IBM TotalStorage LTO Ultrium
Tape Drive

SCSI Reference

GA32-0450-00

IBM TotalStorage LTO Ultrium
Tape Drive

SCSI Reference

GA32-0450-00

Note

Before using this manual and the product it supports, read the information under “Notices” on page 145.

First Edition (November 2002)

This edition applies to the *IBM TotalStorage LTO Ultrium Tape Drive SCSI Reference* and to all subsequent releases and modifications unless otherwise indicated in new editions.

© Copyright International Business Machines Corporation 2002. All rights reserved.
US Government Users Restricted Rights – Use, duplication or disclosure restricted by GSA ADP Schedule Contract with IBM Corp.

Contents

Tables vii

Preface xi
Organization xi
Related Publications xi

Chapter 1. Introduction 1
Supported Servers and Operating Systems 3
SCSI and Fibre Channel Attachment 3
Supported Device Drivers 4
Supported Tape Cartridges 5

Chapter 2. Summary of Drive Generation Differences 7
Differences in Command Timeout Values 7
New Commands and Parameters 9
Data Changes 9
Standard Inquiry Data 9
REPORT DENSITY SUPPORT Command 9
Mode Pages 9
READ POSITION Command 9
Cartridge Eject for Errors 10
Queueing Issues 10

Chapter 3. Command Support 11
ERASE 13
INQUIRY 14
Standard Inquiry Data Valid LUN 15
Standard Inquiry Data Invalid LUN 17
Supported Vital Product Data Page 19
Unit Serial Number Page 19
Device Identification Page 20
Drive Component Revision Levels Pages 22
LOAD/UNLOAD 23
LOCATE 24
LOG SELECT 25
LOG SENSE 26
Log Page Format 27
Supported Log Pages 28
Write Error Counters Log 29
Read Error Counters Log 30
Sequential Access Device Log 31
TapeAlert Log 32
Tape Usage Log 38
Tape Capacity Log 38
Data Compression Log 39
MODE SELECT 40
MODE SENSE 41
Mode Data Format 42
Mode Parameter Header 43
Mode Block Descriptor 44
Read-Write Error Recovery Page 45
Disconnect/Reconnect Page 46
Data Compression Mode Page 47

© Copyright IBM Corp. 2002

Sequential Access Device Configuration Page . . . 49
Fibre Channel Logical Unit Control Page . . . 50
Fibre Channel Port Control Page . . . 51
Information Exceptions Mode Page . . . 52
PERSISTENT RESERVE IN . . . 54
PERSISTENT RESERVE OUT . . . 57
PREVENT/ALLOW MEDIUM REMOVAL . . . 61
READ . . . 62
READ ATTRIBUTE . . . 64
Format for the Attribute Values Service Action . . . 66
Format for the Attribute List Service Action. . . . 67
Format for the Volume List Service Action . . . 68
Format for the Partition List Service Action. . . . 69
Medium Auxiliary Memory . . . 70
READ BLOCK LIMITS . . . 79
READ BUFFER . . . 80
Error Log Buffer . . . 84
Fibre Channel World Wide Name Buffer. . . . 85
SCSI Log Buffer . . . 85
READ POSITION . . . 86
RECEIVE DIAGNOSTIC RESULTS . . . 88
RELEASE UNIT . . . 89
REPORT DENSITY SUPPORT . . . 90
REPORT LUNs. . . . 94
REQUEST SENSE . . . 96
Sense Data Format . . . 96
RESERVE UNIT . . . 99
REWIND. . . . 100
SEND DIAGNOSTIC . . . 101
SIM Data Structure . . . 102
MIM Data Structure. . . . 105
Self-Test . . . 107
Post A Self Test Diagnostic . . . 108
Post B Tape Test Diagnostic . . . 109
Post C Media Test Diagnostic . . . 110
Post D Head Test Diagnostic . . . 111
Force Dump . . . 112
Write Dump To Cartridge . . . 113
Set Traps . . . 115
Remove Traps. . . . 116
Reset Drive. . . . 118
SET CAPACITY . . . 119
SPACE . . . 121
TEST UNIT READY . . . 123
VERIFY . . . 123
WRITE . . . 124
WRITE ATTRIBUTE . . . 125
WRITE BUFFER. . . . 126
WRITE FILE MARKS . . . 128

Chapter 4. Error Sense Information . . . 129
Sense Data. . . . 129
Sense Data Management . . . 129
Unit Attention Conditions . . . 129
Persistent Errors . . . 130

Chapter 5. Sense Keys and Additional Sense 131

Chapter 6. Attachment Features 135
Types of Interface Attachments 135
Common Tape LUN Behaviors. 135
Power-On 135
Reset Strategy 135
Abort Handling 136
Multi-initiator Support 138
Status Codes 138
Features of the SCSI Interface 139
LUN Identification 139
Bus Parity Errors. 139
Disconnect Strategy 139
Messages 140
Features of the Fibre Channel Interface 143

Appendix. Notices 145
Trademarks. 145

Glossary 147

Index 155

Tables

1. Features of the IBM Ultrium Tape Drives and the IBM 3580 Ultrium Tape Drive 2
2. Supported Servers and Operating Systems for SCSI and Fibre Channel Attachment 3
3. Differences in Command Timeout Values 7
4. Supported Common Commands 11
5. ERASE Command 13
6. INQUIRY Command 14
7. Standard Inquiry Data Valid LUN 15
8. Standard Inquiry Data Invalid LUN 17
9. Supported Vital Product Data Inquiry Page 19
10. Unit Serial Number Inquiry Page 19
11. Device Identification Inquiry Page. 20
12. Device Identification Descriptor Format. 20
13. Identifier Format 20
14. Fibre Channel Identification Descriptor 21
15. Drive Component Revision Levels Pages 22
16. LOAD/UNLOAD Command 23
17. LOCATE Command. 24
18. LOG SELECT Command. 25
19. LOG SENSE Command 26
20. Log Page Header Format. 27
21. Log Parameter Format. 27
22. Supported Log Pages Log Page Format 28
23. Write Error Log Parameters 29
24. Read Error Log Parameters 30
25. Sequential Access Device Log Parameters 31
26. TapeAlert Log Parameters 32
27. Tape Usage Log Parameters 38
28. Tape Capacity Log Parameters 38
29. Data Compression Log Parameters 39
30. 6-Byte MODE SELECT Command 40
31. 10-Byte MODE SELECT Command 40
32. 6-Byte MODE SENSE Command. 41
33. 10-Byte MODE SENSE Command 41
34. Mode Data Format 42
35. Mode Parameter Header 6-Byte Command 43
36. Mode Parameter Header 10-Byte Command. 43
37. Mode Block Descriptor. 44
38. Read-Write Error Recovery Page 45
39. Disconnect/Reconnect Mode Page 46
40. Data Compression Mode Page. 47
41. Responses to Data Boundaries 48
42. Sequential Access Device Configuration Page 49
43. Fibre Channel Logical Unit Control Page 50
44. Fibre Channel Port Control Page 51
45. Information Exceptions Mode Page 52
46. PERSISTENT RESERVE IN Command 54
47. PERSISTENT RESERVE IN Parameter Data for Read Keys. 55
48. PERSISTENT RESERVE IN Parameter Data for Read Reservations. 55
49. PERSISTENT RESERVE IN Read Reservations Descriptor 56
50. PERSISTENT RESERVE OUT Command 57
51. Values for Service Action Codes in PERSISTENT RESERVE OUT Command 57
52. Persistent Reservation Type Codes 58
53. PERSISTENT RESERVE OUT Parameter List 60

© Copyright IBM Corp. 2002

54. PREVENT/ALLOW MEDIUM REMOVAL Command 61
55. READ Command 62
56. READ ATTRIBUTE Command 64
57. Supported Service Action Codes 65
58. Parameter Data for an Attribute Values Service Action 66
59. Parameter Data for an Attribute List Service Action 67
60. Parameter Data for a Volume List Service Action 68
61. Parameter Data for a Partition List Service Action 69
62. Types of MAM Attributes 70
63. States for the Types of MAM Attributes 71
64. Format of a MAM Attribute 72
65. Values and Requirements for the Format Field 73
66. Range of Values for MAM Attribute Identifiers 73
67. Standard Device Type Attributes 74
68. Format for Device Vendor Identification/Product Serial Number Attribute, Device Vendor Identification/Product Serial Number at Load-1 Attribute, Device Vendor Identification/Product Serial Number at Load-2 Attribute, and Device Vendor Identification/Product Serial Number at Load-3 Attribute 75
69. Standard Medium Type Attributes 76
70. Values for Medium Type and Medium Type Information Attributes 77
71. Standard Host Type Attributes 77
72. Values for the Text Localization Identifier Attribute 78
73. READ BLOCK LIMITS Command 79
74. READ BLOCK LIMITS Descriptor 79
75. READ BUFFER Command 80
76. Description of the Mode Field 80
77. READ BUFFER Header 82
78. READ BUFFER Descriptor 82
79. READ ECHO BUFFER Descriptor 82
80. Drive Buffers 83
81. Error Log Buffer Command 84
82. Fibre Channel World Wide Name Buffer 85
83. SCSI Log Buffer Command 85
84. READ POSITION Command 86
85. READ POSITION Data 87
86. RECEIVE DIAGNOSTIC RESULTS Command 88
87. 6-Byte RELEASE UNIT Command 89
88. 10-Byte Release Unit Command 89
89. REPORT DENSITY SUPPORT Command 90
90. REPORT DENSITY SUPPORT Header 91
91. REPORT DENSITY SUPPORT Descriptor Block 91
92. Density Information for LTO Formats 92
93. REPORT LUNs Command 94
94. Logical Unit Numbers Data 94
95. REQUEST SENSE Command 96
96. Sense Data Format 96
97. 6-Byte RESERVE UNIT Command 99
98. 10-Byte Reserve Unit Command 99
99. REWIND Command 100
100. SEND DIAGNOSTIC Command 101
101. Supported Diagnostics 101
102. SIM Data Structure 102
103. MIM Data Structure 105
104. Post A Self Test Send Diagnostic Parameter Data 108
105. Post A Self Test Receive Diagnostic Parameter Data 108
106. Post B Tape Test Send Diagnostic Parameter Data 109

107. Post B Tape Test Receive Diagnostic Parameter Data . . . 109
108. Post C Media Test Send Diagnostic Parameter Data . . . 110
109. Post C Media Test Receive Diagnostic Parameter Data . . . 110
110. Post D Head Test Send Diagnostic Parameter Data. . . . 111
111. Post D Head Test Receive Diagnostic Parameter Data . . . 111
112. Force Dump Diagnostic Parameter Data . . . 112
113. Write Dump to Cartridge Send Diagnostic Parameter Data . . . 113
114. Write Dump to Cartridge Receive Diagnostic Parameter Data . . . 114
115. Set Traps Diagnostic Parameter Data . . . 115
116. Remove Traps Diagnostic Parameter Data . . . 116
117. Reset Drive Diagnostic Results Data . . . 117
118. Reset Drive Diagnostic Parameter Data . . . 118
119. SET CAPACITY Command. . . . 119
120. Minimum Supported Capacities for Each Cartridge Type . . . 120
121. SPACE Command . . . 121
122. TEST UNIT READY Command . . . 123
123. VERIFY Command . . . 123
124. WRITE Command . . . 124
125. WRITE ATTRIBUTE Command . . . 125
126. Parameter Data for Attribute Values Service Action Request . . . 125
127. WRITE BUFFER Command . . . 126
128. Description of Mode Field . . . 126
129. WRITE FILE MARKS Command. . . . 128
130. Sense Keys and Additional Sense . . . 131
131. Abort Condition Handling . . . 136
132. Status Codes. . . . 138
133. Supported Outbound Messages . . . 140
134. Supported Inbound Messages . . . 141
135. Supported Extended Messages . . . 142

Preface

This publication contains information about how to use and program all models of the IBM® LTO Ultrium Tape Drive.

Organization

The information in this book is organized as follows:

- Chapter 1, “Introduction” on page 1 describes the features and supported attachments for each type of tape drive.
- Chapter 2, “Summary of Drive Generation Differences” on page 7 lists the differences in command timeout values between the IBM Ultrium Internal Tape Drive and the IBM TotalStorage LTO Ultrium 2 Tape Drive (known respectively as the Generation 1 and Generation 2 tape drive).
- Chapter 3, “Command Support” on page 11 lists the SCSI commands that are supported by the tape drives.
- Chapter 4, “Error Sense Information” on page 129 describes the error sense information for the tape drives.
- Chapter 5, “Sense Keys and Additional Sense” on page 131 describes the sense keys and additional sense information for the tape drives.
- Chapter 6, “Attachment Features” on page 135 describes the features of the SCSI and Fibre Channel tape drives.

Related Publications

- *IBM 3580 Ultrium Tape Drive Setup, Operator, and Service Guide*, GA32-0415, tells how to install and run the IBM 3580 Ultrium Tape Drive. The guide also describes how to administer basic service procedures.
- *IBM TotalStorage LTO Ultrium 2 Tape Drive Models T400 and T400F Setup, Operator, and Service Guide*, GA32-0455, tells how to install and run the IBM Ultrium 2 Tape Drive. The guide also describes how to administer basic service procedures.
- *IBM Ultrium Internal Tape Drive Models T200 and T200F Setup, Operator, and Service Guide*, GA32-0435, tells how to install and run the IBM Ultrium Internal Tape Drive. The guide also describes how to administer basic service procedures.
- *IBM Ultrium Device Drivers Installation and User’s Guide*, GA32-0430, provides instructions for attaching IBM-supported hardware to open-systems operating systems. It indicates what devices and levels of operating systems are supported, gives the requirements for adapter cards, and tells how to configure servers to use the device driver with the Ultrium family of devices.
- *IBM Ultrium Device Drivers Programming Reference*, GC35-0483, supplies information to application owners who want to integrate their open-systems applications with IBM-supported Ultrium hardware. The reference contains information about the application programming interfaces (APIs) for each of the various supported operating-system environments.
- *Fibre Channel Arbitrated Loop (FC-AL-2)*, published by the American National Standards Institute (ANSI) as NCITS 332:1999.
- *Fibre Channel Tape and Tape Medium Changers (FC-TAPE)*, published by the American National Standards Institute. Final draft available as T11/99-069v4 on the web at `http://www.t11.org`; actual document available from ANSI as NCITS TR-24:1999.

© Copyright IBM Corp. 2002

- *Fibre Channel Protocol for SCSI*, Second Version (FCP-2), published by the American National Standards Institute and available on the web at `http://www.t10.org`.
- *SCSI Parallel Interface-3 (SPI-3)*, published by InterNational Committee on Information Technology Standards (INCITS) and available on the web at `http://www.t10.org`.
- *SCSI-3 Stream Commands (SSC)*, published by the American National Standards Institute and available on the web at `http://www.t10.org`.
- *SCSI Stream Commands-2 (SSC-2)*, published by the American National Standards Institute and available on the web at `http://www.t10.org`.
- *SCSI Primary Commands-2 (SPC-2)*, published by the American National Standards Institute and available on the web at `http://www.t10.org`.
- *SCSI Primary Commands-3 (SPC-3)*, published by the American National Standards Institute and available on the web at `http://www.t10.org`.

Portions of this manual were adapted from documentation provided by the InterNational Committee on Information Technology Standards (INCITS).

Chapter 1. Introduction

The products that are discussed in this book are high-performance, high-capacity data-storage devices that connect to and provide additional storage for supported servers. They include all models of the IBM LTO Ultrium Tape Drive, such as:

- IBM Ultrium Internal Tape Drive Models T200 and T200F (known as Generation 1)
- IBM TotalStorage LTO Ultrium 2 Tape Drive Models T400 and T400F (known as Generation 2)
- IBM 3580 Ultrium External Tape Drive

Certain of the products use a Small Computer Systems Interface (SCSI); others use a Fibre Channel interface. Table 1 on page 2 lists the type of interface and other features for each product.

Figure 1 shows the IBM 3580 Ultrium Tape Drive and the IBM TotalStorage LTO Ultrium Tape Drive Model T200.

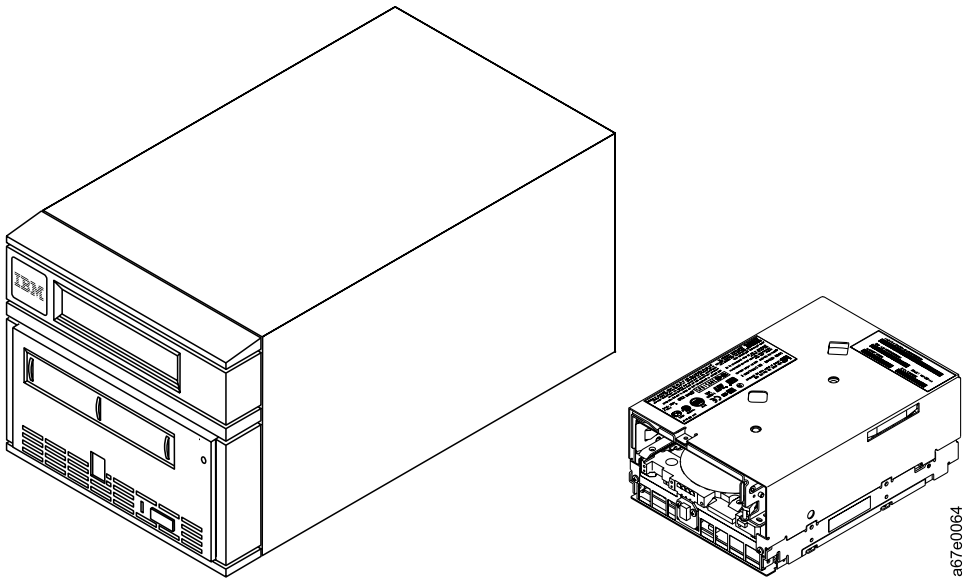


Figure 1. The IBM 3580 Ultrium Tape Drive and the IBM TotalStorage LTO Ultrium Tape Drive Model T200. Model T200 resembles Model T200F, T400, and T400F in appearance. It is shown on the right without a front bezel.

© Copyright IBM Corp. 2002

Designed to perform unattended backups as well as to retrieve and archive files, the Ultrium Tape Drives include the features that are described in Table 1.

Table 1. Features of the IBM Ultrium Tape Drives and the IBM 3580 Ultrium Tape Drive

Feature	Ultrium Tape Drives				3580 Tape Drive
	Model T200	**Model T200F**	**Model T400**	**Model T400F**	
Native storage capacity	100 GB	100 GB	200 GB	200 GB	100 GB
Storage capacity at 2:1 compression	200 GB	200 GB	400 GB	400 GB	200 GB
Native sustained data transfer rate	15 MB	15 MB	35 MB	35 MB	15 MB
Data transfer rate at 2:1 compression	30 MB	30 MB	70 MB	70 MB	30 MB
Burst data transfer rate	80 MB/s	100 MB/s	160 MB/s	200 MB/s	40 to 80 MB/s, depending on model
Type of interface	Ultra2 LVD/SE SCSI	SC-Duplex Fibre Channel, with the use of SCSI protocol	Ultra 160 LVD SCSI	Single-port, LC-Duplex Fibre Channel, with the use of SCSI protocol	SCSI LVD or HVD

Supported Servers and Operating Systems

The Ultrium Tape Drives are supported by a wide variety of servers and operating systems, as well as adapters. These attachments can change throughout the products' life cycles. To determine the latest supported attachments, visit the web at `http://www.ibm.com/storage/lto`.

SCSI and Fibre Channel Attachment

The Ultrium Tape Drives attach to servers and operating systems shown in Table 2. An attachment includes (but is not limited to) the servers and operating systems in the table. Supported interfaces are as follows:

- The Ultrium Tape Drive Models T200 and T400, and the 3580 Ultrium Internal Tape Drive use a SCSI interface
- The Ultrium Tape Drive Models T200F and T400F use a Fibre Channel interface

For specific instructions about attachment, see one or more of the following:

- The chapter about installation in the *IBM Ultrium Internal Tape Drive Models T200 and T200F Setup, Operator, and Service Guide*
- The *IBM TotalStorage LTO Ultrium 2 Tape Drive Models T400 and T400F Setup, Operator, and Service Guide*
- The *IBM 3580 Ultrium Tape Drive Setup, Operator, and Service Guide*

Table 2. Supported Servers and Operating Systems for SCSI and Fibre Channel Attachment

Supported Servers	**Supported Operating Systems**
IBM AS/400® or @server iSeries™	OS/400®
IBM RS/6000®, RS/6000 SP™, or @server pSeries™	AIX®
IBM @server zSeries™ 800 or 900	Linux
Hewlett-Packard	HP-UX
Sun Microsystems	Solaris
32-bit, Intel-compatible servers	Microsoft®Windows® 2000 or Windows NT®
	Red Hat Linux
64-bit, Intel Itanium servers	Red Hat Linux
Supported SAN Components for Fibre Channel Attachment Visit the web at: `http://www.storage.ibm.com/hardsoft/tape/supserver/support.html`	

Supported Device Drivers

IBM maintains the latest levels of device drivers and driver documentation for the IBM Ultrium Tape Drives on the Internet. You can access this material from your browser or through the IBM FTP site by performing one of the following procedures. **(Note: If you do not have Internet access and you need information about device drivers, contact your Marketing Representative.)**

- Using a browser, type one of the following:
  - `http://www.ibm.com/storage`
  - `ftp://ftp.software.ibm.com/storage/devdrvr`
  - `ftp://207.25.253.26/storage/devdrvr`
- Using an IBM FTP site, enter the following specifications:
  - FTP site: `ftp.software.ibm.com`
  - IP Addr: `207.25.253.26`
  - Userid: `anonymous`
  - Password: (use your current e-mail address)
  - Directory: `/storage/devdrvr`

IBM provides PostScript- and PDF-formatted versions of its documentation in the /storage/devdrvr/doc directory:

- IBM_ultrium_tape_IUG.ps and IBM_ultrium_tape_IUG.pdf contain the current version of the *IBM Ultrium Device Drivers Installation and User's Guide*
- IBM_ultrium_tape_PROGREF.ps and IBM_ultrium_tape_PROGREF.pdf contain the current version of the *IBM Ultrium Device Drivers Programming Reference*

Device drivers and utilities for each supported server are beneath /storage/devdrvr/ in the following directories (the device driver for the iSeries or AS/400 server is included in the OS/400 operating system):

- AIX
- HPUX
- Linux
- Solaris
- Tru64
- WinNT
- Win2000

For more information about device drivers, refer to any of the preceding directories.

Supported Tape Cartridges

The Ultrium 2 Tape Drive (Generation 2) uses the IBM TotalStorage LTO Ultrium 200 GB Data Cartridge and is compatible with the cartridges of its predecessor, the IBM Ultrium Internal Tape Drive (called Generation 1). The Ultrium 2 Tape Drive performs the following functions:

- Reads and writes Generation 2 cartridges to Generation 2 format
- Reads and writes Generation 1 cartridges to Generation 1 format
- Does not write Generation 2 cartridges to Generation 1 format
- Does not write Generation 1 cartridges to Generation 2 format

The Ultrium 2 Tape Drive reads tapes that have been written by other licensed Ultrium 2 drives. It also writes to tapes that can be read by other licensed Ultrium 2 drives.

Both generations of Ultrium Tape Drive offer read/write capability for certified LTO Ultrium tape cartridges that have capacities of 100, 50, 30, and 10 GB.

Chapter 2. Summary of Drive Generation Differences

This chapter provides a summary of the differences in host attachment protocol between the Ultrium Internal Tape Drive (Generation 1) and the TotalStorage LTO Ultrium 2 Tape Drive (Generation 2). The features of the Generation 2 drive that differ from the Generation 1 drive include:

- Reduced nominal power consumption
- 64-MB read-and-write cache
- Speed matching
- Channel calibration
- SET CAPACITY SCSI command
- Ultra160 SCSI interface
- Drive external SCSI termination required
- Fibre Channel 2-Gb/s interface
- Fibre Channel support for direct connection to an F port (for example, a McData switch)

Differences in Command Timeout Values

Due to differences between the Generation 2 and Generation 1 drives, the maximum amount of time it takes for various SCSI commands to execute and return status has changed. For comparison, these timeout values are listed in Table 3. The timeout values are based on the point where the drive starts to execute the specified command. They do not take into account the potential delay that is required to complete a prior command. Specifically, three cases need special consideration:

- When tagged command queueing is in effect
- When the prior command was issued with the Immediate bit set in the CDB
- When a manual operation is in progress (for example, a manual load, a manual unload, or a power-on self test)

Table 3. Differences in Command Timeout Values

Op Code	Command	Timeout for Generation 1 (in minutes)	Timeout for Generation 2 (in minutes)		Type
			Generation 2 Cartridge	Generation 1 Cartridge	
00h	TEST UNIT READY	1	1	1	Status
01h	REWIND	8	8	9	Position
03h	REQUEST SENSE	1	1	1	Status
05h	READ BLOCK LIMITS	1	1	1	Status
08h	READ	18	18	18	Data (~ 100 MB)
0Ah	WRITE	18	18	18	Data (~ 100 MB)
0Bh	SET CAPACITY	N/A	13	13	Position
10h	WRITE FILE MARK	15	15	15	Data
11h	SPACE	16 (normal)	14	15	Position
		173 (slow)	151	138	Position
12h	INQUIRY	1	1	1	Status

© Copyright IBM Corp. 2002

Table 3. Differences in Command Timeout Values (continued)

Op Code	Command	Timeout for Generation 1 (in minutes)	Timeout for Generation 2 (in minutes)		Type
			Generation 2 Cartridge	Generation 1 Cartridge	
13h	VERIFY	18	18	18	Position (~ 100 MB)
15h or 55h	MODE SELECT (6- or 10-byte)	1	1	1	Status
16h or 56h	RESERVE UNIT (6- or 10-byte)	1	1	1	Status
17h or 57h	RELEASE UNIT (6- or 10-byte)	1	1	1	Status
19h	ERASE	204	151	138	Position
1Ah or 5Ah	MODE SENSE (6- or 10-byte)	1	1	1	Status
1Bh	LOAD (cartridge insertion to BOM)	11	12	12	Position
	LOAD (LP4 to BOM)	8	8	9	Position
	UNLOAD (BOM to cartridge ejection)	10	10	10	Position
	UNLOAD (LP4 to cartridge ejection)	11	11	12	Position
1Ch	RECEIVE DIAGNOSTIC RESULTS	1	1	1	Status
1Dh	SEND DIAGNOSTIC	29	35	35	Position
1Eh	PREVENT/ALLOW MEDIUM REMOVAL	1	1	1	Status
2Bh	LOCATE	16 (normal)	14	15	Position
		173 (slow)	151	138	Position
34h	READ POSITION	1	1	1	Status
3Bh	WRITE BUFFER	8	8	8	Data
3Ch	READ BUFFER	8	8	8	Data
44h	REPORT DENSITY SUPPORT	1	1	1	Status
4Ch	LOG SELECT	1	1	1	Status
4Dh	LOG SENSE	1	1	1	Status
5Eh	PERSISTENT RESERVE IN	1	1	1	Status
5Fh	PERSISTENT RESERVE OUT	1	1	1	Status
8Ch	READ ATTRIBUTE	1	1	1	Data
8Dh	WRITE ATTRIBUTE	1	1	1	Data
A0h	REPORT LUNs	1	1	1	Status

New Commands and Parameters

The following are new commands and parameters:

Set Capacity Command — The SET CAPACITY command is supported on Ultrium 2 tape drives. For more information, see “SET CAPACITY” on page 119.

Echo Buffer Support — Ultrium 2 drives support the Echo Buffer mode of the READ BUFFER and WRITE BUFFER commands (see pages 80 and 126, respectively).

Data Changes

The sections that follow describe the data changes.

Standard Inquiry Data

The length of Standard Inquiry data increased to 57 bytes. The Standard Inquiry data that is reported includes information about the new DT mode support. For more information, see “Standard Inquiry Data Valid LUN” on page 15.

REPORT DENSITY SUPPORT Command

The REPORT DENSITY SUPPORT command added Generation 2 density values. For more information, see “REPORT DENSITY SUPPORT” on page 90.

Mode Pages

Fibre Channel Port Control Page (19h) Page Length changed from 0Eh (on Ultrium 1 drives) to 06h (on Ultrium 2 drives). This matches the current definition in the SCSI standards (FCP-2). For more information, see “Fibre Channel Port Control Page” on page 51.

READ POSITION Command

The READ POSITION command changed to behave as described in the SCSI standards (SPC-2). For more information, see “READ POSITION” on page 86.

The First Block Location specifies the block address that is associated with the current logical position. The value indicates the block address of the next data block to be transferred between the initiator and the target if a READ or WRITE command is issued.

The Last Block Location is specified by the following procedure:

1. After a WRITE command, this field specifies the block address that is associated with the next data block to be transferred from the buffer to the medium.
2. After a READ command, this field specifies the block address that is associated with the last (most recent) data block to be transferred from the medium to the buffer. For any case where the buffer no longer contains a whole block of data or is empty, the value that is reported for the Last Block Location is equal to the value that is reported for the First Block Location.

A block count unknown (BCU) field of 1 indicates that the Number of Blocks in Buffer field does not represent the actual number of blocks in the buffer. A BCU field of 0 indicates that the Number of Blocks in Buffer field is valid.

The byte count unknown (BYCU) field is always set to 1 and indicates that the Number of Bytes in Buffer field does not represent the actual number of bytes in the buffer.

Cartridge Eject for Errors

Generation 2 drives no longer automatically eject data cartridges when errors occur during loads.

Queueing Issues

It is the expectation of Generation 2 drives that when a cartridge is inserted into the drive through means other than SCSI commands to LUN 0, that the host will poll the drive with TEST UNIT READY commands to determine its readiness before issuing in-order commands (for examples, commands other than INQUIRY, TEST UNIT READY, REQUEST SENSE, or REPORT LUNS). If this is not the case, these commands may timeout in ERP (Error Recovery Procedure) situations.

Chapter 3. Command Support

In the sections that follow, each SCSI command includes a table that describes the fields in the Command Descriptor Block (CDB). The table is similar to those published by the InterNational Committee for Information Technology Standards (INCITS). It includes bit numbering conventions that conform to ANSI standards. The conventions are as follows:

- Bit 0 is the least significant bit (LSB) and occupies the right bit position in the table
- Bits 1-6 continue from right to left in ascending order
- Bit 7 is the most significant bit (MSB) and occupies the left bit position in the table

The LUN field in the CDB has been obsoleted in SCSI-3 and is ignored for every command.

Notes:

1. For this chapter, a megabyte (MB) is equal to 1 048 576 bytes.
2. Binary numbers are represented by numbers followed by `b`. Hexadecimal numbers are represented by `0-9` and `A-F` followed by `h`. Numbers with no suffix can be assumed to be decimal.

Table 4. Supported Common Commands

Command Name	Operation Code	SCSI Spec[1]	Page	Applicable Conditions[2]					
				RVC	UAT	NRD	WRP	MFC	DCC
ERASE	19h	SSC	13	y	y	y	y	y	y
INQUIRY	12h	SPC-2	14	-	-	-	-	-	-
LOAD/UNLOAD	1Bh	SSC	23	y	y	-	-	y	y
LOCATE	2Bh	SSC	24	y	y	y	-	y	y
LOG SELECT	4Ch	SPC-2	25	y	y	-	-	-	y
LOG SENSE	4Dh	SPC-2	26	y	-	-	-	-	-
MODE SELECT (6)	15h	SPC-2	40	y	y	-	-	-	y
MODE SELECT (10)	55h	SPC-2	40	y	y	-	-	-	y
MODE SENSE (6)	1Ah	SPC-2	41	-	y	-	-	-	-
MODE SENSE (10)	5Ah	SPC-2	41	-	y	-	-	-	-
PERSISTENT RESERVE IN	5Eh	SPC-2	54	y	y	-	-	-	-
PERSISTENT RESERVE OUT	5Fh	SPC-2	57	y[3]	y	-	-	-	-
PREVENT ALLOW MEDIUM REMOVAL	1Eh	SPC-2	61	y	y	-	-	-	-
READ	08h	SSC	62	y	y	y	-	y	y
READ ATTRIBUTE	8Ch	SPC-3	64	y	y	y	-	-	y
READ BLOCK LIMITS	05h	SSC	79	y	y	-	-	-	-
READ BUFFER	3Ch	SPC-2	80	y	-	-	-	-	-
READ POSITION	34h	SSC	86	y	y	-	-	-	-
RECEIVE DIAGNOSTIC RESULTS	1Ch	SPC-2	88	y	y	-	-	-	-
RELEASE UNIT (6)	17h	SPC-2	89	-	y	-	-	-	-
RELEASE UNIT (10)	57h	SPC-2	89	-	y	-	-	-	-
REPORT DENSITY SUPPORT	44h	SSC	90	y	y	-	-	-	-

© Copyright IBM Corp. 2002

Table 4. Supported Common Commands (continued)

Command Name	Operation Code	SCSI Spec[1]	Page	Applicable Conditions[2]					
				RVC	UAT	NRD	WRP	MFC	DCC
REPORT LUNs	A0h	SSC	94	-	-	-	-	-	-
REQUEST SENSE	03h	SPC-2	96	-	-	-	-	-	-
RESERVE UNIT (6)	16h	SPC-2	99	y	y	-	-	-	-
RESERVE UNIT (10)	56h	SPC-2	99	y	y	-	-	-	-
REWIND	01h	SSC	100	y	y	y	-	y	y
SEND DIAGNOSTIC	1Dh	SPC-2	101	y	y	-	-	y	y
SET CAPACITY	0Bh	SSC-2	119	y	y	y	y	y	y
SPACE	11h	SSC	121	y	y	y	-	y	y
TEST UNIT READY	00h	SSC	123	y	y	y	-	-	y
VERIFY	13h	SSC	123	y	y	y	-	y	y
WRITE	0Ah	SSC	124	y	y	y	y	y	y
WRITE ATTRIBUTE	8Dh	SPC-3	125	y	y	y	y	-	y
WRITE BUFFER	3Bh	SPC-2	124	y	y	-	-	-	-
WRITE FILE MARKS	10h	SSC	128	y	y	y	y	y	y

Note 1: SCSI specifications are as follows:

SSC-2 = *SCSI Stream Commands - 2*

SSC = *SCSI-3 Stream Commands*

SPC-2 = *SCSI Primary Commands-2*

SPC-3 = *SCSI Primary Commands-3*

Note 2: Applicable Conditions are as follows:

y = condition can apply to the command

- = condition cannot apply to the command

RVC = reservation conflict

UAT = unit attention

NRD = not ready

WRP = write protect

MFC = medium format corrupted

DCC = deferred check condition

Note 3: Reported as appropriate for the type of Service Action and Reservation Type requested and the current reservation state of the drive.

ERASE

Table 5. ERASE Command

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Operation Code (19h)							
1	Logical Unit Number			Reserved			Immed	Long
2	Reserved							
3	Reserved							
4	Reserved							
5	Control							

EOD is written at the current position, which marks it as end of data.

If the Long field is set to 0, no further writing occurs. If the Long field is set to 1, the Data Set Separator (DSS) pattern is written from EOD to the end of the medium to overwrite any data that is currently on the tape.

If the Immediate (Immed) field is set to 1, then the drive validates the command and waits for any previous command from any server to complete, including any immediate commands that are currently being processed. It also waits for any buffered data to be flushed to tape. It then reports 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) field is set to 0, status is not returned until after the command has completed.

After the command is successfully completed, the drive is positioned immediately before End Of Data (not End Of Tape).

INQUIRY

The INQUIRY command instructs the drive to return data about itself to the initiator.

Table 6. INQUIRY Command

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

If the Enable Vital Product Data (EVPD) field is set to 0 and the Page Code is 0, Standard Inquiry Data is returned.

If the Enable Vital Product Data (EVPD) field is set and the Page Code is 0, the Supported Vital Product Data Pages page is returned. This page lists the EVPD pages that are supported by the drive in this configuration.

If the Enable Vital Product Data (EVPD) field is set, if the Page Code is not 0, and if there is a vendor-defined Inquiry data page that corresponds to that page code, then that page is returned. Supported pages are 03h, 80h, 83h, C0h, and D0h. The contents of pages 03h and D0h are not specified in this document.

If the preceding conditions do not apply, Check Condition status is returned. The Sense Key is set to Illegal Request (5) and the ASC/ASCQ is set to Invalid Field in CDB (2400).

Standard Inquiry Data Valid LUN

Table 7. Standard Inquiry Data Valid LUN

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Peripheral Qualifier (000b)			Peripheral Device Type (01h)				
1	RMB(1)	Reserved (0)						
2	ISO version (00b)		ECMA version (000b)			Version (3h)		
3	AERC(0)	Obsolete	NACA(0)	HiSup(0)	Response Data Format (2h)			
4	Additional Length							
5	Reserved							
6	BQue	EncSrv(0)	VS(0)	MultiP(0)	MCh-ngr(0)	Obsolete	Adr32(0)	Adr16
7	RelAdr(0)	Obsolete	WBs16	Sync	Linked(0)	Trans-Dis(0)	CmdQ(0)	VS(0)
8 : 15	Vendor Identification							
16 : 31	Product Identification							
32 : 35	Product Revision Level: YMDV							
36	Reserved							AutDis
37 : 40	Reserved							
41	OEM Specific							
42 : 55	Reserved							
56	Reserved				Clocking		QAS (0b)	IUS (0b)
57	Reserved							

For SCSI devices:

- BQue field is set to 0, which indicates that the drive does not support tagged queueing.
- Adr16 field is set to 1, which indicates that the drive supports 16 SCSI IDs.
- WBs16 field is set to 1, which indicates that the drive supports a 16-bit wide data path on a single cable.

- Sync field is set to 1, which indicates that the drive supports synchronous data transfers.
- Clocking field is supported on Ultrium 2 devices only and is set to 11b because the drive supports both ST and DT modes.

For Fibre Channel devices:

- BQue field is set to 1, which indicates that the drive supports tagged (simple command) queueing.
- Adr16 field is set to 0.
- WBs16 field is set to 0.
- Sync field is set to 0.
- Clocking field is set to 00b (the Clocking field is not used in Fibre Channel devices).

For all devices:

- The Additional Length field specifies how many bytes follow. Currently Ultrium 1 devices set this value to 33 (21h) and Ultrium 2 devices set this value to 53 (35h). This value is subject to change and it is strongly recommended that the user parse the data returned by using the Additional Length field instead of the published values.
- Vendor Identification returns `IBM` in ASCII with trailing blanks.
- Product Identification returns `ULTxxxx-TDy` in ASCII with trailing blanks. If the drive is an IBM drive, `xxxx` equals `3580`; if it is an OEM drive, `xxxx` equals `RIUM`. The character `y` indicates the generation of the drive. For example:
  - `ULT3580-TD1` means an IBM Generation 1 drive
  - `ULT3580-TD2` means an IBM Generation 2 drive
  - `ULTRIUM-TD1` means an OEM Generation 1 drive
  - `ULTRIUM-TD2` means an OEM Generation 2 drive
- Product Revision Level has four parts:
  - `Y` is the last character of the year (for example, 2 indicates the year 2002)
  - `M` is the month, in the alphanumeric set 1 through 9, A, B, or C
  - `D` is the day, in the alphanumeric set 1 through 9, A through V
  - `V` is the version, in the alphanumeric set 0 through 9, A through Z, with 0 being the earliest and Z the latest (to avoid interpretation errors, the characters `i`, `l`, and `o` are not used)
- Automation Disabled (AutDis) field set indicates that the drive is not capable of full automation function. When this field is 0, it indicates that the drive is capable of full automation function.
- The OEM Specific field is intentionally not specified. See the documentation from the OEM vendor to determine the field's definition and application.
- Quick Arbitrate Supported (QAS) is set to 0 because the drive does not support quick arbitration and selection.
- Information Unit Supported (IUS) is set to 0 because the drive does not support information unit transfers.

Standard Inquiry Data Invalid LUN

Table 8. Standard Inquiry Data Invalid LUN

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Peripheral Qualifier (011b)			Peripheral Device Type (1Fh)				
1	RMB(0)	Reserved (0)						
2	ISO version (00b)		ECMA version (000b)			Version (3h)		
3	AERC(0)	Obsolete	NACA(0)	HiSup(0)	Response Data Format (2h)			
4	Additional length							
5	Reserved							
6	BQue	EncSrv(0)	VS(0)	MultiP(0)	MCh-ngr(0)	Obsolete	Adr32(0)	Adr16(1)
7	RelAdr(0)	Obsolete	WBs16(1)	Sync(1)	Linked(0)	Trans-Dis(0)	CmdQ(0)	VS(0)
8 : 15	Vendor Identification							
16 : 31	Product Identification							
32 : 35	Product Revision Level: YMDV							
37 : 40	Reserved							
41	OEM Specific							
42 : 55	Reserved							
56	Reserved				Clocking		QAS (0b)	IUS (0b)
57	Reserved							

For SCSI devices:

- BQue field is set to 0, which indicates that the drive does not support tagged queueing.
- Adr16 field is set to 1, which indicates that the drive supports 16 SCSI IDs.
- WBs16 field is set to 1, which indicates that the drive supports a 16-bit wide data path on a single cable.

- Sync field is set to 1, which indicates that the drive supports synchronous data transfers.
- Clocking field is supported on Ultrium 2 devices only and is set to 11b because the drive supports both ST and DT modes.

For Fibre Channel devices:

- BQue field is set to 1, which indicates that the drive supports tagged (simple command) queueing.
- Adr16 field is set to 0.
- WBs16 field is set to 0.
- Sync field is set to 0.
- Clocking field is set to 00b (the Clocking field is not used in Fibre Channel devices).

For all devices:

- The Additional Length field specifies how many bytes follow. Currently Ultrium 1 devices set this value to 33 (21h) and Ultrium 2 devices set this value to 53 (35h). This value is subject to change and it is strongly recommended that the user parse the data returned by using the Additional Length field instead of the published values.
- Vendor Identification returns `IBM` in ASCII with trailing blanks.
- Product Identification returns `ULTxxxx-TDy` in ASCII with trailing blanks. If the drive is an IBM drive, `xxxx` equals `3580`; if it is an OEM drive, `xxxx` equals `RIUM`. The character `y` indicates the generation of the drive. For example:
  - `ULT3580-TD1` means an IBM Generation 1 drive
  - `ULT3580-TD2` means an IBM Generation 2 drive
  - `ULTRIUM-TD1` means an OEM Generation 1 drive
  - `ULTRIUM-TD2` means an OEM Generation 2 drive
- Product Revision Level has four parts:
  - `Y` is the last character of the year (for example, 2 indicates the year 2002)
  - `M` is the month, in the alphanumeric set 1 through 9, A, B, or C
  - `D` is the day, in the alphanumeric set 1 through 9, A through V
  - `V` is the version, in the alphanumeric set 0 through 9, A through Z, with 0 being the earliest and Z the latest (to avoid interpretation errors, the characters `i`, `l`, and `o` are not used)
- Automation Disabled (AutDis) field set indicates that the drive is not capable of full automation function. When this field is 0, it indicates that the drive is capable of full automation function.
- The OEM Specific field is intentionally not specified. See the documentation from the OEM vendor to determine the field's definition and application.
- Quick Arbitrate Supported (QAS) is set to 0 because the drive does not support quick arbitration and selection.
- Information Unit Supported (IUS) is set to 0 because the drive does not support information unit transfers.

Supported Vital Product Data Page

Table 9. Supported Vital Product Data Inquiry Page

Byte	Bit							
	7	6	5	4	3	2	1	0
0	Peripheral Qualifier (000b)			Peripheral Device Type (01h)				
1	Page Code (00h)							
2	Reserved							
3	Page Length (6h)							
4	Supported Vital Product Data Page Code (00h)							
5	Vendor-Unique Page Code (03h)							
6	Unit Serial Number Page Code (80h)							
7	Device Identification Page Code (83h)							
8	Drive Component Revision Levels Page Code (C0h)							
9	Vendor-Unique Page Code (D0h)							

The Supported Vital Product Data Page contains pages that the device will return. Pages 00h, 03h, 80h, 83h, C0h, and D0h are returned for all drives, but only those drives that have the AS/400 (iSeries) attachment enabled will have valid data in pages 03h and D0h. The contents of pages 03h and D0h are not specified in this document. OEM drives may add pages not specified in this document.

The Page Length field indicates how many bytes follow.

Unit Serial Number Page

Table 10. Unit Serial Number Inquiry Page

Byte	Bit							
	7	6	5	4	3	2	1	0
0	Peripheral Qualifier (000b)			Peripheral Device Type (01h)				
1	Page Code (80h)							
2	Reserved							
3	Page Length (0Ah)							
4 : 13	Unit Serial Number							

The Unit Serial Number Page contains a single value that is a 10-byte ASCII string. The string, with the Vendor Identification and Product Identification fields in the Standard Inquiry Data, uniquely identifies the drive. Valid Serial Number values are 0 through 9, A through D, and F.

Device Identification Page

Table 11. Device Identification Inquiry Page

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Peripheral Qualifier (000b)			Peripheral Device Type (01h)				
1	Page Code (83h)							
2	Reserved							
3	Page Length (n-3)							
4 : n	Identification Descriptor List							

The Identification Descriptor List contains a series of Identification Descriptors that uniquely identify the particular device. SCSI devices return only the Device Identification Descriptor (see Table 12). Fibre Channel devices return the Device Identification Descriptor (see Table 12) followed by the Fibre Channel Identification Descriptor (see Table 14 on page 21).

Table 12. Device Identification Descriptor Format

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
4	Reserved				Code Set (2h)			
5	Reserved				Identifier Type			
6	Reserved							
7	Identifier Length (n-3)							
8 : n	Identifier							

Table 13 describes the Identifier format.

Table 13. Identifier Format

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
8 : 15	Vendor Identification							
16 : 31	Product Identification							

Table 13. Identifier Format (continued)

Byte	Bit							
	7	6	5	4	3	2	1	0
32 : 41	Serial Number							

The Code Set field is 2, indicating the Identification Descriptor contains only ASCII data.

This device supports an Identifier Type of 1. In this case, the Device Identification Descriptor is the Vendor Identification followed by the Product Identification field from the Standard Inquiry Data and the Serial Number field from the Unit Serial Number Inquiry Page (see “Unit Serial Number Page” on page 19). For more information, see the descriptions of the Vendor Identification and Product Identification fields on page 18.

The Parallel SCSI drive reports only the single Identification Descriptor of Identifier Type 1.

The Fibre Channel Identification descriptor is returned only on Fibre-Channel-attached devices. The format is given in Table 14.

Table 14. Fibre Channel Identification Descriptor

Byte	Bit							
	7	6	5	4	3	2	1	0
0	Reserved				Code Set (1h)			
1	Reserved		Association Type (00b)		Identifier Type (3h)			
2	Reserved							
3	Identifier Length (8)							
4 : 11	World Wide Node Name							

Drive Component Revision Levels Pages

Table 15. Drive Component Revision Levels Pages

Byte	Bit							
	7	6	5	4	3	2	1	0
0	Peripheral Qualifier (000b)			Peripheral Device Type (01h)				
1	Page Code (C0h)							
2	Reserved							
3	Page Length (27h)							
4 : 15	Component (CCCCCCCCCCCC)							
16 : 22	Version (RRR.VVV)							
23 : 30	Date (YYYYMMDD)							
31 : 42	Variant (XXXXXXXXXXXX)							

The Drive Component Revision Levels Pages contain details of the revisions of each of the components of the drive. This device supports only one Drive Component Revision Levels Page (Page C0h). The values returned by the device in this page are unique to the vendor and are not specified in this document.

This page contains four null-terminated ASCII strings. The Component entry has a twelve-character entry to identify the component that the revision is for. The Version entry has a seven-character version code, with a three-digit major revision number, a period, and a three-digit minor version number. The date entry has the date of the version, in year-first order. The Variant entry has a variant identifier, indicating the version of the product.

LOAD/UNLOAD

Table 16. LOAD/UNLOAD Command

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Operation Code (1Bh)							
1	Logical Unit Number			Reserved				Immed
2	Reserved							
3	Reserved							
4	Reserved					EOT(0)	Reten(0)	Load
5	Control							

If the Load field is set to 1 and there is a tape in the drive, it is positioned to BOM. If the Load field is set to 1 and there is no tape in the drive, Check Condition status is returned. The Sense Key is set to Not Ready (2) and the ASC/ASCQ is set to Parameter Medium Not Present (3A00).

If the Load field is set to 0, there is a tape in the drive, and medium removal prevention has not been set, then the tape is unloaded and ejected. If the Load field is set to 0, there is a tape in the drive, and medium removal prevention has been set, then Check Condition status is returned. The Sense Key is set to Illegal Request (5) and the ASC/ASCQ is set to Medium Removal Prevented (5302).

If the Load field is set to 0 and the tape is in the ejected position, the command is presented with Check Condition status and associated sense data of 2/0402 (Not Ready, Initialization Required). If the Load field is set to 0 and there is no cartridge present, the command is presented with Check Condition status and associated data of 2/3A00 (Not Ready, Medium Not Present).

If the Immediate (Immed) field is set to 1, then the drive validates the command and waits for any previous command from any server to complete, including any immediate commands that are currently being processed. It also waits for any buffered data to be flushed to tape. It then reports 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) field is set to 0, status is not returned until after the command has completed.

The Retension (Reten) field is not supported and will be ignored.

The End Of Tape (EOT) field is not supported and should be set to 0. If the EOT field is set to 1, then Check Condition status is returned. The Sense Key is set to Illegal Request (5) and the ASC/ASCQ is set to Invalid Field in CDB (2400).

LOCATE

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 BOM and the desired logical position. A value of 0 causes the tape to be positioned at BOM.

Table 17. LOCATE Command

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Operation Code (2Bh)							
1	Logical Unit Number			Reserved		BT(0)	CP(0)	Immed
2	Reserved							
3 : 6	Block Address							
7	Reserved							
8	Partition (0)							
9	Control							

If the Immediate (Immed) field is set to 1, then the drive validates the command and waits for any previous command from any server to complete, including any immediate commands that are currently being processed. It also waits for any buffered data to be flushed to tape. It then reports 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) field is set to 0, status is not returned until after the command has completed.

If the LOCATE command fails for anything other than Illegal Request, the logical position is not guaranteed and a READ POSITION command should be issued to determine the current logical position of the tape.

The Block Type (BT) and Change Partition (CP) fields are not supported and should be set to 0. The Partition field is not supported and will be set to 0. If the Partition field is set to anything other than 0, then Check Condition status is returned. The Sense Key is set to Illegal Request (5) and the ASC/ASCQ is set to Invalid Field in CDB (2400).

LOG SELECT

The LOG SELECT command causes log data on the drive to be reset to its default value or to be set to an initiator-specific value.

Table 18. LOG SELECT Command

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Operation Code (4Ch)							
1	Logical Unit Number			Reserved			PCR	SP(0)
2	PC		Reserved					
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7 : 8	Parameter List Length							
9	Control							

If the Parameter Code Reset (PCR) field is set to 1, the Parameter List Length is 0. The action taken by the drive is specified for the values of the Page Control (PC) field as follows:

- 00b means that no action is taken and Good status is returned.
- 01b means that all resettable logs on the drive are reset to default values.
- 10b means that no action is taken and Good status is returned.
- 11b means that all resettable logs on the drive are reset to default values.

If the Parameter Code Reset (PCR) field is set to 0, the Parameter List Length is not 0. The action taken by the drive is specified for the values of the Page Control (PC) field as follows:

- 00b means that Check Condition status is returned. The Sense Key is set to Illegal Request and the ASC/ASCQ is set to Invalid Field in CDB (2400).
- 01b means that data from the server is written to the indicated logs, provided that the logs are writable.
- 10b means that Check Condition status is returned. The Sense Key is set to Illegal Request and the ASC/ASCQ is set to Invalid Field in CDB (2400).
- 11b means that data from the server is written to the indicated logs, provided that the logs are writable.

The Save Page (SP) field is not supported and must be set to 0.

LOG SENSE

The LOG SENSE command causes log data to be sent to the initiator.

Table 19. LOG SENSE Command

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Operation Code (4Dh)							
1	Logical Unit Number			Reserved			PPC(0)	SP(0)
2	PC		Page Code					
3	Reserved							
4	Reserved							
5 : 6	Parameter Pointer (0)							
7 : 8	Allocation Length							
9	Control							

The log values returned are controlled by the Page Control (PC) field value as follows:

- 00b means that the maximum value for each log entry is returned. For page 2Eh (Tape Alert) only, this will return the current values.
- 01b means that the current values are returned.
- 10b means that the maximum value for each log entry is returned.
- 11b means that the power-on values are returned.

The Parameter Pointer Control (PPC) must be set to 0. Returning changed parameters is not supported. The Save Page (SP) field must be set to 0. Saved pages are not supported. The Parameter Pointer will be 0.

Cartridge-specific log parameter counts are set to 0 when a cartridge has successfully loaded.

Log Page Format

All log pages (except page 0) consist of a log page header, followed by a number of log parameters. The log page header has the format indicated in Table 20.

Table 20. Log Page Header Format

	Bit							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Reserved		Page Code					
1	Reserved							
2 : 3	Page Length							

The Page Code is a byte value that uniquely identifies what log page is being returned. The Page Length describes how many bytes are to follow for the entire log page.

Each log parameter has the format indicated in Table 21.

Table 21. Log Parameter Format

	Bit							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0 : 1	Parameter Code							
2	DU	DS (1)	TSD (0)	ETC (0)	TMC (0)		LBIN	LP
3	Parameter Length (n-3)							
4 : n	Parameter Bytes							

The Parameter Code is a 2-byte value that uniquely identifies the parameter within the log.

The Disable Update (DU) field is set for any parameter that the server can neither write nor reset.

The List Parameter (LP) field is 0 for parameters that are counters and 1 for parameters that are not counters.

If the LP field is 1 and the parameter is a binary parameter, then the List Binary (LBIN) field is set to 1. Otherwise it is set to 0.

The TSD, ETC and TMC fields are always 0 and the DS field is always 1.

The Parameter Length field gives the length of the Parameter Bytes field in bytes.

The Parameter Bytes field contains the actual parameter data.

Supported Log Pages

The Supported Log Pages Log Page code is 00h. The parameter list contains a series of 1-byte entries for the log pages that are supported. At least those logs described in this document must be listed. Any additional logs that are supported must also be listed.

The format of this page is give in Table 22.

Table 22. Supported Log Pages Log Page Format

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

This data can be neither reset nor written.

Write Error Counters Log

The Write Error Counters log is page 02h. Parameters 0 through 2 are not supported and are returned as 0. All parameter lengths are 4 bytes long, except parameter 8000 which is 8 bytes long.

The supported fields are listed in Table 23.

Table 23. Write Error Log Parameters

Parameter	Definition	Description	DU	LP	LBIN
0	Errors corrected without substantial delay	Not supported	0	0	0
1	Errors corrected with possible delays	Not supported	0	0	0
2	Total	Not supported	0	0	0
3	Total errors corrected	Total Write Retries less Total Unrecovered Write Errors	0	0	0
4	Total times error correction processed	Total Write Retries	0	0	0
5	Total bytes processed	Total Data Sets Written	0	0	0
6	Total uncorrected errors	Total Unrecovered Write Errors	0	0	0
8000h	Unspecified	Not applicable	0	0	0
8001h	Unspecified	Not applicable	0	0	0

This data can be reset to 0, but cannot be written.

Read Error Counters Log

The Read Error Counters log is page 03h. Parameters 0 through 2 are not supported and are returned as 0. All parameter lengths are 4 bytes long, except parameter 8000 which is 8 bytes long.

The supported fields are listed in Table 24.

Table 24. Read Error Log Parameters

Parameter	Definition	Description	DU	LP	LBIN
0	Errors corrected without substantial delay	Not supported	0	0	0
1	Errors corrected with possible delays	Not supported	0	0	0
2	Total	Not supported	0	0	0
3	Total errors corrected	Total Number of Read Retries less Total Unrecovered Read Errors	0	0	0
4	Total times error correction processed	Total Number of Read Retries	0	0	0
5	Total bytes processed	Total Data Sets Read	0	0	0
6	Total uncorrected errors	Total Unrecovered Read Errors	0	0	0
8000h	Unspecified	Not applicable	0	0	0

This data can be reset to 0, but not written.

Sequential Access Device Log

The Sequential Access Device Log Page is 0Ch.

Table 25. Sequential Access Device Log Parameters

Parameter	Description	Length	DU	LP	LBIN
0h	Write Data Bytes Received, before compression	8	0	0	0
1h	Write Data Bytes Received, after compression	8	0	0	0
2h	Read Data Bytes Sent, before compression	8	0	0	0
3h	Read Data Bytes Sent, after compression	8	0	0	0
0100h	Cleaning Required	8	0	0	0
8000h	Megabytes processed since last cleaning	4	0	0	0
8001h	Lifetime load cycles	4	0	0	0
8002h	Lifetime cleaning cycles	4	0	0	0
8003h	Power-on time (in seconds)	4	0	0	0

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.

TapeAlert Log

The TapeAlert log page is page 2Eh. There are 64 parameters, numbered from 1 through 64 (01h through 37h). Table 26 shows the parameters that are supported for Generations 1 or 2 of the Ultrium Tape Drive. The supported parameters are 0 in the absence of the condition that generates the flag and are set to a non-zero value when the condition occurs. All unsupported parameters are always set to 0.

All parameters are 1 byte long. Each parameter is either 0 to indicate that the corresponding condition has not occurred or non-zero to indicate that the corresponding condition has occurred. All log parameters are set to 0 when the log is read. The Log parameters are also set to 0 at power-on, on a reset condition, or by a LOG SELECT command. Specific flags may be set to 0 when corrective action has removed the condition that caused the flag to be set. For all parameters, the DU field is 1, the LP field is 0, and the LBIN field is 0.

The PC field for this page is interpreted as follows:

- 00b means that the current values are returned.
- 01b means that the current values are returned.
- 10b means that the maximum value for each log entry is returned.
- 11b means that the power-on values are returned.

For a description of service actions associated with the supported parameters, refer to the *IBM TotalStorage LTO Ultrium 2 Tape Drive Models T400 and T400F Setup, Operator, and Service Guide*, the *IBM Ultrium Internal Tape Drive Models T200 and T200F Setup, Operator, and Service Guide*, or the *IBM 3580 Ultrium Tape Drive Setup, Operator, and Service Guide*.

Table 26. TapeAlert Log Parameters

Parameter Number (in hex)	Flag Number	Flag	Generation (see Note 1)	Flag Type (see Note 2)	Recommended Application Client Message	Probable Cause
01h	1	Read warning	-	W	The tape drive is having problems reading data. No data has been lost, but there has been a reduction in the performance of the tape.	The drive is having severe trouble reading.
02h	2	Write warning	-	W	The tape drive is having problems writing data. No data has been lost, but there has been a reduction in the capacity of the tape.	The drive is having severe trouble writing.
03h	3	Hard error	1,2	W	The operation has stopped because an error has occurred while reading or writing data which the drive cannot correct.	The drive had a hard read or write error.
04h	4	Media	1,2	C	Your data is at risk: 1. Copy any data you require from this tape. 2. Do not use this tape again. 3. Restart the operation with a different tape.	Media can no longer be written or read, or performance is severely degraded.
05h	5	Read failure	1,2	C	The tape is damaged or the drive is faulty. Call the tape drive supplier help line.	The drive can no longer read data from the tape.

Table 26. TapeAlert Log Parameters (continued)

Parameter Number (in hex)	Flag Number	Flag	Generation (see Note 1)	Flag Type (see Note 2)	Recommended Application Client Message	Probable Cause
06h	6	Write failure	1,2	C	The tape is from a faulty batch or the tape drive is faulty: 1. Use a good tape to test the drive. 2. If the problem persists, call the tape drive supplier help line.	The drive can no longer write data to the tape.
08h	8	Not data grade	1,2	W	The cartridge is not data-grade. Any data you write to the tape is at risk. Replace the cartridge with a data-grade tape.	None.
09h	9	Write protect	1,2	C	You are trying to write to a write protected cartridge. Remove the write protection or use another tape.	The WRITE command was attempted to a write-protected tape.
0Ah	10	No removal	1,2	I	You cannot eject the cartridge because the tape drive is in use. Wait until the operation is complete before ejecting the cartridge.	A manual or software unload was attempted when Prevent Media Removal was on.
0Bh	11	Cleaning media	1,2	I	The tape in the drive is a cleaning cartridge.	A cleaning tape is loaded in the drive.
0Ch	12	Unsupported format	1,2	I	You have tried to load a cartridge of a type that is not supported by this drive.	You attempted to load a cartridge with an unsupported tape format (for example, Ultrium 2 cartridge in Ultrium 1 drive)
0Dh	13	Recoverable snapped tape	-	C	The operation has failed because the tape in the drive has snapped: 1. Discard the old tape. 2. Restart the operation with a different tape.	The tape snapped or cut in the drive where media can be ejected.
0Eh	14	Unrecoverable snapped tape	-	C	The operation has failed because the tape in the drive has snapped: 1. Do not attempt to extract the tape cartridge. 2. Call the tape drive supplier help line.	The tape snapped or cut in the drive where media cannot be ejected.
0Fh	15	Memory chip in cartridge failed	1,2	W	The memory in the tape cartridge has failed, which reduces performance. Do not use the cartridge for further write operations.	The memory chip failed in the cartridge.
10h	16	Forced eject	1,2	C	The operation has failed because the tape cartridge was manually ejected while the tape drive was actively writing or reading.	You performed a manual or forced eject while the drive was actively writing or reading.
11h	17	Read only format	-	W	You have loaded a cartridge of a type that is read-only in this drive. The cartridge will appear as write protected.	The media that is loaded is in a read-only format.
12h	18	Tape directory corrupted on load	1,2	W	The tape directory on the tape cartridge has been corrupted. File search performance will be degraded. The tape directory can be rebuilt by reading all the data on the cartridge.	The tape drive powered down with a tape loaded, or a permanent error prevented the tape directory from being updated.

Table 26. TapeAlert Log Parameters (continued)

Parameter Number (in hex)	Flag Number	Flag	Generation (see Note 1)	Flag Type (see Note 2)	Recommended Application Client Message	Probable Cause
13h	19	Nearing media life	1,2	I	The tape cartridge is nearing the end of its calculated life. It is recommended that you: 1. Use another tape cartridge for your next backup. 2. Store this tape cartridge in a safe place in case you need to restore data from it.	The media may have exceeded its specified number of passes.
14h	20	Clean now	1,2	C	The tape drive needs cleaning: 1. If the operation has stopped, eject the tape and clean the drive. 2. If the operation has not stopped, wait for it to finish and then clean the drive. Check the tape drive users manual for device specific cleaning instructions.	The drive thinks it has a head clog or needs cleaning.
15h	21	Clean periodic	1,2	W	The tape drive is due for routine cleaning: 1. Wait for the current operation to finish. 2. Then use a cleaning cartridge. Check the tape drive users manual for device specific cleaning instructions.	The drive is ready for a periodic cleaning.
16h	22	Expired cleaning media	1,2	C	The last cleaning cartridge used in the tape drive has worn out: 1. Discard the worn out cleaning cartridge. 2. Wait for the current operation to finish. 3. Then use a new cleaning cartridge.	The cleaning tape has expired.
17h	23	Invalid cleaning tape	1,2	C	The last cleaning cartridge used in the tape drive was an invalid type: 1. Do not use this cleaning cartridge in this drive. 2. Wait for the current operation to finish. 3. Then use a valid cleaning cartridge.	An invalid cleaning tape type was used.
18h	24	Retention requested	-	W	The tape drive has requested a retention operation.	The drive is having severe trouble reading or writing, which will be resolved by a retension cycle.
1Ah	26	Cooling fan failure	-	W	A tape drive cooling fan has failed.	A fan failure exists inside the tape drive mechanism or tape drive enclosure.

Table 26. TapeAlert Log Parameters (continued)

Parameter Number (in hex)	Flag Number	Flag	Generation (see Note 1)	Flag Type (see Note 2)	Recommended Application Client Message	Probable Cause
1Bh	27	Power supply failure	-	W	A redundant power supply has failed inside the tape drive enclosure. Check the enclosure users manual for instructions on replacing the failed power supply.	A redundant power supply unit failed inside the tape drive enclosure or rack subsystem.
1Ch	28	Power consumption	-	W	The tape drive power consumption is outside the specified range.	The power consumption of the tape drive is outside the specified range.
1Dh	29	Drive maintenance	-	W	Preventive maintenance of the tape drive is required. Check the tape drive users manual for device specific preventive maintenance tasks or call the tape drive supplier help line.	The drive requires preventive maintenance (not cleaning).
1Eh	30	Hardware A	1,2	C	The tape drive has a hardware fault: 1. Eject the tape or magazine. 2. Reset the drive. 3. Restart the operation.	The drive has a hardware fault that requires a reset to recover.
1Fh	31	Hardware B	1,2	C	The tape drive has a hardware fault: 1. Turn the tape drive off and then on again. 2. Restart the operation. 3. If the problem persists, call the tape drive supplier help line.	The drive has a hardware fault that is not related to a read/write operation, or the drive requires a power cycle to recover.
20h	32	Interface	1,2	W	The tape drive has a problem with the application client interface: 1. Check the cables and cable connections. 2. Restart the operation.	The drive has identified an interface fault.
21h	33	Eject media	1,2	C	The operation has failed: 1. Eject the tape or magazine. 2. Insert the tape or magazine again. 3. Restart the operation.	Error recovery action is necessary.
22h	34	Download fail	1,2	W	The firmware download has failed because you have tried to use the incorrect firmware for this tape drive. Obtain the correct firmware and try again.	Firmware download failed.
23h	35	Drive humidity	1,2	W	Environmental conditions inside the tape drive are outside the specified temperature range.	The drive's humidity limits are exceeded.
24h	36	Drive temperature	1,2	W	Environmental conditions inside the tape drive are outside the specified temperature range.	The drive's temperature limits are exceeded.
25h	37	Drive voltage	1,2	W	The voltage supply to the tape drive is outside the specified range.	The drive's voltage limits are exceeded.
26h	38	Predictive failure	1,2	C	A hardware failure of the tape drive is predicted. Call the tape drive supplier help line.	Predictive failure of drive hardware.

Table 26. TapeAlert Log Parameters (continued)

Parameter Number (in hex)	Flag Number	Flag	Generation (see Note 1)	Flag Type (see Note 2)	Recommended Application Client Message	Probable Cause
27h	39	Diagnostics required	1,2	W	The tape drive may have a hardware fault. Run extended diagnostics to verify and diagnose the problem. Check the tape drive users manual for device specific instructions on running extended diagnostic tests.	The drive may have a hardware fault that could be identified by extended diagnostics (such as the test that starts when you issue the SEND DIAGNOSTIC command).
28h	40	Loader hardware A	-	C	The changer mechanism is having difficulty communicating with the tape drive: 1. Turn the autoloader off then on. 2. Restart the operation. 3. If a problem persists, call the tape drive supplier help line.	Loader mechanism does not communicate properly with the tape drive.
29h	41	Loader stray tape	-	C	A tape has been left in the autoloader by a previous hardware fault: 1. Insert an empty magazine to clear the fault. 2. If the fault does not clear, turn the autoloader off and then on again. 3. If the problem persists, call the tape drive supplier help line.	A tape was left in the autoloader after a previous error recovery.
2Ah	42	Loader hardware B	-	W	There is a problem with the autoloader mechanism.	The loader mechanism has a hardware fault.
2Bh	43	Loader door	-	C	The operation has failed because the autoloader door is open: 1. Clear any obstructions from the autoloader door. 2. Eject the magazine and then insert it again. 3. If the fault does not clear, turn the autoloader off and then on again. 4. If the problem persists, call the tape drive supplier help line.	The door of the autoloader is open.
2Ch	44	Loader hardware C	-	C	The autoloader has a hardware fault: 1. Turn the autoloader off and then on again. 2. Restart the operation. 3. If the problem persists, call the tape drive supplier help line. Check the autoloader users manual for device specific instructions on turning the device power on and off.	The autoloader's mechanism has a non-mechanical hardware fault.
2Dh	45	Loader magazine	-	C	The autoloader cannot operate without the magazine: 1. Insert the magazine into the autoloader. 2. Restart the operation.	The autoloader's magazine is not present.

Table 26. TapeAlert Log Parameters (continued)

Parameter Number (in hex)	Flag Number	Flag	Generation (see Note 1)	Flag Type (see Note 2)	Recommended Application Client Message	Probable Cause
2Eh	46	Loader predictive failure	-	W	A hardware failure of the changer mechanism is predicted. Call the tape drive supplier help line.	Predictive failure of loader mechanism's hardware.
32h	47	Lost statistics	-	W	Media statistics have been lost at some time in the past.	The drive or library was powered off with a tape still loaded.
33h	48	Tape directory invalid at unload	-	W	The tape directory on the tape cartridge just unloaded has been corrupted. File search performance will be degraded. The tape directory can be rebuilt by reading all the data.	An error prevented the tape directory from being updated during an unload operation.
34h	49	Tape system	-	C	The tape just unloaded could not write its system area successfully: 1. Copy data to another tape cartridge. 2. Discard the old cartridge.	Write errors occurred while the drive was writing the system log during an unload operation.
36h	51	No start of data	-	C	The start of data could not be found on the tape: 1. Check that you are using the correct format tape. 2. Discard the tape or return the tape to your supplier.	The tape was damaged or bulk erased, or an incorrect format was used.
37h	52	Loading failure	-	C	The operation has failed because the media cannot be loaded and threaded: 1. Remove the cartridge, inspect it as specified in the product manual, and retry the operation. 2. If the problem persists, call the tape drive supplier help line.	The drive was unable to load the media and thread the tape.

Notes:

1. - means not currently supported; n means supported in the Ultrium n tape drive, where n is the generation of the drive
2. C = critical; W = warning; I = informational

See the *SCSI Stream Commands - 2 (SSC-2)* command set standard for more complete descriptions of the flags.

This data cannot be written or reset. The flags are cleared by the action of reading the log.

Tape Usage Log

The Tape Usage Log Page Code is 30h. These are all read directly from the tape logs.

Table 27. Tape Usage Log Parameters

Parameter	Description	Length	DU	LP	LBIN
1	Thread Count	4	1	0	0
2	Total Data Sets Written	8	1	0	0
3	Total Write Retries	4	1	0	0
4	Total Unrecovered Write Errors	2	1	0	0
5	Total Suspended Writes	2	1	0	0
6	Total Fatal Suspended Writes	2	1	0	0
7	Total Data Sets Read	8	1	0	0
8	Total Read Retries	4	1	0	0
9	Total Unrecovered Read Errors	2	1	0	0
10	Total Suspended Reads	2	1	0	0
11	Total Fatal Suspended Reads	2	1	0	0

This data cannot be written or reset.

Tape Capacity Log

The Tape Capacity Log Page Code is 31h. Parameters 2 and 4 are not supported and are returned as 0. All parameter lengths are 4 bytes long. The supported fields are listed in Table 28.

Table 28. Tape Capacity Log Parameters

Parameter	Description	Length	DU	LP	LBIN
1	Main Partition Remaining Capacity	4	1	0	0
2	Alternate Partition Remaining capacity	4	1	0	0
3	Main Partition Maximum Capacity	4	1	0	0
4	Alternate Partition Maximum Capacity	4	1	0	0

All parameters are in megabytes and assume no data compression. This data cannot be reset or written.

Note: For this command, a megabyte is equal to 1 048 576 bytes. As an example, a value of 17487h in Parameter 3 is equal to 95 367 megabytes, which is equal to 100 000 000 000 bytes.

Data Compression Log

The Data Compression Log Page Code is 32h. Parameter byte fields 0 and 1 are 2 bytes long. Parameter byte fields 2 through 9 are each 4 bytes long.

The supported fields are listed in Table 29.

Table 29. Data Compression Log Parameters

Parameter	Description	Length	DU	LP	LBIN
0	Read Compression ratio × 100	2	0	0	0
1	Write Compression Ratio × 100	2	0	0	0
2	Megabytes transferred to server	4	0	0	0
3	Bytes transferred to server	4	0	0	0
4	Megabytes read from tape	4	0	0	0
5	Bytes read from tape	4	0	0	0
6	Megabytes transferred from server	4	0	0	0
7	Bytes transferred from server	4	0	0	0
8	Megabytes written to tape	4	0	0	0
9	Bytes written to tape	4	0	0	0

Parameters 2 through 9 occur as pairs that represent a large number of bytes transferred. The first 4-byte parameter represents the number of whole megabytes transferred, rounded to the nearest megabyte. The second 4-byte parameter represents the difference between this number of megabytes and the actual number of bytes. This may be a signed quantity.

This data may be reset, but may not be written.

MODE SELECT

The MODE SELECT command causes configuration data to be sent to the drive. For the format of Mode data and supported Mode pages see “MODE SENSE” on page 41. Both the 10-byte and 6-byte versions of the MODE SELECT command are supported.

Table 30. 6-Byte MODE SELECT Command

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

Table 31. 10-Byte MODE SELECT Command

	Bit							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Operation Code (55h)							
1	Logical Unit Number			PF	Reserved			SP(0)
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7 : 8	Parameter List Length							
9	Control							

The Page Format (PF) field may be any value. However, the drive assumes that the format is SCSI-2. The Save Pages (SP) field must be set to 0, because saved pages are not supported. The Parameter List Length field should be set to the amount of data to be sent to the drive.

The Parameter List Length value is checked to ensure that it is less than or equal to the sum of the lengths of all the supported mode pages. Any command with a larger value results in a Check Condition status. The associated sense data returns with a Sense Key of Illegal Request and an ASC/ASCQ of Invalid Field in CDB (2400).

If any of the fields in the Mode pages are invalid, no parameters are altered, Check Condition status is returned, the Sense Key is set to Illegal Request, and the ASC/ASCQ is set to Invalid Field in Parameter List (2600).

MODE SENSE

The MODE SENSE command requests that the drive send its configuration data to the initiator. Pages 01h, 02h, 0Fh, 10h, and 1Ch are supported. Mode Pages 18h and 19h are supported only on Fibre Channel drives. A page 3Fh request returns all supported pages.

Both the 10-byte and the 6-byte versions of the command are supported.

Table 32. 6-Byte MODE SENSE Command

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

Table 33. 10-Byte MODE SENSE Command

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

If the Disable Block Descriptors (DBD) field is set to 1, then no block descriptors are returned with the mode data. If it is set to 0, then block descriptors are returned.

The type of data returned is determined by the value of the Page Control (PC) field as follows:

- 00b means the current configuration.
- 01b means the changeable bitmap (changeable = 1; unchangeable = 0).
- 10b means the default (power-on) values.
- 11b means the saved values. Because the drive does not support saved values, the default values are returned.

The PC field only affects the mode parameters within the modes pages. It does not affect the mode parameter header or the mode block descriptor. Within the mode parameters, the PC field does not affect the PS field, the Page Code, or the Additional Page Length fields. These fields will return the current values, as there is no meaning if they are changed.

The Page Code must be set to the page to be returned.

Mode Data Format

Mode data returned by a MODE SENSE command or sent with a MODE SELECT command consists of a Mode Parameter Header, an optional Mode Block Descriptor, and zero or more Mode Parameter Pages.

Table 34. Mode Data Format

	Bit							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0 : m	Mode Parameter Header							
m + 1 : m + 8	Mode Block Descriptor							
m + 9 : n	Mode Parameter Pages							

Mode Parameter Header

Table 35. Mode Parameter Header 6-Byte Command

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

Table 36. Mode Parameter Header 10-Byte Command

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0 : 1	Mode Data Length							
2	Medium Type (0)							
3	WP	Buffered Mode			Speed (0)			
4	Reserved							
5	Reserved							
6 : 7	Block Descriptor Length							

In a MODE SENSE command, the Mode Data Length indicates the total amount of data available to be transferred. In a MODE SELECT command, this field is 0.

The Medium Type field is not used and must be set to 0.

The Write Protect field indicates whether the currently loaded tape is write protected in a MODE SENSE command. It is ignored in a MODE SELECT command.

Buffered Mode values dictate the behavior of the drive as follows:

- 0h (unbuffered) means that the drive will not report Good status on WRITE commands until the data blocks are actually written on the medium.
- 1h (buffered) means that the drive may report Good status on WRITE commands as soon as all the data specified in the WRITE command has been transferred to the logical unit's buffer. One or more blocks may be buffered prior to writing the blocks to the medium.
- 2h - 7h (unsupported modes) means that the drive will default to a value of 1h (buffered).

The Speed field is not used and must be set to 0.

The Block Descriptor Length is 0 if no Block Descriptor is transferred or 8 if a Block Descriptor is transferred. The Mode parameter value is stored for each initiator.

Mode Block Descriptor

Table 37. Mode Block Descriptor

Byte	Bit							
	7	6	5	4	3	2	1	0
0	Density Code							
1 : 3	Number of Blocks (0)							
4	Reserved							
5 : 7	Block Length							

The Density Code field returns a code identifying the format of the tape currently loaded in the drive. If there is no tape loaded, the code for the highest capacity format supported by the drive is returned. See Table 92 on page 92 for details of supported density codes.

The Number of Blocks field is 0.

The Block Length field indicates the length (in bytes) of each logical block to be used in subsequent READ, WRITE and VERIFY commands when the Fixed field is set to 1. (See “READ” on page 62, “VERIFY” on page 123, and “WRITE” on page 124.) A Block Length value of 0 indicates that only variable block transfers are allowed. The default value is 0. This value must be an even number. If a transfer of odd byte-length blocks is desired, a variable length (Fixed field set to 0 in READ, VERIFY, or WRITE command) transfer must be used.

Read-Write Error Recovery Page

Table 38. Read-Write Error Recovery Page

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	PS (0)	Reserved	Page Code (01h)					
1	Additional Page Length (0Ah)							
2	Reserved		TB (0)	Reserved	EER(1)	PER	DTE(0)	DCR(0)
3	Read Retry Count (FFh)							
4	Reserved							
5	Reserved							
6	Reserved							
7	Reserved							
8	Write Retry Count (FFh)							
9	Reserved							
10	Reserved							
11	Reserved							

A post error (PER) field of 1 specifies that the tape drive will return Check Condition status to report recovered errors. A PER field of 0 specifies that the tape drive will not report errors that are recovered within the limits established by the error recovery parameters. If this field is 0, the disable transfer on error (DTE) field must also be set to 0.

A DTE field of 0 specifies that the tape drive will not terminate the transfer for errors that are recovered within the limits that are established by the read-write error recovery parameters. On Ultrium drives, the DTE is always set to 0.

Disconnect/Reconnect Page

Table 39. Disconnect/Reconnect Mode Page

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	PS (0)	Reserved	Page Code (02h)					
1	Additional Page Length (0Eh)							
2	Buffer Full Ratio (0)							
3	Buffer Empty Ratio (0)							
4 : 5	Bus Inactivity Limit (0)							
6 : 7	Disconnect Time Limit (0)							
8 : 9	Connect Time Limit (0)							
10 : 11	Maximum Burst Size							
12	Reserved							DTDC (0)
13	Reserved							
14	Reserved							
15	Reserved							

The Maximum Burst Size field for the SCSI parallel interface indicates (in multiples of 512 bytes) the number of bytes that the drive should attempt to send or receive between disconnects. The default is 0, which implies that the drive may send bursts of data at any size.

The Maximum Burst Size field for the Fibre Channel interface indicates the sequence size that the drive should attempt to use when transferring data. Any value is allowed and ignored. The value for the Maximum Burst Size field is stored for each initiator.

The Buffer Full Ratio and Buffer Empty Ratio fields will be 0, because buffer management is controlled by the drive.

The Bus Inactivity Limit, Disconnect Time Limit, and Connect Time limit fields are not supported and must be set to 0.

The Data Transfer Disconnect Control field is not supported and must be set to 0.

Data Compression Mode Page

Table 40. Data Compression Mode Page

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	PS (0)	Reserved	Page Code (0Fh)					
1	Additional Page Length (0Eh)							
2	DCE	DCC(1)	Reserved					
3	DDE(1)	RED (00b)		Reserved				
4 : 7	Compression Algorithm (1)							
8 : 11	Decompression Algorithm (1)							
12	Reserved							
13	Reserved							
14	Reserved							
15	Reserved							

A data compression enable (DCE) field of 1 indicates that data compression is enabled. The default for DCE is 1. If DCE is 0, the drive uses Scheme 2 of the LTO-DC algorithm (passthrough mode).

A data decompression enable (DDE) field is set to 1 to specify that data decompression is enabled.

The report exception on the decompression (RED) field is set to 00b and specifies the response to certain boundaries that the drive detects in the data on the medium. Table 41 on page 48 describes those responses.

Table 41. Responses to Data Boundaries

Prior Data	Current Data	Response Sense Key (see Notes 1 and 2)
Uncompressed	Compressed unsupported algorithm	Medium Error
Uncompressed	Compressed supported algorithm	None
Compressed supported algorithm	Uncompressed	None
Compressed supported algorithm	Compressed unsupported algorithm	Medium Error
Compressed unsupported algorithm	Uncompressed	None
Compressed unsupported algorithm	Compressed supported algorithm	None
All other combinations	- -	None

Notes:

1. None in the Response Sense Key column means that no Check Condition status is returned, given the data boundary condition and the current value of the Report Exception on the Decompression (RED) field.
2. The appropriate additional sense code (ASC) is specified as follows:
   - If a Check Condition status is returned, the ASC must be set to DECOMPRESSION EXCEPTION SHORT ALGORITHM ID OF NN, with the additional sense code qualifier (ASCQ) set to the algorithm id (ASC/ASCQ = 7001h).
   - The drive will return a Check Condition status when data is encountered on a medium (during a read operation) that the device is unable to decompress. In this table, data boundaries that are marked other than None in Response Sense Key column will generate Check Condition status with the specified sense key.
   - If the application client selects an algorithm that the drive does not support, the drive will return a Check Condition status. The Sense Key must be set to Illegal Request and the ASC must be set to Invalid Field in Parameter List. The SELECT DATA COMPRESSION ALGORITHM field in the Device Configuration mode page will be ignored if a Data Compression mode page with the DCE field set to 1 is also received by the device in the same MODE SELECT command.

No other fields are changeable.

Sequential Access Device Configuration Page

The Write Delay Time field indicates the time (in 100-ms increments) that the drive should wait with unwritten data in the buffer and no activity on the interface before forcing data to tape.

The Active Partition field will be 0 because multiple partitions are not supported.

The Change Active Format (CAF) and Active Format fields will be 0 because changing formats is not supported.

The Write Buffer Full Ratio and Read Buffer Empty Ratio fields will be 0 because buffer management is done by the drive.

The Data Buffer Recovery (DBR), Report Set Marks (RSmk), Stop On Consecutive File Marks (SOCF), Recover Buffer Order (RBO), Report Early Warning on Read (REW), and Synchronize at Early Warning fields must be set to 0 because these features are not supported.

The Automatic Velocity Control (AVC) field must be set to 0 because velocity control is managed by the drive.

The Gap Size field must be set to 0 because there is no concept of inter-block gaps in the format.

Table 42. Sequential Access Device Configuration Page

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

The Block Identifiers Supported (BIS) field must be set to 1 because block identifiers are supported.

The enable EOD generation (EEG) field must be set to 1 because the drive always generates EOD.

The Buffer Size at Early Warning field will be 0, as this cannot be set.

The default value for the Select Data Compression Algorithm is 1 and indicates that data compression is enabled. If Select Data Compression Algorithm is 0, the drive uses Scheme 2 of the LTO-DC algorithm (passthrough mode). In the event that Select Data Compression Algorithm does not agree with DCE of the Data Compression Mode Page received in the same MODE SELECT command (see “Data Compression Mode Page” on page 47), the DCE setting takes precedence.

Fibre Channel Logical Unit Control Page

There is one copy of this page for each initiator. This page is defined for Fibre-Channel-attached devices only.

Table 43. Fibre Channel Logical Unit Control Page

	Bit							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	PS (0)	Reserved	Page Code (18h)					
1	Page Length (06h)							
2	Reserved				Protocol Identifier (0h)			
3	Reserved							EPDC
4 : 7	Reserved							

Enable Precise Delivery Control (EPDC), when set to 1b, enables checking of a Fibre Channel Command Reference Number and ensures that the command packets are delivered in order.

The Protocol Identifier is set to 0h, which indicates that this is for use with the FCP protocol.

Fibre Channel Port Control Page

There is one copy of this page per Fibre Channel port. This page is defined for Fibre Channel drives only.

Table 44. Fibre Channel Port Control Page

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	PS (0)	Reserved	Page Code (19h)					
1	Page Length							
2	Reserved							
3	DTFD (0)	PLPB (0)	DDIS (0)	DLM (0)	RHA (0)	ALWI (0)	DTIPE (0)	DTOLI (0)
4 : 5	Reserved							
6	Reserved					RR_TOV Units		
7	Resource Recovery Time Out Value (RR_TOV)							
8	Reserved						Control MCM (01b)	
9 : 10	Reserved							
11	Originator CMRs Per Port (0)							
12	Reserved							
13	Responder CMRs Per Port (0)							
14 : 15	MCM_TOV (0)							

The Page Length field is returned by Mode Sense commands and should be set by Mode Select commands on Ultrium 1 drives as 0Eh and on Ultrium 2 drives as 06h.

The Page Length field returns the number of remaining bytes. On Ultrium 1 drives this value is 0Eh. On Ultrium 2 drives this value is 06h.

The Resource Recovery Time Out Value (RR_TOV) is the minimum amount of time that the drive will wait for an expected response before implicitly cleaning up the resources that are related to that initiator. This may, depending on the circumstances, implicitly log-out the initiator that stopped communicating with the drive.

Care should be taken when adjusting this value, because a value that is too small has the potential to cause resources to be discarded prior to the completion of a class 3 error recovery and to prematurely log-out an initiator. It also has the potential, when the value is set too large, to cause command timeouts for non-failing initiators in a multi-initiator environment, if one of the initiators fails.

The Protocol Identifier is set to 0h, which indicates that this is for use with the FCP protocol.

Resource Recovery Time Out Value (RR_TOV) Units can have the following values:

- 000b (no timer is specified)
- 001b (timer is specified in .001-second units)
- 011b (timer is specified in .1-second units)
- 101b (timer is specified in 10-second units)

RR_TOV Value can be between 0 and FFh.

The following conditions will round the RR_TOV. If the value is rounded, a MODE PARAMETERS ROUNDED Unit Attention is presented.

- The value of RR_TOV that is determined by the RR_TOV Units and RR_TOV Value fields is less than the minimum supported value (RR_TOV set to Minimum Value)
- The value of RR_TOV that is determined by the RR_TOV Units and RR_TOV Value fields is greater than the maximum supported value (RR_TOV set to Maximum Value)
- The RR_TOV Units is an unsupported value (RR_TOV set to Default Value)

Note that when the RR_TOV value is returned from the drive, it may be returned using different RR_TOV Units than were used to set the value in a previous Mode Select command.

Information Exceptions Mode Page

Table 45. Information Exceptions Mode Page

	Bit							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	PS (0)	Reserved	Page Code (1Ch)					
1	Page Length (0A)							
2	Perf (0)	Reserved			DExcpt	Test	Reserved	LogErr(0)
3	Reserved				MRIE (3)			
4 : 7	Interval Timer (0)							
8 : 11	Report Count (0)							

The Information Exceptions mode page is used to control Exception Reporting by using the TapeAlert log page.

A disable exception control (DExcpt) field of 0 indicates that reporting for failure prediction threshold exceeded will be enabled. The method for reporting the failure prediction threshold exceeded when the DExcpt field is set to 0 is determined from

the MRIE field. A DExcpt field of 1 indicates that the target will disable reporting of the failure prediction threshold exceeded. The default value for DExcpt is 0.

If the Test field is set to 1, the next command will fail, the Sense Key will be set to Unit Attention, and the ASC/ASCQ will be set to Failure Prediction Threshold Exceeded - False (5DFF). If the Test field is set to 0, the next command is processed normally. The default for Test is 0.

The Perf and LogErr fields will be 0. These features are not supported.

The MRIE field must be set to 3 (Conditionally generate recovered error). This method instructs the drive to report informational exception conditions (if the reporting of recovered errors is allowed) by returning a Check Condition status. If the Test field is set to 0, the status may be returned after the informational exception condition occurs on any command for which Good status would have been returned. If the Test field is set to 1, the status will be returned on the next command that is normally capable of returning an informational exception condition when the Test field is set to 0. The Sense Key must be set to Recovered Error and the Additional Sense Code will indicate the cause of the informational exception condition. This will be Failure Prediction Threshold Exceeded (5D00) if the Test field is set to 0 (true error), and Failure Prediction Threshold Exceeded -False (5DFF) if the Test field is set to 1 (test).

The command that returns the Check Condition status for the informational exception will complete without error before any informational exception condition may be reported.

The Interval Timer and Report Count must be set to 0. These fields are not supported.

PERSISTENT RESERVE IN

The PERSISTENT RESERVE IN command is used for reservation management to show what types of Reservations and Reservation Keys exist.

Table 46. PERSISTENT RESERVE IN Command

	Bit							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Operation Code (5Eh)							
1	Reserved			Service Action				
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7 : 8	Allocation Length							
9	Control							

Service Action may have one of two valid values:

- 00000b (reads all registered Reservation Keys)
- 00001b (reads all current persistent reservations)

Allocation Length is set to the maximum number of bytes to be transferred.

The PERSISTENT RESERVE IN parameter data for Read Keys is defined in Table 47.

Table 47. PERSISTENT RESERVE IN Parameter Data for Read Keys

	Bit							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0 : 3	Generation							
4 : 7	Additional Length							
8 : 15	First Reservation Key							
16 : n	Additional Reservation Keys							

Generation is a counter for PERSISTENT RESERVE OUT command requests.

Additional Length is a count of the number of bytes in the Reservation Key list.

For Additional Reservation Keys, a maximum of one reservation key per initiator is supported.

The PERSISTENT RESERVE IN parameter data for Read Reservations is defined in Table 48.

Table 48. PERSISTENT RESERVE IN Parameter Data for Read Reservations

	Bit							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0 : 3	Generation							
4 : 7	Additional Length							
8 : n	Reservation Descriptors							

Generation is a counter for PERSISTENT RESERVE OUT command requests.

Additional Length is a count of the number of bytes in the Reservation Key list.

Reservation Descriptors are defined in Table 49.

The PERSISTENT RESERVE IN Read Reservations Descriptor is defined in Table 49.

Table 49. PERSISTENT RESERVE IN Read Reservations Descriptor

	Bit							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0 : 7	Reservation Key							
8 : 11	Scope-specific address (0)							
12	Reserved							
13	Scope (0h)				Type			
14 : 15	Extent Length (0)							

A Scope value of 0h indicates that the persistent reservation applies to the entire logical unit.

Type may have one of the following values:

- 3h means Exclusive Access
- 6h means Exclusive Access, Registrants only

PERSISTENT RESERVE OUT

The PERSISTENT RESERVE OUT command is used for reservation management to allow different types of Reservations and Reservation Keys to be created or removed.

Table 50. PERSISTENT RESERVE OUT Command

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Operation Code (5Fh)							
1	Reserved			Service Action				
2	Scope (0)				Type			
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7 : 8	Parameter List Length (18h)							
9	Control							

Table 51 contains the values for Service Action field. For additional information about the descriptions of each service action code, refer to the *SCSI Primary Commands-3 (SPC-3)* manual.

Table 51. Values for Service Action Codes in PERSISTENT RESERVE OUT Command

Code	Name	Description	PERSISTENT RESERVE Generation Field Incremented
00h	REGISTER	Registers a reservation key with the device server or unregisters a reservation key.	Yes
01h	RESERVE	Creates a persistent reservation that has a specified SCOPE and TYPE.	No
02h	RELEASE	Releases the selected persistent reservation.	No
03h	CLEAR	Clears all reservation keys (for example, registrations) and all persistent reservations.	Yes
04h	PREEMPT	Preempts persistent reservations or removes registrations.	Yes
05h	PREEMPT AND ABORT	Preempts persistent reservations or removes registrations and aborts all tasks for all preempted initiator ports.	Yes
06h	REGISTER AND IGNORE EXISTING KEY	Registers a reservation key with the device server or unregisters a reservation key.	Yes
07h - 1Fh	Reserved		

The value in the Type field specifies the characteristics of the persistent reservation that is being established for all data blocks within the logical unit. Table 52 defines the characteristics of the different type values. For each persistent reservation type, Table 52 lists the value of the code, its name, the type of drive support, and a description of the drive support.

Table 52 contains the values for the Type field.

Table 52. Persistent Reservation Type Codes

Code	Name	Drive Support (see Note 1)	Description of Drive Support (see Note 2)
0h		N/S	Obsolete
1h	Write Exclusive	N/S	**Reads Shared:** Any application client on any initiator port may initiate tasks that request transfers from the storage medium or cache of the logical unit to the initiator port. **Writes Exclusive:** Any task from any initiator port other than the initiator port that holds the persistent reservation that requests a transfer from the initiator port to the storage medium or cache of the logical unit will be terminated with RESERVATION CONFLICT status. **Persistent Reservation Holder:** The initiator port that delivered the PERSISTENT RESERVE OUT command with RESERVE, PREEMPT, or PREEMPT AND ABORT service action as identified by its registered reservation key.
2h		N/S	Obsolete
3h	Exclusive Access	1,2	**Reads Exclusive:** Any task from any initiator port other than the initiator port that holds the persistent reservation that requests a transfer from the storage medium or cache of the logical unit to the initiator port will be terminated with RESERVATION CONFLICT status. **Writes Exclusive:** Any task from any initiator port other than the initiator port that holds the persistent reservation that requests a transfer from the initiator port to the storage medium or cache of the logical unit will be terminated with RESERVATION CONFLICT status. **Persistent Reservation Holder:** The initiator port that delivered the PERSISTENT RESERVE OUT command with RESERVE, PREEMPT, or PREEMPT AND ABORT service action as identified by its registered reservation key.
4h		N/S	Obsolete
5h	Write Exclusive - Registrants Only	N/S	**Reads Shared:** Any application client on any initiator port may initiate tasks that request transfers from the storage medium or cache of the logical unit to the initiator port. **Writes Exclusive:** A task that requests a transfer to the storage medium or cache of the logical unit from an initiator port that is not currently registered with the device server will be terminated with RESERVATION CONFLICT status. **Persistent Reservation Holder:** The initiator port that delivered the PERSISTENT RESERVE OUT command with RESERVE, PREEMPT, or PREEMPT AND ABORT service action as identified by its registered reservation key.

Table 52. Persistent Reservation Type Codes (continued)

Code	Name	Drive Support (see Note 1)	Description of Drive Support (see Note 2)
6h	Exclusive Access - Registrants Only	1,2	**Reads Exclusive:** A task that requests a transfer from the storage medium or cache of the logical unit to an initiator port that is not currently registered with the device server will be terminated with RESERVATION CONFLICT status. **Writes Exclusive:** A task that requests a transfer to the storage medium or cache of the logical unit from an initiator port that is not currently registered with the device server will be terminated with RESERVATION CONFLICT status. **Persistent Reservation Holder:** The initiator port that delivered the PERSISTENT RESERVE OUT command with RESERVE, PREEMPT, or PREEMPT AND ABORT service action as identified by its registered reservation key.
7h	Write Exclusive - All Registrants	N/S	**Reads Shared:** Any application client on any initiator port may initiate tasks that request transfers from the storage medium or cache of the logical unit to the initiator port. **Writes Exclusive:** A task that requests a transfer to the storage medium or cache of the logical unit from an initiator port that is not currently registered with the device server will be terminated with RESERVATION CONFLICT status. **Persistent Reservation Holder:** Any registered initiator port as identified by a zero reservation key value.
8h	Exclusive Access - All Registrants	N/S	**Reads Exclusive:** A task that requests a transfer from the storage medium or cache of the logical unit to an initiator port that is not currently registered with the device server will be terminated with RESERVATION CONFLICT status. **Writes Exclusive:** A task that requests a transfer to the storage medium or cache of the logical unit from an initiator port that is not currently registered with the device server will be terminated with RESERVATION CONFLICT status. **Persistent Reservation Holder:** Any registered initiator port as identified by a zero reservation key value.
9h - Fh	Reserved		

Notes:

1. Drive Support is categorized as follows:
   - 1 = Generation 1
   - 2 = Generation 2
   - N/S = not supported
2. The Description of Drive Support column is divided into three categories:
   - A definition of the required handling for read operations.
   - A definition of the required handling for write operations.
   - A definition of the persistent reservation holder (for more information, refer to the *SCSI Primary Commands-3 (SPC-3)* manual.

The PERSISTENT RESERVE OUT parameter list is defined in Table 53.

Table 53. PERSISTENT RESERVE OUT Parameter List

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0 : 7	Reservation Key							
8 : 15	Service Action Reservation Key							
16 : 19	Scope-specific Address (0)							
20	Reserved							APTPL (0)
21	Reserved							
22 : 23	Obsolete (0)							

Any value is allowed for the Reservation Key and the Service Action Reservation Key.

The value for Activate Persist Through Power Loss (APTPL) will be 0.

PREVENT/ALLOW MEDIUM REMOVAL

The PREVENT/ALLOW MEDIUM REMOVAL command is used to prevent accidental removal of the medium while it is required by an initiator.

Table 54. PREVENT/ALLOW MEDIUM REMOVAL Command

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

If the Prevent field is set, then eject requests from the front panel are ignored and Unload commands give Check Condition status. The Sense Key is set to Illegal Request and the ASC/ASCQ to Medium Removal Prevented (5302).

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

READ

The READ command causes data to be transferred from the tape medium to the initiator.

Table 55. READ Command

	Bit							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Operation Code (08h)							
1	Logical Unit Number			Reserved			SILI	Fixed
2 : 4	Transfer Length							
5	Control							

If the Fixed field is set to 0 and Transfer Length is not 0, then a single block of the length in Transfer Length is to be 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. A Check Condition for incorrect length is returned, and the logical position is set after the block. If the length of the block was the same as the Transfer Length field, then Good status is returned.

If the Suppress Incorrect Length Indicator (SILI) field is 1 and the Fixed field is 0, the drive will do one of the following:

- Report Check Condition status for an incorrect length condition only if the overlength condition exists and the BLOCK LENGTH field in the mode parameter block descriptor is non-zero (see clause 8.3 in the *SCSI-3 Stream Commands (SSC)*).
- Not report Check Condition status if the only error is the underlength condition, or if the only error is the overlength condition and the BLOCK LENGTH field of the mode parameters block descriptor is 0.

If the SILI field is 0 and an incorrect length block is read, Check Condition status will be returned. The ILI and VALID fields must be set to 1 in the sense data and the Additional Sense Code must be set to NO ADDITIONAL SENSE INFORMATION. Upon termination, the logical position will be after the incorrect length block (end-of-partition side). If the Fixed field is 1, the INFORMATION field must be set to the requested transfer length minus the actual number of blocks read (not including the incorrect length block). If the Fixed field is 0, the INFORMATION field must be set to the requested transfer length minus the actual block length.

If the Fixed field is set to 1, the Block Length (see “Mode Block Descriptor” on page 44) is set to 0, and the Transfer Length field is not 0, Check Condition status is returned with Illegal Field in CDB (5/2400h).

If the Fixed field is set to 1, the Transfer Length field is not 0, and the Suppress Illegal Length Indicator (SILI) field is set to 0, 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 0, and if the Suppress Illegal Length Indicator and the Fixed field are not both set, then Good status is returned and no action is taken in the drive.

If Suppress Illegal Length Indicator (SILI) field is set and the Fixed field is set, then Check Condition status is returned. The Sense Key is set to Illegal Request and the ASC/ASCQ is set to Invalid Field in CDB (2400).

READ ATTRIBUTE

The READ ATTRIBUTE command allows an application client to read attribute values from medium auxiliary memory.

Table 56. READ ATTRIBUTE Command

	Bit							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Operation Code (8Ch)							
1	Reserved (0)			Service Action				
2 : 3	Reserved							
4	Reserved							
5	Volume Number (0)							
6	Reserved							
7	Partition Number (0)							
8 : 9	First Attribute ID							
10 : 13	Allocation Length							
14	Reserved							
15	Control							

If the medium auxiliary memory is not accessible because there is no medium present, the READ ATTRIBUTE command will be terminated with a Check Condition status. The Sense Key must be set to Not Ready and the Additional Sense Code must be set to Medium Not Present (3A00h).

If the medium auxiliary memory is not accessible but the medium is present, the READ ATTRIBUTE command will be terminated with a Check Condition status. The Sense Key must be set to Medium Error and the Additional Sense Code must be set to Logical Unit Not Ready, Auxiliary Memory Not Accessible (0410h).

If the medium auxiliary memory has failed, the READ ATTRIBUTE command will be terminated with a Check Condition status. The Sense Key must be set to Medium Error and the Additional Sense Code must be set to Auxiliary Memory Read Error (1112h).

The supported Service Action codes are listed in Table 57 on page 65. The sections that follow the table give the format for each supported service action.

Table 57. Supported Service Action Codes

Code	Name	Description	Format of Returned Data
00h	Attribute Values	Return attribute values	See “Format for the Attribute Values Service Action” on page 66
01h	Attribute List	Returns a list of available attribute identifiers	See “Format for the Attribute List Service Action” on page 67
02h	Volume List	Returns a list of available Volume Numbers	See “Format for the Volume List Service Action” on page 68
03h	Partition List	Returns a list of available Partition Numbers	See “Format for the Partition List Service Action” on page 69
04h	Restricted	Not applicable	Not applicable
05h - 1Fh	Reserved	Not applicable	Not applicable

The First Attribute ID field specifies the attribute identifier of the first attribute to be returned. If the specified attribute identifier is in the unsupported or nonexistent state, the READ ATTRIBUTE command will be terminated with a Check Condition status (see clause 5.10 in the *SCSI Primary Commands-3 (SPC-3)*). The Sense Key must be set to Illegal Request and the Additional Sense Code must be set to Invalid Field in CDB.

The Allocation Length field specifies how many bytes have been allocated for the returned parameter list. If the length is not sufficient to contain the entire parameter list, the first portion of the list will be returned. This is not considered an error. If the remainder of the list is required, the application client should send a new READ ATTRIBUTE command with an allocation length large enough to contain the entire parameter list or use the First Attribute ID field to restrict the attributes that are returned.

The format of parameter data that is returned by the READ ATTRIBUTE command depends on the service action that is specified.

Format for the Attribute Values Service Action

The READ ATTRIBUTE command with Attribute Values service action returns parameter data that contains the attributes that are specified by the Partition Number, Volume Number, and First Attribute ID fields in the CDB. The returned parameter data contains the requested attributes in ascending numerical order by attribute identifier value and in the format shown in Table 58.

Table 58. Parameter Data for an Attribute Values Service Action

	Bit							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0 : 3	Available Data (n-3)							
4 : x	Attribute #1							
m : n	Attribute #y							

The Available Data field will contain the number of bytes of attribute information in the parameter list. If the parameter list is truncated as a result of insufficient allocation length, the content of the Available Data field is not altered. The format of the attribute is described in Table 64 on page 72.

Format for the Attribute List Service Action

The READ ATTRIBUTE command with Attribute List service action returns parameter data that contains the attribute identifiers for the attributes that are not in the unsupported state and not in the nonexistent state (for information about MAM attribute states, see Table 63 on page 71). The contents of First Attribute ID field in the CDB is ignored. The returned parameter data contains the requested attribute identifiers in ascending numerical order by attribute identifier value and in the format shown in Table 59.

Table 59. Parameter Data for an Attribute List Service Action

	Bit							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0 : 3	Available Data (n-3)							
4 : 5	Attribute ID #1							
n-1 : n	Attribute ID #y							

Format for the Volume List Service Action

The READ ATTRIBUTE command with Volume List service action returns parameter data that identifies the supported number of volumes (see Table 60). The contents of Volume Number, Partition Number, and First Attribute ID fields in the CDB are ignored.

Table 60. Parameter Data for a Volume List Service Action

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0 : 1	Available Data (2)							
2	First Volume Number (0)							
3	Number of Volumes Available (1)							

The Available Data field contains two.

The First Volume Number field indicates the first volume that is available and will be set to 0.

The Number of Volumes Available field indicates the number of volumes that are available and will be set to 1.

Format for the Partition List Service Action

The READ ATTRIBUTE command with Partition List service action returns parameter data that identifies the number of partitions that are supported in the specified volume number (see Table 61). The contents of the Partition Number and First Attribute ID fields in the CDB are ignored.

Table 61. Parameter Data for a Partition List Service Action

Byte	Bit							
	7	6	5	4	3	2	1	0
0 : 1	Available Data (2)							
2	First Partition Number (0)							
3	Number of Partitions Available (1)							

The Available Data field contains two.

The First Partition Number field indicates the first partition that is available on the specified volume number and is set to 0.

The Number of Partitions Available field indicates the number of partitions that are available on the specified volume number and is set to 1.

Medium Auxiliary Memory

Ultrium media includes a non-volatile memory that is referred to as medium auxiliary memory (MAM). MAM is used to store data that describes the media and its contents. The Ultrium drives support MAM with the READ ATTRIBUTE and WRITE ATTRIBUTE commands. The commands retrieve and store information as attributes in MAM. For more information, see “READ ATTRIBUTE” on page 64 and “WRITE ATTRIBUTE” on page 125.

A MAM attribute is composed of the following components:

- Attribute identifier
- Attribute format code
- Bit that indicates whether the attribute is read only.
- Attribute length that specifies the number of bytes in the attribute’s value
- Value of the attribute

Table 62 lists the three types of MAM attributes.

Table 62. Types of MAM Attributes

Type of MAM Attribute	Attribute Source	Example	Readable with READ ATTRIBUTE	Writable with WRITE ATTRIBUTE
Medium	Permanently stored in the MAM during manufacture.	Media Serial Number	Yes	No
Device	Maintained by the tape drive.	Load Count	Yes	No
Host	Maintained by the application client.	Backup Date	Yes	Yes

Table 63 shows the states for the types of MAM attributes.

Table 63. States for the Types of MAM Attributes

Attribute Type	Attribute State	Description
Medium or Device	Read Only	An application server may read the contents of the attribute with the READ ATTRIBUTE command, but an attempt to clear or change the attribute by using the WRITE ATTRIBUTE command will result in the command being terminated with a Check Condition status. When the Read Only field of the MAM attribute is 1, the attribute is in the read only state. (For information about the Read Only field, see “Format of MAM Attribute” on page 72.)
	Unsupported	The tape drive does not support the attribute and will not return it in response to a READ ATTRIBUTE command.
Host	Nonexistent	A host attribute does not exist in the MAM until a WRITE ATTRIBUTE command creates it.
	Read/Write	The attribute has been created by using the WRITE ATTRIBUTE command. After the attribute has been created, the contents may be altered by using subsequent WRITE ATTRIBUTE commands. A read/write attribute may be returned to the nonexistent state by using a WRITE ATTRIBUTE command with the Attribute Length set to 0. When the Read Only field of the MAM attribute is 0, the attribute is in the read/write state. (For information about the Read Only field, see “Format of MAM Attribute” on page 72.)

Format of MAM Attribute

Each MAM attribute will be communicated between the application client and tape drive in the format shown in Table 64. This format will be used in the parameter data for the WRITE ATTRIBUTE and READ ATTRIBUTE commands. The attribute format implies nothing about the physical representation of an attribute in the MAM. For more information, see “READ ATTRIBUTE” on page 64 and “WRITE ATTRIBUTE” on page 125.

Table 64. Format of a MAM Attribute

	Bit							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	(MSB)							
:	Attribute Identifier							
1								(LSB)
2	Read Only	Reserved					Format	
3	(MSB)							
:	Attribute Length (n-4)							
4								(LSB)
5	(MSB)							
:	Attribute Value							
n								(LSB)

The Attribute Identifier field contains a value that identifies the attribute. For the range of values in this field, see “Values for the Attribute Identifier Field” on page 73.

The Read Only field indicates whether the attribute is in the read only or read/write state. If the field is 1, the attribute is in the read only state; if the field is 0, the attribute is in the read/write state.

The Format field specifies the format of the data in the Attribute Value field. Table 65 on page 73 describes the values and requirements for the Format field.

Table 65. Values and Requirements for the Format Field

Format	Name	Generation (see Legend)	Description
00b	Binary	1,2	The Attribute Value field will contain binary data.
01b	ASCII	1,2	The Attribute Value field will contain only graphic codes (for example, byte code values 20h through 7Eh), will be left-aligned and place any unused bytes at the highest offset in the field, and will contain 20h (for example, ASCII space) in any unused bytes.
10b	Text	N/S	The attribute contains textual data. For a description of the character set, see page 78 and Table 72 on page 78.
11b	Reserved	N/S	The Attribute Value field is reserved.
Legend: 1 = supported in IBM TotalStorage LTO Ultrium Tape Drive (commonly called the Ultrium 1 tape drive) 2 = supported in IBM TotalStorage LTO Ultrium 2 Tape Drive (commonly called the Ultrium 2 tape drive) N/S = not supported			

The Attribute Length field specifies the length in bytes of the Attribute Value field. The value of the Attribute Length field depends on the attribute that is returned.

The Attribute Value field contains the current (READ ATTRIBUTE) or desired (WRITE ATTRIBUTE) value of the attribute.

Values for the Attribute Identifier Field: The values in the Attribute Identifier field are assigned according to the attribute type and whether the attribute is standard or vendor unique. Table 66 lists the range of values for the each attribute type.

Table 66. Range of Values for MAM Attribute Identifiers

Range of Attribute Identifiers	Attribute Type	Standard or Vendor Unique
0000h - 03FFh	Device	Standard
0400h - 07FFh	Medium	Standard
0800h - 0BFFh	Host	Standard
0C00h - 0FFFh	Device	Vendor Unique
1000h - 13FFh	Medium	Vendor Unique
1400h - 17FFh	Host	Vendor Unique
1800h - FFFFh	Reserved	Not applicable
Note: Ultrium drives accept and process a WRITE ATTRIBUTE command that contains standard host type attribute identifier values (for example 0800h to 0BFFh) or vendor-unique host type attribute identifier values (for example 1400h to 17FFh). Standard host type attribute identifier values may be checked for conformance to the requirements described in “Standard Host Type Attributes” on page 77.		

The sections that follow describe the standard type attributes for device, medium, and host.

Standard Device Type Attributes: Device type attributes are maintained and updated by the drive when the medium and associated MAM are present. Table 67 describes the standard device type attributes.

Table 67. Standard Device Type Attributes

Attribute Identifier	Name	Attribute Length (in bytes)	Format
0000h	Remaining Capacity in Partition	8	Binary
0001h	Maximum Capacity in Partition	8	Binary
0002h	Restricted	N/A	N/A
0003h	Load Count	8	Binary
0004h	MAM Space Remaining	8	Binary
0005h - 0006h	Restricted	N/A	N/A
0007h	Initialization Count	2	Binary
0008h - 0209h	Reserved	N/A	N/A
020Ah	Device Make/Serial Number at Last Load	40	ASCII
020Bh	Device Make/Serial Number at Load-1	40	ASCII
020Ch	Device Make/Serial Number at Load-2	40	ASCII
020Dh	Device Make/Serial Number at Load-3	40	ASCII
020Eh - 021Fh	Reserved	N/A	N/A
0220h	Total MBytes Written in Medium Life	8	Binary
0221h	Total MBytes Read in Medium Life	8	Binary
0222h	Total MBytes Written in Current/Last Load	8	Binary
0223h	Total MBytes Read in Current/Last Load	8	Binary
0224h - 033Fh	Reserved	N/A	N/A
0340h	Medium Usage History (not supported)	N/A	N/A
0341h	Partition Usage History (not supported)	N/A	N/A
0342h - 03FFh	Reserved	N/A	N/A
Note: N/A = not applicable			

Remaining Capacity in Partition and Maximum Capacity in Partition are native capacities, assuming that there is no data compression for the specified medium partition. These values are expressed in increments of 1 048 576 bytes (for example, a value of 1 means 1 048 576 bytes; a value of 2 means 2 097 152 bytes; and so forth).

Load Count indicates how many times this medium has been fully loaded. This attribute should not be reset by any action of the device server.

MAM Space Remaining indicates the space that is currently free in the medium auxiliary memory. The total MAM capacity is reported in the MAM Capacity attribute. (For a description of the MAM Capacity attribute, see page 76.) **Note:** It may not always be possible to use all of the free space that is reported.

Initialization Count indicates the number of times that a device server has logically formatted the medium. This figure is cumulative over the life of the medium and will never be reset.

The Device Vendor Identification/Product Serial Number at Last Load, Device Vendor Identification/Product Serial Number at Load-1, Device Vendor Identification/Product Serial Number at Load-2, and Device Vendor Identification/Product Serial Number at Load-3 attributes give a rolling history of the last four device servers in which the medium has been loaded. The format for the attributes is shown in Table 68.

Table 68. Format for Device Vendor Identification/Product Serial Number Attribute, Device Vendor Identification/Product Serial Number at Load-1 Attribute, Device Vendor Identification/Product Serial Number at Load-2 Attribute, and Device Vendor Identification/Product Serial Number at Load-3 Attribute

	Bit							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	(MSB)							
:	Vendor Identification							
7								(LSB)
8	(MSB)							
:	Product Serial Number							
39								(LSB)

The Vendor Identification field will be the same value that is returned in the Standard Inquiry Data.

The Product Serial Number field contains a vendor-unique serial number. If the product serial number is not available, the Product Serial Number field will contain ASCII spaces (20h).

Total MBytes Written in Medium Life and Total MBytes Read in Medium Life indicate the number of data bytes that are transferred to or from the medium surface (after any data compression has been applied) over the entire life of the medium. These values are cumulative and will never be reset. They are expressed in increments of 1 048 576 bytes (for example, a value of 1 means 1 048 576 bytes; a value of 2 means 2 097 152 bytes; and so forth).

Total MBytes Written in Current/Last Load and Total MBytes Read in Current/Last Load indicate the total number of data bytes that are transferred to or from the medium surface (after any data compression has been applied) during the current load if the medium is currently loaded, or during the last load if the medium is currently unloaded. The device server should reset these attributes to 0 when the medium is loaded. These values are expressed in increments of 1 048 576 bytes (for example, a value of 1 means 1 048 576 bytes; a value of 2 means 2 097 152 bytes; and so forth).

Standard Medium Type Attributes: Medium type attributes are hard-coded into the MAM at the time of manufacture. All supported medium type attributes have a status of read only. Table 69 describes the standard medium type attributes.

Table 69. Standard Medium Type Attributes

Attribute Identifier	Name	Attribute Length (in bytes)	Format
0400h	Medium Manufacturer	8	ASCII
0401h	Medium Serial Number	32	ASCII
0402h - 0405h	Restricted	N/A	N/A
0406h	Medium Manufacture Date	8	ASCII
0407h	MAM Capacity	8	Binary
0408h	Medium Type	1	Binary
0409h	Medium Type Information	2	Binary
040Ah	Numeric Medium Serial Number (not supported)	N/A	N/A
040Bh - 07FFh	Reserved	N/A	N/A
Note: N/A = not applicable			

Medium Manufacturer contains 8 bytes of ASCII data that identifies the vendor of the media.

Medium Serial Number identifies the manufacturer's serial number for the medium.

Medium Manufacture Date identifies the date of manufacture of the medium. The format is `YYYYMMDD` (four numeric ASCII characters for the year, followed by two numeric ASCII characters for the month, followed by two numeric ASCII characters for the day, with no intervening spaces).

MAM Capacity is the total capacity of the medium auxiliary memory (in bytes) at the time of manufacture. It does not indicate the free space of unused MAM because some of the MAM space may be reserved for device-specific use, which makes it inaccessible to the application client.

Medium Type and Medium Type Information give information about non-data media and other types of media. The Medium Type Information attribute is interpreted according to the type of medium that is indicated by the Medium Type attribute. Table 70 on page 77 give the values for the Medium Type and Medium Type Information attributes.

Table 70. Values for Medium Type and Medium Type Information Attributes

Medium Type	Description	Medium Type Information
00h	Data medium	Reserved
01h	Cleaning medium	Maximum number of cleaning cycles permitted
02h - 7Fh	Reserved	Reserved
80h	Write-once medium	Reserved
81h - FFh	Reserved	Reserved

Standard Host Type Attributes: Table 71 describes the standard host type attributes. Application clients may use the WRITE ATTRIBUTE and READ ATTRIBUTE commands to maintain the attributes shown in the table. All existing host type attributes have a status of read/write.

Table 71. Standard Host Type Attributes

Attribute Identifier	Name	Attribute Length (in bytes)	Format
0800h	Application Vendor	8	ASCII
0801h	Application Name	32	ASCII
0802h	Application Version	8	ASCII
0803h	User Medium Text Label	160	Text
0804h	Date and Time Last Written	12	ASCII
0805h	Text Localization Identifier	1	Binary
0806h	Barcode	32	ASCII
0807h	Owning Host Textual Name	80	Text
0808h	Media Pool	160	Text
0809h	Partition User Text Label (not supported)	N/A	N/A
080Ah	Load/Unload at Partition (not supported)	1	Binary
080Bh - BFFh	Reserved	N/A	N/A
Note: N/A = not applicable			

Application Vendor contains 8 bytes of ASCII data that identifies the manufacturer of the application client (for example, a class driver or backup program) that most recently sent a WRITE ATTRIBUTE command to the tape drive while this MAM was accessible.

Application Name contains the name of the application client.

Application Version contains the version of the application client.

User Medium Text Label is the user-level identifier for the medium.

Date and Time Last Written contains when the application client last wrote to the MAM. The format is `YYYYMMDDHHMM` (four numeric ASCII characters for the year, followed by two numeric ASCII characters for the month, followed by two numeric

ASCII characters for the day, followed by two numeric ASCII characters between 00 and 24 for the hour, followed by two numeric ASCII characters for the minute, with no intervening spaces).

Text Localization Identifier defines the character set that is used for attributes with a Text format. Table 72 gives the values for the Text Localization Identifier attribute.

Table 72. Values for the Text Localization Identifier Attribute

Value	Meaning
00h	No code specified (ASCII)
01h	ISO/IEC 8859-1 (Europe, Latin America)
02h	ISO/IEC 8859-2 (Eastern Europe)
03h	ISO/IEC 8859-3 (Southeastern Europe, miscellaneous)
04h	ISO/IEC 8859-4 (Scandinavia/Baltic)
05h	ISO/IEC 8859-5 (Cyrillic)
06h	ISO/IEC 8859-6 (Arabic)
07h	ISO/IEC 8859-7 (Greek)
08h	ISO/IEC 8859-8 (Hebrew)
09h	ISO/IEC 8859-9 (Latin 5)
0Ah	ISO/IEC 8859-10 (Latin 6)
0Bh - 7Fh	Reserved
80h	ISO/IEC 10646-1 (UCS-2BE)
81h	ISO/IEC 10646-1 (UTF-8)
82h - FFh	Reserved

Barcode is the contents of a bar code that is associated with the medium in the MAM.

Owning Host Textual Name indicates the host from which the User Medium Text label originates.

Media Pool indicates the media pool to which this medium belongs.

READ BLOCK LIMITS

The READ BLOCK LIMITS command (see Table 73) requests that the READ BLOCK LIMITS data (see Table 74) be returned. The READ BLOCK LIMITS data specifies the drive's limit on block lengths.

Table 73. READ BLOCK LIMITS Command

	Bit							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Operation Code (05h)							
1	Logical Unit Number			Reserved				
2	Reserved							
3	Reserved							
4	Reserved							
5	Control							

The format of the data returned in the READ BLOCK LIMITS Descriptor is shown in Table 74.

Table 74. READ BLOCK LIMITS Descriptor

	Bit							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Reserved			Granularity (0h)				
1 : 3	Maximum Block Length Limit (FFFFFFh)							
4 : 5	Minimum Block Length Limit (0001h)							

The Granularity field specifies the supported block size granularity. For Ultrium drives this is set to 0, which indicates that the drive supports all block sizes equal to n, where n is greater than or equal to the Minimum Block Length Limit and less than or equal to the Maximum Block Length Limit.

The Maximum Block Length Limit is set to 0xFFFFFF.

The Minimum Block Length Limit is set to 1.

For READ and WRITE commands with the Fixed field set to 1, block lengths are limited to multiples of four.

The Ultrium drives support fixed-block transfers or variable-block transfers, with the block length constrained between the given limits in either transfer mode. The transfer mode is controlled by the Fixed field in the WRITE or READ commands.

READ BUFFER

The READ BUFFER command reads data from the memory on the drive and sends it to the initiator. The command is used in conjunction with the WRITE BUFFER command as a diagnostic function for testing memory in the drive and the integrity of the service delivery subsystem. The READ BUFFER command is also used for retrieving data that is specified by the value of the Buffer ID. This command does not alter the medium.

Table 75. READ BUFFER Command

	Bit							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Operation Code (3Ch)							
1	Logical Unit Number			Mode				
2	Buffer ID							
3 : 5	Buffer Offset							
6 : 8	Allocation Length							
9	Control							

The Mode field and its meaning are described in Table 76.

Table 76. Description of the Mode Field

Mode	Description	Support
00h	Combined header and data	1,2
01h	Vendor specific	N/S
02h	Data	1,2
03h	Descriptor	1,2
04h - 06h	Reserved	N/S
07h	Descriptor (see Note)	1,2
08h - 09h	Reserved	N/S
0Ah	Echo buffer	2
0Bh	Echo buffer descriptor	2
0Ch - 19h	Reserved	N/S
1Ah	Enable expander communications protocol and Echo buffer	N/S
1Bh - 1Fh	Reserved	N/S

Table 76. Description of the Mode Field (continued)

Mode	Description	Support
Legend: 1 = supported in IBM TotalStorage LTO Ultrium Tape Drive (commonly called the Ultrium 1 tape drive) 2 = supported in IBM TotalStorage LTO Ultrium 2 Tape Drive (commonly called the Ultrium 2 tape drive) N/S = not supported **Note:** The descriptor that is returned for Mode 07h has the Buffer Capacity field reported in 64-byte increments.		

The Buffer ID indicates which buffer is to be read. The Buffer IDs are shown in Table 80 on page 83.

The Buffer Offset field may be set to any address in the buffer.

If the Mode is set to 07h and the Buffer ID is 0, the descriptor that is returned is for the Main Data buffer, and the Buffer Capacity field is the number of 64-byte segments that are available.

The format of the 4-byte descriptor is shown in Table 78 on page 82.

Note: The Main Data buffer capacity is larger than can be represented in the Buffer Offset field of the CDB and Buffer Capacity field of the header. To compensate for this, the Buffer Offset and Buffer Capacity fields for the Main Buffer (buffer ID = 0) are interpreted and expressed in multiples of 64 bytes (for example, a value of 1 equals 64 bytes). This interpretation is for buffer modes 00h, 01h, 02h, 03h, and 07h only.

If the Mode is set to 0Ah, data from the echo buffer is returned.

In this mode, Buffer ID and Buffer Offset fields are ignored. Prior to issuing a READ BUFFER command that uses the echo buffer, a WRITE BUFFER command that uses the echo buffer must have been successfully completed (see “WRITE BUFFER” on page 126). If not, the Read Echo Buffer terminates with a Check Condition status, the Sense Key is set to Illegal Request, and ASC/ASCQ is set to Command Sequence Error (2C00h). The Read Echo Buffer returns the same number of bytes of data as was received in the prior Write Echo Buffer from the same initiator.

If the Mode is set to 0Bh, the descriptor information of the echo buffer is returned. The format of the echo buffer descriptor is shown in Table 79 on page 82. The Echo Buffer Overwritten Supported (EBOS) is set to 1 because the drive keeps the echo buffer for each initiator.

Table 77. READ BUFFER Header

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Reserved							
1 : 3	Buffer Capacity							

Table 78. READ BUFFER Descriptor

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Offset Boundary (0h means byte boundary)							
1 : 3	Buffer Capacity							

Table 79. READ ECHO BUFFER Descriptor

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Reserved							EBOS (1)
1	Reserved							
2	Reserved			Buffer Capacity				
3	Buffer Capacity							

Table 80. Drive Buffers

Supported Buffers	ID	Offset Boundary	Ultrium Support
Main Data	00h	4	1,2
Dump Data (Read Only) (See Note)	01h	4	1,2
Test	02h	4	1,2
VPD	03h	4	1,2
Firmware	04h	4	1,2
Cartridge Memory (Read Only)	05h	4	1,2
Error Log (Read Only)	06h	4	1,2
SCSI Log (Read Only)	07h	4	1,2
Fibre Channel WWN (Read Only)	08h	4	1,2
Reserved	09h	N/A	N/A
Library-Specific Buffers (IBM and OEM customers only: see the *IBM Library/Drive Interface Specification* for details about these buffers)	10h-29h	N/A	N/A
Reserved	30h-80h	N/A	N/A
TapeMap (Read Only) (IBM use only)	81h	N/A	N/A
VPD Replica (IBM use only)	83h	N/A	N/A
Reserved	84h-FFh	N/A	N/A

Legend:

1 = supported in IBM TotalStorage LTO Ultrium Tape Drive (commonly called the Ultrium 1 tape drive)

2 = supported in IBM TotalStorage LTO Ultrium 2 Tape Drive (commonly called the Ultrium 2 tape drive)

N/A = not applicable

Note: When reading dump data on a Fibre Channel drive, take care to ensure that the amount of data in each transfer does not exceed the DMA settings of the HBA. The dump data currently exceeds 1 MB in size. The default DMA setting for some HBAs is 1 MB. For this reason, it is recommended that the dump data is read in a series of smaller blocks with appropriate offsets (for example, 64 K bytes).

Error Log Buffer

The error log buffer contains zero or more entries described in Table 81.

Table 81. Error Log Buffer Command

	Bit							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0 : 3	Time Stamp							
4	Entry Number							
5	Error Code							
6 : 7	Fsc 1st Text							
8 : 9	Fsc 1st Data							
10 : 11	Fsc 2nd Text							
12 : 13	Fsc 2nd Data							
14 : 21	Cartridge Serial Number							
22 : 27	EC Level							
28 : 31	Hardware Level							

Fibre Channel World Wide Name Buffer

This buffer contains the Fibre Channel World Wide Name values that are used by the drive on LUN 0. Table 82 describes the Fibre Channel World Wide Name buffer.

Table 82. Fibre Channel World Wide Name Buffer

	Bit							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0 : 7	World Wide Node Name							
8 : 15	World Wide Port Name							

SCSI Log Buffer

The SCSI log buffer contains 10 entries, each of which has the format described in Table 83.

Table 83. SCSI Log Buffer Command

	Bit							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0 : 3	Time Stamp (seconds)							
4	Entry Number							
5	Initiator SCSI ID							
6	SCSI Status							
7	Reserved							
8 : 23	CDB							
24 : 59	Sense Data							

An Entry Number set to 0 indicates that the entry is not valid. The scheme used for setting the Entry Number is not described in this manual.

Valid entries are built for commands that are issued to LUN 0 and that get a Check Condition status for sense data that contain a Sense Key of 3 or 4.

The CDB field contains the contents of the CDB that received Check Condition status even when the check condition is a Deferred Check Condition.

READ POSITION

The READ POSITION command returns current position information to the initiator. It can be used to find the current logical position of the medium and to find information about the number of bytes or blocks in the buffer. Table 85 shows the format of the returned data.

Table 84. READ POSITION Command

	Bit							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Operation Code (34h)							
1	Logical Unit Number			Service Action (0)				
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7 : 8	Parameter Length (0)							
9	Control							

Table 85. READ POSITION Data

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	BOP	EOP	BCU	BYCU(1)	Rsvd	BPU(0)	PERR(0)	Rsvd
1	Partition Number (0)							
2	Reserved							
3	Reserved							
4 : 7	First Block Location							
8 : 11	Last Block Location							
12	Reserved							
13 : 15	Number of blocks in buffer							
16 : 19	Number of bytes in buffer							

The First Block Location specifies the block address that is associated with the current logical position. The value indicates the block address of the next data block to be transferred between the initiator and the target if a READ or WRITE command is issued.

The Last Block Location is specified by the following procedure:

1. After a WRITE command, this field specifies the block address that is associated with the next data block to be transferred from the buffer to the medium.
2. After a READ command, this field specifies the block address that is associated with the last (most recent) data block to be transferred from the medium to the buffer. For any case where the buffer no longer contains a whole block of data or is empty, the value that is reported for the Last Block Location is equal to the value that is reported for the First Block Location.

The Beginning of Partition (BOP) field is set if the Block Location fields are 0.

An end-of-partition (EOP) field of 1 specifies that the logical unit is positioned between early-warning and end-of-partition. An EOP field of 0 specifies that the current logical position is not between early-warning.

The Block Position Unknown (BPU) field is always set to 0, because the position is always known.

The Partition Number is set to 0 because partitioning is not supported.

A block count unknown (BCU) field of 1 indicates that the Number of Blocks in Buffer field does not represent the actual number of blocks in the buffer. A BCU field of 0 indicates that the Number of Blocks in Buffer field is valid.

A byte count unknown (BYCU) field of 1 indicates that the Number of Bytes in Buffer field does not represent the actual number of bytes in the buffer. This field is always set to 1.

RECEIVE DIAGNOSTIC RESULTS

The RECEIVE DIAGNOSTIC RESULTS command returns the results of diagnostic tests to the initiator. The format of the data returned is specified in “SEND DIAGNOSTIC” on page 101.

Table 86. RECEIVE DIAGNOSTIC RESULTS Command

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

RELEASE UNIT

The RELEASE UNIT command removes a reservation made by a RESERVE UNIT command. If there is an existing reservation from the same initiator with the same parameters, then that reservation is removed and Good status is returned. It is not an error to attempt to release a reservation that is not currently valid or is held by another initiator. In this case, the drive returns Good status without altering any reservation.

Table 87. 6-Byte RELEASE UNIT Command

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Operation Code (17h)							
1	Logical Unit Number			Obsolete				
2	Obsolete							
3	Reserved							
4	Obsolete (0)							
5	Control							

Table 88. 10-Byte Release Unit Command

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Operation Code (57h)							
1	Logical Unit Number			3rdPty (0)		LongID (0)		Reserved
2	Reserved							
3	Third Party Device ID (0)							
4	Reserved							
5	Reserved							
6	Reserved							
7 : 8	Parameter List Length (0)							
9	Control							

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 field is set, then one descriptor block is returned with the data for the currently loaded tape. If the Media field is set to 0, the density support data block descriptors are returned by ascending Primary Density Code values.

Table 89. REPORT DENSITY SUPPORT Command

	Bit							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Operation Code (44h)							
1	Logical Unit Number			Reserved				Media
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7 : 8	Allocation Length							
9	Control							

The Allocation Length field specifies the maximum number of bytes that the device server may return.

The REPORT DENSITY SUPPORT command returns the REPORT DENSITY SUPPORT header (see Table 90 on page 91) followed by one or more density support data block descriptors (see Table 91 on page 91). The density support data block descriptors follow the density support header.

In an Ultrium 1 drive, the Ultrium 1 descriptor is always returned with the DEFLT field set to 1.

In an Ultrium 2 drive, if a medium is loaded in the drive and the Media field is set to 1, the descriptor of the loaded medium will be returned with the DEFLT field set to 1. If the Media bit is set to 0, the density support data block descriptors are returned with the Ultrium 1 descriptor followed by the Ultrium 2 descriptor. If there is no medium in the drive and the Media field is set to 0, both descriptors will have the DEFLT field set to 1. If a medium is loaded in the drive and the Media field is set to 0, the descriptor of the density of the loaded medium will be returned with the DEFLT field set to 1 and the descriptor of other density will be returned with the DEFLT bit set to 0.

The format of the REPORT DENSITY SUPPORT header is as follows:

Table 90. REPORT DENSITY SUPPORT Header

Byte	Bit							
	7	6	5	4	3	2	1	0
0 : 1	Available Density Descriptor Length							
2	Reserved							
3	Reserved							

The Available Density Descriptor Length gives the total amount of data that is available to be returned and does not include itself.

The header is followed by one or more REPORT DENSITY SUPPORT descriptor blocks with the format in Table 91.

Table 91. REPORT DENSITY SUPPORT Descriptor Block

Byte	Bit							
	7	6	5	4	3	2	1	0
0	Primary Density Code							
1	Secondary Density Code							
2	WRTOK	DUP(0)	DEFLT	Reserved				
3	Reserved							
4	Reserved							
5 : 7	Bits per mm							
8 : 9	Media Width							
10 : 11	Tracks							
12 : 15	Capacity							
16 : 23	Assigning Organization							

Table 91. REPORT DENSITY SUPPORT Descriptor Block (continued)

Byte	Bit							
	7	6	5	4	3	2	1	0
24 : 31	Density Name							
32 : 51	Description							

Table 92 shows the values that are reported for the Ultrium format.

Table 92. Density Information for LTO Formats

Field	Ultrium 1	Ultrium 2
Primary density code	40h	42h
Secondary density code	40h	42h
Bits per mm	4880	7398
Media width (in tenths of mm)	127	127
Tracks	384	512
Capacity (in 2^{20} bytes)	95,367	190,734
Assigning organization	LTO-CVE	LTO-CVE
Density name	U-18	U-28
Description	Ultrium 1/8T	Ultrium 2/8T

The Write Okay (WRTOK) field is set to 0 if the drive does not support writing to this format, but does support reading it. This is always set to 1 for Ultrium 1 and Ultrium 2 drives. The Duplicate (DUP) field is set to 0 for every descriptor block, indicating that each density is only reported once. A DEFLT field of 0 specifies that this density is not the default density of the drive. A DEFLT field of 1 specifies that this density is the default density.

Note: The default density of the drive will vary, depending on the currently mounted media. Multiple codes may return a DEFLT field of 1 when the Media field is 0 because more than one default is possible.

If the Media field is set to 0, the maximum values possible are reported. In Ultrium 2 drives the Ultrium 1 descriptor is returned, followed by the Ultrium 2 descriptor.

If the Media field is set to 1, the Capacity field specifies the approximate capacity of the current tape, assuming that recording occurs in this density with one partition.

If the Media field is 1 and the logical unit is not in the ready state, Check Condition status will be returned. The Sense Key must be set to Not Ready and the Additional Sense Code will specify the reason for Not Ready.

The Bits per mm field specifies the number of bits per millimeter per track as recorded on the medium. See Table 92 for the values that are returned.

The Media Width field specifies the width of the medium that is supported by this density. See Table 92 on page 92 for the values that are returned.

The Tracks field specifies the number of data tracks that are supported on the medium by this density. See Table 92 on page 92 for the values that are returned.

If the Media field is 0, the Capacity field specifies the approximate capacity of the longest supported medium for this density. If the Media field is 1, the Capacity field specifies the approximate capacity of the current medium for this density. If the approximate capacity of the current medium is not available for the mounted medium, the longest supported medium capacity for this density is used. The capacity assumes that compression is disabled. The capacity also assumes that the media is in good condition, and that normal data and block sizes are used. This value is in units of megabytes (10^6 bytes). The drive does not guarantee that this space is actually available in all cases. See Table 92 on page 92 for the values that are returned.

The Assigning Organization field contains 8 bytes of ASCII data that identifies the organization that is responsible for the specifications that define the values in this density support data block descriptor. The data is left-aligned within this field. The ASCII value for a space (20h) is used for padding. See Table 92 on page 92 for the values that are returned.

The Density Name field contains 8 bytes of ASCII data that identifies the document (or other identifying name) that is associated with this density support data block descriptor. The data is left-aligned within this field. The ASCII value for a space (20h) is used for padding. See Table 92 on page 92 for the values that are returned.

The Description field contains 20 bytes of ASCII data that describe the density. The data is left-aligned within this field. The ASCII value for a space (20h) is used for padding. See Table 92 on page 92 for the values that are returned.

REPORT LUNs

The server uses the REPORT LUNs command to retrieve information about the Logical Units that the drive supports.

Table 93. REPORT LUNs Command

	Bit							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Operation Code (A0h)							
1	Reserved							
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6 : 9	Allocation Length							
10	Reserved							
11	Control							

The allocation length is at least 16 bytes. If this is not the case, the drive returns Check Condition status, with a Sense Key of Illegal Request and an ASC/ASCQ of Invalid Field in CDB.

Table 94 shows the data that is returned:

Table 94. Logical Unit Numbers Data

	Bit							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0 : 3	LUN List Length							
4 : 7	Reserved							
8 : 15	First LUN (0000000000000000h)							
16 : 23	Second LUN (0001000000000000h)							

The LUN List Length field contains the length in bytes of the LUN list that is available to be transferred. The LUN list length is the number of logical unit numbers in the logical unit inventory multiplied by eight. On drives that do not have the library control path feature enabled this value is 8. On drives that have the library control path feature enabled this value is 16. If the allocation length in the CDB is too small to transfer information about the entire logical unit inventory, the LUN list length value will not be adjusted to reflect the truncation.

The Second LUN field is only returned on drives that have the library control path feature enabled.

REQUEST SENSE

Table 95. REQUEST SENSE Command

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

The sense data returned is described in Table 96.

Sense Data Format

Table 96. Sense Data Format

Byte	Bit							
	7	6	5	4	3	2	1	0
0	Valid	Error Code						
1	Segment Number (0)							
2	File Mark	EOM	ILI	Reserved	Sense Key			
3 : 6	Information							
7	Additional Sense Length							
8 : 11	Command Specific Information							
12	Additional Sense Code							
13	Additional Sense Code Qualifier							
14	Field Replaceable Unit Code							
15	SKSV	C/D	Reserved		BPV	Bit Pointer		
16 : 17	SKSV (1: Field Pointer) SKSV (0: Error Fault Symptom Code)							
18 : 19	Error Flag Data							
20	Reserved (0)							

Table 96. Sense Data Format (continued)

Byte	Bit							
	7	6	5	4	3	2	1	0
21	Reserved				CLN	Reserved	Dump	VolValid
22 : 28	Volume Label							
29	Current Wrap							
30 : 33	Relative LPOS							
34	SCSI Address							
35	Reserved - RS-422 Information							

The Valid field is set if the Information field contains valid information.

The descriptions that follow serve only as an overview of sense reporting in the tape drive. This tape drive conforms to all sense field reporting, as specified in the *SCSI Primary Commands-2 (SPC-2)*.

The Error Code field is set to 70h to indicate a current error that is associated with the most recently received command. It is set to 71h to indicate a deferred error that is not associated with the current command.

The segment number is 0, because the COPY, COMPARE, and COPY and VERIFY commands are not supported.

The File Mark field is set if a SPACE, READ, or VERIFY command did not complete because a file mark was read.

The End of Medium (EOM) field is set if a WRITE or WRITE FILE MARKS command completed in the early warning area. Spacing into BOM also causes this field to be set. It is also set on an attempt to read or space past EOD or if an attempt is made to space into Beginning of Media.

The Illegal Length Indicator (ILI) field is set if a READ or VERIFY ended because a block was read from tape that did not have the block length requested in the command.

For values of the Sense Key field see Chapter 5, “Sense Keys and Additional Sense” on page 131.

The Information Bytes are only valid if the Valid field is set. This occurs only for current errors and not for deferred errors. See the specific command for details about when Information Bytes are valid.

The Additional Sense Length is set to n-7, and is at least 10. When the sense data is associated with an Illegal Length read, the Additional Sense Length may be 10.

The Command Specific Information is set to 0, because no supported commands define a use for this field.

For supported Additional Sense Codes and Additional Sense Code Qualifiers, see Chapter 5, “Sense Keys and Additional Sense” on page 131.

The Field Replaceable Unit field is set to 0 or to a non-zero, vendor-specific code that indicates the part of the drive that is suspected of causing the failure.

The only Sense Key-specific data supported is for Illegal Request (5h). For this sense key, the Sense Key Specific Valid field is set and the following fields are set:

- The Command/Data (C/D) field is set to 1 if the illegal parameter was detected in the Command Descriptor Block, and is set to 0 if it was detected in the Data phase.
- If a bit within a byte was invalid, the Bit Pointer Valid (BPV) field is set and the Bit Pointer field is set to indicate which bit was in error.
- The Field Pointer is set to indicate which byte was in error.

The Clean (CLN) field is set if the drive needs cleaning, and is otherwise set to 0.

The Dump field indicates that the drive has a Dump available. The field is used to indicate when it is appropriate to read a dump.

The Volume Label Fields Valid (VolValid) field is set if the Volume Label being reported is valid.

If a cartridge is loaded in the drive and the Volume Label Fields Valid is set, the Volume Label field reports the seven characters from the left of the volume label from the CM Mechanism Related Data page (if one exists), or it reports the seven characters from the left of the volume label from the host bar code field in the CM (if it exists), or it reports all spaces (ASCII 20h).

The Current Wrap reports the physical wrap of the tape. The least significant bit reflects the current physical direction. A 0 means the current direction is away from physical beginning of tape. A 1 means the current direction is towards physical beginning of tape.

Relative LPOS reports the current physical position on tape.

SCSI Address reports the SCSI Bus Address for the drive. Values returned range from 00h to 0Fh.

This Reserved field may contain a value passed across the RS-422 serial interface by, for example, a tape library if the library vendor chooses to send such a value. The value passed from across the RS-422 interface is reported persistently until a different value is sent, at which time the new value is reported persistently.

RESERVE UNIT

The RESERVE UNIT command creates a reservation for the drive. Third-party reserves are not supported.

Table 97. 6-Byte RESERVE UNIT Command

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Operation Code (16h)							
1	Logical Unit Number			Obsolete (00h)				
2	Reserved							
3	Reserved							
4	Reserved							
5	Control							

Table 98. 10-Byte Reserve Unit Command

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Operation Code (56h)							
1	Logical Unit Number			3rdPty(0)	Reserved		LongID (0)	Reserved
2	Reserved							
3	Third Party Device ID (0)							
4	Reserved							
5	Reserved							
6	Reserved							
7 : 8	Parameter List Length (0)							
9	Control							

REWIND

The REWIND command causes the logical position to be set to BOM.

Table 99. REWIND Command

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

If the Immediate (Immed) field is set to 1, then the drive validates the command and waits for any previous command from any server to complete, including any immediate commands that are currently being processed. It also waits for any buffered data to be flushed to tape. It then reports 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) field is set to 0, status is not returned until after the command has completed.

SEND DIAGNOSTIC

Table 100. SEND DIAGNOSTIC Command

Byte	Bit							
	7	6	5	4	3	2	1	0
0	Operation Code (1Dh)							
1	Self-Test Code (000b)			PF	Reserved	SelfTest	DevOfL	UnitOfL
2	Reserved							
3 : 4	Parameter List Length							
5	Control							

The SEND DIAGNOSTIC command requests the drive to perform diagnostic operations. When the SelfTest field is 0 and the Self-Test Code field contains 000b, this command is usually followed by a RECEIVE DIAGNOSTIC RESULTS command.

Table 101 lists the supported diagnostics.

Table 101. Supported Diagnostics

Name	Diagnostic ID	Go To Page...
Self-Test	N/A	107
Post A Self Test Diagnostic	0100h	108
Post B Tape Test Diagnostic	0101h	109
Post C Media Test Diagnostic	0102h	110
Post D Head Test Diagnostic	0103h	111
Force Dump	0160h	112
Write Dump to Cartridge	0161h	113
Set Traps	0190h	115
Remove Traps	0191h	116
Reset Drive	2002h	118
Note: N/A = not applicable		

SIM Data Structure

The following data structure is used in several of the diagnostics. Its purpose is to give detailed error information about drive problems:

Table 102. SIM Data Structure

Byte	Bit							
	7	6	5	4	3	2	1	0
0	Page Code (31h)							
1	Reserved							
2 : 3	Page Length (0044h)							
4 : 5	Parameter Code (0000h)							
6	Parameter Control (061h)							
7	Parameter Length (040h)							
8	Indicator (01h)							
9 : 15	Reserved							
16 : 19	Microcode Level							
20 : 21	SIM Message Code							
22 : 23	Reserved							
24	Exception Message							
25	Service Message							
26	Severity Code							
27	Reserved							
28 : 29	Exception Data (00h)							

Table 102. SIM Data Structure (continued)

Byte	Bit							
	7	6	5	4	3	2	1	0
30 : 33	Error Code							
34 : 37	First FSC							
38 : 41	Last FSC							
42 : 45	Product ID (8000h)							
46 : 48	Vendor ID “IBM”							
49 : 50	Plant of Manufacture							
51	Product ID3 ’-’							
52 : 63	Serial Number							
64 : 71	Device Type//Dev SIM_MESSAGE_TYPE							

The SIM Message Code may be one of six values:

- ’00’=No Message
- ’41’=Device Degraded
- ’42’=Device Hardware Failure
- ’43’=Service Circuit Failed
- ’55’=Drive Needs Cleaning
- ’57’=Drive Has Been Cleaned

The Exception Message may be one of eight values:

- '1'=Effect of Failure is Unknown
- '2'=Device Exception No Performance Impact
- '3'=Exception on SCSI Interface xx
- '4'=Device Exception on Operator Panel
- '5'=Device Exception on Tape Path
- '6'=Device Exception in Drive
- '7'=Cleaning Required
- '8'=Cleaning Done

The Service Message may be one of four values:

- '1'=Repair Impact is Unknown
- '7'=Repair will Disable Access to Device Servo
- '9'=Clean Device
- 'A'=Device Cleaned

The Severity Code may be one of four values:

- '0'=Service
- '1'=Moderate
- '2'=Serious
- '3'=Acute

MIM Data Structure

The following data structure is used in several of the diagnostics. Its purpose is to give detailed error information about media problems:

Table 103. MIM Data Structure

Byte	Bit							
	7	6	5	4	3	2	1	0
0	Page Code (31h)							
1	Reserved							
2 : 3	Page Length (0044h)							
4 : 5	Parameter Code (0000h)							
6	Parameter Control (061h)							
7	Parameter Length (040h)							
8	Indicator (02h)							
9 : 15	Reserved							
16 : 19	Engineering Data Microcode Level							
20 : 21	MIM Message Code							
22 : 23	SARS Data							
24	Exception Message							
25	Reserved							
26	Severity Code							
27 : 29	Reserved							
30 : 33	Error Code							

Table 103. MIM Data Structure (continued)

Byte	Bit							
	7	6	5	4	3	2	1	0
34 : 39	Volume ID Volume Serial Number							
40	Volume ID Flag							
41	Reserved							
42 : 45	Product ID (8000h)							
46 : 48	Vendor ID “IBM”							
49 : 50	Plant of Manufacture							
51	Product ID3 ’-’							
52 : 63	Serial Number							
64 : 71	Device Type							

The MIM Message Code may be one of four values:

- ’00’=No Message
- ’60’=Bad Media Read Only Permitted
- ’61’=Rewrite Media if Possible
- ’72’=Replace Cleaning Cartridge

The Exception Message may be one of four values:

- ’2’=Data Degraded
- ’4’=Medium Degraded
- ’6’=CM Error
- ’7’=Medium Exception

The Severity Code may be one of four values:

- '0'=Service
- '1'=Moderate - Temporary Read/Write Errors
- '2'=Serious - Permanent Read/Write Errors
- '3'=Acute - CM Error

The Volume ID Flag may be one of four values:

- '0'=VOLID not valid
- '1'=VOLID valid - obtained from tape (CM)
- '3'=VOLID valid - obtained from cartridge label (server data)
- '5'=VOLID valid - obtained from cartridge level (library)

Self-Test

For the Self-Test Diagnostic, the CDB values must be set as follows:

- PF - Any value allowed and ignored
- SelfTest - 1
- DevOfl - Any value allowed and ignored
- UnitOfl - Any value allowed and ignored
- Parameter List Length - 0000h

Receive Diagnostics Results: There are no diagnostic results for the Self-Test diagnostic.

Post A Self Test Diagnostic

Table 104. Post A Self Test Send Diagnostic Parameter Data

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Page Code (80h)							
1	Reserved							
2 : 3	Page Length (0004h)							
4 : 5	Diagnostic ID (0100h)							
6	Flags (0000000b)							Cartridge Required (bx)
7	Reserved							

Table 105. Post A Self Test Receive Diagnostic Parameter Data

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Page Code (80h)							
1	Reserved							
2 : 3	Page Length (0004Dh)							
4 : 5	Diagnostic ID (0100h)							
6	Flags							
7	Reserved							
8	Flags (00000b)					Diag. Blocked	SIM/MIM Present	Error
9 : 80	SIM/MIM Message or All Zeros							

Post B Tape Test Diagnostic

Table 106. Post B Tape Test Send Diagnostic Parameter Data

Byte	Bit 7	6	5	4	3	2	1	0
0	Page Code (80h)							
1	Reserved							
2 : 3	Page Length (0004h)							
4 : 5	Diagnostic ID (0101h)							
6	Flags (0000000b)							Cartridge Required (1b)
7	Reserved							

Table 107. Post B Tape Test Receive Diagnostic Parameter Data

Byte	Bit 7	6	5	4	3	2	1	0
0	Page Code (80h)							
1	Reserved							
2 : 3	Page Length (0004Dh)							
4 : 5	Diagnostic ID (0101h)							
6	Flags							
7	Reserved							
8	Flags (00000b)					Diag. Blocked	SIM/MIM Present	Error
9 : 80	SIM/MIM Message or All Zeros							

Post C Media Test Diagnostic

Table 108. Post C Media Test Send Diagnostic Parameter Data

Byte	Bit							
	7	6	5	4	3	2	1	0
0	Page Code (80h)							
1	Reserved							
2 : 3	Page Length (0004h)							
4 : 5	Diagnostic ID (0102h)							
6	Flags (0000000b)							Cartridge Required (1b)
7	Reserved							

Table 109. Post C Media Test Receive Diagnostic Parameter Data

Byte	Bit							
	7	6	5	4	3	2	1	0
0	Page Code (80h)							
1	Reserved							
2 : 3	Page Length (004Dh)							
4 : 5	Diagnostic ID (0102h)							
6	Flags							
7	Reserved							
8	Flags (00000b)					Diag. Blocked	SIM/MIM Present	Error
9 : 80	SIM/MIM Message or All Zeros							

Post D Head Test Diagnostic

Table 110. Post D Head Test Send Diagnostic Parameter Data

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Page Code (80h)							
1	Reserved							
2 : 3	Page Length (0004h)							
4 : 5	Diagnostic ID (0103h)							
6	Flags (0000000b)							Cartridge Required (1b)
7	Reserved							

Table 111. Post D Head Test Receive Diagnostic Parameter Data

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Page Code (80h)							
1	Reserved							
2 : 3	Page Length (004Dh)							
4 : 5	Diagnostic ID (0103h)							
6	Flags							
7	Reserved							
8	Flags (00000b)					Diag. Blocked	SIM/MIM Present	Error
9 : 80	SIM/MIM Message or All Zeros							

Force Dump

The Force Dump Diagnostic causes the drive to capture into a reserved space in memory a log of data that is used to assist field and development engineers in determining the root cause of drive behavior. This log is called a drive dump. This diagnostic copies the dump to memory, but does not save it for later use. The save operation must be done by using a READ BUFFER command or a Write Dump To Cartridge Diagnostic.

Note: Because forcing a drive dump will overwrite any previously stored dump, before forcing the dump it may be desirable to check the Dump field of the sense data to determine if a drive dump exists.

For the Force Dump Diagnostic, the CDB values should be set as follows:

- PF - 1
- SelfTest - 0
- DevOfl - Any value allowed and ignored
- UnitOfl - Any value allowed and ignored
- Parameter List Length - 0008h

Table 112 shows the parameter data to be sent with the Force Dump diagnostic.

Table 112. Force Dump Diagnostic Parameter Data

	Bit							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Page Code (80h)							
1	Reserved							
2 : 3	Page Length (0004h)							
4 : 5	Diagnostic ID (0160h)							
6	Flags (0000000b)							Cartridge Required (0)
7	Reserved							

Receive Diagnostics Results: There are no diagnostic results for the Force Dump diagnostic.

Write Dump To Cartridge

The Write Dump To Cartridge Send Diagnostic causes the drive to write a dump from memory to the cartridge that is loaded in the drive. The dump might exist because of a previous Force Dump diagnostic command or it might exist because of other scenarios where the drive code automatically creates a dump. To determine if a drive dump exists before forcing a dump, the application client can look at the Dump field of the sense data.

Table 113. Write Dump to Cartridge Send Diagnostic Parameter Data

	Bit							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Page Code (80h)							
1	Reserved							
2 : 3	Page Length (0004h)							
4 : 5	Diagnostic ID (0161h)							
6	Flags (0000000b)							Cartridge Required (1b)
7	Reserved							

The Write Dump To Cartridge Receive Diagnostic returns information about the attempted Write Dump To Cartridge Send Diagnostic.

Table 114. Write Dump to Cartridge Receive Diagnostic Parameter Data

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Page Code (80h)							
1	Reserved							
2 : 3	Page Length (004Dh)							
4 : 5	Diagnostic ID (0161h)							
6	Flags							
7	Reserved							
8	Flags (00000b)					Diag. Blocked	SIM/MIM Present	Error
9 : 80	SIM/MIM Message or All Zeros							

Set Traps

The Set Traps diagnostic is used to cause the drive to force a Panic when the specified Fault Symptom Code (FSC) is created in the drive. A Panic will cause the drive to capture a drive dump, then reboot. The drive dump will be available for retrieval after the reboot.

In Ultrium 2 drives a list of traps can be created. When the list is full, the next trap that is set will automatically clear the least recently set trap. Currently, the maximum number of traps that can be set is 10 but may be modified at any time.

In Ultrium 1 drives only one trap is allowed to be set at a time.

For the Set Traps Diagnostic, the CDB values should be set as follows:

- PF - 1
- SelfTest - 0
- DevOfl - Any value allowed and ignored
- UnitOfl - Any value allowed and ignored
- Parameter List Length - 000Ah

Table 115 shows the parameter data to be sent with the Set Traps diagnostic.

Table 115. Set Traps Diagnostic Parameter Data

	Bit							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Page Code (80h)							
1	Reserved							
2 : 3	Page Length (0006h)							
4 : 5	Diagnostic ID (0190h)							
6	Flags (0000000b)							Cartridge Required (0)
7	Reserved							
8 : 9	Fault Symptom Code							

Receive Diagnostics Results: There are no diagnostic results for the Set Traps diagnostic.

Remove Traps

The Remove Traps diagnostic is used to remove a trap that has been previously set by a Set Traps diagnostic. The Fault Symptom Code (FSC) that is specified is cleared from the trap list.

For the Remove Traps Diagnostic, the CDB values should be set as follows:

- PF - 1
- SelfTest - 0
- DevOfl - Any value allowed and ignored
- UnitOfl - Any value allowed and ignored
- Parameter List Length - 000Ah

Table 116 shows the parameter data to be sent with the Remove Traps diagnostic.

If all that is desired is to inspect which Traps have been set, sending down Remove Traps with the Fault Symptom Code set to 0000h will set up diagnostic results that show which traps are currently set without changing the state of any traps.

Table 116. Remove Traps Diagnostic Parameter Data

	Bit							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Page Code (80h)							
1	Reserved							
2 : 3	Page Length (0006h)							
4 : 5	Diagnostic ID (0191h)							
6	Flags (0000000b)							Cartridge Required (0)
7	Reserved							
8 : 9	Fault Symptom Code							

Receive Diagnostics Results - Table 117 shows the diagnostic results data returned for the Remove Traps diagnostic.

Table 117. Reset Drive Diagnostic Results Data

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Page Code (80h)							
1	Reserved							
2 : 3	Page Length (n - 4)							
4 : 5	Diagnostic ID (0191h)							
6	Flags (0)							
7	Reserved							
8	Reserved					Diag Blocked	Reserved	Error
9-10 : (n-1)-n	First Fault Symptom Code with Trap Still Set : Last Fault Symptom Code with Trap Still Set							

Reset Drive

The Reset Drive diagnostic causes the drive to reboot. All data in the drive is lost.

For the Reset Drive Diagnostic, the CDB values should be set as follows:

- PF - 1
- SelfTest - 0
- DevOfl - 1
- UnitOfl - Any value allowed and ignored
- Parameter List Length - 0008h

Table 118 shows the parameter data to be sent with the Reset Drive.

Table 118. Reset Drive Diagnostic Parameter Data

	Bit							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Page Code (80h)							
1	Reserved							
2 : 3	Page Length (0004h)							
4 : 5	Diagnostic ID (2002h)							
6	Flags (0000000b)							Cartridge Required (0)
7	Reserved							

Receive Diagnostics Results: There are no diagnostic results for the Reset Drive diagnostic.

SET CAPACITY

The SET CAPACITY command is supported in Ultrium 2 drives only and sets the available medium for the currently mounted tape to a proportion of the total capacity of that tape. Any excess space will be unavailable on the tape after successful completion of this command until changed by a new SET CAPACITY command. This change will persist through power cycles, logical unit resets, and the unloading or reloading of the tape.

Table 119. SET CAPACITY Command

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Operation Code (0Bh)							
1	Reserved							Immed
2	Reserved							
3	(MSB)							
:	Capacity Proportion Value							
4								(LSB)
5	Control							

If the tape drive does not contain a tape, then the command will be terminated with Check Condition status. The Sense Key must be set to Not Ready, and the Additional Sense Code must be set to Medium Not Present.

The SET CAPACITY command will be accepted only when the tape is at beginning-of-tape (BOT). If the tape is logically at any other position, the command will be rejected with Check Condition status. The Sense Key will be Illegal Request and the Additional Sense Code must be set to Position Past Beginning Of Medium.

A valid SET CAPACITY command will cause all data on the entire physical tape to be lost.

Buffered write data may be discarded by the tape drive upon successful validation of the SET CAPACITY command.

An Immediate (Immed) field of 0 specifies that the device server will not return status until the set capacity operation has completed. An Immed field of 1 specifies that the device server will return status as soon as the command descriptor block of the SET CAPACITY command has been validated. If Check Condition status is returned for a SET CAPACITY command with an Immed field set to 1, the set capacity operation has not been performed.

The Capacity Proportion Value field specifies the portion of the total tape capacity to be made available for use. This field is the numerator to a fraction that has a denominator of 65 535 (FFFFh). The resulting available capacity on the tape is equal to the total tape capacity multiplied by this fraction. The tape drive may round up the capacity to the next highest supported value. This rounding error is not considered an error and will not be reported. Table 120 on page 120 gives the minimum supported capacities for each cartridge type.

Note: Available and total tape capacities are approximate values that may be affected by defects which reduce the actual available capacity of the tape.

Other factors, such as compression and block packing, may also affect available capacity.

Table 120. Minimum Supported Capacities for Each Cartridge Type

Cartridge Type	Minimum Value
A	1613h
B	2C27h
C	499Ah
D	DD0Ch

SPACE

The SPACE command instructs the drive to set a new logical position relative to the current logical position. How this is done depends on the value of the Code field and the Count field. The Count field is a signed value that indicates the distance to move. A negative value indicates movement towards BOM; a positive value indicates movement towards EOM.

Table 121. SPACE Command

	Bit							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Operation Code (11h)							
1	Logical Unit Number			Reserved		Code		
2 : 4	Count							
5	Control							

If the Code field is 000b, then the logical position is moved the number of blocks that is indicated by the Count field. If a filemark is encountered while spacing over blocks, the command is terminated. Check Condition status is returned, and the Filemark and Valid fields are set to 1 in the sense data. The Sense Key is set to No Sense and the Additional Sense Code is set to Filemark Detected. The Information field is set to the requested count minus the actual number of blocks spaced over (not including the filemark). The new logical position is set immediately after the file mark in the direction of the space operation. If BOM 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 BOM or EOD is detected before the requested logical position, then the logical position is set to that position.

If end-of-data is encountered while spacing over blocks or filemarks, Check Condition status is returned, the Sense Key is set to Blank Check, and the sense data Valid field is set to 1 in the sense data. The Additional Sense Code is set to End-Of-Data Detected. The sense data EOM field is set to 1 if end-of-data is encountered at or after early-warning. The Information field is set to the requested count minus the actual number of blocks or filemarks spaced over as defined by the Code value. The medium is positioned such that a subsequent write operation would append to the last record or filemark.

If the end-of-tape is encountered while spacing forward over blocks or filemarks, Check Condition status is returned, and the Sense Key is set to Medium Error. The Additional Sense Code is set to End-Of-Partition/Medium Detected, and the sense data EOM and Valid fields are set to 1. The Information field is set to the requested count minus the actual number of blocks or filemarks spaced over, as defined by the Code value.

If beginning-of-tape is encountered while spacing over blocks or filemarks in the reverse direction, the drive returns Check Condition status and sets the Sense Key to No Sense. The Additional Sense Code is set to Beginning-Of-Partition/Medium Detected. The sense data EOM and Valid fields are set to 1, and the Information

field is set to the total number of blocks or filemarks not spaced over (the requested number of blocks or filemarks minus the actual number of blocks or filemarks spaced over). A successfully completed SPACE command does not set EOM to 1 at beginning-of-tape.

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 causes 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 ASC/ASCQ is set to Invalid Field in CDB (2400).

TEST UNIT READY

The TEST UNIT READY command returns Good status if a cartridge is loaded and ready.

Table 122. TEST UNIT READY Command

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

VERIFY

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 field in the same manner as is used in a READ command. (See "READ" on page 62.)

Table 123. VERIFY Command

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Operation Code (13h)							
1	Logical Unit Number			Reserved		Immed(0)	BCmp(0)	Fixed
2 : 4	Verification Length							
5	Control							

The VERIFY command is supported by all drives.

The Immed and BCmp fields are not supported and must be set to 0.

WRITE

The WRITE command causes data to be transferred to the drive in a Data Out and written to tape.

Table 124. WRITE Command

	Bit							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Operation Code (0Ah)							
1	Logical Unit Number			Reserved				Fixed
2 : 4	Transfer Length							
5	Control							

If the Fixed field is set to 1, the Block Length (see “Mode Block Descriptor” on page 44) is set to 0, and the Transfer Length field is not 0, Check Condition status is returned with Illegal Field in CDB (5/2400h).

If the Fixed field is set to 0, the initiator transfers a single block of the length indicated in Transfer Length.

If the Fixed field is set to 1, the initiator transfers a sequence of blocks. The number of blocks is given by the Transfer Length field. The length of the blocks is given by the current fixed block length (see “Mode Block Descriptor” on page 44).

If the current logical block number is greater than FFFFFF00h and less than FFFFFFF0h, rules for Logical EOM processing are applied. If the current logical block number is greater than or equal to FFFFFFF0h, rules for physical end of tape processing are applied.

WRITE ATTRIBUTE

Table 125. WRITE ATTRIBUTE Command

Byte	Bit							
	7	6	5	4	3	2	1	0
0	Operation Code (8Dh)							
1 : 4	Reserved							
5	Volume Number (0)							
6	Reserved							
7	Partition Number (0)							
8 : 9	Reserved							
10 : 13	Allocation Length							
14	Reserved							
15	Control							

Refer to *SCSI Primary Commands-3 (SPC-3)* for support for the WRITE ATTRIBUTE command.

For information about attributes that are supported, see “READ ATTRIBUTE” on page 64.

Table 126 gives the format of the data that is returned for an Attribute Values service action request.

Table 126. Parameter Data for Attribute Values Service Action Request

Byte	Bit							
	7	6	5	4	3	2	1	0
0 : 3	Parameter Data Length (n-3)							
4 : x	Attribute #1							
m : n	Attribute #y							

WRITE BUFFER

The WRITE BUFFER command transfers data into the memory on the drive for the purpose of diagnostics, tests, or firmware upgrade.

Table 127. WRITE BUFFER Command

	Bit							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Operation Code (3Bh)							
1	Logical Unit Number			Mode				
2	Buffer ID							
3 : 5	Buffer Offset							
6 : 8	Parameter List Length							
9	Control							

Values for the Mode field and their meaning are described in Table 128.

Table 128. Description of Mode Field

Mode	Description	Support
00h	Write combined header and data	1,2
01h	Vendor specific	N/S
02h	Write data	1,2
03h	Reserved	N/S
04h	Download microcode	1,2
05h	Download microcode and save	1,2
06h	Download microcode with offsets	1,2
07h	Download microcode with offsets and save	1,2
08h - 09h	Reserved	N/S
0Ah	Echo buffer	2
0Bh - 19h	Reserved	N/S
1Ah	Enable expander communications protocol and echo buffer	N/S
1Bh	Disable expander communications protocol	N/S
1Ch - 1Fh	Reserved	N/S

Table 128. Description of Mode Field (continued)

Mode	Description	Support
Legend: 1 = supported in IBM TotalStorage LTO Ultrium Tape Drive (commonly called the Ultrium 1 tape drive) 2 = supported in IBM TotalStorage LTO Ultrium 2 Tape Drive (commonly called the Ultrium 2 tape drive) N/S = not supported		

If the Mode field is 00h, the data to be written is sent with a 4-byte header, which must be set to all zeroes.

The Buffer ID field indicates which buffer is to be written.

To download firmware, Modes 04h, 05h, 06h, and 07h are accepted and handled in the same fashion. Any Buffer ID value in these modes is allowed and ignored. The code must be downloaded with strictly increasing offsets. If it is not, no data is written and Check Condition status is generated. The Sense Key is set to Illegal Request (5) and the ASC/ASCQ is set to Invalid Field in CDB (2400). Ending status is given when the code has been successfully saved to flash, but before the drive has initiated its reset.

If Mode is set to 0Ah, the data is stored in the echo buffer. The Buffer ID and Buffer Offset fields are ignored in this mode.

The Buffer Offset field indicates where in the buffer the data should be written. This must be smaller than the size of the buffer.

The Parameter List Length field holds the amount of data. This must be smaller than the difference between the Buffer Offset field and the size of the buffer. If it is not, no data is written and Check Condition status is generated. The Sense Key is set to Illegal Request (5) and the ASC/ASCQ is set to Invalid Field in CDB (2400).

Buffers that may be written to are Test, Firmware, and VPD (see “READ BUFFER” on page 80).

WRITE FILE MARKS

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 field is set, status is returned immediately, before the file marks are written to tape. If the Immed field is set to 0, the file marks and any buffered data is written to tape before status is returned.

The Write Set Mark (WSmk) field must be 0. Set marks are not supported.

Table 129. WRITE FILE MARKS Command

	Bit							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Operation Code (10h)							
1	Logical Unit Number			Reserved			WSmk(0)	Immed
2 : 4	Count							
5	Control							

If the Immed field is set to 0 and the Count field is 0, then all buffered data is flushed to tape before the status is reported.

If the current logical block number is greater than FFFFFF00h and less than FFFFFFF0h, rules for Logical EOM processing are applied. If the current logical block number is greater than or equal to FFFFFFF0h, rules for physical end of tape processing are applied.

Chapter 4. Error Sense Information

Sense Data

For a description of Sense data, see “Sense Data Format” on page 96.

Sense Data Management

The drive maintains three types of Sense data:

Current Sense
The Sense data associated with the last command received from the initiator.

Deferred Sense
The 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 generates sense for the server that sent the command. A buffered write may generate sense for all servers.

Unit Attention Sense
The Sense data generated by a Unit Attention condition. (See “Unit Attention Conditions” on page 129.) This is generated for all servers. When a Unit Attention condition has been driven by a command (for example, when mode parameters have changed), a Unit Attention is posted for all initiators except the one that caused the change.

Any command other than a REQUEST SENSE command or an INQUIRY command generates Check Condition status if there is Deferred Sense data or Unit Attention data available. All commands 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.

Unit Attention Conditions

The drive generates a Unit Attention condition under the following circumstances:

- Reset condition (for example, power-on, SCSI reset, bus device reset)
- Tape Loaded condition (for example, media inserted, LOAD command from another initiator)
- Mode parameters changed by another initiator
- Drive firmware has been upgraded

The drive only maintains one Unit Attention condition at any one time for any one initiator. If a subsequent Unit Attention condition is generated, it replaces the existing one if it is of higher priority. If it is of lower priority, it is ignored. The priorities are in the order listed above, with a reset being highest priority and a firmware upgrade being lowest priority.

© Copyright IBM Corp. 2002

Persistent Errors

When errors occur that prevent tape operation, they are reported persistently until the problem is cleared. For medium-related errors (usually reported with a Sense Key of 3), the error is reported until the cartridge is successfully unloaded. For hardware-related errors (usually reported with a Sense Key of 4), the error is reported until the drive successfully performs a power-on self test. These persistent errors are only reported on those commands that are eligible for deferred Check Condition reporting (see Table 3 on page 7). The error may or may not be reported as Deferred.

Chapter 5. Sense Keys and Additional Sense

Note: If temporary error reporting is enabled, many combinations of the Additional Sense Code and Additional Sense Code Qualifier (ASC/ASCQ) are possible.

Table 130. Sense Keys and Additional Sense

Sense Key	Additional Sense (ASC/ASCQ)	Explanation
No Sense (0h)	No Additional Sense (0000h)	The flags in the sense data indicate the reason for the command failure.
No Sense (0h)	Mark (0001h)	A READ or a SPACE command has terminated early because a file mark has been encountered. The File Mark flag is set.
No Sense (0h)	EOM (0002h)	A WRITE or WRITE FILE MARKS command ended in the early warning area. EOM flag is set.
No Sense (0h)	BOM (0004h)	A SPACE command ended at Beginning of Tape. The EOM bit is also set.
No Sense (0h)	Op in Progress (0016h)	A new operation could not be carried out because an operation is currently in progress.
No Sense (0h)	Drive Requires Cleaning (8282h)	The drive has detected that a cleaning operation is advisable to maintain good operation.
Recovered Error (1h)	No Additional Sense (0000h)	A recovered error has occurred.
Recovered Error (1h)	Write Error (0C00h)	A write error occurred, but was recovered. Data was written to tape successfully.
Recovered Error (1h)	Read Error (1100h)	A read error occurred, but was recovered. Data was successfully read from tape.
Recovered Error (1h)	Recovered Data with Retries (1701h)	An error occurred, but was successfully recovered with retries.
Recovered Error (1h)	Media Load or Eject Error (5300h)	A LOAD or UNLOAD command required retries to complete successfully.
Recovered Error (1h)	Failure Prediction Threshold (5D00h)	Failure Prediction thresholds have been exceeded, indicating that a failure may occur soon.
Not Ready (2h)	Cause Not Reportable (0400h)	A tape is present in the drive, but it is in the process of being unloaded.
Not Ready (2h)	Becoming Ready (0401h)	A medium access command has been received during a front-panel-initiated load or an immediately reported LOAD command.
Not Ready (2h)	Initializing Command Required (0402h)	A tape is present in the drive, but it is not logically loaded. A LOAD command is required.
Not Ready (2h)	Cleaning Cartridge Installed (3003h)	An operation could not be carried out because the tape in the drive is a cleaning cartridge.
Not Ready (2h)	Cleaning Failure (3007h)	A cleaning operation was attempted, but could not be completed for some reason.
Not Ready (2h)	Medium Not Present (3A00h)	A media access command has been received when there is no tape loaded.
Not Ready (2h)	Logical Unit Has Not Self-configured (3E00h)	The drive has powered on, has not completed its self test sequence, and cannot process commands.
Medium Error (3h)	Write Error (0C00h)	A WRITE operation has failed. This is probably due to bad media, but may be related to hardware.

© Copyright IBM Corp. 2002

Table 130. Sense Keys and Additional Sense (continued)

Sense Key	Additional Sense (ASC/ASCQ)	Explanation
Medium Error (3h)	Unrecovered Read Error (1100h)	A READ operation failed. This is probably due to bad media, but may be related to hardware.
Medium Error (3h)	Recorded Entity Not Found (1400h)	A SPACE or LOCATE command failed because a format violation prevented the target of the operation from being found.
Medium Error (3h)	Unknown Format (3001h)	An operation could not be carried out because the tape in the drive is of a format not supported by the drive.
Medium Error (3h)	Incompatible Format (3002h)	An operation could not be completed because the Logical Format is not correct.
Medium Error (3h	Medium Format Corrupted (3100h)	Data could not be read because the format on tape is not valid, but is a known format. A failure occurred attempting to write the FID.
Medium Error (3h)	Sequential Positioning Error (3B00h)	A command has failed and left the logical position at an unexpected location.
Medium Error (3h)	Write Append Error (5000h)	A WRITE-type command failed because the point at which to append data was unreadable.
Medium Error (3h)	Cartridge Fault (5200h)	A command could not be completed due to a fault in the tape cartridge.
Medium Error (3h)	Media Load/Eject Failed (5300h)	An attempt to load or eject the tape failed due to a problem with the tape.
Hardware Error (4h)	Manual Intervention Required (0403h)	A tape is present in the drive but could not be loaded or unloaded without manual intervention.
Hardware Error (4h)	Diagnostic Failure (40XXh)	A diagnostic test failed. The Additional Sense Code Qualifier is a vendor-specific code that indicates the failing component.
Hardware Error (4h)	Internal Target Failure (4400h)	A hardware failure has been detected in the drive and caused the command to fail.
Hardware Error (4h)	Erase Failure (5100h)	An ERASE command failed to erase the required area on the medium.
Hardware Error (4h)	Media Load/Eject Failed (5300h)	An attempt to load or eject the tape failed due to a problem with the drive.
Illegal Request (5h)	Parameter List Length Error (1A00h)	The amount of parameter data sent is incorrect.
Illegal Request (5h)	Invalid Command Operation Code (2000h)	The Operation Code in the command was not valid.
Illegal Request (5h)	Invalid Field in CDB (2400h)	An invalid field has been detected in a Command Descriptor Block.
Illegal Request (5h)	LUN Not Supported (2500h)	The command was addressed to a non-existent logical unit number.
Illegal Request (5h)	Invalid Field in Parameter List (2600h)	An invalid field has been detected in the data sent during the data phase.
Illegal Request (5h)	Medium Removal Prevented (5302h)	An UNLOAD command has failed to eject the tape because medium removal has been prevented.
Illegal Request (5h)	Bad Microcode Detected (8283h)	The data transferred to the drive during a firmware upgrade is corrupt or incompatible with the drive hardware.
Unit Attention (6h)	Not Ready To Transition (2800h)	A tape has been loaded successfully into the drive and is now ready to be accessed.
Unit Attention (6h)	Reset (2900h)	The drive has powered on and received a reset signal or a bus device reset message since the initiator last accessed it.

Table 130. Sense Keys and Additional Sense (continued)

Sense Key	Additional Sense (ASC/ASCQ)	Explanation
Unit Attention (6h)	Mode Parameters Changed (2A01h)	The Mode parameters for the drive have been changed by an initiator other than the one issuing the command.
Unit Attention (6h)	Microcode Downloaded (3F01h)	The firmware in the drive has just been changed by a WRITE BUFFER command.
Unit Attention (6h)	Failure Prediction False (5DFFh)	A MODE SELECT command has been used to test the Failure Prediction system.
Data Protect (7h)	Write Protect (2700h)	A WRITE-type operation has been requested on a tape that has been write protected.
Blank Check (8h)	EOD (0005h)	A READ or a SPACE command terminated early because End of Data was encountered.
Blank Check (8h	End of Data not Found (1403h)	A READ-type operation failed because a format violation related to a missing EOD data set.
Aborted Command (Bh)	Invalid Bits in Identify Message (3D00h)	An illegal Identify message has been received by the drive at the start of a command.
Aborted Command (Bh)	Message Error (4300h)	A message could not be sent or received due to excessive transmission errors.
Aborted Command (Bh)	Select/Reselect Failure (4500h)	An attempt to reselect an initiator (to complete the command) has failed.
Aborted Command (Bh)	Initiator Detected Error Message (4800h)	A command failed because an Initiator Detected Error message was received.
Aborted Command (Bh)	Invalid Message Error (4900h	The command failed because an invalid message was received by the drive.
Aborted Command (Bh)	Command Phase Error (4A00h)	A command could not be executed because too many parity errors occurred in the Command phase.
Aborted Command (Bh)	Data Phase Error (4B00h)	A command could not be completed because too many errors occurred during the Data phase.
Aborted Command (Bh)	Overlapped Commands (4E00h)	An initiator selected the drive even though it already had a command outstanding in the drive.
Volume Overflow (Dh)	EOM (0002h)	A WRITE or WRITE FILE MARKS command failed because the physical end of tape was encountered. A READ or SPACE command encountered EOM. The EOM flag is set.

Chapter 6. Attachment Features

Types of Interface Attachments

The Ultrium Tape Drive communicates with servers that use SCSI parallel or Fibre Channel interfaces. The interfaces share certain tape LUN behaviors, but also possess unique features. This chapter describes the common and unique features of both types of interfaces.

Common Tape LUN Behaviors

SCSI parallel and Fibre Channel interfaces share the following tape LUN behaviors:

- Power-on procedure
- Reset strategy
- Abort handling
- Multi-initiator support
- Status codes

The sections that follow describe each behavior.

Power-On

The drive responds to INQUIRY, REPORT LUNs, REQUEST SENSE, and TEST UNIT READY commands within 5 seconds of power-on. The first command (other than INQUIRY or REQUEST SENSE) from any initiator gets a Check Condition status with Unit Attention sense data for the power-on. After this, any medium access command is reported with a Sense Key of Not Ready and an ASC/ASCQ of LUN Has Not Self-Configured Yet (3E00). Once the drive has completed its self test and setup procedures, the drive attempts to load any tape that is present. Medium access commands are reported with an ASC/ASCQ of Drive in Process of Becoming Ready (0401).

Reset Strategy

The drive supports the hard reset option as is required by SCSI-3. On receiving a reset, the following actions are taken:

- The current I/O process is aborted, as in “Abort Handling” on page 136.
- Any queued I/O processes from other initiators are removed.
- All reservations are cleared.
- All mode values are reset to their defaults.
- Synchronous/Wide negotiations are cleared (applies only to SCSI parallel attach).
- A unit attention condition is set.
- A logical position is established that may or may not be the same as the position prior to the reset. Where possible, the logical position prior to reset is maintained.

For drives that use a Fibre Channel interface, the next command that is eligible for the Unit Attention Check Condition from each initiator gets a Check Condition status, with Unit Attention sense data for the reset. However, other commands may not be processed until the internal state of the drive has been reset.

Drives that use a SCSI interface are able to respond to the INQUIRY, REPORT LUNs, REQUEST SENSE, and TEST UNIT READY commands within 250 ms of the reset line being released. The next command that is eligible for the Unit

© Copyright IBM Corp. 2002

Attention Check Condition from each initiator gets a Check Condition status, with Unit Attention sense data for the reset. However, other commands may not be processed until the internal state of the drive has been reset. Any commands that allow Disconnects and cannot be processed are accepted and queued until the drive is ready to process them. Those commands that do not allow Disconnects receive Busy status response.

Abort Handling

If a command is aborted on a drive with a Fibre Channel interface, see Table 131 for abort processing.

If a command is aborted on a drive with a SCSI interface, one of the following conditions will occur:

- If an abort condition is detected before a command phase completes, the bus is set to Bus Free and the command is not executed.
- If an abort condition is detected during status phase, the bus is set to bus free.
- If an abort condition is detected between the end of the command phase and the start of the status phase, then the bus is set to Bus Free and the processing in Table 131 on page 136 is carried out.

Table 131. Abort Condition Handling

Command	Abort Processing
ERASE	Long erase is aborted as quickly as possible without corrupting tape format. Short erase completes.
INQUIRY	None.
LOAD/UNLOAD	Load completes and logically positions tape at BOM. Unload is aborted, leaving logical position at BOM unless operation is past the 'point of no return', in which case the tape is ejected.
LOCATE	The logical position is set back to that at the start of the operation unless the operation is past its 'point of no return', in which case the operation completes.
LOG SELECT	If data transfer is completed, command is completed; otherwise, no action is taken.
LOG SENSE	None.
MODE SELECT	If data transfer is completed, command is completed; otherwise, no action is taken.
MODE SENSE	None.
PERSISTENT RESERVE IN	None.
PERSISTENT RESERVE OUT	If data transfer is completed, the command is completed; otherwise, no action is taken.
PREVENT/ALLOW MEDIUM REMOVAL	The command completes.
READ	The current position is set to the first record boundary at or after the start of the current data burst.
READ ATTRIBUTE	None.
READ BLOCK LIMITS	None.
READ BUFFER	None.
READ POSITION	None.

Table 131. Abort Condition Handling (continued)

Command	Abort Processing
RECEIVE DIAGNOSTIC RESULTS	None.
RELEASE UNIT	The command completes.
REPORT DENSITY SUPPORT	None.
REPORT LUNs	None.
REQUEST SENSE	Sense data is discarded.
RESERVE UNIT	The command completes.
REWIND	The command completes.
SEND DIAGNOSTIC	Vendor unique.
SPACE	The logical position is set back to that at the start of the operation unless the operation is past its 'point of no return', in which case the operation completes.
TEST UNIT READY	None.
VERIFY	The logical position is set to the next record boundary after the point where the verify was aborted.
WRITE	The data up to first record boundary in the current burst is written to buffer or tape, depending on Buffered Mode. Any subsequent data is discarded. If there is no record boundary in the current burst, the record is truncated to the amount of data transferred and written to buffer or tape, again depending on Buffered Mode.
WRITE BUFFER	If data transfer is completed, the command is completed; otherwise, no action is taken.
WRITE FILE MARKS	The command completes.

For drives with a SCSI interface, if a command other than INQUIRY, REPORT LUNs, REQUEST SENSE, or TEST UNIT READY is received after the abort but before the drive is ready to process the command, the drive attempts to disconnect and wait until the abort processing has completed before executing the command. If disconnects are not allowed, Busy status is returned. A TEST UNIT READY command reports with status immediately.

For drives with a Fibre Channel interface, an INQUIRY command returns the required data and gives Good status. A REQUEST SENSE command gives no sense. A TEST UNIT READY command reports with status immediately.

Multi-initiator Support

SCSI-attached drives support a maximum of two initiators on the same bus. Fibre-Channel-attached drives support an infinite number of initiators, but have a limit on how many initiators can be logged in concurrently. When this limit is exceeded, the least recently used (LRU) initiator that is not reserved or does not have an outstanding command will be implicitly logged out.

The drive supports untagged queuing when operating with multiple initiators. If a command from one initiator is being processed when a command other than INQUIRY, REPORT LUNs, REQUEST SENSE, and TEST UNIT READY is received from a second initiator, the new command is queued. Commands (other than INQUIRY, REPORT LUNs, REQUEST SENSE, and TEST UNIT READY) from different initiators are always executed in strict order of receipt. For drives with a SCSI interface, if the queue is full or disconnect privilege is not granted in the new command, the drive reports busy status.

The INQUIRY, REPORT LUNs, REQUEST SENSE, and TEST UNIT READY commands are always processed immediately, irrespective of whether a command from another initiator is being processed.

The drive maintains sense data for the supported number of initiators. On Fibre-Channel-attached drives, if an additional initiator connects to the drive, the drive erases all sense data for the initiator that least recently connected before processing the command for the new initiator. See “Sense Data Management” on page 129 for more details of sense data management.

Status Codes

Table 132. Status Codes

Status Code	Value	Circumstance
Good	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.
Condition Met	04h	This status is never returned, since no supported commands generate this status.
Busy	08h	The drive is unable to accept the command at this time. This status is returned during the power-on sequence or if there are commands from too many initiators outstanding. (See “Multi-initiator Support” on page 138.) It is also returned when commands are issued without Disconnect Privilege and when another command is in progress.
Intermediate	10h	This status is never returned, since Linked commands are not supported.
Intermediate Condition met	14h	This status is never returned, since no supported commands generate this status.
Reservation Conflict	18h	This status is returned if the drive is reserved for an initiator other than the one sending the command.
Command Terminated	22h	This status is never returned, since the terminate I/O process message is not supported.
Queue Full	28h	This status is never returned, since tagged queuing is not supported.

Features of the SCSI Interface

The Ultrium Tape Drive's SCSI parallel interface features the following:

- LUN identification
- Bus parity errors
- Disconnect strategy
- Messages

LUN Identification

Identify messages are used to identify the LUN to which an initiator is connecting and to identify which LUN is reconnecting to an initiator. These are required. The LUN field in SCSI-2 commands is not used.

Bus Parity Errors

On detecting a bus parity error during a Command or Data Out phase or receiving an Initiator Detected Error message during a Data In or Status phase, the drive attempts to retry the Bus phase. A Restore Pointers message is sent to the initiator and the transfer is repeated. Only one retry is attempted for any given burst. If the retry fails or the Restore Pointers message is rejected by an Initiator Detected Error, Message Reject, or Message Parity message, then the drive goes to the Status phase and attempts to report Check Condition status. If this fails with an Initiator Detected Error message, the drive goes to Bus Free. The Sense Key is set to Aborted Command and the ASC/ASCQ is set to Command Phase Error (4A00) (if the error was in the Command phase) or to Data Phase Error (4B00) (if the error was in the Data phase). If the error was in the Status phase, the sense data remains as that from the command.

If an Initiator Detected Error or Message Parity Error message is received during the Message In phase, the initiator has detected an error in the message. The drive goes to Message In and resends the message that was in error. If the subsequent message is rejected with an Initiator Detected Error, then the drive goes to the Status phase and sends Check Condition status. The Sense Key is set to Aborted Command and the ASC/ASCQ is set to Initiator Detected Error (4800). If the subsequent message is rejected with a Message Parity Error, then the drive goes to the Status phase and sends Check Condition status. The Sense Key is set to Aborted Command and the ASC/ASCQ is set to Message Error (4300).

On detecting a bus parity error during a Message Out phase, the drive handshakes in all message bytes until ATN is deasserted. It then stays in the Message Out phase to indicate to the initiator that the whole Message Out phase should be resent.

Disconnect Strategy

The disconnect strategy used by the drive is based on the assumption of maximizing bus utilization for large sequential data transfers from a large data buffer. The drive disconnects whenever it believes that it can provide better bus utilization. This may be between Command and Data phases, between bursts of data, or before sending status. However, the drive guarantees that it sends the configured maximum burst size or the remaining data in the transfer in any single Data phase burst if the maximum burst size has been set to a value other than 0.

Messages

Message Out

Table 133. Supported Outbound Messages

Name	Code	Support
Abort	06h	An abort condition is generated (see “Abort Handling” on page 136).
Bus Device Reset	0Ch	A reset condition is generated (see “Abort Handling” on page 136).
Extended Message	01h	See “Unit Attention Conditions” on page 129 for 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 0. The Identify Out message must be sent as the first thing after selection. If it is sent at any other time, the drive responds with a Message Reject message and goes 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 retries the data burst or message (see “Bus Parity Errors” on page 139). If the message is received immediately after an Identify message or after the Command Complete message has been sent, the drive goes to Bus Free.
Message Parity Error	09h	The initiator has detected a parity error in a message. The drive retries the message (see “Bus Parity Errors” on page 139). 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 goes to 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 goes to Bus Free.
No Operation	08h	This message has no effect and is ignored.

Message In

Table 134. Supported Inbound Messages

Name	Code	Support
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 “Extended Messages” on page 142 for extended message support.
Identify	80h+	The Identify In message is sent to the initiator during reconnect to indicate which Logical Unit is reconnecting. The Disconnect Privilege and LUNTAR flags are both clear.
Ignore Wide Residue	23	This message is sent by the drive to the initiator to indicate that a byte on a wide bus is not valid. This is supported whenever a wide transfer is active.
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 is sent when a parity error is detected on the bus or when an Initiator Detected Error message is received in order to retry 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 is always sent before a Disconnect message during Data phases.

Extended Messages

Table 135. Supported Extended Messages

Name	Code	Support
Synchronous Data Transfer Request	01h	The default mode is for the drive to never initiate a Synchronous data transfer negotiation. The initiator is expected to do so. Since this mode is most important at power-on, no SCSI method of changing this mode is provided. Instead, an internal method of changing this mode is provided (VPD or jumper setting). If the message is received after selection and before the Command phase, it then goes to the Message In phase and responds with a valid response to complete the negotiation. If the message is received at any other time, a Message Reject is sent in response, placing the drive data transfer mode for that initiator to asynchronous.
Wide Data Transfer Request	03h	The default mode is for the drive to never initiate a Wide data transfer negotiation. The initiator is expected to do so. Since this mode is most important at power-on, no SCSI method of changing this mode is provided. Instead, an internal method of changing this mode is provided (VPD or jumper setting). If the message is received after selection and before the Command phase, it then goes to the Message In phase and responds with a valid response to complete the negotiation. If the message is received at any other time, a Message Reject is sent in response, placing the Bus Width to 1 byte wide and data transfer mode to asynchronous for that initiator.

Features of the Fibre Channel Interface

The Ultrium Internal Tape Drive Model T200F (the Fibre Channel Generation 1 drive) is an Arbitrated-Loop-only device (also known as an NL port). The drive supports Fibre Channel Arbitrated Loop (FC-AL) protocol, and uses Class 3 Service frames. The drive also supports both public (switch-attached) and private loops.

Like the Ultrium Internal Tape Drive, the Ultrium 2 Tape Drive Model T400F (the Fibre Channel Generation 2 drive) can attach as an FC-AL device. The Generation 2 drive can also attach as a point-to-point device (also known as an N Port). In either topology, the Ultrium 2 drive can be a public (switch-attached) or private device.

The World Wide Node Name and Port Name that are used by an Ultrium Tape Drive follow the format of the Institute of Electrical and Electronics Engineers (IEEE).

The IBM Ultrium Tape Drive is compliant with the FC-Tape Technical Report of the Accredited Standard Committee NCITS. IBM recommends that your server's device driver and host bus adapter (HBA) use the Class 3 Error Recovery procedures that are specified in the Fibre Channel Protocol for SCSI, Second Version (FCP-2).

Appendix. Notices

Trademarks

The following terms are trademarks of International Business Machines Corporation in the United States or other countries (or regions) or both:

AIX	OS/400
AS/400	pSeries
eserver	SP
IBM	RS/6000
iSeries	TotalStorage

The following are U. S. trademarks of Hewlett-Packard Company, International Business Machines Corporation, and Seagate Technology:

Linear Tape-Open
LTO
Ultrium

Intel is a registered trademark of Intel Corporation in the United States, or other countries (or regions), or both.

Microsoft, Windows, Windows NT, and the Windows logo are registered trademarks of Microsoft Corporation in the United States, or other countries (or regions), or both.

Other company, product, and service names may be trademarks or service marks of others.

© Copyright IBM Corp. 2002

Glossary

This glossary defines the special terms, abbreviations, and acronyms that are used in this publication.

Numbers and Symbols

2:1 compression. The relationship between the quantity of data that can be stored with compression as compared to the quantity of data that can be stored without compression. In 2:1 compression, twice as much data can be stored with compression as can be stored without compression.

A

adapter. See *adapter card*.

adapter card. A circuit board that adds function to a computer.

AL_PA. See *Arbitrated Loop Physical Address*.

Arbitrated Loop Physical Address (AL_PA). An 8-bit value that identifies a device in an arbitrated loop. All Fibre Channel ports communicate by using AL_PAs.

B

backups. The short-term retention of records used for restoring essential business and server files when vital data has been lost because of program or server errors or malfunctions.

bezel. The removable frame that fits over the front of the Ultrium Tape Drives.

bit. The smallest unit of data in a computer. A bit (short for binary digit) has a single binary value (either 0 or 1). Computers store data and execute instructions in bit multiples called bytes. In most computer systems, there are eight bits in a byte.

bus. See *SCSI bus*.

byte. A string that consists of a certain number of bits (usually 8) which are treated as a unit and represent a character. A byte is a fundamental unit of data.

C

capacity. The amount of data that can be contained on storage media and expressed in bytes.

cartridge. See *tape cartridge*.

cartridge memory. See *LTO cartridge memory*.

circuit board. A thin sheet on which chips and other electronic components are placed. Computers consist of one or more boards, often called cards or adapters.

cleaning cartridge. A tape cartridge that is used to clean the heads of a tape drive. Contrast with *data cartridge*.

command timeout. Following the issuance of a command, a period of time during which it is determined that there is a bad connection between the server and the drive.

compression. The process of eliminating gaps, empty fields, redundancies, and unnecessary data to shorten the length of records or blocks.

configure. To describe to a server the devices, optional features, and programs installed on the system.

D

data. Any representations such as characters or analog quantities to which meaning is, or might be, assigned.

data cartridge. A tape cartridge that is dedicated to storing data. Contrast with *cleaning cartridge*.

data compression. See *compression*.

data transfer rate. The average number of bits, characters, or blocks per unit of time that pass between corresponding equipment in a data transmission system. The rate is expressed in bits, characters, or blocks per second, minute, or hour.

device. Any hardware component or peripheral, such as a tape drive or tape library, that can receive and send data.

device driver. A binary file that is installed on a host system and enables the host system to access a device.

diagnostic. A software program that is designed to recognize, locate, and explain faults in equipment or errors in programs.

diagnostic cartridge. A tape cartridge that enables the detection and isolation of errors in programs and faults in equipment.

drive. See *IBM Ultrium Internal Tape Drive Models T200 and T200F* or *IBM TotalStorage LTO Ultrium 2 Tape Drive Models T400 and T400F*.

drive dump. The recording, at a particular instant, of the contents of all or part of one storage device into

© Copyright IBM Corp. 2002

another storage device, usually as a safeguard against faults or errors, or in connection with debugging.

drive head. The component that records an electrical signal onto magnetic tape, or reads a signal from tape into an electrical signal.

drive sense data. See *SCSI drive sense data*.

dump. See *drive dump*.

duplex. See *duplex transmission*.

duplex adapter. A mechanism that allows a device to send and receive communication at the same time.

duplex transmission. Transmission in both directions, either one direction at a time (half-duplex) or both directions simultaneously (full-duplex).

E

eject. To remove or force out from within.

electronic mail. Correspondence in the form of messages transmitted between user terminals over a computer network.

e-mail. See *electronic mail*.

enclosure. A device, such as a desktop unit, tape cartridge autoloader, or tape library, into which you can install an Ultrium Tape Drive.

error log. Maintained by an Ultrium Tape Drive, a list that contains the ten most recent error codes. The codes identify errors that pertain to the drive.

F

Fibre Channel. A 100-MB-per-second, full-duplex, serial communications technology that is capable of interconnecting Ultrium Tape Drives and servers which are separated by as much as 11 kilometers (7 miles). Fibre Channel technology combines features of the input/output (I/O) and networking interfaces.

Fibre Channel cable. The cable that connects a Fibre Channel tape drive to another device. The conductive element within the cable is constructed of either copper wires or optical fibers. Generally, copper wires are used for short distances (up to 30 meters or 98 feet); optical fibers are used for longer distances. Fiber-optic cabling is referred to by mode or the frequencies of light waves that are carried by a particular cable type. Multimode fiber cables are generally used for distances up to 500 meters (1640 feet) and with short-wave (780 nanometer) laser light. Single-mode fiber cables are used for distances greater than 500 m (1640 feet) and with long-wave (1300 nanometer) laser light.

file. A named set of records that are stored or processed as a unit.

filemark. Located on the magnetic tape within a tape cartridge, a recorded element that typically marks the organizational boundaries in a serial file structure (such as directory boundaries) and that is requested to be written or read by the server.

firmware. Proprietary code that is usually delivered as part of an operating system. Firmware is more efficient than software that is loaded from an alterable medium, and is more adaptable to change than pure hardware circuitry. An example of firmware is the Basic Input/Output System (BIOS) in read-only memory (ROM) on a PC motherboard.

G

Gb. See *gigabit*.

GB. See *gigabyte*.

gigabit (Gb). 1 000 000 000 bits.

gigabyte (GB). 1 000 000 000 bytes.

H

hard addressing. Pertaining to the Fibre Channel drives (Models T200F and T400F), a method that identifies the drive's LID and, consequently, its AL_PA (the AL_PA enables the drive to communicate with other devices).

hardware. The physical equipment or devices that form a computer.

head. See *drive head*.

host. The controlling or highest-level system in a data communication configuration. Synonymous with *server*.

I

IBM Ultrium Internal Tape Drive Models T200 and T200F. A data-storage device that controls the movement of the magnetic tape in an IBM LTO Ultrium Tape Cartridge. The drive houses the mechanism (drive head) that reads and writes data to the tape. Its native data capacity is 100 GB per cartridge and up to 200 GB at 2:1 compression. Its native data transfer rate is 15 MB per second and 30 MB per second at 2:1 compression.

IBM TotalStorage LTO Ultrium 2 Tape Drive Models T400 and T400F. A data-storage device that controls the movement of the magnetic tape in an IBM LTO Ultrium Tape Cartridge. The drive houses the mechanism (drive head) that reads and writes data to the tape. Its native data capacity is 200 GB per

cartridge and up to 400 GB at 2:1 compression. Its native data transfer rate is 35 MB per second and 70 MB per second at 2:1 compression.

ID. Identifier.

initiator. In SCSI terms, a SCSI device that requests an I/O process to be performed by another SCSI device (a target). In many cases, an initiator can also be a target.

input/output (I/O). Data that is provided to a computer or data that results from computer processing.

install. (1) To set up for use or service. (2) The act of adding a product, feature, or function to a server or device either by a singular change or by the addition of multiple components or devices.

Internet. The worldwide collection of interconnected networks that use the Internet suite of protocols and permit public access.

I/O. See *input/output*.

J

jumper. (1) A tiny connector that fits over a pair of protruding pins in a connector. A jumper can be moved to change electrical connectors. When in place, the jumper connects the pins electrically. (2) To place a jumper on a connector pin.

L

Linear Tape-Open (LTO). A type of tape storage technology developed by the IBM Corporation, Hewlett-Packard, and Seagate. LTO technology is an "open format" technology, which means that its users have multiple sources of product and media. The "open" nature of LTO technology enables compatibility between different vendors' offerings by ensuring that vendors comply with verification standards.

load. Following the insertion of a tape cartridge into the tape load compartment, the act of positioning the tape (performed by the tape drive) for reading or writing by the drive's head.

load and unload cycle. The act of inserting a cartridge into a tape drive, loading the tape to load point, rewinding the tape into the cartridge, and ejecting the cartridge from the drive.

log sense data. See *SCSI log sense data*.

Low Voltage Differential (LVD). A low-noise, low-power, and low-amplitude electrical signaling system that enables data communication between a supported server and the Ultrium Tape Drive. LVD signaling uses two wires to drive one signal over copper wire. The use of wire pairs reduces electrical noise and crosstalk.

LTO. See *Linear Tape-Open*.

LTO cartridge memory (LTO-CM). Within each LTO Ultrium Data Cartridge, an embedded electronics and interface module that can store and retrieve a cartridge's historical usage and other information.

LTO-CM. See *LTO cartridge memory*.

LTO-DC. See *LTO Data Compression*.

LTO Data Compression (LTO-DC). A method that compresses a server's data before the drive writes it to tape. LTO-DC detects but does not recompress or test record boundaries and file markers (which are encoded as control symbols). It also allows switching between compression and no compression within the data stream, which prevents data from expanding when the drive compresses random or encrypted data.

LVD. See *Low Voltage Differential*.

M

magnetic tape. A tape with a magnetizable surface layer on which data can be stored by magnetic recording.

MB. See *megabyte*.

media. The plural of *medium*.

media capacity. See *capacity*.

medium. A physical material in or on which data may be represented, such as magnetic tape.

megabyte (MB). 1 000 000 bytes.

micrometer. One millionth of a meter (.000001 m). Synonymous with *micron*. Abbreviated as µm.

micron. One millionth of a meter (.000001 m). Synonymous with *micrometer*. Abbreviated as µm.

microsecond. One millionth of a second (.000001 s). Abbreviated as µs.

millimeter (mm). One thousandth of a meter (.001 m).

millisecond (ms). One thousandth of a second (.001 s).

mm. See *millimeter*.

ms. See *millisecond*.

Model T200. The version of the IBM Ultrium Internal Tape Drive that uses the SCSI interface, has a native storage capacity of 100 GB, and a native data transfer rate of 15 MB per second.

Model T200F. The version of the IBM Ultrium Internal Tape Drive that uses the Fibre Channel interface, has a

native storage capacity of 100 GB, and a native data transfer rate of 15 MB per second.

Model T400. The version of the IBM TotalStorage LTO Ultrium 2 Tape Drive that uses the SCSI interface, has a native storage capacity of 200 GB, and a native data transfer rate of 35 MB per second.

Model T400F. The version of the IBM TotalStorage LTO Ultrium 2 Tape Drive that uses the Fibre Channel interface, has a native storage capacity of 200 GB, and a native data transfer rate of 35 MB per second.

N

N/A. Not applicable.

native storage capacity. The amount of data that can be stored without compression on a tape cartridge.

native sustained data transfer rate. See *data transfer rate*.

network. A configuration of data processing devices and software that is connected for information interchange.

network server. In a local area network, a personal computer that provides access to files for all of the workstations in the network.

node. In Fibre Channel technology, a communicating device.

ntutil. Created by IBM, a utility program for LTO devices that connect to Windows NT and Windows 2000. *ntutil* provides problem determination for hardware or connections, assists with device and medium changer recognition, forces dumps, loads new firmware, sends and receives SCSI commands to and from the hardware, and obtains SCSI sense data to use in resolving errors.

O

offline. The operating condition that the Ultrium Tape Drives are in when the server's applications cannot interact with it.

online. The operating condition that the Ultrium Tape Drives are in when the server's applications can interact with it.

Open Systems. Computer systems whose standards are not proprietary.

operating system. The master computer control program that translates the user's commands and allows software application programs to interact with the computer's hardware.

P

parity. The state of being even-numbered or odd-numbered. A parity bit is a binary number that is added to a group of binary numbers to make the sum of that group always odd (odd parity) or even (even parity).

parity error. A transmission error that occurs when the received data does not have the parity that is expected by the receiving system. This usually occurs when the sending and receiving systems have different parity settings.

port. (1) A system or network access point for data entry or exit. (2) A connector on a device to which cables for other devices such as display stations and printers are attached. (3) The representation of a physical connection to hardware. A port is sometimes referred to as an adapter; however, there can be more than one port on an adapter.

power-off. To remove electrical power from a device.

power-on, powered-on. (1) To apply electrical power to a device. (2) The state of a device when power has been applied to it.

protocol. The meanings of, and the sequencing rules for, requests and responses that are used to manage a network, transfer data, and synchronize the states of network components.

Q

quiesce. To put a device into a temporarily inactive or inhibited state, but not remove it from the server.

R

read. To acquire or interpret data from a storage device, from a data medium, or from another source.

reboot. To reinitialize the execution of a program by repeating the initial program load (IPL) operation.

record. The smallest distinct set of data bytes that is supplied from a server for processing and recording by a tape drive, and the smallest distinct set of data to be read from tape, reprocessed, and made available to a server by a tape drive.

record boundaries. The fixed limits of a record.

repeater. A device that regenerates signals to extend the range of transmission between data stations or to interconnect two branches. A repeater is a node of a local area network.

reset. To return a device or circuit to a clear state.

RS-422 connector. Located at the rear of the Ultrium Tape Drive, the connector to which the internal RS-422

cable of an enclosure connects. The connection enables serial devices to communicate with the drive.

RS-422 interface. An electrical interface standard that is approved by the Electronic Industries Association (EIA) for connecting serial devices. The RS-422 standard, which supports higher data rates and greater immunity to electrical interference, is an alternative to the older RS-232 interface, and uses individual differential signal pairs for data transmission. Depending on data transmission rates, RS-422 can be used at distances up to 1,275 m (4,000 ft). The RS-422 interface also supports multi-point connections.

S

s. See *second*.

SAN. See *Storage Area Network*.

SAN Data Gateway. A device that provides Fibre Channel attachment between Open Systems servers and SCSI disk and tape storage systems.

SC. See *subscription channel connector*.

SCSI. See *Small Computer Systems Interface*.

SCSI bus. (1) A collection of wires through which data is transmitted from one part of a computer to another. (2) A generic term that refers to the complete set of signals that define the activity of the Small Computer Systems Interface (SCSI).

SCSI connector. Located at the rear of the Ultrium Tape Drive, the connector that facilitates commands to and from the server, and to which the internal SCSI cable of an enclosure connects.

SCSI device. Anything that can connect into the SCSI bus and actively participate in bus activity.

SCSI drive sense data. In response to inquiry from the server about an error condition, a packet of SCSI sense bytes that contains information about the error and that is sent back to the server by the drive.

SCSI ID. The unique address (from 1 to 15) that you assign to an Ultrium Tape Drive that uses a SCSI interface.

SCSI ID connector. Located at the rear of the Ultrium Tape Drive, the connector that enables the drive's SCSI address to be set. Addresses are determined by the placement of jumpers on the pins.

SCSI ID switch. Located on an enclosure that contains a Ultrium Tape Drive, a mechanism that connects to the drive and allows you to change the drive's SCSI ID without using jumpers.

SCSI log sense data. In response to inquiry from the server about the Ultrium Tape Drive's error logs and counters, a packet of SCSI sense bytes which contains that information and which is sent back to the server by the drive. Log sense data is used to diagnose problems, especially if the problems are intermittent.

second. One sixtieth of a minute.

selection timeout. Following the selection of an option (for example, a data transfer), the period of time during which it is determined that there is a bad connection between the server and the drive.

sense data. Data that describes an I/O error. Sense data is presented to a server in response to a Sense I/O command.

serial interface. An interface that sequentially or consecutively executes two or more operations in a single device, such as an arithmetic and logic operation.

server. A functional unit that provides services to one or more clients over a network. Examples include a file server, a print server, or a mail server. The IBM @server pSeries, IBM @server iSeries, HP, and Sun are servers. Synonymous with *host*.

short-wave cable. In Fibre Channel technology, a laser cable that uses a wavelength of 780 nanometers and is only compatible with multimode fiber.

Small Computer Systems Interface (SCSI). A standard used by computer manufacturers for attaching peripheral devices (such as tape drives, hard disks, CD-ROM players, printers, and scanners) to computers (servers). Pronounced ″scuzzy.″ Variations of the SCSI interface provide for faster data transmission rates than standard serial and parallel ports (up to 160 megabytes per second). The variations include:

- Fast/Wide SCSI: Uses a 16-bit bus, and supports data rates of up to 20 MBps.
- SCSI-1: Uses an 8-bit bus, and supports data rates of 4 MBps.
- SCSI-2: Same as SCSI-1, but uses a 50-pin connector instead of a 25-pin connector, and supports multiple devices.
- Ultra SCSI: Uses an 8- or 16-bit bus, and supports data rates of 20 or 40 MBps.
- Ultra2 SCSI: Uses an 8- or 16-bit bus and supports data rates of 40 or 80 MBps.
- Ultra3 SCSI: Uses a 16-bit bus and supports data rates of 80 or 160 MBps.
- Ultra160 SCSI: Uses a 16-bit bus and supports data rates of 160 MBps.

soft addressing. Pertaining to the Fibre Channel drive, a method that enables the drive to dynamically arbitrate its AL_PA with other Fibre Channel devices on the loop. The AL_PA enables the drive to communicate with other devices.

software. Programs, procedures, rules, and any associated documentation pertaining to the operation of a computer system.

Storage Area Network (SAN). A high-speed subnetwork of shared storage devices. A SAN's architecture makes all storage devices available to all servers on a LAN or WAN. As more storage devices are added to a SAN, they too will be accessible from any server in the larger network. Because stored data does not reside directly on any of a network's servers, server power is used for business applications, and network capacity is released to the end user.

subscription channel connector (SC). A push-pull type of optical connector that features high density, low loss, low backreflection, and low cost.

switch. A network infrastructure component to which multiple nodes attach. Unlike hubs, switches typically have the ability to switch node connections from one to another. A typical switch can facilitate several simultaneous bandwidth transmissions between different pairs of nodes.

T

TapeAlert. A patented technology and ANSI standard that defines conditions and problems that are experienced by tape drives.

TapeAlert flags. Status and error messages that are generated by the TapeAlert utility and display on the server's console.

tape cartridge. A removable storage case that houses belt-driven magnetic tape that is wound on a supply reel and a takeup reel.

tape drive. See *IBM Ultrium Internal Tape Drive Models T200 and T200F* or *IBM TotalStorage LTO Ultrium 2 Tape Drive Models T400 and T400F*.

tape path. Within a tape drive, the channel in which the media moves.

tapeutil. Created by IBM, a utility program for LTO devices that connect to all supported servers except Windows NT and Windows 2000. *tapeutil* provides service aids for tape subsystems, offers a menu-driven tool for exercising or testing IBM tape and medium changer devices, and includes a command-line interface that is convenient for use in shell scripts.

terminate. To prevent unwanted electrical signal reflections by applying a device (known as a terminator) that absorbs the energy from the transmission line.

topology. In communications, the physical or logical arrangement of nodes in a network, especially the relationships among nodes and the links between them.

TotalStorage LTO Ultrium Tape Drive Models T400 and T400F. See *IBM TotalStorage LTO Ultrium 2 Tape Drive Models T400 and T400F*.

transfer rate. See *data transfer rate*.

U

Ultrium Tape Drive. See *IBM Ultrium Internal Tape Drive Models T200 and T200F* or *IBM TotalStorage LTO Ultrium 2 Tape Drive Models T400 and T400F*.

Ultrium 2 Tape Drive. See *IBM TotalStorage LTO Ultrium 2 Tape Drive*.

uniform resource locator (URL). The address of an item on the World Wide Web. It includes the protocol followed by the fully qualified domain name (sometimes called the host name) and the request. The web server typically maps the request portion of the URL to a path and file name. For example, if the URL is `http://www.networking.ibm.com/nsg/nsgmain.htm`, the protocol is `http`; the fully qualified domain name is `www.networking.ibm.com`; and the request is `/nsg/nsgmain.htm`.

unload. The act (performed by the drive) of unthreading tape from the drive's internal tape path and returning it (with the leader block) to the tape cartridge.

URL. See *uniform resource locator*.

utility. See *utility program*.

utility program. A computer program that supports computer processes. For example, a diagnostic program, a trace program, or a sort program.

V

vital product data (VPD). Information about a product. Among other details, the VPD may include a model number, serial number, part number, or level of firmware.

W

web. See *World Wide Web*.

World Wide Name. A unique, 8-byte identifier that is assigned by IBM Manufacturing to each Ultrium Tape Drive and used to identify a drive.

World Wide Web. A network of servers that contain programs and files. Many of the files contain hypertext links to other documents that are available through the network.

write. To make a permanent or transient recording of data in a storage device or on a data medium.

write protected. Applicable to a tape cartridge, the condition that exists when some logical or physical mechanism prevents a device from writing on the tape in that cartridge.

Index

A

abort condition, handling 136
AS/400
  device driver support 4
  requirements for attaching tape drive to 3
attaching tape drive to server 3
Attribute List service action, format 67
Attribute Values service action, format 66

B

burst data transfer rate 2
bus parity errors, handling 139

C

capacity 2, 5
commands, supported SCSI 11
compatible tape cartridges 5
compressed capacity 2
Current Sense data 129

D

Data Compression Log 39
Data Compression Mode Page 47
data transfer rate 2
Deferred Sense data 129
description of tape drives 1
device drivers, supported 4
Device Identification Page 20
disconnect strategy 139
Disconnect/Reconnect Page 46
Drive Component Revision Level Pages 22

E

ERASE command 11, 13
error log buffer 84
error sense information 129
errors
  bus parity 139
  persistent 130
extended messages 142

F

Fibre Channel attachment
  abort condition, handling 135, 136
  features of interface 143
  LUN behaviors 135
  multi-initiator support 135, 138
  power-on procedure 135
  requirements 3
  reset strategy 135
  status codes 135, 138
Fibre Channel interface 1
Fibre Channel Logical Unit Control Page 50
Fibre Channel Port Control Page 51
Fibre Channel World Wide Name buffer 85
Force Dump diagnostic 112

H

Hewlett-Packard
  device driver support 4
  requirements for attaching tape drive to 3
high voltage differential (HVD) SCSI interface 1, 2
HP
  device driver support 4
  requirements for attaching tape drive to 3
HVD interface 1, 2

I

Information Exceptions Mode Page 52
INQUIRY command 11, 14
Intel-compatible servers
  device driver support 4
  requirements for attaching tape drive to 3
interface
  HVD 1, 2
  LVD 1, 2
  type of drive 1
interface attachment 135
iSeries server
  device driver support 4
  requirements for attaching tape drive to 3

L

LC-duplex 2
Linux
  device driver support 4
  requirements for attaching tape drive to 3
LOAD/UNLOAD command 11, 23
LOCATE command 11, 24
Log Page format 27
Log Pages, supported 28
LOG SELECT command 11, 25
LOG SENSE command 11, 26
low voltage differential (LVD) SCSI interface 1, 2
LUN identification 139
LVD interface 1, 2

M

MAM
  description 70
  format 72
Medium Auxiliary Memory (MAM)
  description 70
  format 72

© Copyright IBM Corp. 2002

message in 141
message out 140
messages 140, 141, 142
MIM data structure 105
Mode Block Descriptor 44
Mode data format 42
Mode Parameter Header 43
MODE SELECT (10) command 11, 40
MODE SELECT (6) command 11, 40
MODE SENSE (10) command 11, 41
MODE SENSE (6) command 11, 41
multi-initiator support 135, 138

N

native storage capacity 2
native sustained data transfer rate 2

O

operating systems, supported 3

P

Partition List service action, format 69
persistent errors 130
PERSISTENT RESERVE IN command 11, 54
PERSISTENT RESERVE OUT command 11, 57
Post A self test diagnostic 108
Post B tape test diagnostic 109
Post C media test diagnostic 110
Post D head test diagnostic 111
power-on procedure 135
PREVENT/ALLOW MEDIUM REMOVAL command 11, 61
pSeries server
  device driver support 4
  requirements for attaching tape drive to 3

R

READ ATTRIBUTE command 11, 64
READ BLOCK LIMITS command 11, 79
READ BUFFER command 11, 80
READ command 11, 62
Read Error Counters log 30
READ POSITION command 11, 86
Read-Write Error Recovery Page 45
read/write capability 5
RECEIVE DIAGNOSTIC RESULTS command 11, 88
RELEASE UNIT (10) command 11, 89
RELEASE UNIT (6) command 11, 89
Remove Traps diagnostic 116
REPORT DENSITY SUPPORT command 11, 90
REPORT LUNs command 12, 94
REQUEST SENSE command 12, 96
requirements for attaching tape drive to server 3
RESERVE UNIT (10) command 12, 99
RESERVE UNIT (6) command 12, 99
Reset Drive diagnostic 118
reset strategy 135
REWIND command 12, 100
RS-422 interface 2
RS/6000
  device driver support 4
  requirements for attaching tape drive to 3
RS/6000 SP
  device driver support 4
  requirements for attaching tape drive to 3

S

SAN connection 2
SC-duplex 2
SCSI attachment
  abort condition, handling 135, 136
  features of interface 139
  LUN behaviors 135
  multi-initiator support 135, 138
  power-on procedure 135
  requirements 3
  reset strategy 135
  status codes 135, 138
SCSI interface 1
SCSI log buffer 85
Self-Test diagnostic 107
SEND DIAGNOSTIC command 12, 101
Sense data
  description 97
  types of and management 129
Sense keys and additional Sense 131
Sequential Access Device Configuration Page 49
Sequential Access Device Log Page 31
servers, supported 3
SET CAPACITY command 12, 119
Set Traps diagnostic 115
SIM data structure 102
SPACE command 12, 121
Standard Inquiry Data Invalid LUN 17
Standard Inquiry Data Valid LUN 15
status codes 135, 138
Storage Area Network (SAN) connection 2
storage capacity 2
Sun Microsystems
  device driver support 4
  requirements for attaching tape drive to 3
supported device drivers 4
supported Log Pages 28
supported SAN components 3
supported SCSI commands 11
supported servers and operating systems 3
supported tape cartridges 5
Supported Vital Product Data Page 19

T

Tape Capacity Log 38
tape cartridge
  capacity 5
  compatible cartridges 5

tape drives
description 1
type of interface 1
Tape Usage Log 38
TapeAlert Log 32
TEST UNIT READY command 12, 123
transfer rate 2
Tru64
device driver support 4

U

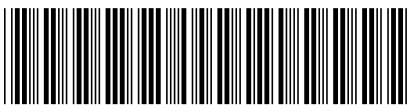
Ultra 160 LVD SCSI interface 2
Unit Attention Conditions 129
Unit Attention Sense data 129
Unit Serial Number Page 19

V

VERIFY command 12, 123
viewing latest supported attachments 4
Volume List service action, format 68

W

Windows 2000
device driver support 4
requirements for attaching tape drive to 3
Windows NT
device driver support 4
requirements for attaching tape drive to 3
WRITE ATTRIBUTE command 12, 125
WRITE BUFFER command 12, 126
WRITE command 12, 124
Write Dump to Cartridge diagnostic 113
Write Error Counters log 29
WRITE FILE MARKS command 12, 128

Printed in U.S.A.

GA32-0450-00