Test Flag Number
10	Test Flag Number
11	Test Flag Number, LSB

Field Descriptions

Field	Bytes	Bits	Description
Page Code	0	0-5	1Ch, indicating the Information Exceptions Mode Page.
Additional Page Length	1		Always 0Ah, indicating that 10 parameter bytes follow the Page Length byte.
Perf	2	7	Always 0, indicating that this feature is not supported.
DExcept	2	3	0 = Exception reporting is enabled. 1 = Exception reporting is disabled (default).
Test	2	2	0 = Normal operation (default). 1 = Fail next command (see below) with: 01/5D/FF if Test Flag Numbert is 0. 01/5D/00 if Test Flag Number indicates a valid value (see below). This will be reported only one time between resets. Test bit and Test Flag Number are cleared right away after the Mode Select and are displayed as 0s in Mode Sense.
LogErr	2	0	Always 0, indicating that this feature is not supported.
MRIE	3	0-3	Always 3, so if an exception occurs, the next command (except Inquiry and Request Sense) will get check condition status and the Sense Key will be set to Recovered Error (01) and the Additional Sense will be set to Failure Prediction Threshold Exceeded (5D00).
Interval Timer	4-7		Always 0, indicating that this feature is not supported.
Test Flag Number	8-11		This field is in 2's complement. 0 = No flag number. If Test = 1, then Test bit will be cleared only in Mode Sense when 01/5D/FF is returned. If Test = 0 and Test Flag Number is not 0, return Check Condition. If Test = 1 and Test Flag Number is one of the following: 1 to 64 = Set the indicated tape alert flag in log page 2Eh if it is supported. Otherwise, return Check Condition. -1 to -64 = Clear the indicated tape alert flag (from 1 to 64) if it is supported. Otherwise, return Check Condition. 32767 = Set all supported tape alert flags.
Reserved			All reserved bits must be 0.

Drive Capabilities Control Mode Page

The Drive Capabilities Control mode page controls the capabilities of the Viper drive. A single copy of this page is maintained for all initiators. New Inquiry String Control, Firmware Test Control, and Data Compression Control will be in effect immediately after Mode Select. New Operating Systems Support, Extended POST Mode, and Autounload Mode will be in effect the next power cycle, after Mode Select. This page persists across power cycles.

	Bits							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Reserved		Page Code (21h)					
1	Page Length (07h)							
2	Operating Systems Support							

3	Reserved
4	Extended POST Mode
5	Inquiry String Control
6	Firmware Test Control
7	Data Compression Control
8	Auto-Unload Mode

Field Descriptions

Field	Bytes	Bits	Description
Page Code	0	0-5	21h, indicating the Drive Capabilities Control Mode Page.
Additional Page Length	1		07h, indicating that seven parameter bytes follow the Page Length byte.
Operating Systems Support	2		0 = Standard LTO (default AU1-SCSI and ISV)
POST Mode	4		0 = Enable POST (default) 1 = Disable POST
Inquiry String Control	5		0 = Standard Seagate Viper Inquiry string (default) 1 = Factory test only Inquiry string 1 2 = Factory test only Inquiry string 2
Firmware Test Control	6		0 = disable Factory test mode code (default) 1 = enable Factory test code 1 2 = enable Factory test code 2
Data Compression Control	7		0 = Full Mode Page 0Fh & 10h Control of Compression (default) 1 = Auto compression with No SCSI Mode control 2 = Compression Disabled with No SCSI Mode control
Auto Unload Mode	8		The Auto Unload Mode allows the drive to control how the tape is unloaded when (a) a power cycle occurs with a tape inside, (b) an incompatible tape is inserted, (c) a firmware download occurs with a tape inside, and (d) the cleaning tape has finished the cleaning process. 0 = Stay at BOT or SEATED; do not unthread and do not unload. (default) 1 = Unthread. 2 = Unthread and unload.
Reserved			All reserved bits must be 0.

Interface Control Mode Page

The Interface Control mode page controls the selection ID used by the primary interface (SCSI Parallel or Fibre Channel), as well as parameters of the Library serial interface. A single copy of this page is maintained for all initiators. New CmdFwd and Alerts will be in effect immediately after Mode Select. New Baud Rate, 2StopBits, Next Selection ID, Target Initiated Bus Control, and Disable Wide Bus Mode will be in effect the next reset or power cycle after Mode Select. This page persists across power cycles.

Alerts are not implemented, so this field has a value of 0 and is not changeable.

	Bits							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Reserved		Page Code (22h)					
1	Page Length (0Eh)							
2	Baud Rate							

3	Reserved		CmdFwd	2StopBits Alerts
4	Port A Transport Type			
5	Port A Present Selection ID, MSB			
6	Port A Present Selection ID			
7	Port A Present Selection ID, LSB			
8	Port B Transport Type			
9	Port B Present Selection ID, MSB			
10	Port B Present Selection ID			
11	Port B Present Selection ID, LSB			
12	Next Selection ID			
13	Jumpered Selection ID			
14	Target Initiated Bus Control			
15	Reserved			Disable Wide Bus Mode

Field Descriptions

Field	Bytes	Bits	Description
Page Code	0	0-5	22h, indicating the Interface Control Mode Page.
Additional Page Length	1		Always 0Eh, indicating that fourteen parameter bytes follow the Page Length byte.
Baud Rate	2		The baud rate at which the Library interface will operate after the next reset. 0 = 9600 baud 1 = 4800 baud 2 = 9600 baud 3 = 19200 baud 4 = 38400 baud 5 = 57600 baud 6 = 112500 baud
Alerts	3	0	0 = Disable unsolicited alert messages to the tape library via the serial interface. 1 = Enable unsolicited alert messages to the tape library via the serial interface. This field is fixed at 0 and is not changeable, because Alerts are not implemented.
2StopBits	3	1	0 = Library interface transmits 1 stop bit per byte. 1 = Library interface transmits 2 stop bits per byte.
Cmd Fwd	3	2-3	0 = Command forwarding disabled. 1 = Command forwarding enabled. Note: Not all drives support command forwarding. If the value in this field is zero and it is not changeable, then command forwarding is not supported.
Port A Transport Type	4		Always 1, indicating SCSI Parallel.
Port A Present Selection ID	5-7		Byte 5 = 0 for SCSI drives. Byte 6 = 0 for SCSI drives. Byte 7 = The current SCSI device ID.
Port B Transport Type	8		Always 0 for SCSI drives

Field	Bytes	Bits	Description
Port B Present Selection ID	9-11		Always 0 for SCSI drives
Next Selection ID	12		The SCSI device ID that the drive will change to the next time it is reset. This is provided to obviate the need for changing address jumpers.
Jumpered Selection ID	13		The SCSI device ID that is set by external jumpers.
Target Initiated Bus Control	14		0 = no Target Initiated modes (default) 1 through FFh = Reserved
Disable Wide Bus Mode	15	00	0 = Enable Wide bus operations (default) 1 = Disable Wide bus operations – this will allow the Viper drive to be connected to narrow SCSI buses.
Reserved			All reserved bits must be 0.

Completion Status

Code	Message	Description
00h	Good Status	• The drive is ready to perform any appropriate command. • The defined mode is set and remains set until another MODE SELECT or RESET command is issued. • The tape position is not changed.
02h	Check Condition	Use the Request Sense command to retrieve status information. Possible Sense Keys are:

Code	Message	Description
04h	Hardware Error	Parity error on the SCSI bus or drive hardware failure.
05h	Illegal Request	The Page Length field is incorrect, or the Command Descriptor Block is invalid.
06h	Unit Attention	The cartridge was changed, or the drive was reset prior to this command.

MODE SENSE

The MODE SENSE command allows the host to determine various drive parameters. These parameters are sent from the drive to the host as data formatted in a parameter list. This command is complementary to the Mode Select command that sets device parameters.

The drive terminates execution of the Mode Sense command:

- When the number of bytes specified in the Allocation Length field have been sent to the host, or
- When all available Mode Sense data has been sent to the host.

If a Mode Select command has not been performed since power-on or SCSI Reset, the default mode parameters are in effect.

All Mode Select parameters may be rounded up or down, as appropriate. A Mode Sense command may be issued after a Mode Select command to determine which parameters have been rounded.

Block and page descriptions for this command are shown below and on subsequent pages.

Command Descriptor Block

6-Byte Command Descriptor Block

	Bits							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Operation Code (1Ah)							
1	Ignored LUN			Reserved	DBD	Reserved		
2	PC		Page Code					
3	Reserved							
4	Allocation Length							
5	Control							

Field Descriptions

Field	Bytes	Bits	Description
Operation Code	0		The Operation Code for the 6-byte version of Mode Sense is 1Ah.
Ignored Logical Unit	1	5-7	The LUN field is residual from the SCSI-1 days and is ignored.
DBD	1	3	0 = Return the block descriptor in the Mode Sense data. 1 = Disable Block Descriptors (DBD). NOTE: When the DBD is 1, the Block Descriptor Length in the parameter header is 0.

Field	Bytes	Bits	Description
PC	2	6-7	Page Control specifies the type of values to be returned. 00b = Report current values. 01b = Report changeable values. Any bit that can be changed by Mode Select is set to 1; otherwise, the bits are set to 0. 10b = Report default values. Returns the power-up, or reset, values. 11b = Report saved values. Returns the power-up, or reset, values.
Page Code	2	0-5	The Page Code selects the page or pages to be returned by the drive. 00h = Return only the Parameter List Header/Block Descriptor 02h = Return the Disconnect/Reconnect Page 0Ah = Return the Control Mode Page 0Fh = Return the Data Compression Control Page 10h = Return the Device Configuration Page 1Ch = Return the Information Exceptions Page 21h = Return the Drive Capabilities Page 22h = Return the Interface Control Page 3Fh = Return all available pages in ascending order starting from page 02h
Allocation Length	4		Specifies the number of bytes the host has allocated for returned Mode Sense data. The drive will not return more than this amount of data. A value of 0 is a valid entry and indicates no data.
Reserved			All reserved bits must be 0.
Control	5		See Control Byte Format on page 18.

10-Byte Command Descriptor Block

	Bits							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Operation Code (5Ah)							
1		Ignored LUN		Reserved	DBD	Reserved		
2	PC		Page Code					
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	Allocation Length, MSB							
8	Allocation Length, LSB							
9	Control							

Field Descriptions

Field	Bytes	Bits	Description
Operation Code	0		The Operation Code for the 6-byte version of Mode Sense is 1Ah.
Ignored Logical Unit	1	5-7	The LUN field is residual from the SCSI-1 days and is ignored.
DBD	1	3	0 = Return the block descriptor in the Mode Sense data. 1 = Disable Block Descriptors (DBD). NOTE: When the DBD is 1, the Block Descriptor Length in the parameter header is 0.

Field	Bytes	Bits	Description
PC	2	6-7	Page Control specifies the type of values to be returned. 00b = Report current values. 01b = Report changeable values. Any bit that can be changed by Mode Select is set to 1; otherwise, the bits are set to 0. 10b = Report default values. Returns the power-up, or reset, values. 11b = Report saved values. Returns the power-up, or reset, values. 76b = Unit
Page Code	2	0-5	The Page Code selects the page or pages to be returned by the drive. 00h = Return only the Parameter List Header/Block Descriptor 02h = Return the Disconnect/Reconnect Page 0Ah = Return the Control Mode Page 0Fh = Return the Data Compression Control Page 10h = Return the Device Configuration Page 1Ch = Return the Information Exceptions Page 21h = Return the Drive Capabilities Page 22h = Return the Interface Control Page 3Fh = Return all available pages in ascending order starting from page 02h
Allocation Length	7-8		Specifies the number of bytes the host has allocated for returned Mode Sense data. The drive will not return more than this amount of data. A value of 0 is a valid entry and indicates no data.
Reserved			All reserved bits must be 0.
Control			See Control Byte Format on page 18.

Mode Sense Data

The Mode Sense data list, for both the 6-byte CDB and 10-byte CDB versions is in the following general format:

Mode Parameter Header	The Mode Parameter Header is always returned.
Block Descriptor	The Block Descriptor is returned if DBD is 0 in the Mode Sense CDB.
Mode Parameter Pages	One or all Mode Parameter Pages may be returned depending on the value of Page Code in the Mode Sense CDB.

Mode Parameter Header

6-Byte CDB Mode Parameter Header

	Bits							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Mode Data Length							
1	Medium Type							
2	WP	Buffered Mode			Speed			
3	Block Descriptor Length							

Field Descriptions

Field	Bytes	Bits	Description
Mode Data Length	0		Mode Select: Always 0. Mode Sense: The number of bytes of data available.
Medium Type	1		Identifies the type of media currently in the drive. 0 = Data Cartridge 1 = Cleaning Cartridge
WP	2	7	Mode Select: Ignored. Mode Sense: 0 = The cartridge is not write protected. 1 = the cartridge is write protected.
Buffered Mode	2	4-6	0 = Unbuffered mode. 1 = Buffered mode (default).
Speed	2	0-3	This field indicates the tape speed. 0 = Default 3 = 2.077 m/sec (meter/second) 4 = 2.576 m/sec 5 = 3.097 m/sec 6 = 3.643 m/sec 7 = 4.153 m/sec
Block Descriptor Length	3		0 = No Block Descriptor follows. 8 = 8-byte Block Descriptor follows.
Reserved			All reserved bits must be 0.

When Buffered Mode is 1, a Write command is terminated when the data is transferred to the internal buffer of the drive. When Buffered Mode is 0 a Write command is not terminated until all data has been transferred to tape.

10-Byte CDB Mode Parameter Header

	Bits							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0 – 1	Mode Data Length							
2	Medium Type							
3	WP	Buffered Mode		Speed				
4	Reserved							
5	Reserved							
6	Block Descriptor Length, MSB							
7	Block Descriptor Length, LSB							

Field Descriptions

Field	Bytes	Bits	Description
Mode Data Length	0-1		Mode Select: Always 0. Mode Sense: The number of bytes of data available.
Medium Type	1		Identifies the type of media currently in the drive. 0 = Data Cartridge 1 = Cleaning Cartridge
WP	3	7	Mode Select: Ignored. Mode Sense: 0 = The cartridge is not write protected. 1 = the cartridge is write protected.
Buffered Mode	3	4-6	0 = Unbuffered mode. 1 = Buffered mode (default).

Field	Bytes	Bits	Description
Speed	3	0-3	This field indicates the tape speed. 0 = Default 3 = 2.077 m/sec (meter/second) 4 = 2.576 m/sec 5 = 3.097 m/sec 6 = 3.643 m/sec 7 = 4.153 m/sec
Block Descriptor Length	6-7		0 = No Block Descriptor follows. 8 = 8-byte Block Descriptor follows.
Reserved			All reserved bits must be 0.

When Buffered Mode is 1, a Write command is terminated when the data is transferred to the internal buffer of the drive. When Buffered Mode is 0 a Write command is not terminated until all data has been transferred to tape.

Block Descriptor

	Bits							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Density Code							
1	Reserved							
2	Reserved							
3	Reserved							
4	Reserved (0)							
5	Block Length, MSB							
6	Block Length							
7	Block Length, LSB							

Field Descriptions

Field	Bytes	Bits	Description
Density Code	0		Identifies the format of the tape currently in the drive. Mode Select: 00h = Default of Ultrium 1 40h = Ultrium 1 7Fh = No-op Mode Sense: 00h = Default of Ultrium 1
Block Length	5-7		0 = Variable length block mode. The Fixed bit in Read and Write commands must be 0. 1 to FFFFFFh = The length of the fixed-length block to be read or written when the Fixed bit is set in a Read or Write command.
Reserved			All reserved bits must be 0.

Mode Parameter Pages

There are several mode parameter pages that allow you to retrieve different drive parameters. The format of these pages is described in the Mode Select command, starting on page 42. The following mode parameter pages are supported:

Mode Parameter Page	See Page
Disconnect/Reconnect Page	55
Control Mode Page	56
Data Compression Control Page	57
Sequential Access Device Configuration Page	58
Information Exceptions Mode Page	59
Drive Capabilities Control Mode Page	60
Interface Control Mode Page	61

Completion Status

Code	Message	Description
00h	Good Status	• The drive is ready to perform any appropriate command. • The drive remains in any previously set mode. MODE SENSE does not set or change any modes. • The tape position is not changed. It remains at the previous position.
02h	Check Condition	Use the Request Sense command to retrieve status information. Possible Sense Keys are:

Code	Message	Description
04h	Hardware Error	Parity error on the SCSI bus or drive hardware failure.
05h	Illegal Request	The Command Descriptor Block is invalid.
06h	Unit Attention	The cartridge was changed, or the drive was reset prior to this command.

PARK UNPARK

The Park Unpark command with the park bit set requests that the drive park the load arm in preparation for transport.

The Park Unpark command with the park bit not set requests that the drive load arm be unparked. This is not usually necessary as the drive automatically unparks on power up.

In either case, attempting to issue this command while the medium is present will result in a vendor specific check condition of MEDIUM_IS_PRESENT (09/80/80).

The Park Unpark command is a vendor unique command.

Command Descriptor Block

	Bits							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Operation Code (06h)							
1	Ignored LUN			Reserved				
2	Reserved							
3	Reserved							
4	Reserved							Park
5	Control							

Field Descriptions

Field	Bytes	Bits	Description
Operation Code	0		The Operation Code for Park Unpark is 06h.
Ignored Logical Unit	1	5-7	The LUN field is residual from the SCSI-1 days and is ignored.
Park	4	0	0b = Requests the drive to be unparked. 1b = Requests the drive to be parked.
Reserved			All reserved bits must be 0.
Control	5		See Control Byte Format on page 18.

Completion Status

Code	Message	Description
00h	Good Status	• The drive is ready to perform any appropriate command. • The drive remains in any previously set mode. • The tape position is not changed.
02h	Check Condition	Use the Request Sense command to retrieve status information. Possible Sense Keys are:

Code	Message	Description
04h	Hardware Error	Drive hardware failure.
05h	Illegal Request	The Command Descriptor Block is invalid.
06h	Unit Attention	The cartridge was changed, or the drive was reset prior to this command.
09h	Medium Present	Cannot park drive with medium present.

PREVENT ALLOW MEDIA REMOVAL

The Prevent Allow Medium Removal command requests that the target enable or disable the removal of the medium from the drive. The drive will not allow medium removal if any initiator currently has medium removal prevented.

If medium removal is prevented and the medium is in the loaded position, then:

- Pressing the eject button on the front panel will be ignored.
- The Load Unload command with the LOAD bit set to zero will result in a Check Condition status. The sense code is set to Illegal Request and the Additional Sense to Medium Removal Prevented (5302).

All initiators that have prevented medium removal must enable it before the medium can be removed from the drive.

A bus reset, BDR message or power cycle will clear any previous medium removal prevented setting and allow medium removal.

Command Descriptor Block

	Bits							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Operation Code (1Eh)							
1	Ignored LUN			Reserved				
2	Reserved							
3	Reserved							
4	Reserved						Prevent	
5	Control							

Field Descriptions

Field	Bytes	Bits	Description
Operation Code	0		The Operation Code for Prevent/Allow Medium Removal is 1Eh.
Ignored Logical Unit	1	5-7	The LUN field is residual from the SCSI-1 days and is ignored.
Prevent	4	0-1	00b = Medium removal allowed. 01b = Medium removal prevented. 10b = Not supported, no medium changer. 11b = Not supported, no medium changer.
Reserved			All reserved bits must be 0.
Control	5		See Control Byte Format on page 18.

Completion Status

Code	Message	Description
00h	Good Status	• The drive is ready to perform any appropriate command. • The drive remains in any previously set mode. • The tape position is not changed.
02h	Check Condition	Use the Request Sense command to retrieve status information. Possible Sense Keys are:

Code	Message	Description
04h	Hardware Error	Parity error on the SCSI bus or drive hardware failure.
05h	Illegal Request	The Command Descriptor Block is invalid.
06h	Unit Attention	The cartridge was changed, or the drive was reset prior to this command.

READ

The READ command transfers one or more bytes or blocks from the drive to the Initiator beginning with the next block on tape.

If the Fixed flag is clear and Transfer Length is not zero, then a single block of the length in Transfer Length is transferred. If the next block on tape is of this length or shorter then it is transferred to the initiator. If the next block is longer than this length, then only the length requested is returned and the logical position is set to after the record. If the length of the block was the same as the Transfer Length field, then good status is returned. If the length of the block was not the same as in Transfer Length and the Suppress Illegal Length Indicator (SILI) flag was clear, then Check Condition Status is returned. If the length of the block was not the same as in Transfer Length and the Suppress Illegal Length Indicator (SILI) flag was set, then Good status is returned.

If the fixed flag is set and the Transfer Length field is not zero and the Suppress Illegal Length Indicator (SILI) flag is clear, then a sequence of blocks of the currently configured block length is to be returned, the number of blocks being indicated in the Transfer Length field. If there is a sequence of blocks of this length on the tape, they are returned to the initiator with good status. If a block that is longer than the configured length is encountered before the sequence is complete, the blocks up to that block are returned followed by the configured length from the record that was too long and Check Condition status. If a block that is shorter than the configured length is encountered before the sequence is complete, the blocks up to that block are returned followed by all of that block and Check Condition status. The current position is set after the last block that was returned or partially returned.

If the Transfer Length field is zero and the Suppress Illegal Length Indicator and the Fixed bit are not both set, then no action is taken.

If Suppress Illegal Length Indicator (SILI) flag is set and the Fixed bit is set, then Check Condition status is returned. The sense key is set to Illegal Request and the Additional Sense to Invalid Field in CDB (2400).

Command Descriptor Block

The following table shows the layout of the CDB.

	Bits							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Operation Code (08h)							
1	Ignored LUN			Reserved			SILI	Fixed
2	Transfer Length, MSB							
3	Transfer Length							
4	Transfer Length, LSB							
5	Control							

Field Descriptions

Field	Bytes	Bits	Description
Operation Code	0		The Operation Code for Read is 08h.
Ignored Logical Unit	1	5-7	The LUN field is residual from the SCSI-1 days and is ignored.
SILI	1	1	0 = Return Check Status when an incorrect block length is detected. 1 = Suppresses incorrect length error reporting when reading variable-length blocks
Fixed	1	0	0 = Variable block length. Transfer Length contains the number of bytes to return. 1 = Fixed block length, as specified by the Mode Select Block Descriptor. Transfer Length contains the number of blocks to return
Transfer Length	2-4		This field specifies the number of bytes (Fixed = 0) or blocks (Fixed = 1) to be read. A transfer length of 0 is valid and no data is transferred.
Reserved			All reserved bits must be 0.
Control	5		See Control Byte Format on page 18.

If the SILI bit is 1 and the Fixed bit is 1, the drive returns a Check Condition with Illegal Request sense key with an additional sense code of Invalid Field in CDB.

When the SILI bit is 1 and Fixed bit is 0 and the only error encountered by the drive is that the actual block length differs from the requested transfer length, then the drive:

- Returns a Check Condition if the actual block length is larger than the requested transfer length and the Block Length field in the Mode Parameter block descriptor is nonzero.
- Does not return a Check Condition if the actual block length is smaller than the requested transfer length or if the actual block is larger than the requested block and the block length in the Mode Parameter block descriptor is 0.

If the Fixed flag is clear and Transfer Length is not zero, then a single block of the length in Transfer Length is transferred. If the next block on tape is of this length or shorter then it is transferred to the initiator. If the next block is longer than this length, then only the length requested is returned and the logical position is set to after the record. If the length of the block was the same as the Transfer Length field, then good status is returned. If the length of the block was not the same as in Transfer Length and the Suppress Illegal Length Indicator (SILI) flag was clear, then Check Condition Status is returned. If the length of the block was not the same as in Transfer Length and the Suppress Illegal Length Indicator (SILI) flag was set, then Good status is returned.

If the fixed flag is set and the Transfer Length field is not zero and the Suppress Illegal Length Indicator (SILI) flag is clear, then a sequence of blocks of the currently configured block length is returned, the number of blocks being indicated in the Transfer Length field. If there is a sequence of blocks of this length on the tape, they are returned to the initiator with good status. If a block that is longer than the configured length is encountered before the sequence is complete, the blocks up to that block are returned followed by the configured length from the record that was too

long and Check Condition status. If a block that is shorter than the configured length is encountered before the sequence is complete, the blocks up to that block are returned followed by all of that block and Check Condition status. The current position is set after the last block that was returned or partially returned.

If the Transfer Length field is zero and the Suppress Illegal Length Indicator and the Fixed bit are not both set, then no action is taken.

If Suppress Illegal Length Indicator (SILI) flag is set and the Fixed bit is set, then Check Condition status is returned. The sense key is set to Illegal Request and the Additional Sense to Invalid Field in CDB (2400).

Read Command Operation

The Read command is complete when one of the following conditions is met. These conditions are described in the following paragraphs.

- End-of-Data (EOD) is reached.
- A filemark (FM) is read.
- Transfer length is satisfied
- End-of-Tape (EOT) or end-of-partition (EOP) is reached.
- Unrecoverable data error occurs.
- Detection of incorrect block length.

End-of-Data

If EOD is encountered, the command terminates with a Check Condition status and a Sense Key of 08h. If the Valid bit (byte 0, bit 7) is set indicating a residual count, the Residual length field is determined as follows:

- If the Fixed bit is 1, it equals the difference between the CDB transfer length and the number of actual blocks read.
- If the Fixed bit is 0, it equals the CDB transfer length.

The tape is then positioned to allow an Append Data operation.

Filemark

If a filemark is encountered, the command terminates with a Check Condition, and the filemark bit (byte 2, bit 7) of the sense data is set to 1. If the Valid bit (byte 0, bit 7) is set indicating a residual count, the Residual length field is determined as follows:

- If the Fixed bit is 1, it equals the difference between the CDB transfer length and the number of actual blocks read.
- If the Fixed bit is 0, it equals the CDB transfer length.

On termination, the tape is positioned after the filemark on the EOT side of tape.

Transfer Length Satisfied

If the CDB Transfer Length is satisfied, the command completes successfully with a Good Status, and the tape is positioned on the EOT side of the last block read.

End of Tape (EOT) or End-of-Partition (EOP)

When the end-of-tape or end-of-partition position is encountered, the command terminates with a Check Condition and Medium Error (03h) sense key. The Valid bit (byte 0, bit 7) and the EOM bit (byte 2, bit 6) are set.

The Residual Length field is then set as follows:

- If the Fixed bit is 1, it equals the difference between the CDB transfer length and the number of actual blocks read.
- If the Fixed bit is 0, it equals the CDB transfer length.

The logical position after encountering an end-of-tape or end-of-partition error is undetermined.

Recoverable Data Error

If an error is encountered while reading the drive applies its retry algorithms. If the retry algorithm reread attempts fail the error is considered unrecoverable and is reported as such.

Unrecoverable Data Error

If an Unrecoverable Data Error is encountered, the READ command terminates with Check Condition and a Medium Error (03h) sense key.

If the Valid bit (byte 0, bit 7) is set, Residual Length field equals the difference between the requested Transfer Length and the actual number of blocks or bytes transferred. On termination, the tape is positioned after the error block on the EOT side of tape.

Incorrect Length

Writing fixed- and variable-length blocks varies according to the setting of the Fixed bit.

When the Fixed bit is set (1), one or more tape blocks can be read. The CDB Transfer Length field specifies the block count to read. The block size is the current block size of the drive, which is set to 512 at power-up or after a SCSI Bus Reset.

The host can change the current block size by issuing a MODE SELECT command with a new block descriptor parameter that specifies a new block size. If the current block size differs from the actual block size of the block being read, the drive reports an Incorrect Length error.

When the Fixed bit is reset (0), the CDB Transfer Length field indicates the number of bytes to be read. When the actual block size found on tape differs from the CDB Transfer Length, an Incorrect Length error is reported.

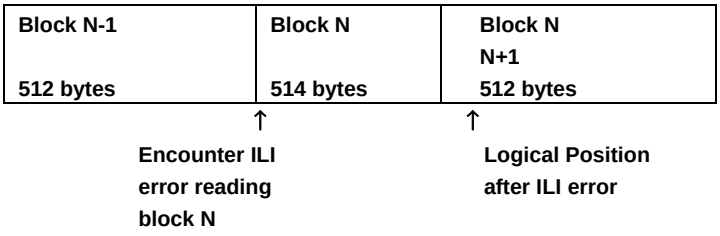
The drive reports the Incorrect Length error based on the Suppress Incorrect Length Indicator (SILI) bit as follows:

- If the actual block length exceeds the CDB Transfer Length, the Incorrect Length error is reported.
- If the actual block length is smaller than the CDB Transfer Length and the SILI bit is 1, the drive ignores (that is, suppresses) the Incorrect Length error.
- If the actual block length is different than the CDB Transfer Length and the SILI bit is 0, the drive reports the Incorrect Length error.

The drive reports the Incorrect Length error by returning a Check Condition. The Incorrect Length Indicator bit (byte 2, bit 5) of the Request Sense data is set (1) indicating the Incorrect Length error. The Valid bit (byte 0, bit 7) of the Request Sense data is also set (1) indicating that the residual data (bytes 3 through 6) is valid. The meaning of the residual data depends on the setting of the Fixed bit.

For reading both fixed- and variable-length blocks, the logical position after encountering an Incorrect Length error in block N is always at the end of block N. The following figure illustrates this position.

Current Block Size = 512 bytes/block



Fixed Mode Residual Data

When the Fixed bit is set (1), the residual data is set to the CDB Transfer Length *minus* the actual number of blocks *correctly* read without encountering an ILI error.

For example, assume the following:

- The current block size is 512 bytes/block.
- The drive is currently positioned before block N.
- Block N contains 514 bytes.

If the host issues a READ command with a CDB Transfer Length of one, indicating one 512-byte block is to be read, the drive transfers the first 512 bytes of block N; then skips the last two bytes (513 and 514) and reports a Check Condition (caused by an Incorrect Length error). The residual is set to one. This residual is determined as follows:

CDB Transfer Length = Number of blocks correctly read without encountering an ILI error (1 - 0 = 1).

The logical position after the error is after byte 514 of block N.

Variable Mode Residual Data

When the Fixed bit is reset (0), the residual data is always set to the CDB Transfer Length.

For example, assume the following:

- The drive is currently positioned before block N.
- Block N + 1 contains 512 bytes.

The host issues a READ command with a CDB Transfer Length of 514, indicating 514 bytes of data to be read. The drive transfers the first 512 bytes of block N; then stops because of an Incorrect Length error. The logical position after the error is after byte 512 of block N.

If the SILI bit is set (1), the drive does not report a Check Condition (caused by Incorrect Length error).

If the SILI bit is reset (0), the drive reports a Check Condition, and the residual is set to 2 (CDB Transfer Length = 514).

In the above example, if the block size of block N is 514 bytes and a READ command specifies a Transfer Length of 512 bytes, the drive transfers the first 512 bytes of block N; then skips the last two bytes to position itself at the end of byte 514 of block N. The residual is set to -2. Because the actual block length exceeds the CDB Transfer Length, the drive unconditionally reports Check Condition. In this case, the residual is set to -2.

Completion Status

<table>
<tr><th>Code</th><th>Message</th><th colspan="3">Description</th></tr>
<tr><td>00h</td><td>Good Status</td><td colspan="3">• The drive is ready to perform any appropriate command.
• The drive remains in any previously set mode.
• The tape is positioned on the EOT side of the last block read.</td></tr>
<tr><td>02h</td><td>Check Condition</td><td colspan="3">Use the Request Sense command to retrieve status information. Possible Sense Keys are:</td></tr>
<tr><td></td><td></td><td>Code</td><td>Message</td><td>Description</td></tr>
<tr><td></td><td></td><td>02h</td><td>Not Ready</td><td>No cartridge is in the drive.</td></tr>
<tr><td></td><td></td><td>03h</td><td>Media Error</td><td>Unrecoverable data error encountered.</td></tr>
<tr><td></td><td></td><td>04h</td><td>Hardware Error</td><td>Parity error on the SCSI bus or drive hardware failure.</td></tr>
<tr><td></td><td></td><td>05h</td><td>Illegal Request</td><td>The Command Descriptor Block is invalid.</td></tr>
<tr><td></td><td></td><td>06h</td><td>Unit Attention</td><td>The cartridge was changed, or the drive was re-set prior to this command.</td></tr>
<tr><td></td><td></td><td>08h</td><td>Blank Check</td><td>The drive encountered EOD.</td></tr>
</table>

READ BLOCK LIMITS

The Read Block Limits command requests that the drive return the maximum and minimum block sizes that it supports. The minimum block length is always reported as 1 byte, the maximum as 2^{24}-1 bytes.

Command Descriptor Block

	Bits							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Operation Code (05h)							
1	Ignored LUN			Reserved				
2	Reserved							
3	Reserved							
4	Reserved							
5	Control							

Field Descriptions

Field	Bytes	Bits	Description
Operation Code	0		The Operation Code for Read Block Limits is 05h
Ignored Logical Unit	1	5-7	The LUN field is residual from the SCSI-1 days and is ignored.
Reserved			All reserved bits must be 0.
Control	5		See Control Byte Format on page 18.

The host specifies the actual block size in fixed mode with the Mode Select command and in variable mode with the transfer/allocation length of Read and Write commands. The use of the Mode Sense command determines the current block size. The Read Block Limits command indicates the minimum and maximum block size that the drive can support.

Block Limit Data

The Read Block Limits command returns data in the following format.

	Bits							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Reserved							
1	Maximum Block Length, MSB							
2	Maximum Block Length							
3	Maximum Block Length, LSB							
4	Minimum Block Length, MSB							
5	Minimum Block Length, LSB							

Field Descriptions

Field	Bytes	Bits	Description
Reserved			All reserved bits must be 0.
Maximum Block Length	1-3		Always FFFFFFh, indicating a maximum block length of 2^{24}-1 bytes.
Minimum Block Length	4-5		Always 0001h, indicating a minimum block length of 1.

Completion Status

Code	Message	Description
00h	Good Status	• The drive is ready to perform any appropriate command. • The drive remains in any previously set mode. • The tape position is not changed.
02h	Check Condition	Use the Request Sense command to retrieve status information. Possible Sense Keys are:

Code	Message	Description
02h	Not Ready	No cartridge is in the drive.
04h	Hardware Error	Parity error on the SCSI bus or drive hardware failure.
05h	Illegal Request	The Command Descriptor Block is invalid.
06h	Unit Attention	The cartridge was changed, or the drive was reset prior to this command.

READ BUFFER

The Read Buffer command reads data from the memory on the drive and sends it to the initiator. This command is used in conjunction with the Write Buffer command as a diagnostic function for testing the drive buffer memory and confirming the SCSI bus integrity. The tape is not accessed during execution of this command.

Command Descriptor Block

Byte	Bits 7	6	5	4	3	2	1	0
0	Operation Code (3Ch)							
1	Ignored LUN			Reserved			Mode	
2	Buffer ID							
3	Buffer Offset (MSB)							
4	Buffer Offset							
5	Buffer Offset (LSB)							
6	Allocation Length (MSB)							
7	Allocation Length							
8	Allocation Length (LSB)							
9	Control							

Field Descriptions

Field	Bytes	Bits	Description
Operation Code	0		The operation code for Read Buffer is 3Ch.
Ignored Logical Unit	1	5-7	The LUN field is residual from the SCSI-1 days and is ignored.
Mode	1	0-3	0000b = Return descriptor and data. 0001b = Return Medium Auxiliary Memory(MAM) 0010b = Return data only. 0011b = Return descriptor only. 0100b = Return Trace Buffer data.
Buffer ID	2		00h = normal access (default) 54h = specifies access to MAM
Buffer Offset	3-5		For Mode not equal 0001b: The offset from the beginning of the specified buffer in bytes. For Mode equal 0001b: Set to the MAM page code as described in the tables or FFFFFFh to specify the entire 4KB MAM.
Allocation length	6-8		Specifies the amount of data bytes to be returned. A value of 0 is a valid entry and returns no data. The drive stops sending data when the number of bytes specified has been transferred or when all available data has been sent.
Reserved			All reserved bits must be 0.
Control	9		See Control Byte Format on page 18.

A Mode of 0000b requests that the data returned consist of a 4-byte descriptor header followed by the data from the buffer. The 4-byte header is included in the number of bytes specified by the Allocation Length. The Buffer ID and Buffer Offset fields are reserved.

A Mode of 0001b requests that data from the Medium Auxiliary Memory or EEPROM is returned.

A Mode of 0010b requests that only the data from the buffer is returned.

A Mode of 0011b requests that only the 4-byte descriptor header is returned. A Buffer ID value for which there is no buffer associated will result in an all zero header. The Buffer Offset field is reserved.

The Buffer ID field indicates which buffer is to be read. All drives support buffer 0. Other buffers may be available in the drive.

The Buffer Offset field may be used to specify the offset within the specified buffer from which the data will be transferred.

The Allocation Length is used to specify the number of bytes that the initiator has allocated for the returned data.

Read Buffer Descriptor

If the Mode field is set to 0000b or 0011b, then the data returned includes a 4 byte Read Buffer Descriptor. The following table shows the fields in the Read Buffer Descriptor.

	Bits							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Reserved (0)							
1	Buffer capacity, MSB							
2	Buffer capacity							
3	Buffer capacity, LSB							

Field Descriptions

Field	Bytes	Bits	Description
Reserved	0		All bits are 0.
Buffer Capacity	1-3		The capacity of the drive's data buffer.

MAM Page Definitions

The following sections detail the pages available in the MAM. Always refer to document 10005285-001 EEPROM Usage Specification for the latest up-to-date EEPROM data and Ultrium Generation 1 8-Channel Format Specification Document for the latest up-to-date MAM data.

MAM Pages

The table below shows the Page ID used to identify each page within the MAM. Note that a Page ID of 0xFFFFFF is used when reading the entire MAM.

An optional page will not exist unless the drive has preformed an operation that requires information be stored to that optional page. A Read Buffer command to an

optional page that has not been created will result in a check condition LUN NOT READY AUXILIARY MEMORY NOT ACCESSIBLE.

Page ID	Access	Description
FFFFFFh	RO	All pages.
FFFFFEh	RO	Page of pages.
000001h	RO	Cartridge Manufacturer's Information
000002h	RO	Media Manufacturer's Information (optional)
0000F0h-0000FFh	RO	Drive Manufacturer Support (cleaning tape only)
000101h	RO	Initialization Data
000102h	RO	Tape Write Pass
000103h	RO	Tape Directory
000104h	RO	EOD Information
000105h	RO	Cartridge Status and Tape Alert Flags
000106h	RO	Mechanism Related (optional)
000107h	RO	Suspended Append Writes
000108h-00010Bh	RO	Usage Information (optional)
0001FCh-0001FFh	RO	Cleaning Usage Information (optional, cleaning tape only)
000200h	RW	Application Specific (optional)

Completion Status

Code	Message	Description
00h	Good Status	• The drive is ready to perform any appropriate command. • The drive remains in any previously set mode. • The tape position is not changed.
02h	Check Condition	Use the Request Sense command to retrieve status information. Possible Sense Keys are:

Code	Message	Description
04h	Hardware Error	Drive hardware failure detected.
05h	Illegal Request	The Command Descriptor Block is invalid.
06h	Unit Attention	The cartridge was changed or the drive was reset prior to this command.

READ POSITION

The Read Position command reports the block address of the current data block. The current data block is the first data block that would be read from the current tape partition if a Read command were issued.

Command Descriptor Block

Byte	Bits 7	6	5	4	3	2	1	0
0	Operation Code (34h)							
1	Ignored LUN			Reserved		TCLP	Long	Reserved
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	Reserved							
8	Reserved							
9	Control							

Field Descriptions

Field	Bytes	Bits	Description
Operation Code	0		The Operation Code for Read Position is 34h.
Ignored Logical Unit	1	5-7	The LUN field is residual from the SCSI-1 days and is ignored.
TCLP	1	2	1 = The drive returns data specifying the partition, file and set number with the current logical position. 0 = The drive returns data specifying the first and last block location. The Long bit and the TCLP bit must be equal, otherwise, the command shall be terminated with Check Condition status. The sense key shall be set to Illegal Request, and the additional sense code and an additional sense code qualifier set to Invalid Field in CDB.
Long	1	1	1 = The drive shall return 32 bytes of data. 0 = The drive shall return 20 bytes of data. The Long bit and the TCLP bit must be equal, otherwise, the command shall be terminated with Check Condition status. The sense key shall be set to Illegal Request, and the additional sense code and an additional sense code qualifier set to Invalid Field in CDB.
Reserved	2-8		All reserved bits must be 0.
Control	9		See Control Byte Format on page 18.

Read Position Data

The Read Position command returns a block of Read Position Data. The following table shows the fields in the Read Position Data when Long is 0.

Byte	Bits 7	6	5	4	3	2	1	0
0	BOP	EOP	Reserved			BPU	Reserved	
1	Partition Number (0)							
2	Reserved							
3	Reserved							
4	First Block Location, MSB							
5	First Block Location							
6	First Block Location							
7	First Block Location, LSB							
8	Last Block Location, MSB							
9	Last Block Location							
10	Last Block Location							
11	Last Block Location, LSB							
12	Reserved							
13	Number of blocks in buffer, MSB							
14	Number of blocks in buffer							
15	Number of blocks in buffer, LSB							
16	Number of bytes in buffer, MSB							
17	Number of bytes in buffer							
18	Number of bytes in buffer							
19	Number of bytes in buffer, LSB							

Field Descriptions

Field	Bytes	Bits	Description
BOP	0	7	0 = The current logical position is not at BOT. 1 = The current logical position is at Beginning-of-Partition (BOT).
EOP	0	6	0 = The current logical position is not between early-warning and end-of-tape. 1 = The current logical position is between early-warning and end-of-tape.
BPU	0	2	0 = First Block Location and Last Block Location fields are valid. 1 = First Block Location and Last Block Location fields are invalid.
Partition Number	1		This field is always 0.
First Block Location	4-7		The block address of the current logical position.
Last Block Location	8-11		The block address of the current logical position. Always the same as First Block Location.
Number of blocks in buffer	13-15		This field is not supported and is always 0.
Number of bytes in buffer	16-19		This field is not supported and is always 0.
Reserved			All bits are 0.

The First Block Location and the Last Block Location are both set to the number of blocks and file marks between BOT and current logical position. If the tape is at BOT, 0 is returned in these fields. The Beginning of Partition (BOP) flag is set if the Block Location fields are zero.

The following table shows the fields in the Read Position Data when Long and TCLP bits are set to 1.

Byte	Bits 7	6	5	4	3	2	1	0
0	BOP	EOP	Reserved		MPU	BPU	Reserved	
1	Reserved							
2	Reserved							
3	Reserved							
4	Partition Number, MSB (0)							
5	Partition Number (0)							
6	Partition Number (0)							
7	Partition Number, LSB (0)							
8	Block Number, MSB							
9	Block Number							
10	Block Number							
11	Block Number							
12	Block Number							
13	Block Number							
14	Block Number							
15	Block Number, LSB							
16	File Number, MSB							
17	File Number							
18	File Number							
19	File Number							
20	File Number							
21	File Number							
22	File Number							
23	File Number, LSB							
24	Set Number, MSB (0)							
25	Set Number (0)							
26	Set Number (0)							
27	Set Number (0)							
28	Set Number (0)							
29	Set Number (0)							
30	Set Number (0)							
31	Set Number, LSB (0)							

Field Descriptions

Field	Bytes	Bits	Description
BOP	0	7	0 = The current logical position is not at BOT. 1 = The current logical position is at Beginning-of-Partition (BOT).
EOP	0	6	0 = The current logical position is not between early-warning and end-of-tape. 1 = The current logical position is between early-warning and end-of-tape.
MPU	0	3	0 = File Number field is valid. 1 = File Number field is invalid.
BPU	0	2	0 = Block Number field is valid. 1 = Block Number field is invalid.
Partition Number	4-7		This field is always 0.

Field	Bytes	Bits	Description
Block Number	8-15		This field indicates the number of logical blocks including filemarks between beginning-of-medium and the current logical position.
File Number	16-23		This field indicates the number of filemarks between beginning-of-medium and the current logical position.
Set Number	24-31		This field is always 0.
Reserved			All bits are 0.

Completion Status

Code	Message	Description
00h	Good Status	• The drive is ready to perform any appropriate command. • The drive remains in any previously set mode. • The tape is not moved.
02h	Check Condition	Use the Request Sense command to retrieve status information. Possible Sense Keys are:

Code	Message	Description
02h	Not Ready	No cartridge is in the drive.
04h	Hardware Error	Drive hardware failure detected.
05h	Illegal Request	The CDB contains an invalid bit.
06h	Unit Attention	The cartridge was changed, or the drive was reset prior to this command.

RECEIVE DIAGNOSTIC RESULTS

The Receive Diagnostic Results command requests that the results of a previously executed Send Diagnostics command be sent to the initiator.

Command Descriptor Block

Byte	Bits 7	6	5	4	3	2	1	0
0	Operation Code (1C)							
1	Ignored LUN			Reserved				PCV
2	Page Code							
3	Allocation Length (MSB)							
4	Allocation Length (LSB)							
5	Control							

Field Descriptions

Field	Bytes	Bits	Description
Operation Code	0		The Operation Code for Receive Diagnostic Results is 1Ch.
Ignored Logical Unit	1	5-7	The LUN field is residual from the SCSI-1 days and is ignored.
Reserved	1	1-4	All reserved bits must be 0.
PCV	1	0	Page Code Valid bit. Not supported, should be set to 0.
Page Code	2		Valid only when PCV bit is set.
Allocation length	3-4		Specifies the amount of data to be returned. An ALLOCATION LENGTH of 0 is valid and shall not be considered an error.
Control	5		See Control Byte Format on page 18.

Returned Data

The Receive Diagnostic Results command returns a diagnostic page that reports the results of the previous Send Diagnostics command.

Returned Data Format

Byte	Bits 7	6	5	4	3	2	1	0
0	Page Code							
1	Reserved							
2	Page Length (MSB)							
3	Page Length (LSB)							
4	Diagnostic Parameter (MSB)							
5	Diagnostic Parameter							
6	Diagnostic Parameter							
7	Diagnostic Parameter (LSB)							

Field Descriptions

Field	Bytes	Description
Page Code	0	Identifies the type of diagnostic page being returned.
Reserved	1	All reserved bits must be 0.
Page Length	2-3	Indicates the number of bytes of data to be returned after this block.
Diagnostic Parameter	4-7	The results of the Send Diagnostics command test. A code of zero indicates that the drive passed the test. A non zero code indicates that the drive has failed the test. The value returned corresponds to the Message Code described in Appendix A.

Completion Status

Status	Message	Description
00h	Good Status	♦ The drive is ready to perform any appropriate command. ♦ The drive remains in any previously set mode. ♦ The tape position is not changed.
02h	Check Condition	Use the Request Sense command to retrieve status information. Possible Sense Keys are:

Code	Message	Description
04h	Hardware Error	Drive hardware failure detected.
05h	Illegal Request	The CDB contains an invalid bit.
06h	Unit Attention	The cartridge was changed, or the drive was reset prior to this command.

RELEASE UNIT

The Release Unit command releases a current drive reservation, if the command is received from the Initiator that established the reservation.

Any Release Unit command that arrives from other than the originating requester is ignored and Good Status is returned in response to the command.

Third Party reservations are not supported.

It is not an error to attempt to release an ID that is not currently reserved to the requesting Initiator. A reservation cannot be released if the reservation was made by another Initiator. Other events and conditions that can cause a reservation to be released are discussed under the Reserve Unit command.

Command Descriptor Blocks

6-Byte Command Descriptor Block

Byte	Bits 7	6	5	4	3	2	1	0
0	Operation Code (17h)							
1	Ignored LUN			Reserved				
2	Reserved							
3	Reserved							
4	Reserved							
5	Control							

Field Descriptions

Field	Bytes	Bits	Description
Operation Code	0		The Operation code for the 6-byte version of Release Unit is 17h.
Ignored Logical Unit	1	5-7	The LUN field is residual from the SCSI-1 days and is ignored.
Reserved			All reserved bits must be 0.
Control	5		See Control Byte Format on page 18.

10-byte Command Descriptor Block

Byte	Bits 7	6	5	4	3	2	1	0
0	Operation Code (57h)							
1	Ignored LUN			Reserved				
2	Reserved							
3	Ignored Third Party Device ID							
4	Reserved							
5	Reserved							
6	Reserved							
7	Reserved							
8	Reserved							
9	Control							

Field Descriptions

Field	Bytes	Bits	Description
Operation Code	0		The Operation code for the 10-byte version of Release Unit is 57h.
Ignored Logical Unit	1	5-7	The LUN field is residual from the SCSI-1 days and is ignored.
Ignored Third Party Device ID	3		This field is ignored by the drive.
Reserved			All reserved bits must be 0.
Control	5		See Control Byte Format on page 18.

Completion Status

Code	Message	Description
00h	Good Status	• The drive is ready to perform any appropriate command. • The drive remains in any previously set mode. • The drive accepts commands from any Initiator. • The tape position is not changed.
02h	Check Condition	Use the Request Sense command to retrieve status information. Possible Sense Keys are:

Code	Message	Description
04h	Hardware Error	Parity error on the SCSI bus or drive hardware failure.
05h	Illegal Request	The Command Descriptor Block is invalid.
06h	Unit Attention	The cartridge was changed, or the drive was reset prior to this command.

REPORT DENSITY SUPPORT

The Report Density Support command returns details about the tape formats supported by the drive. The data is returned as a header and a series of descriptor blocks. If the Media flag is set, then one descriptor block is returned with the data for the currently loaded tape. If the Media bit is clear, then one descriptor block is returned for each format supported by the drive.

Command Descriptor Block

Byte	Bits 7	6	5	4	3	2	1	0
0	Operation Code (44h)							
1	Ignored LUN			Reserved				Media
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	Allocation Length, MSB							
8	Allocation Length, LSB							
9	Control							

Field Descriptions

Field	Bytes	Bits	Description
Operation Code	0		The Operation code for Report Density is 44h.
Ignored Logical Unit	1	5-7	The LUN field is residual from the SCSI-1 days and is ignored.
Media	1	0	0 = Report all densities supported by drive. 1 = Report current media density.
Allocation Length	7-8		Specifies the amount of data to be returned, in bytes.
Reserved			All reserved bits must be 0.
Control	9		See Control Byte Format on page 18.

Report Density Support Data

The Report Density Support returns a header followed by one or more pages of data.

Report Density Support Header

Byte	Bits 7	6	5	4	3	2	1	0
0	Available Density Descriptor Length, MSB							
1	Available Density Descriptor Length, LSB							
2	Reserved							
3	Reserved							

Field Descriptions

Field	Bytes	Bits	Description
Available Density Descriptor Length	0-1		The total amount of data that is available to be returned excluding this field.
Reserved	2-3		All reserved bits are 0.

One or more Report Density Support pages in the format shown below follow the header.

Report Density Support Data Block Descriptor

Byte	Bits 7	6	5	4	3	2	1	0
0	Primary Density Code							
1	Secondary Density Code							
2	WRTOK	DUP	DEFLT	Reserved				
3	Reserved							
4	Reserved							
5	Bits per mm, MSB							
6	Bits per mm							
7	Bits per mm, LSB							
8	Media Width, MSB							
9	Media Width, LSB							
10	Tracks, MSB							
11	Tracks, LSB							
12	Capacity, MSB							
13	Capacity							
14	Capacity							
15	Capacity, LSB							
16-23	Assigning Organization							
24-31	Density Name							
32-51	Description							

Field Descriptions

Field	Bytes	Bits	Description
Primary Density Code	0		40h, indicating Ultrium 1
Secondary Density Code	1		40h, indicating Ultrium 1
WRTOK	2	7	0 = This format can only be read. 1 = This format can be read and written.
DUP	2	6	Always 0, indicating that each density is only reported once.
DEFLT	2	5	0 = Not the density of the current medium. 1 = This is the density of the current medium. This is always 1 for first generation drives since all media is the same format.
Bits per mm	5-7		4880
Media Width	8-9		127
Tracks	10-11		384

Field	Bytes	Bits	Description
Capacity	12-15		Can be one of the following nominal values: 100,000 MB 50,000 MB 30,000 MB 10,000 MB
Assigning Organization	16-23		8 bytes of ASCII data, “LTO-CVE ”
Density Name	24-31		8 bytes of ASCII data. Can be one of the following: “U-18-100” “U-18-50 “ “U-18-30 “ “U-18-10 “
Description	32-51		20 bytes of ASCII data. Can be one of the following: “Ultrium 1/8T 100GB ” “Ultrium 1/8T 50GB ” “Ultrium 1/8T 30GB ” “Ultrium 1/8T 10GB ”
Reserved			All reserved bits are 0.

Completion Status

Code	Message	Description
00h	Good Status	• The drive is ready to perform any appropriate command. • The drive remains in any previously set mode. • The drive accepts commands from any Initiator. • The tape position is not changed.
02h	Check Condition	Use the Request Sense command to retrieve status information. Possible Sense Keys are:

Code	Message	Description
04h	Hardware Error	Parity error on the SCSI bus or drive hardware failure.
05h	Illegal Request	The Command Descriptor Block is invalid.
06h	Unit Attention	The cartridge was changed, or the drive was reset prior to this command.

REPORT LUNS

The host uses this command to retrieve information about which Logical Units the drive supports. The allocation length shall be at least 16 bytes. If this is not the case, drive will return Check Condition status and provide a sense key of Illegal Request and additional sense of INVALID FIELD IN CDB.

Command Descriptor Block

The following table shows the layout of the CDB.

Byte	Bits 7	6	5	4	3	2	1	0
0	Operation Code (A0h)							
1	Ignored LUN			Reserved				
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	Allocation Length, MSB							
7	Allocation Length							
8	Allocation Length							
9	Allocation Length, LSB							
10	Reserved							
11	Control							

Field Descriptions

Field	Bytes	Bits	Description
Operation Code	0		The Operation code for Report LUNS is A0h.
Ignored Logical Unit	1	5-7	The LUN field is residual from the SCSI-1 days and is ignored.
Allocation Length	6-9		Specifies the amount of data to be returned, in bytes. Must be at least 16 bytes or the drive will return Check Condition.
Reserved			All reserved bits must be 0.
Control	11		See Control Byte Format on page 18.

Report LUNS Data

The following header is returned by the Report LUNS command.

Byte	Bits 7	6	5	4	3	2	1	0
0	LUN List Length, MSB							
1	LUN List Length							
2	LUN List Length							
3	LUN List Length, LSB							
4	Reserved							
5	Reserved							
6	Reserved							

Byte	Bits 7	6	5	4	3	2	1	0
7	Reserved							
8-15	LUN 0							

Field Descriptions

Field	Bytes	Bits	Description
LUN List Length	0-3		Always 8, indicating the length of the LUN list, starting in byte 8.
Reserved	4-7		All reserved bits must be 0.
LUN 0	8-15		Always 0, indicating LUN 0.

Future drives may supports multiple Logical Unit Numbers. This would increase the LUN List Length and add additional LUNs to the LUN List after byte 15.

Completion Status

Code	Message	Description
00h	Good Status	• The drive is ready to perform any appropriate command. • The drive remains in any previously set mode. • The drive accepts commands from any Initiator. • The tape position is not changed.
02h	Check Condition	Use the Request Sense command to retrieve status information. Possible Sense Keys are:

Code	Message	Description
04h	Hardware Error	Parity error on the SCSI bus or drive hardware failure.
05h	Illegal Request	The Command Descriptor Block is invalid.
06h	Unit Attention	The cartridge was changed, or the drive was reset prior to this command.

REQUEST SENSE

The Request Sense command returns the status of the last command.

Sense Data is updated with each command; therefore, the sense data only reports the status of the immediately previous command. If a Check Condition status results, a Request Sense command should be issued to recover the information form the Sense Data.

The Request Sense command returns Check Condition status only if a fatal error occurs during execution of the Request Sense command. If nonfatal errors occur during the Request Sense execution, Good Status is returned. Sense Data may be invalid following a fatal error on a Request Sense command.

Sense Data Management

The drive maintains three types of sense data.

- Current Sense is sense data associated with the last command received from the initiator.
- Deferred Sense is sense data from a command that has been reported as good, but has generated sense data after being reported. This may be a command with the Immediate flag set or may be a buffered write. A command with the Immediate flag set will generate sense for the host that sent the command. A buffered write will generate sense for all hosts.
- Unit Attention Sense is sense data generated by a Unit Attention condition. This is generated for all hosts.

Any command other than a Request Sense command or an Inquiry command will generate Check Condition status if there is Deferred Sense data or Unit Attention data available. All commands will generate Check Condition status if the command itself generates sense data. If the next command after the Check Condition status is not a Request Sense command, then all the sense data for that initiator is cleared.

When a Request Sense command is received, the Current Sense is returned. If there is no Current Sense, the Deferred Sense is returned. If there is no Deferred Sense, the Unit Attention Sense is returned. If there is no Unit Attention Sense, default sense data is returned. Once a particular set of sense data has been returned, that sense data is cleared. Any other sense data that is still pending may still cause Check Condition status for subsequent commands.

Command Descriptor Block

	Bits							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Operation Code (03h)							
1	Ignored LUN			Reserved				
2	Reserved							
3	Reserved							
4	Allocation Length							
5	Control							

Field Descriptions

Field	Bytes	Bits	Description
Operation Code	0		The Operation code for Request Sense is 03h.
Ignored Logical Unit	1	5-7	The LUN field is residual from the SCSI-1 days and is ignored.
Allocation Length	4		Specifies the amount of data to be returned, in bytes.
Reserved			All reserved bits must be 0.
Control	5		See Control Byte Format on page 18.

Sense Data Format

The Request Sense command returns sense data in the following format.

	Bits							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Valid	Error Code						
1	Segment Number							
2	FM	EOM	ILI	Reserved	Sense Key			
3	Information, MSB							
4	Information							
5	Information							
6	Information, LSB							
7	Additional Sense Length							
8	Command-specific Information, MSB							
9	Command-specific Information							
10	Command-specific Information							
11	Command-specific Information, LSB							
12	Additional Sense Code							
13	Additional Sense Code Qualifier							
14	Field-Replaceable Unit Code							
15	SKSV	C/D	Reserved		BPV	Bit Pointer		
16	Field Pointer, MSB							
17	Field Pointer, LSB							
18	Reserved							
19	Reserved							
20	Reserved							
21	Reserved					CLN	Reserved	

Field Descriptions

Field	Bytes	Bits	Description
Valid	0	7	0 = The Information field does not contain valid information 1 = The Information field contains valid information This is always 0 for deferred errors.
Error Code	0	0-6	70h = A current error, associated with the most recent command. 71h = A deferred error, not associated with the current command.
Segment Number	1		Always 0, because the Copy, Compare, and Copy and Verify commands are not supported.
FM bit	2	7	1 = A Space, Read, or Verify command did not complete because a file mark was read.

Field	Bytes	Bits	Description
EOM bit	2	6	1 = A Write or Write File Marks command completed in the early warning area. If no other error occurred, the Sense Code will be set to No Sense and the Additional Sense will be set to EOT (0002). If another error occurred, then the Sense Code and Additional Sense will reflect that error.
Incorrect Length Indicator (ILI)	2	5	1 = A Read or Verify ended because a block was read from tape that did not have the block length requested in the command.
Sense Key	2	0-3	This field indicates the status of the last command and provides a generic error category. See Sense Key Values.
Information	3-6		♦ For a Read, Verify or Write with the Fixed flag clear, this field contains the number of bytes in the command less the number of bytes actually processed. ♦ For a Read, Verify, or Write with the fixed flag set, or a Space with the Code set to zero, this field contains the number of blocks in the command less the number of blocks processed. Any block partially transferred in a Read or Write command or partially verified in a Verify command is considered processed but is not included in the calculation. ♦ For a Write File Marks or Space command, this field contains the difference between the number of file marks in the command and the number of file marks processed. Note that for a Space command, the Information bytes will contain a negative number in 2s complement form if the Space is in a reverse direction.
Additional Sense Length	7		n-7, indicating the length of the Sense Data.
Command Specific	8-11		Always 0, because no commands use this field.
Additional Sense Code	12		This field provides further detail for the current Sense Key. See Sense Key Values.
Additional Sense Code Qualifier	13		This field provides further detail for the current Additional Sense Code. See Sense Key Values.
Field Replaceable Unit Codes	14		0 = No part of the drive is suspected of failing 1 to *n* = Identifies a part of the drive that is suspected of causing the failure.
SKSV	15	7	0 = Bytes 16-17 contain a message code as defined in Message Codes, below. 1 = Sense Key Specific data in bytes 15-17 is valid and can be used to determine the first parameter that caused an Illegal Request sense key (as defined below).
C/D	15	6	0 = The first error was encountered in the Data-Out Phase. 1 = The first error was encountered in the Command Descriptor Block.
BPV	15	3	1 = The Bit Pointer field indicates the bit field in error.
Bit Pointer	15	0-2	♦ If BPV is set, this field points to the most significant bit of the field in error. ♦ When a Log Exception is generated, this field indicates the affected page that caused the Log Exception.

Field	Bytes	Bits	Description
Field Pointer	16-17		♦ If BPV is set, this field points to the most significant byte of the field in error. ♦ When a Log Exception is generated, bytes 16 and 17 indicate the MSB and LSB of the Log Parameter code that caused the Log Exception. Byte 15 indicates the affected page that caused the Log Exception. ♦ For all other errors, this field contains message codes as defined in Message Codes, Appendix A.
CLN	21	3	0 = The drive does not need cleaning. 1 = The drive needs cleaning.
Reserved			All reserved bits are 0.

Sense Key Values

The following table shows the meaning of the Sense Key values. For expanded information, see Additional Sense Codes and Code Qualifiers, below.

Key	Message	Definition
00h	No Sense	The Check Condition occurred in conjunction with detection of FM, EOT, or ILI, or status was not available.
01h	Recovered Error	The Log Sense counter reached its maximum value and the RLEC bit is set.
02h	Not Ready	The drive is not ready to accept tape access commands. Operator intervention may be required to correct this condition, or the drive may be coming ready.
03h	Medium Error	The command terminated with a nonrecoverable error that was probably caused by a flaw in the medium or an error in the recorded data.
04h	Hardware Error	The drive detected a nonrecoverable hardware failure (parity, etc.) while performing the command. Until the cartridge is ejected or a reset is received, the drive continues to return this sense key to any tape motion command.
05h	Illegal Request	The CDB or command parameters contained an illegal parameter.
06h	Unit Attention	One of the following actions occurred: the cartridge was changed; the drive was reset; the operational mode was changed; a Log Exception occurred; or the firmware was changed.
07h	Data Protect	The cartridge is write-protected; the operation was not performed.
08h	Blank Check	A no-data condition was encountered on the tape, or the wrong data format was encountered on tape.
09h	Vendor Specific	Vendor specific conditions.
0Bh	Aborted Command	The drive aborted the command. This key is returned if a bus parity error is detected. The Initiator may be able to recover by trying the command again.
ODh	Volume Overflow	The drive reached the physical EOT, and write data remains in the buffer.
0Eh	Miscompare	The source data did not match the tape data during a VERIFY command.

Additional Sense Codes and Code Qualifiers

Additional Sense Codes and Additional Sense Codes Qualifiers are returned in the Request Sense data in bytes 12 and 13. These codes are loaded whenever a Check Condition is returned for a SCSI command. The purpose of the codes is to provide more specific error information.

Sense Key Byte 2	ASC Byte 12	ASCQ Byte 13	Message	Explanation
00h No Sense				
00h	00h	00h	No additional sense information	The flags in the sense data indicate the reason for command failure
00h	00h	01h	Filemark detected	A Read or a Space command has terminated early because a file mark has been encountered. The File Mark flag will be set.
00h	00h	02h	EOM detected	A Write or a Write File Marks command ended in the early warning area. The EOM flag will be set.
00h	00h	04h	BOM detected	
00h	00h	17h	Cleaning requested	
00h	5Dh	00h	Failure prediction threshold exceeded	
00h	5Dh	FFh	Failure prediction threshold exceeded false	
00h	70h	00h	Decompression exception short algorithm id of nn	
01h Recovered Error				
01h	00h	17h	Cleaning requested	
01h	18h	01h	Recovered data with error correction and retries	
01h	37h	00h	Rounded parameter	A Mode Select command parameter has been rounded because the drive cannot store it with the accuracy of the command
01h	3Fh	00h	Target operation conditions have changed.	CM inquiry failure detected
01h	5Bh	01h	Threshold condition met	
01h	5Bh	02h	Log counter at maximum	
01h	5Dh	00h	Failure prediction threshold exceeded	Failure Prediction thresholds have been exceeded indicating that a failure may occur soon.
01h	5Dh	FFh	Failure prediction threshold exceeded false	
01h	70h	00h	Decompression exception short algorithm id of nn	
02h Not Ready				
02h	04h	00h	LUN not ready CNR	Cause Not Reportable - A tape is present in the drive, but it is in the process of being unloaded.
02h	04h	01h	LUN not ready POBR	Process of Becoming Ready - A medium access command has been received during a front panel initiated load or an immediate reported load command
02h	04h	02h	LUN not ready ICR	Initializing Command Required - A tape is present in the drive, but it is not logically loaded. A Load command is required.
02h	04h	03h	LUN not ready MIR	Manual Intervention Required
02h	04h	10h	LUN not ready AMNA	Auxiliary Memory Not Accessible

Sense Key Byte 2	ASC Byte 12	ASCQ Byte 13	Message	Explanation
02h	30h	00h	Incompatible medium installed	
02h	30h	03h	Cleaning cartridge installed	An operation could not be carried out because the tape in the drive is a cleaning cartridge.
02h	30h	04h	Cannot write medium unknown format	
02h	30h	07h	Cleaning failure	A cleaning operation was attempted, but could not be completed for some reason
02h	3Ah	00h	Medium not present	A media access command has been received when there is no tape loaded
02h	3Ah	03h	Medium not present, but loadable	A media access command has been received when the is tape is loadable.
02h	3Ah	04h	Medium not present, Medium Auxiliary Memory Accessible	A media access command has been received when the tape seated but not loaded. The MAM is accessible.
02h	3Eh	00h	Logical unit has not self configured yet	The drive has just powered on and has not completed its self-test sequence and cannot process commands.
02h	3Eh	02h	Timeout on logical unit	
02h	4Ch	00h	LUN failed self configuration	
02h	53h	00h	Media load or eject failed	
02h	5Ah	01h	Operator medium removal request	
03h Medium Error				
03h	00h	02h	EOM detected	A Read or a Space command terminated early because End of Tape was encountered. The EOM flag will be set.
03h	00h	04h	BOM detected	A Space command terminated early because beginning of tape was encountered. The EOM flag will be set
03h	03h	02h	Excessive write errors	
03h	09h	00h	Track following error	
03h	0Ch	00h	Write error	A Write operation has failed. This is probably due to bad media, but may be hardware related.
03h	0Ch	0Bh	Auxiliary memory write error	
03h	11h	00h	Unrecovered read error	A Read operation failed. This is probably due to bad media, but may be hardware related.
03h	11h	01h	Read retries exhausted	
03h	11h	02h	Error too long to correct	
03h	11h	12h	Auxiliary memory read error	

Sense Key Byte 2	ASC Byte 12	ASCQ Byte 13	Message	Explanation
03h	14h	00h	Recorded entity not found	A Space or Locate failed because a format violation prevented the target of the operation from being found.
03h	14h	01h	Record not found	
03h	30h	00h	Incompatible medium installed	
03h	30h	02h	Cannot read medium incompatible format	An operation could not be completed because the Logical Format is not correct.
03h	30h	07h	Cleaning failure	
03h	30h	80h	Firmware tape fail	
03h	31h	00h	Medium format corrupted	Data could not be read because the format on tape is not valid, but is a known format
03h	3Bh	00h	Sequential positioning error	A command has failed and left the logical position at an unexpected location
03h	3Bh	01h	Tape position error at BOM	
03h	3Bh	02h	Tape position error at EOM	
03h	3Bh	08h	Reposition error	
03h	50h	00h	Write append error	A Write type command failed because the point at which to append data was unreadable.
03h	50h	01h	Write append position error	
03h	51h	00h	Erase failure	
03h	52h	00h	Cartridge fault	A command could not be completed due to a fault in the tape cartridge
03h	52h	01h	Media end of life	
03h	53h	00h	Media load or eject failed	An attempt to load or eject the tape failed due to a problem with the tape
03h	53h	01h	Unload tape failure	
03h	70h	00h	Decompression exception short algorithm id of nn	
04h Hardware Error				
04h	15h	01h	Mechanical positioning error	
04h	40h	BDh	HE diagnostic task timeout	
04h	44h	00h	HE internal target failure	
04h	44h	D0h	AIC interrupt DMA FIFO overrun or underrun	
04h	44h	D1h	AIC interrupt DMA offset error	
04h	44h	D2h	AIC interrupt DMA parity error	
04h	44h	D3h	AIC interrupt read parity error	

Sense Key Byte 2	ASC Byte 12	ASCQ Byte 13	Message	Explanation
04h	44h	D4h	Diagnostic cache test failed	
04h	51h	00h	Erase failure	An Erase command failed to erase the required area on the medium.
04h	52h	00h	Cartridge fault	The tape is snapped
04h	53h	00h	Media load or eject failed	An attempt to load or eject the tape failed due to a problem with the drive
05h Illegal Request				
05h	1Ah	00h	Parameter list length error	The amount of data sent in a Mode Select or Log Select command is incorrect
05h	20h	00h	Invalid command operation code	The Operation Code in the command was not a valid Operation Code
05h	21h	01h	Invalid element address	
05h	24h	00h	Invalid field in CDB	An invalid field has been detected in a Command Descriptor Block.
05h	25h	00h	LUN not supported	The command was addressed to a non-existent logical unit number.
05h	26h	00h	Invalid field in parameter list	An invalid field has been detected in the data sent during the data phase
05h	26h	02h	Parameter value invalid	Firmware download flash failure.
05h	26h	04h	Invalid release of persistent reservation	
05h	26h	0984h	Invalid field parameter checksum	Microcode image invalid, bad checksum or CRC.
05h	3Bh	0Ch	Position past beginning of medium	
05h	53h	02h	Medium removal prevented	An Unload command has failed to eject the tape because medium removal has been prevented.
05h	55h	04h	Insufficient registration resource	
06h Unit Attention				
06h	04h	10h	Auxiliary Memory not accessible	An access attempt was made to the Medium Auxiliary Memory or the EEPROM that was not successful.
06h	28h	00h	Not ready to ready transition	A tape has been loaded successfully into the drive and is now ready to be accessed.
06h	29h	00h	Power on reset or bus device reset occurred	The drive has powered on, received a reset signal or a bus device reset message since the initiator last accessed it
06h	2Ah	01h	Mode parameters changed	An initiator other than the one issuing the command has changed the Mode parameters for the drive.
06h	2Ah	02h	Log parameters changed	
06h	2Ah	04h	Reservations released	
06h	2Ah	05h	Registration preempted	

Sense Key Byte 2	ASC Byte 12	ASCQ Byte 13	Message	Explanation
06h	3Fh	01h	Microcode has been changed	The firmware in the drive has just been changed by a Write Buffer command or firmware tape.
06h	3Fh	0Eh	Reported LUNs Data Has Changed	Command Forwarding has been changed from disabled to enabled or vice-versa.
06h	3Fh	10h	Media Loadable	Medium has transistioned to a loadable state.
06h	3Fh	11h	Auxiliary Cartridge Memory accessible.	Medium has transistioned to MAM accessible state from a MAM inaccessible state.
06h	5Bh	01h	Threshold condition met	
06h	5Dh	00h	Failure prediction threshold exceeded	
06h	5Dh	FFh	Failure prediction threshold exceeded false	A Mode Select command has been used to test for Failure Prediction system.
06h	67h	00h	Power on reset or bus device soft reset occurred	
07h Data Protect				
07h	27h	00h	Write protected	A Write type operation has been requested on a tape that has been write protected.
07h	30h	00h	Incompatible medium installed	A Write type operation could not be executed because it is not supported on the tape type that is loaded
08h Blank Check				
08h	00h	05h	EOD detected	A Read or a Space command terminated early because End of Data was encountered.
08h	14h	03h	EOD not found	A Read type operation failed because a format violation related to a missing EOD data set
08h	30h	01h	Cannot read medium unknown format	
08h	30h	02h	Cannot read medium incompatible format	
09h Vendor Unique				
09h	00	05	VS EOD detected	Raw reader
09h	80	80	VS Medium is present	Park Unpark command
0Bh Aborted Command				
0Bh	08h	01h	LUN communication time out	
0Bh	1Bh	00h	Synchronous data transfer error	
0Bh	3Dh	00h	Invalid bits in identify message	An illegal Identify message has been received by the drive at the start of a command.
0Bh	43h	00h	Message error	A message could not be sent or received due to excessive transmission errors.

Sense Key Byte 2	ASC Byte 12	ASCQ Byte 13	Message	Explanation
0Bh	45h	00h	Select or reselect failure	An attempt to reselect an initiator in order to complete the command has failed.
0Bh	47h	00h	SCSI parity error	
0Bh	48h	00h	Initiator detected error message received	A command failed because an Initiator Detected Error message was received.
0Bh	49h	00h	Invalid message error	The command failed because an invalid message was received by the drive.
0Bh	4Ah	00h	Command phase error	A command could not be executed because too many parity errors occurred in the Command phase
0Bh	4Bh	00h	Data phase error	A command could not be completed because too many errors occurred during the Data phase.
0Bh	4Eh	00h	Overlapped commands attempted	An initiator selected the drive even though it already had a command outstanding in the drive.
0Bh	5Ah	01h	Operator medium removal request	The command was aborted because the eject button was pressed.
0Dh Volume Overflow				
0Dh	00h	02h	EOM detected	A Write or Write File Marks command failed because the physical end of tape was encountered. The EOM flag will be set.

Message Codes

The table in Appendix A: Message Codes, beginning on page 126, lists the vendor unique message codes that are returned in the Field Pointer field (bytes 16-17) when the SKSV bit is 0.

Completion Status

Code	Message	Description
00h	Good Status	• The drive is ready to perform any appropriate command. • The drive remains in any previously set mode. • The tape position is not changed.
02h	Check Condition	Use the Request Sense command to retrieve status information. Possible Sense Keys are: **Code** **Message** **Description** 05h Illegal Request The Command Descriptor Block is invalid.

RESERVE UNIT

The Reserve Unit command reserves the drive for exclusive use of the requesting Initiator.

The drive reservation once established, remains in effect until one of the following occurs:

- Another Reserve Unit command arrives from the same Initiator that requested the current reservation. The new reservation supersedes the current one and may be the same as the current one. Redundant use of the command is not considered an error.
- A Release Unit command arrives from the same Initiator that requested the current reservation. The drive returns to unreserved mode.
- A Bus Device Reset Message arrives from any Initiator.
- A Reset condition occurs.
- Firmware is updated.

When the drive is reserved, it returns Reservation Conflict Status in response to most commands received from excluded Initiators. Inquiry, Request Sense, Prevent Medium Removal (with a prevent bit of zero), and Release Unit commands are accepted from any initiator.

Command Descriptor Block

6-Byte Command Descriptor Block

Byte	Bits 7	6	5	4	3	2	1	0
0	Operation Code (16h)							
1	Ignored LUN			Reserved				
2	Reserved							
3	Reserved							
4	Reserved							
5	Control							

Field Descriptions for 6-Byte Command

Field	Bytes	Bits	Description
Operation Code	0		The Operation code for the 6-byte version of Reserve Unit is 16h.
Ignored Logical Unit	1	5-7	The LUN field is residual from the SCSI-1 days and is ignored.
Reserved			All reserved bits must be 0.
Control	5		See Control Byte Format on page 18.

10-byte Command Descriptor Block

Byte	Bits 7	6	5	4	3	2	1	0
0	Operation Code (56h)							

Byte	Bits 7	6	5	4	3	2	1	0
1	Ignored LUN				Reserved			
2	Reserved							
3	Ignored Third Party Device ID							
4	Reserved							
5	Reserved							
6	Reserved							
7	Reserved							
8	Reserved							
9	Control							

Field Descriptions for 10-Byte Command

Field	Bytes	Bits	Description
Operation Code	0		The Operation code for the 10-byte version of Reserve Unit is 57h.
Ignored Logical Unit	1	5-7	The LUN field is residual from the SCSI-1 days and is ignored.
Ignored Third Party Device ID	3		This field is ignored by the drive.
Reserved			All reserved bits must be 0.
Control	9		See Control Byte Format on page 18.

Completion Status

Code	Message	Description
00h	Good Status	• The drive is ready to perform any appropriate command. • The drive remains in any previously set mode. • The drive is reserved for the use of the specified ID. • The tape position is not changed.
02h	Check Condition	Use the Request Sense command to retrieve status information. Possible Sense Keys are:
		Code / **Message** / **Description**
		02h / Not Ready / No cartridge is in the drive.
		03h / Media Error / Unrecoverable data error encountered.
		04h / Hardware Error / Parity error on the SCSI bus or drive hardware failure.
		05h / Illegal Request / The Command Descriptor Block is invalid.
		06h / Unit Attention / The cartridge was changed, or the drive was reset prior to this command.
18h	Reservation Conflict	The drive is reserved for another initiator.

REWIND

The Rewind command requests that the medium be positioned to the Beginning Of Tape (BOT). Prior to performing the Rewind operation, the buffered data and filemarks are written to the tape, and an EOD marker is recorded. The Rewind operation is done at high speed.

Command Descriptor Block

Byte	Bits 7	6	5	4	3	2	1	0
0	Operation Code (01h)							
1	Ignored LUN			Reserved				Immed
2	Reserved							
3	Reserved							
4	Reserved							
5	Control							

Field Descriptions

Field	Bytes	Bits	Description
Operation Code	0		The Operation code for Rewind is 01h.
Ignored Logical Unit	1	5-7	The LUN field is residual from the SCSI-1 days and is ignored.
Immed	1	0	Immediate bit: 0 = Status is not returned the rewind operation has completed. 1 = Status is returned as soon as all buffered data and filemarks have been written to the medium and the Rewind CDB has been validated.
Reserved			All reserved bits must be 0.
Control	5		See Control Byte Format on page 18.

If Check Condition status is returned from Rewind command with the Immed bit set to 1, then the rewind operation is not performed.

Completion Status

Code	Message	Description
00h	Good Status	• The drive is ready to perform any appropriate command. • The drive remains in any previously set mode. • The tape position is BOT (if not an Immediate command). Note: If IMMED is one, then Good Status only indicates that all buffered data and filemarks have been written to the medium and that the Rewind CDB is valid.
02h	Check Condition	Use the Request Sense command to retrieve status information. Possible Sense Keys are:

Code	Message	Description
02h	Not Ready	No cartridge is in the drive.
03h	Media Error	Unrecoverable data error encountered.
04h	Hardware Error	Parity error on the SCSI bus or drive hardware failure.
05h	Illegal Request	The Command Descriptor Block is invalid.

SEND DIAGNOSTIC

The Send Diagnostic command requests the drive to perform diagnostic operations on itself. The diagnostic tests are part of the drive's resident firmware.

The Receive Diagnostic Results command may be used to retrieve the result of the diagnostic operations.

A Self Test bit of one requests the drive to perform its self test diagnostic.

Command Descriptor Block

Byte	Bits 7	6	5	4	3	2	1	0
0	Operation Code (1Dh)							
1	Self-Test Code			PF	Reserved	Selftest	Devoffl	UnitOffl
2	Reserved							
3	Parameter List Length (MSB)							
4	Parameter List Length (LSB)							
5	Control							

Field Descriptions

Field	Bytes	Bits	Description
Operation code	0		The Operation Code for Send Diagnostic is 1Dh.
Self-test code	1	5-7	This bit field is not supported and must be set to 0.
Pf	1	4	This bit is not supported and must be set to 0.
Selftest	1	2	1 = Perform self test diagnostic.
Devoffl	1	1	This bit is not supported and must be set to 0.
UnitOffl	1	0	This bit is not supported and must be set to 0.
Parameter list length	3-4		This field is not supported and must be to 0.
Reserved			All reserved bits must be 0.
Control	5		The control field must be 0.

Completion Status

Code	Message	Description
00h	Good Status	• The drive is ready to perform any appropriate command. • The drive remains in any previously set mode. • The tape position is not changed.
02h	Check Condition	Use the Request Sense command to retrieve status information. Possible Sense Keys are: **Code** **Message** **Description** 02h Not Ready — No cartridge is inserted in the drive. 04h Hardware Error — Drive hardware failure detected. 05h Illegal Request — The CDB contains an invalid bit. 06h Unit Attention — The cartridge was changed, or the drive was reset prior to this command.

SET CAPACITY

The Set Capacity command sets the available medium for a volume to a proportion of the total capacity of that volume. Any excess space is unavailable on the volume after successful completion of this command until reset by a new Set Capacity command.

The Set Capacity command is valid only when the medium is at beginning-of-medium. If the medium is logically at any other position, the command is rejected with Check Condition status. The sense key is Illegal Request with the additional sense code and an additional sense code qualifier set to position past beginning of medium.

If the medium is write protected, the command is rejected with Check Condition status. The sense key is Data Protect with the additional sense code and an additional sense code qualifier set to Write Protected.

If the Set Capacity command specifies the portion of the total volume capacity to be made available for use less than 10 gigabytes, the device will round up the capacity to 10 gigabytes. The command is terminated with Check Condition status. The sense key is Recovered Error with the additional sense code and an additional sense code qualifier set to Rounded Parameter.

A valid Set Capacity command causes all data on the tape to be lost.

Command Descriptor Block

Byte	Bits 7	6	5	4	3	2	1	0
0	Operation Code (0Bh)							
1	Ignored LUN			Reserved				Immed
2	Reserved							
3	Capacity Proportion Value, MSB							
4	Capacity Proportion Value, LSB							
5	Control							

Field Descriptions

Field	Bytes	Bits	Description
Operation Code	0		The Operation Code for Set Capacity is 0Bh.
Ignored Logical Unit	1	5-7	The LUN field is residual from the SCSI-1 days and is ignored.
Immed	1	0	0 = Status is not returned until the operation is complete 1 = Status is returned as soon as the operation is initiated.
Capacity Proportion Value	3-4		This field specifies the portion of the total tape capacity to be made available for use. The Capacity Proportion Value is the numerator of a fraction with a denominator of 65535. The resulting available tape capacity is equal to the total tape capacity multiplied by this fraction. The drive rounds up the capacity to the next higher supported value.
Reserved			All reserved bits must be 0.
Control	5		See Control Byte Format on page 18.

The Set Capacity command sets the available tape capacity to:
Tape Capacity = Total Tape Capacity × Capacity Proportion Value / 65535

Completion Status

<table>
<tr><th>Code</th><th>Message</th><th>Description</th></tr>
<tr><td>00h</td><td>Good Status</td><td>♦ The drive is ready to perform any appropriate command.
♦ The drive remains in any previously set mode.
♦ The tape position is at BOT.
♦ Data on tape is logically inaccessible.
Note: If Immed is 1, then Good Status only indicates that the command is valid.</td></tr>
<tr><td>02h</td><td>Check Condition</td><td>Use the Request Sense command to retrieve status information. Possible Sense Keys are:
<table>
<tr><th>Code</th><th>Message</th><th>Description</th></tr>
<tr><td>01h</td><td>Recovered Error</td><td>Tape capacity is rounded up to 10% of total capacity.</td></tr>
<tr><td>02h</td><td>Not Ready</td><td>No cartridge is in the drive.</td></tr>
<tr><td>04h</td><td>Hardware Error</td><td>Drive hardware failure detected.</td></tr>
<tr><td>05h</td><td>Illegal Request</td><td>The tape is not at BOT or the Command Descriptor Block is not valid.</td></tr>
<tr><td>06h</td><td>Unit Attention</td><td>The cartridge was changed or the drive was reset prior to this command.</td></tr>
<tr><td>07h</td><td>Write Protected</td><td>The cartridge is write-protected.</td></tr>
</table>
</td></tr>
</table>

SPACE

The Space command uses three methods to move the tape. This command moves the position:

- Forward or backward a specified number of blocks.
- Forward or backward a specified number of filemarks.
- Forward to the end of recorded data (EOD).

If the target block or filemark is in the buffer of the drive, no tape motion results, otherwise, spacing is done at high search speed.

Command Descriptor Block

Byte	Bits 7	6	5	4	3	2	1	0
0	Operation Code (11h)							
1	Ignored LUN			Reserved			Code	
2	Count, MSB							
3	Count							
4	Count, LSB							
5	Control							

Field Descriptions

Field	Bytes	Bits	Description
Operation Code	0		The Operation Code for Space is 11h.
Ignored Logical Unit	1	5-7	The LUN field is residual from the SCSI-1 days and is ignored.
Code	1	0-2	000b = Move Count blocks 001b = Move Count filemarks 011 = Move to end of recorded data (EOD)
Count	2-4		This field specifies the number of blocks or filemarks to space over. A positive Count moves the tape forward. A negative (2's comple-ment) Count moves the tape backward. A zero Count causes no media movement and is not an error. For Space to EOD operation, this field is ignored.
Reserved			All reserved bits must be 0.
Control	5		See Control Byte Format on page 18.

The Space command instructs the drive to set a new logical position relative to the current logical position. How this is done is dependent on the value of the Code field and the Count field. The Count field is a signed value indicating the distance to move, negative indicating movement towards BOT and positive indicating movement towards EOT.

If the Code field is 000b, then the logical position is moved the number of blocks indicated by the Count field. If a file mark is detected between the current logical position and the requested logical position, the new logical position is set to immediately after the file mark in the direction of the space operation. If BOT or EOD is detected before the requested logical position, then the logical position is set to that position.

If the Code field is 001b, then the logical position is moved the number of file marks indicated by the Count field. If BOT or EOD is detected before the requested logical position, then the logical position is set to that position.

If the Code field is 011b, then the logical position is set to after the last valid block on tape. In this case the count field is ignored.

Any other value of the Code field will cause Check Condition status to be returned. Spacing to sequential file marks is not supported. Set marks are not supported. The Sense Key is set to Illegal Request and the Additional Sense is set to Invalid field in CDB (2400).

Space-by-Count Functions

The Count field indicates both direction and number of blocks or filemarks to space over from the current logical position. A positive value N in the Count field moves the tape forward over N blocks or filemarks. A negative value -N (2's complement) in the Count field moves the tape backward over N blocks or filemarks. Zero in the count field causes no tape movement and is not considered an error.

When there are no exception conditions during space functions, forward tape motion ends on the EOT side of the last block or filemark and reverse motion ends on the BOT side of the last block or filemark.

- If a filemark is encountered while spacing over blocks, a Check Condition Status is returned. The Sense FM bit is set and the Sense Valid bit is set, indicating Residual Length is non-zero.

  The Residual Length equals the difference in the requested count and the actual number of blocks spaced over not including the filemark. The tape is positioned on the logical EOT side of the filemark if movement was forward or on the logical BOT side of the filemark if movement was reverse.
- If EOD is encountered while spacing forward, Check Condition is returned with 08h Sense Key. Extended Sense Valid bit is set, indicating Residual Length is nonzero.
- If BOT is encountered while spacing in reverse, Check Condition is returned with 40h Sense Key. Extended sense Valid bit is set, indicating a nonzero Residual Length.
- If EOT is encountered while spacing forward, Check Condition is returned with 40h or 43h Sense Key. Extended Sense Valid bit is set, indicating a nonzero Residual Length.
- If an unrecoverable data error is encountered, Check Condition is returned, Extended Sense Key is set to Medium Error, and Extended Sense Valid bit is set, indicating Residual Length is nonzero.

Space to EOD

The Count field is ignored in the space-to-EOD function.

In the space-to-EOD function, the tape is positioned such that a subsequent WRITE command appends data to the last recorded information on the tape. This positioning is done at high search speed.

The space-to-EOD function is useful in support of user-defined directories located at the end of recorded data.

- If physical EOT is encountered while spacing to end of data, Check Condition Status is returned and Extended Sense is set to Medium Error.
- If unrecoverable data error is encountered, Check Condition Status is returned, Extended Sense Key is set to Medium Error, and Extended Sense Valid bit is set, indicating Residual Length is non-zero.

Completion Status

Code	Message	Description
00h	Good Status	• The drive is ready to perform any appropriate command. • The drive remains in any previously set mode. • The tape is positioned on the EOT side if space forward and on the BOT side if space reverse.
02h	Check Condition	Use the Request Sense command to retrieve status information. Possible Sense Keys are:

Code	Message	Description
02h	Not Ready	No cartridge is inserted in the drive.
03h	Media Error	Unrecoverable data error encountered while performing a Space command.
04h	Hardware Error	Drive hardware failure detected.
05h	Illegal Request	The Command Descriptor Block is invalid.
06h	Unit Attention	The cartridge was changed or the drive was reset prior to this command.
08h	Blank Check	EOD was encountered while executing a Space forward.

TEST UNIT READY

The Test Unit Ready command provides a means to check that the drive is ready.

If the drive is able to accept a medium-access command without returning a Check Condition status, then the Test Unit Ready command will result in Good status.

If the drive is unable to become operational or is in a state that requires action from the host to make the drive ready, then the Test Unit Ready command will result in a Check Condition status with a sense key of Not Ready.

This command does not access the medium or initiate a diagnostic routine.

Command Descriptor Block

Byte	Bits 7	6	5	4	3	2	1	0
0	Operation Code (00h)							
1	Ignored LUN			Reserved				
2	Reserved							
3	Reserved							
4	Reserved							
5	Control							

Field Descriptions

Field	Bytes	Bits	Description
Operation Code	0		The Operation Code for Test Unit Ready is 00h.
Ignored Logical Unit	1	5-7	The LUN field is residual from the SCSI-1 days and is ignored.
Reserved			All reserved bits must be 0.
Control	5		The control field must be 0.

Completion Status

Code	Message	Description
00h	Good Status	• The drive is ready to perform any appropriate medium access command. • The drive remains in any previously set mode. • The tape is not moved.
02h	Check Condition	Use the Request Sense command to retrieve the sense data.

Code	Message	Description
02h	Not Ready	No cartridge is present; an immediate command is in progress; or the eject button has been pressed.
04h	Hardware Error	Parity error on the SCSI bus or drive hardware failure.
05h	Illegal Request	The Command Descriptor Block is invalid.
06h	Unit Attention	The cartridge was changed or the drive was reset.

VERIFY

The Verify command verifies one or more blocks of data beginning with the next block from the tape unit.

The command terminates after the specified number of bytes or blocks are verified or when the drive encounters a filemark, the EOD, the EOT, or an unrecoverable error. On completion the medium is positioned after the last block verified, after the end-of-data, after a filemark or after an unrecoverable block.

If a Verify with a zero verification length is issued, no data is verified, and the current position on the tape does not change. This condition is not considered an error.

The Verify command causes data to be read from the tape and passed through the drive's error detection and correction hardware to determine whether it can be recovered from the tape. The amount of data to be read is indicated by the Verification Length field and the Fixed flag in the same manner as is used in a Read command.

Command Descriptor Block

Byte	Bits 7	6	5	4	3	2	1	0
0	Operation Code (13h)							
1		Ignored LUN			Reserved			Fixed
2	Verification Length, MSB							
3	Verification Length							
4	Verification Length, LSB							
5	Control							

Field Descriptions

Field	Bytes	Bits	Description
Operation Code	0		The Operation Code for Verify is 00h.
Ignored Logical Unit	1	5-7	The LUN field is residual from the SCSI-1 days and is ignored.
Fixed	1	0	0 = Variable block length. Verify Length contains the number of bytes to return. 1 = Fixed block length, as specified by the MODE SELECT Block Descriptor. Verify Length contains the number of blocks to return
Verify Length	2-4		This field specifies the number of bytes (Fixed = 0) or blocks (Fixed = 1) to be verified. A transfer length of 0 is valid and no data is verified.
Reserved			All reserved bits must be 0.
Control	5		The control field must be 0.

Verify Command Operation

Comparison errors cause a Check Condition with the Sense Key set to 0Eh, which indicates miscompare. The residual byte or block count is reflected in the Request Sense data.

When the Fixed bit is set, the Verify Length specifies the number of contiguous blocks to be verified on the tape. When the Fixed bit is cleared, the Verify Length specifies the number of bytes in the block to verify.

The byte compare starts on a block boundary starting at the current tape block position.

Completion Status

<table>
<tr><th>Code</th><th>Message</th><th>Description</th></tr>
<tr><td>00h</td><td>Good Status</td><td>• The drive is ready to perform any appropriate command.
• The drive remains in any previously set mode.
• The tape is positioned on the EOT side of the last block verified.</td></tr>
<tr><td>02h</td><td>Check Condition</td><td>Use the Request Sense command to retrieve status information. Possible Sense Keys are:
<table>
<tr><th>Code</th><th>Message</th><th>Description</th></tr>
<tr><td>02h</td><td>Not Ready</td><td>No cartridge is in the drive.</td></tr>
<tr><td>03h</td><td>Media Error</td><td>Unrecoverable data error encountered.</td></tr>
<tr><td>04h</td><td>Hardware Error</td><td>Parity error on the SCSI bus or drive hardware failure.</td></tr>
<tr><td>05h</td><td>Illegal Request</td><td>The Command Descriptor Block is invalid.</td></tr>
<tr><td>06h</td><td>Unit Attention</td><td>The cartridge was changed, or the drive was reset prior to this command.</td></tr>
<tr><td>08h</td><td>Blank Check</td><td>EOD was encountered.</td></tr>
<tr><td>0Eh</td><td>Miscompare</td><td>Verify data miscompare.</td></tr>
</table></td></tr>
</table>

WRITE

The Write command transfers one or more data blocks from the Initiator to the drive. If the Transfer Length is zero, no data is transferred, and the current position of the tape is not changed. This condition is not considered an error.

Command Descriptor Block

Byte	Bits 7	6	5	4	3	2	1	0
0	Operation Code (0Ah)							
1	Ignored LUN			Reserved				Fixed
2	Transfer Length, MSB							
3	Transfer Length							
4	Transfer Length, LSB							
5	Control							

Field Descriptions

Field	Bytes	Bits	Description
Operation Code	0		The Operation Code for Write is 0Ah.
Ignored Logical Unit	1	5-7	The LUN field is residual from the SCSI-1 days and is ignored.
Fixed	1	0	0 = Variable block length. Transfer Length contains the number of bytes to write. 1 = Fixed block length, as specified by the MODE SELECT Block Descriptor. Transfer Length contains the number of blocks to write.
Transfer Length	2-4		This field specifies the number of bytes (Fixed = 0) or blocks (Fixed = 1) to be written. A transfer length of 0 is valid and no data is written.
Reserved			All reserved bits must be 0.
Control	5		The control field must be 0.

If the Fixed flag is clear, the initiator will transfer a single block of the length indicated in Transfer Length.

If the Fixed flag is set, the initiator will transfer a sequence of blocks. The Transfer Length field gives the number of blocks. The current fixed block length gives the length of the blocks.

At Early Warning, the drive completes the current block transfer and terminates the command with a Check Condition, EOM bit set, and Sense Key equal to 0. If the SEW bit (in Mode Select Device Configuration Page) is set, the data in the buffer is then written to tape.

Subsequent Write commands complete with a Check Condition and the EOM bit set.

If writing the buffer to tape is unsuccessful because of EOT, a Volume Overflow is reported. The Residual count field in the Request Sense data reports the amount of data not transferred. Writing can continue in the Early Warning region until EOT is

encountered. Any Write command issued within Early Warning and successfully completed, finishes with a Check Condition and the EOM bit set.

Completion Status

Code	Message	Description
00h	Good Status	• The SCSI data has been transferred to the data buffer. • The drive remains in any previously set mode.
02h	Check Condition	Use the Request Sense command to retrieve status information. Possible Sense Keys are:

Code	Message	Description
02h	Not Ready	No cartridge is in the drive.
03h	Media Error	Unrecoverable data error encountered.
04h	Hardware Error	Parity error on the SCSI bus or drive hardware failure.
05h	Illegal Request	The Command Descriptor Block is invalid.
06h	Unit Attention	The cartridge was changed, or the drive was reset prior to this command.
07h	Write Protect	The tape is write-protected; check the cartridge before continuing.
0Dh	Volume Overflow	The Write command completed with data in the buffer because the end-of-partition was encountered.

WRITE BUFFER

The Write Buffer command is used in conjunction with the Read Buffer command as a diagnostic function for testing the data buffer memory of the drive and confirming the SCSI bus integrity. The medium is not accessed during the execution of this command.

The Write Buffer command is also used to download microcode to the drive.

Command Descriptor Block

Byte	Bits 7	6	5	4	3	2	1	0
0	Operation Code (3B)							
1	Ignored LUN			Reserved			Mode	
2	Buffer ID							
3	Buffer Offset, MSB							
4	Buffer Offset							
5	Buffer Offset, LSB							
6	Parameter List Length, MSB							
7	Parameter List Length							
8	Parameter List Length, LSB							
9	Control							

Field Descriptions

Field	Bytes	Bits	Description
Operation Code	0		The operation code for Write Buffer is 3Bh.
Ignored Logical Unit	1	5-7	The LUN field is residual from the SCSI-1 days and is ignored.
Reserved	1	4	All Reserved bits must be 0.
MODE	1	0-3	0000b = Write header and data. 0001b = Write Medium Auxiliary Memory(MAM). 0010b = Write data only. 0100b = Microcode download. Do not write to flash memory. 0101b = Microcode download. Write to flash memory. 0110b = Microcode download. Do not write to flash memory. 0111b = Microcode download. Write to flash memory.
Buffer ID			00h = normal access (default) 54h = specifies access to Medium Auxiliary Memory
BUFFER OFFSET	3-5		For Mode not equal to 0001b: The offset from the beginning of the specified buffer in bytes. For Mode equal 0001b: Set to the Medium Auxiliary Memory page code as described in the tables.
PARAMETER LIST LENGTH	6-8		Specifies the amount of data to be sent. A value of 0 is a valid entry and shall not be considered an error. This value must be smaller than the difference between the Buffer Offset and the size of the buffer.
CONTROL	9		See Control Byte Format on page 18.

A Mode field of 0000b indicates that the data to be written will be preceded with a four-byte header. This Write Buffer Data Header is reserved and must be set to all zeros. The header will not be placed into buffer memory.

A Mode field of 0001b indicates that data to be written to the Medium Auxiliary Memory will be sent.

A Mode field of 0010b indicates that only data to be written to the buffer will be sent.

A Mode field of 0100b or 0110b indicates download microcode.

A Mode field of 0101b or 0111b indicates download microcode and save.

The Buffer ID field indicates which buffer is to be written. All drives support buffer 0. Other buffers may be available in the drive.

The Buffer Offset is used to specify the byte location within the specified buffer where data is to be written.

The Parameter List Length field indicated the amount of data to be transferred. Care needs to be taken so that the Buffer Offset plus the Parameter List Length does not exceed the buffer capacity. If the buffer capacity is exceeded, no data is written and Check Condition status is generated.

Soft Microcode Download

A soft microcode download will load the microcode image and reboot the drive without flashing the image into memory.

Use Mode field of 0100b or 0110b to download the microcode image into memory without saving (flashing). Buffer Offsets may be used in either of these Modes.

After the downloaded microcode image is in memory, it may be booted (without flashing) by issuing a Write Buffer command with Mode 0100b or 0110b and a Parameter List Length of zero. The downloaded code will then run on the drive until the drive is power cycled. Upon power cycling the drive, the original firmware revision will be restored.

Hard Microcode Download

A hard microcode download will load the microcode image, flash it into memory and reboot the drive.

Use Mode field of 0100b or 0110b to download the microcode image into memory without saving (flashing). Buffer Offsets may be used in either of these Modes.

After the downloaded microcode image is in memory, it may be flashed and booted by issuing a Write Buffer command with Mode 0101b or 0111b and a Parameter List Length of zero. The downloaded code will then run on the drive and remain in memory until a subsequent hard microcode download is done.

Write Buffer Data Header

If the Mode field is set to 0000b, then the data sent must be preceded by a 4 byte Write Buffer Data Header. The following table shows the fields in the Write Buffer Data Header.

Byte	Bits 7	6	5	4	3	2	1	0
0	Reserved							
1	Reserved							
2	Reserved							
3	Reserved							

Field Descriptions

Field	Bytes	Bits	Description
Reserved	0-3		All bits are 0.

Completion Status

Code	Message	Description
00h	Good Status	• The drive is ready to perform any appropriate command. • The drive remains in any previously set mode. • The tape position is not changed.
02h	Check Condition	Use the Request Sense command to retrieve status information. Possible Sense Keys are:

Code	Message	Description
04h	Hardware Error	Drive hardware failure detected.
05h	Illegal Request	The Command Descriptor is invalid, the transfer length exceeds the maximum, or the microcode file is invalid.
06h	Unit	The cartridge was changed, or the drive was reset prior to this command. Microcode image has been changed.

WRITE FILE MARKS

The Write Filemarks command causes the specified number of filemarks to be written to tape.

This command can be used to force all remaining buffered data blocks to be written to tape without appending filemarks by specifying zero filemarks. When zero filemarks are specified, the command does not return Good Status to the Initiator until all buffered data blocks and filemarks are written correctly on the tape. Otherwise, status is returned immediately.

Command Descriptor Block

Byte	Bits 7	6	5	4	3	2	1	0
0	Operation Code (10h)							
1				Reserved				Immed
2				Count, MSB				
3				Count				
4				Count, LSB				
5				Control				

Field Descriptions

Field Name	Bytes	Bits	Description
Operation Code	0		The Operation Code for Write Filemarks is 10h.
Immed	1	0	0 = Status is not returned until the tape is positioned. 1 = Status is returned as soon as the operation is initiated.
Count	2-4		The number of filemarks to record.
Reserved			All Reserved bits must be 0.
Control	5		See Control Byte Format on page 18.

The Write File Marks command causes a sequence of file marks to be written at the current logical position. The number of file marks to be written is indicated in the Count field.

If the Immed flag is set, status is returned immediately, before the file marks are written to tape. If the Immed flag is clear, the file marks and any buffered data is written to tape before status is returned. If the Immed flag is clear and the Count field is 0, then all buffered data is flushed to tape before the command is reported.

Completion Status

<table>
<tr><th>Code</th><th>Message</th><th>Description</th></tr>
<tr><td>00h</td><td>Good Status</td><td>• The filemarks have been sent to the buffer.
• The drive remains in any previously set mode.
Note: If Immed is 1, then Good Status only indicates that the command is valid.</td></tr>
<tr><td>02h</td><td>Check Condition</td><td>Use the Request Sense command to retrieve status information. Possible Sense Keys are:
<table>
<tr><th>Code</th><th>Message</th><th>Description</th></tr>
<tr><td>02h</td><td>Not Ready</td><td>No cartridge is in the drive.</td></tr>
<tr><td>03h</td><td>Media Error</td><td>Unrecoverable data error encountered.</td></tr>
<tr><td>04h</td><td>Hardware Error</td><td>Parity error on the SCSI bus or drive hardware failure.</td></tr>
<tr><td>05h</td><td>Illegal Request</td><td>The Command Descriptor Block is invalid.</td></tr>
<tr><td>06h</td><td>Unit Attention</td><td>The cartridge was changed, or the drive was reset prior to this command.</td></tr>
<tr><td>07h</td><td>Write Protect</td><td>The tape is write-protected; check the cartridge before continuing.</td></tr>
<tr><td>0Dh</td><td>Volume</td><td>The command completed with Overflow data in the buffer because EOT was encountered.</td></tr>
</table></td></tr>
</table>

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Manufacturing Part Number: 100109647, Rev. B, Printed in USA