Ultrium Internal Tape Drive
Models T200 and T200F
and 3580 Ultrium Tape Drive

SCSI Reference

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> **Note**
>
> Before using this information and the product it supports, be sure to read the general information under "Appendix. Notices" on page 103.

Fifth Edition (October 2001)

This edition applies to the *IBM® Ultrium™ Internal Tape Drive Models T200 and T200F and 3580 Ultrium Tape Drive SCSI Reference* and to all subsequent releases and modifications unless otherwise indicated in new editions. This edition replaces WB1109-01.1.

Contents

Tables

Preface

This publication contains information about how to use and program the IBM Ultrium Internal Tape Drive Models T200 and T200F and the IBM 3580 Ultrium Tape Drive.

Organization

The information in this book is organized as follows:

- "Chapter 1. Introduction" on page 1 describes the tape drives.
- "Chapter 2. Command Support" on page 5 lists the SCSI commands that are supported by the tape drives.
- "Chapter 3. Error Sense Information" on page 87 describes the error sense information for the tape drives.
- "Chapter 4. Sense Keys and Additional Sense" on page 89 describes the sense keys and additional sense information for the tape drives.
- "Chapter 5. Attachment Features" on page 93 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 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*, WB1304, 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 Changes (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.
- *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`.
- *Proposed Addition of Read and Write Attribute Commands to SPC-2*, 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`.

Chapter 1. Introduction

The IBM Ultrium Internal Tape Drive Models T200 and T200F and the IBM 3580 Ultrium Tape Drive are high-performance, high-capacity data-storage devices that connect to and provide additional storage for supported servers.

The Model T200 uses a Small Computer Systems Interface (SCSI) and the Model T200F uses a Fibre Channel interface.

The 3580 Ultrium Tape Drive contains the Ultrium Tape Drive Model T200 (the SCSI drive).

Figure 1 shows the IBM 3580 Ultrium Tape Drive.
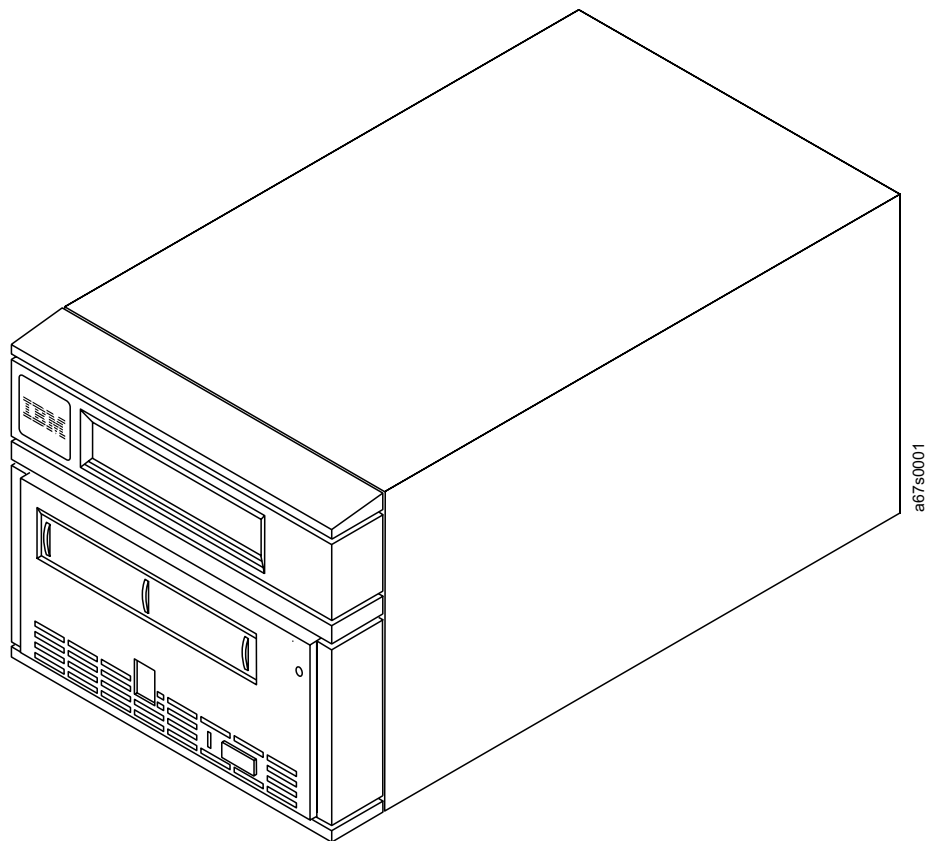
Figure 1. The IBM 3580 Ultrium Tape Drive

Designed to perform unattended backups as well as to retrieve and archive files, the Ultrium Internal Tape Drives feature:

- Native storage capacity of 100 GB per cartridge (200 GB at 2:1 compression)[1]
- Native sustained data transfer rate of 15 MB per second (30 MB at 2:1 compression)[2]
- RS-422 interface for enhanced performance in automated tape libraries.

The Ultrium Internal Tape Drive Model T200 uses an Ultra2 SCSI Low Voltage Differential/Single Ended (LVD/SE) interface. It features a burst data transfer rate of 80 MB per second.

The Ultrium Internal Tape Drive Model T200F uses a Fibre Channel interface with a SC-Duplex, multimode optical connector and SCSI protocol. It features a burst data transfer rate of 100 MB per second and can attach to Storage Area Network (SAN) components.

The 3580 Ultrium Tape Drive is available in two models. The models vary according to the type of SCSI interface that each uses to communicate with the server:

- Model L11 uses the Ultra2, Low Voltage Differential/Single Ended (LVD/SE) interface. It has a burst data transfer rate of 80 MB per second.
- Model H11 uses the Ultra, High Voltage Differential (HVD) interface. It has a burst data transfer rate of 40 MB per second.

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1. 1 GB = one gigabyte or 1 000 000 000 bytes

2. 1 MB = one megabyte or 1 000 000 bytes

Supported Servers and Operating Systems

The IBM Ultrium Internal Tape Drive Models T200 and T200F and the IBM 3580 Ultrium Tape Drive 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:

- For the Ultrium Tape Drive Models T200 and T200F, visit the Web at `http://www.ibm.com/storage/storagesmart/lto`
- For the 3580 Ultrium Tape Drive, visit the Web at `http://www.ibm.com/storage/lto`

Attachments to the drives include (but are not limited to) the servers and operating systems in the following sections.

SCSI Attachment

The Ultrium Tape Drive Model T200 and the 3580 Ultrium Tape Drive use a SCSI interface and attach to the following servers. For specific instructions about attachment, see the *IBM Ultrium Device Drivers Installation and User's Guide*.

Server	Operating System
IBM AS/400® or IBM eserver iSeries™	IBM OS/400® Level V4R4 or later
IBM RS/6000®, IBM RS/6000 SP™, or IBM eserver pSeries™	IBM AIX® 4.3.3 or 5.1
Hewlett-Packard	HP-UX 11.0 PCI 64-bit or HP-UX 11i
SUN®	Solaris Version 2.6, 7, or 8
Intel-compatible servers	Microsoft® Windows® 2000 Level 2195 or later, or Windows NT® Server Version 4 with Service Pack 6 or later
	Red Hat® Linux® 7.1 kernel 2.4.2-2

Fibre Channel Attachment

The Ultrium Tape Drive Model T200F uses a Fibre Channel interface and attaches to the following servers. For specific instructions about attachment, see the *IBM Ultrium Device Drivers Installation and User's Guide*. For more information, visit the Web at `http://www.storage.ibm.com/hardsoft/products/sangateway/supserver.htm`.

Server	Operating System
IBM AS/400 or IBM eserver iSeries	IBM OS/400 Level V5R1 or later
IBM RS/6000, IBM RS/6000 SP, or IBM eserver pSeries	IBM AIX 4.3.3 with APARs IY10452 and IY15766, or AIX 5.1
Hewlett-Packard	HP-UX 11.0
SUN	Solaris Version 2.6, 7, or 8
Intel-compatible servers	Microsoft Windows 2000 Level 2195 or later, or Windows NT Server Version 4 with Service Pack 6a or later
Supported SAN Components	
IBM 2103 Fibre Channel hub (distance solution, only one target per hub	
IBM 2109 Fibre Channel switches	

Supported Device Drivers

IBM maintains the latest levels of device drivers and driver documentation for the 3580 Ultrium Tape Drive on the Internet. You can access this material from your browser or through the IBM FTP site by doing the following:

Note: If you do not have Internet access and you need information about device drivers, contact your IBM 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 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 for each supported server are beneath /storage/devdrvr/ in the following directories (the device driver for the eserver iSeries or AS/400 server is included in the OS/400 operating system):

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

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

Chapter 2. Command Support

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 1. Supported Common Commands

Command Name	Operation Code	SCSI Class[1]	SCSI Spec[2]	Page	Applicable Conditions[3]					
					RVC	UAT	NRD	WRP	MFC	DCC
ERASE	19h	M	SSC	6	y	y	y	y	y	y
INQUIRY	12h	M	SPC-2	7	-	-	-	-	-	-
LOAD/UNLOAD	1Bh	O	SSC	14	y	y	-	-	y	y
LOCATE	2Bh	O	SSC	15	y	y	y	-	y	y
LOG SELECT	4Ch	O	SPC-2	16	y	y	-	-	-	y
LOG SENSE	4Dh	O	SPC-2	17	y	-	-	-	-	-
MODE SELECT (6)	15h	M	SPC-2	26	y	y	-	-	-	y
MODE SELECT (10)	55h	O	SPC-2	26	y	y	-	-	-	y
MODE SENSE (6)	1Ah	M	SPC-2	27	y	y	-	-	-	-
MODE SENSE (10)	5Ah	O	SPC-2	27	y	y	-	-	-	-
PERSISTENT RESERVE IN	5Eh	O	SPC-2	36	y	y	-	-	-	-
PERSISTENT RESERVE OUT	5Fh	O	SPC-2	39	y[4]	y	-	-	-	-
PREVENT ALLOW MEDIUM REMOVAL	1Eh	O	SPC-2	41	y	y	-	-	-	-
READ	08h	M	SSC	42	y	y	y	-	y	y
READ ATTRIBUTE	8Ch	O	SPC-3	43	y	y	y	-	-	y
READ BLOCK LIMITS	05h	M	SSC	48	y	y	-	-	-	-
READ BUFFER	3Ch	O	SPC-2	49	y	-	-	-	-	-
READ POSITION	34h	M	SSC	52	y	y	-	-	-	-
RECEIVE DIAGNOSTIC RESULTS	1Ch	O	SPC-2	53	y	y	-	-	-	-
RELEASE UNIT (6)	17h	M	SPC-2	54	-	y	-	-	-	-
RELEASE UNIT (10)	57h	M	SPC-2	54	-	y	-	-	-	-
REPORT DENSITY SUPPORT	44h	M	SSC	55	y	y	-	-	-	-
REPORT LUNs	A0h	M	SSC	58	-	-	-	-	-	-
REQUEST SENSE	03h	M	SPC-2	59	-	-	-	-	-	-
RESERVE UNIT (6)	16h	M	SPC-2	63	y	y	-	-	-	-
RESERVE UNIT (10)	56h	M	SPC-2	63	y	y	-	-	-	-
REWIND	01h	M	SSC	64	y	y	y	-	y	y
SEND DIAGNOSTIC	1Dh	M	SPC-2	65	y	y	y	-	y	y
SPACE	11h	M	SSC	81	y	y	y	-	y	y
TEST UNIT READY	00h	M	SSC	82	y	y	y	-	-	y
VERIFY	13h	O	SSC	82	y	y	y	-	y	y
WRITE	0Ah	M	SSC	83	y	y	y	y	y	y

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Table 1. Supported Common Commands (continued)

Command Name	Operation Code	SCSI Class[1]	SCSI Spec[2]	Page	Applicable Conditions[3]					
					RVC	UAT	NRD	WRP	MFC	DCC
WRITE ATTRIBUTE	8Dh	O	SPC-3	84	y	y	y	y	-	y
WRITE BUFFER	3Bh	O	SPC-2	83	y	y	-	-	-	-
WRITE FILE MARKS	10h	M	SSC	86	y	y	y	y	y	y

Note 1: O=optional M=mandatory

Note 2: SCSI specifications are as follows:
• SSC = *SCSI-3 Stream Commands (SSC)*
• SPC = *SCSI Primary Commands-2 (SPC-2)*

Note 3: Applicable Conditions are as follows:
• RVC = reservation conflict
• UAT = unit attention
• NRD = not ready
• WRP = write protect
• MFC = medium format corrupted
• DCC = deferred check condition

Note 4: Reported as appropriate for the type of Service Action and Reservation Type requested and the current reservation state of the drive.

ERASE

Table 2. ERASE Command

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

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

If the Immediate (Immed) flag 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) flag 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

Table 3. INQUIRY Command

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

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

If the Enable Vital Product Data (EVPD) flag is clear and the Page Code is 0, standard Inquiry Data is returned.

If the Enable Vital Product Data (EVPD) flag is set and the Page Code is 0, the Supported Vital Product Data Pages page is returned.

If the Enable Vital Product Data (EVPD) flag 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 4. Standard Inquiry Data Valid LUN

	7	6	5	4	3	2	1	0
0	Peripheral Qualifier (000b)			Peripheral Device Type (01h)				
1	RMB(1)	Device-type modifier (0)						
2	ISO version (0)		ECMA version (0)			Version (3)		
3	AENC(0)	Obsolete	NACA(0)	HiSup(0)	Response Data Format (2)			
4	Additional length (33)							
5	Reserved							
6	BQue(0)	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	Vendor Identification							
15								
16	Product Identification							
31								
32	Product Revision Level: YMDV							
35								
36	Reserved							AutDis
37	Reserved							

Values for the Adr16 bit are 1 (for SCSI) or 0 (for Fibre Channel).

Values for the WBs16 bit are 1 (for SCSI) or 0 (for Fibre Channel).

Values for the Sync bit are 1 (for SCSI) or 0 (for Fibre Channel).

The AutDis or Automation Disabled bit indicates that this drive is not capable of full automation function.

The Standard Inquiry Data is based on the SCSI-3 standard for Standard Inquiry Data.

The Vendor Identification returns `IBM` in ASCII with trailing blanks.

The Product Identification returns `ULT3580-TD1` in ASCII with trailing blanks. `TD` stands for tape drive and `1` stands for Generation 1 of this product family.

The Product Revision Level has four values: `Y` represents year, `M` represents month, `D` represents day, and `V` is a suffix. For `V`, values of `0` through `9` and A through Z are valid; a value of `0` is designated as earliest or least significant, and Z is designated as most significant.

Standard Inquiry Data Invalid LUN

Table 5. Standard Inquiry Data Invalid LUN

	7	6	5	4	3	2	1	0
0	Peripheral Qualifier (011b)			Peripheral Device Type (1Fh)				
1	RMB(0)	Device-type modifier (0)						
2	ISO version (0)		ECMA version (0)			Version (3)		
3	AENC(0)	Obsolete	NACA(0)	HiSup(0)	Response Data Format (2)			
4	Additional length (21)							
5	Reserved							
6	BQue(0)	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	Vendor Identification							
15								
16	Product Identification							
31								
32	Product Revision Level: YMDV							
35								

Values for the Adr16 bit are 1 (for SCSI) or 0 (for Fibre Channel).

Values for the WBs16 bit are 1 (for SCSI) or 0 (for Fibre Channel).

Values for the Sync bit are 1 (for SCSI) or 0 (for Fibre Channel).

The Vendor Identification returns IBM in ASCII with trailing blanks. Product Identification and Product Revision Level are set to vendor-specific strings.

The Vendor Identification returns IBM in ASCII with trailing blanks.

The Product Identification returns ULT3580-TD1 in ASCII with trailing blanks.

The Product Revision Level has four values: Y represents year, M represents month, D represents day, and V is a suffix. For V, values of 0 through 9 and A through Z are valid; a value of 0 is designated as earliest or least significant, and Z is designated as most significant.

Supported Vital Product Data Page

Table 6. Supported Vital Product Data Inquiry Page

	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 Pages are Page 0h, 80h, 83h, C0h, and D0h.

Unit Serial Number Page

Table 7. Unit Serial Number Inquiry Page

	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	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 8. Device Identification Inquiry Page

	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 Descriptors							

The device Identification Descriptor Page contains a series of device Identification Descriptors that uniquely identify the particular device. The format of each is given in Table 9.

Table 9. Identifier Descriptor Format

	7	6	5	4	3	2	1	0
0	Reserved				Code Set (2h)			
1	Reserved				Identifier Type			
2	Reserved							
3	Identifier Length (n-3)							
4 : n	Identification Descriptor							

The device Identification Descriptor is returned by both the Parallel SCSI- and Fibre-Channel-attached devices.

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

This device supports Identifier Type of 1. In this case, the Identification Descriptor is the Vendor ID followed by the Product Identification field from the standard inquiry data and the Serial Number field from the Serial Number Inquiry Page (see "Unit Serial Number Page" on page 10).

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 10.

Table 10. Fibre Channel Identification Descriptor

	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	Name Format (0101b)				OUI Format Identifier			
5 : 6	OUI Format Identifier (continued)							
7	OUI Format Identifier (continued)				Vendor-specific Identifier			
8	Vendor-specific Identifier (continued)							
9	Port/Node ID (0)		Serial Number					
10 : 11	Serial Number (continued)							

Drive Component Revision Levels Pages

Table 11. Drive Component Revision Levels Pages

		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 12. LOAD/UNLOAD Command

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

If the Load flag is set and there is a tape in the drive, it is positioned to BOM. If the Load flag is set 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 flag is clear, 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 flag is clear, 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 flag is clear 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 flag is clear 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) flag 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) flag is set to 0, status is not returned until after the command has completed.

The End Of Tape (EOT) and Retension (Reten) flags are not supported and should be set to 0.

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.

If the Immediate (Immed) flag 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) flag is set to 0, status is not returned until after the command has completed.

Table 13. LOCATE Command

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

The Block Type (BT) and Change Partition (CP) flags are not supported and should be set to 0. The Partition field is not supported and should be set to 0.

LOG SELECT

Table 14. LOG SELECT Command

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

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.

If the Parameter Code Reset (PCR) flag is set, the Parameter List Length is 0, and the Page Control (PC) field is 01b or 11b, then all the logs on the drive that can be reset are reset to their default values.

If the Parameter Code Reset (PCR) flag is set, the Parameter List Length is 0, and the Page Control (PC) field is 00b or 10b, then no action is taken and Good status is returned.

If the Parameter Code Reset (PCR) flag is clear, the Parameter List Length is not 0, and the Page Control (PC) field is 01b or 11b, then data is sent from the server and is written to the indicated logs, provided those logs are writable.

If the preceding conditions do not apply, 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).

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

LOG SENSE

Table 15. LOG SENSE Command

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

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

If the Page Control (PC) field is 00b or 10b, the maximum value for each log entry is returned. If it is 01b, the current values are returned. If it is 11b, the power-on values for the log are returned.

The Page Code indicates the log page to return.

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

Cartridge-specific log parameter counts are cleared 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 16.

Table 16. Log Page Header Format

	7	6	5	4	3	2	1	0
0	Reserved		Page Code					
1	Reserved							
2	Page Length							
3								

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 17.

Table 17. Log Parameter Format

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

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

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

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

If the LP flag is 1 and the parameter is a binary parameter, then the List Binary (LBIN) flag 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 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 18.

Table 18. Supported Log Pages Log Page Format

	7	6	5	4	3	2	1	0
0	Reserved		Page Code (00h)					
1	Reserved							
2	Page Length (n-3)							
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 19.

Table 19. 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	Undefined		0	0	0
8001h	Undefined		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 20.

Table 20. 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	Undefined		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 21. 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

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. Only parameters 1 through 18, 20 through 23, and 29 through 39 have definitions for tape drives without attached loaders. The remaining parameters are always 0.

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

The supported parameters are listed in Table 22. For a description of service actions associated with these parameters, refer to 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 22. TapeAlert Log Parameters

Parameter	Description	Type	DU	LP	LBIN
3	Hard Error	Warning	1	0	0
4	Media	Critical	1	0	0
5	Read Failure	Critical	1	0	0
6	Write Failure	Critical	1	0	0
7	Media Life	Warning	1	0	0
8	Not Data Grade	Warning	1	0	0
9	Write Protect	Critical	1	0	0
10	No Removal	Information	1	0	0
11	Cleaning Media	Information	1	0	0
12	Unsupported Format	Information	1	0	0
15	Memory in Cartridge Failure	Warning	1	0	0
16	Forced Eject	Critical	1	0	0
18	Tape Directory Corrupted	Warning	1	0	0
19	Nearing Media Life	Information	1	0	0
20	Clean Now	Critical	1	0	0
21	Clean Periodic	Warning	1	0	0
22	Expired Cleaning Media	Critical	1	0	0
23	Invalid Cleaning Cartridge	Critical	1	0	0
30	Hardware A	Critical	1	0	0
31	Hardware B	Critical	1	0	0
32	Interface	Warning	1	0	0
33	Eject Media	Critical	1	0	0
34	Download Fault	Warning	1	0	0
35	Drive Humidity	Warning	1	0	0
36	Drive Temperature	Warning	1	0	0
37	Drive Voltage	Warning	1	0	0

Table 22. TapeAlert Log Parameters (continued)

Parameter	Description	Type	DU	LP	LBIN
38	Predictive Failure	Critical	1	0	0
39	Diagnostics Required	Warning	1	0	0

See the TapeAlert specification for more complete descriptions of the flags.

This data can be neither written nor 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 23. 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 can be neither reset nor written.

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 24.

Table 24. 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 25.

Table 25. 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

Table 26. Byte MODE SELECT Command

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

Table 27. Byte MODE SELECT Command

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

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

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 27.

The Page Format (PF) flag may be any value. However, the drive assumes that the
format is SCSI-2. The Save Pages (SP) flag must be set to 0, since 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 maximum acceptable Parameter List Length for a SCSI parallel drive is 198
bytes, and the maximum acceptable Parameter List Length for a Fibre Channel
drive is 222 bytes. 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

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

Table 28. Byte MODE SENSE Command

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

Table 29. Byte MODE SENSE Command

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

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 when the device is attached by a Fibre Channel interface. A page 3Fh request returns all supported pages.

If the Disable Block Descriptors (DBD) flag is set, then no block descriptors are returned with the mode data. If it is clear, then block descriptors are returned.

If the Page Control (PC) field is set to 00b, the current configuration is returned. If it is set to 01b, the configuration is returned with every bit that can be modified set to 1 and every bit that cannot be modified set to 0. If it is set to 10b or 11b, the power-on configuration is returned.

The Page Code should 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 30. Mode Data Format

	7	6	5	4	3	2	1	0
0 : 3	Mode Parameter Header							
4 : 11	Mode Block Descriptor							
12 : n	Mode Parameter Pages							

Mode Parameter Header

Table 31. Mode Parameter Header 6-Byte Command

	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 32. Mode Parameter Header 10-Byte Command

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

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 should be set to 0.

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

If the Buffered Mode is 0, then the drive does not report Good status on WRITE and WRITE FILE MARKS commands until the data is written to tape. If Buffered Mode is 1, then the drive reports Good status as soon as data has been transferred into the drive's data buffer. The default value is 1.

The Speed field is not used and should 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 33. Mode Block Descriptor

	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 75 on page 57 for details of supported density codes.

The Number of Blocks field is 0.

The Block Length field indicates the block length to be used in subsequent READ, WRITE, and VERIFY commands, with the Fixed bit set. (See "READ" on page 42, "VERIFY" on page 82, and "WRITE" on page 83.) The default is 1024. The block size may only be an even number. (For variable block transfers, which do not use this field, both odd and even values are supported.)

Read-Write Error Recovery Page

Table 34. Read-Write Error Recovery Page

	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							

The only supported field is Post Error (PER). A value of 1 specifies that the device server will report Check Condition status to report recovered errors.

Disconnect/Reconnect Page

Table 35. Disconnect/Reconnect Mode Page

	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	Bus Inactivity Limit (0)							
5								
6	Disconnect Time Limit (0)							
7								
8	Connect Time Limit (0)							
9								
10	Maximum Burst Size							
11								
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 should be 0, since buffer management is controlled by the drive.

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

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

Data Compression Mode Page

Table 36. Data Compression Mode Page

	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) bit 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).

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 Change Active Partition (CAP) flag and the Active Partition field should be 0, since multiple partitions are not supported.

The Change Active Format (CAF) and Active Format fields should be 0, since changing formats is not supported.

The Write Buffer Full Ratio and Read Buffer Empty Ratio fields should be 0, since 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 flags should be clear, since these features are not supported.

The Automatic Velocity Control (AVC) flag should be clear, since velocity control is managed by the drive.

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

Table 37. Sequential Access Device Configuration Page

	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	Write Delay Time							
7								
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	Buffer Size at Early Warning (0)							
:								
13								
14	Select Data Compression Algorithm							
15	Reserved							

The Block Identifiers Supported (BIS) flag should be set, since block identifiers are supported.

The Enable EOD Generation flag should be set, since EOD generation is always enabled.

The Buffer Size at Early Warning field should 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 (see "Data Compression Mode Page" on page 31), 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 38. Fibre Channel Logical Unit Control Page

	7	6	5	4	3	2	1	0
0	PS (0)	Reserved	Page Code (18h)					
1	Page Length (06h)							
2	Reserved							
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.

Fibre Channel Port Control Page

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

Table 39. Fibre Channel Port Control Page

	7	6	5	4	3	2	1	0
0	PS (0)	Reserved	Page Code (19h)					
1	Page Length (0Eh)							
2	Reserved							
3	DTFD (0)	PLPB (0)	DDIS (0)	DLM (0)	RHA (0)	ALWI (0)	DTIPE (0)	DTOLI (0)
4 : 5	Reserved f							
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)							

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)

Information Exceptions Mode Page

Table 40. Information Exceptions Mode Page

	7	6	5	4	3	2	1	0
0	PS (0)	Reserved	Page Code (1Ch)					
1	Page Length (0A)							
2	Perf (0)	Reserved			DExcept	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.

If the DExcept flag is clear, Exception Reporting is enabled. If the DExcept flag is set, Exception Reporting is disabled. The default for DExcept is 0.

If the Test flag is set, 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 flag is clear, the next command is processed normally. The default for Test is 0.

The Perf and LogErr flags must be 0. These features are not supported.

The MRIE field must be 3. If an exception occurs, the next command will get Check Condition status, the Sense Key will be set to Recovered Error, and the ASC/ASCQ will be set to Failure Prediction Threshold Exceeded (5D00).

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

PERSISTENT RESERVE IN

Table 41. PERSISTENT RESERVE IN Command

	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							

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

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 42.

Table 42. PERSISTENT RESERVE IN Parameter Data for Read Keys

	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 43.

Table 43. PERSISTENT RESERVE IN Parameter Data for Read Reservations

	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 44.

The PERSISTENT RESERVE IN Read Reservations Descriptor is defined in Table 44.

Table 44. PERSISTENT RESERVE IN Read Reservations Descriptor

		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

Table 45. PERSISTENT RESERVE OUT Command

	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							

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

Service Action may have one of the following values:

- 00000h (register a reservation key with the device server)
- 00001h (create a persistent reservation by using a reservation key)
- 00002h (release a persistent reservation)
- 00003h (clear all reservation keys and all persistent reservations)
- 00004h (preempt persistent reservations from another initiator)
- 00005h (preempt persistent reservations from another initiator and clear the task set for the preempted initiator)

Type may have one of the following values:

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

The PERSISTENT RESERVE OUT parameter list is defined in Table 46.

Table 46. PERSISTENT RESERVE OUT Parameter List

	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) is 0.

PREVENT/ALLOW MEDIUM REMOVAL

Table 47. PREVENT/ALLOW MEDIUM REMOVAL Command

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

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

If the Prevent flag 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

Table 48. READ Command

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

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

If the Fixed flag is clear 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 and the logical position is set to after the record. If the length of the block was the same as the Transfer Length field, then Good status is returned. For additional details about Suppress Illegal Length Indicator (SILI) management, see *SCSI-3 Stream Commands (SSC)*, available on the Web at `http://www.t10.org`.

If the Fixed flag is set, the Transfer Length field is not 0, and the Suppress Illegal Length Indicator (SILI) flag is clear, then a sequence of blocks of the currently configured block length is to be returned, the number of blocks being indicated in the Transfer Length field. If there is a sequence of blocks of this length on the tape, they are returned to the initiator with Good status. If a block that is longer than the configured length is encountered before the sequence is complete, the blocks up to that block are returned, followed by the configured length from the record that was too long and Check Condition status. If a block that is shorter than the configured length is encountered before the sequence is complete, the blocks up to that block are returned, followed by all of that block and Check Condition status. The current position is set after the last block that was returned or partially returned.

If the Transfer Length field is 0, and if the Suppress Illegal Length Indicator and the Fixed bit are not both set, then no action is taken.

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

READ ATTRIBUTE

Table 49. READ ATTRIBUTE Command

	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							

Until the *SCSI Primary Commands-3 (SPC-3)* is published, refer to SCSI proposal T10/99-148r7 for support for the READ ATTRIBUTE command.

The supported Service Action codes are listed in Table 50.

Table 50. Supported Service Action Codes

Code	Name	Description	Format of Returned Data
00h	Attribute Values	Return attribute values	See Table 51 on page 44
01h	Attribute List	Returns a list of available attribute identifiers	See Table 52 on page 44
02h	Volume List	Returns a list of available Volume Numbers	See Table 53 on page 44
03h	Partition List	Returns a list of available Partition Numbers	See Table 54 on page 45

Table 51 on page 44 describes the format of the Attribute Values service action request.

Table 51. Parameter Data for an Attribute Values Service Action Request

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

Table 52 describes the format of the data returned for an Attribute List service action request.

Table 52. Parameter Data for an Attribute List Service Action Request

	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							

Table 53 describes the format of the data returned for a Volume List service action request.

Table 53. Parameter Data for a Volume List Service Action Request

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

Table 54 describes the format of the data returned for a Partition List service action request.

Table 54. Parameter Data for a Partition List Service Action Request

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

Medium Auxiliary Memory Attribute Data

The Medium Auxiliary Memory Attribute data is used by both the READ ATTRIBUTE and WRITE ATTRIBUTE commands. Table 55 describes the attribute format. The supported format codes are 00h binary and 01h ASCII.

Table 55. Format for Medium Auxiliary Memory Attribute

	7	6	5	4	3	2	1	0
0 : 1				Attribute ID				
2	Rd Only			Reserved				Format
3 : 4				Attribute Length (n-4)				
5 : n				Attribute Value				

Table 56 describes the attribute identification ranges.

Table 56. Attribute Descriptions

Attribute Identifiers	Description
0000h - 03FFh	Device Common attributes
0400h - 07FFh	Medium Common attributes
0800h - 0BFFh	Host (server) Common attributes
0C00h - FFFFh	Device Vendor-Unique attributes
1000h - 13FFh	Medium Vendor-Unique attributes
1400h - 17FFh	Host (server) Vendor-Unique attributes

Table 57 describes Device Common attributes. All Device Common attributes are read only.

Table 57. Device Common Attributes

ID	Attribute Name	Number of Bytes	Format
0000h	Remaining Capacity in Partition	8	Binary
0001h	Maximum Capacity in Partition	8	Binary
0002h	TapeAlert Flags	8	Binary
0003h	Load Count	8	Binary
0004h	MAM Space Remaining	8	Binary
0005h	Assigning Organization	8	ASCII
0006h	Formatted Density Code	1	Binary
0007h	Initialization Count	2	Binary
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
0220h	Total Megabytes Written in Medium Life	8	Binary
0221h	Total Megabytes Read in Medium Life	8	Binary
0222h	Total Megabytes Written in Current/Last Load	8	Binary
0223h	Total Megabytes Read in Current/Last Load	8	Binary

Table 58 describes the format and contents for the Device Vendor/Serial Number Attribute.

Table 58. Device Vendor/Serial Number Attribute

	7	6	5	4	3	2	1	0
0 : 7	Vendor Identification ('IBM '), left justified							
8 : 39	Product Serial Number							

Table 59 describes the Medium Common Attributes.

Table 59. Medium Common Attributes

ID	Attribute Name	Number of Bytes	Format
0400h	Medium Manufacturer	8	ASCII
0401h	Medium Serial Number	32	ASCII
0402h	Medium Length	4	Binary
0403h	Medium Width	4	Binary
0404h	Assigning Organization	8	ASCII
0405h	Medium Density Code	1	Binary
0406h	Medium Manufacture Date	8	ASCII
0407h	MAM Capacity	8	Binary
0408h	Medium Type	1	Binary
0409h	Medium Type Information	2	Binary

All Medium Common attributes are read only.

The Medium Manufacture Date format is YYYYMMDD.

Medium Type value of 0 means Data Medium. A Medium Type value of 6 means Cleaning Medium.

For the Medium Type of Cleaning Medium, the Medium Type Information specifies the total number of cleaning cycles available in a cleaning cartridge.

Table 60 describes the Host Common Attributes.

Table 60. Host Common Attributes

ID	Attribute Name	Number of 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 & 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

All Host Common attributes can be both read and written.

The Date & Time Written format for the string is YYYYMMDDHHMM, using a 24-hour time format. At this time, there are no vendor-unique attributes.

READ BLOCK LIMITS

Table 61. READ BLOCK LIMITS Command

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

The READ BLOCK LIMITS command requests that the drive return the maximum and minimum block sizes that it supports. The maximum block size is set to 0xFFFFFF and the minimum block size is set to 1.

The format of the data returned is shown in Table 62.

Table 62. READ BLOCK LIMITS Descriptor

	7	6	5	4	3	2	1	0
0	Reserved							
1 : 3	Maximum block length limit (FFFFFFh)							
4 5	Minimum block length limit (1)							

READ BUFFER

Table 63. READ BUFFER Command

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

The READ BUFFER command reads data from the memory on the drive and sends it to the initiator.

Modes 000b, 010b and 011b are supported. If it is set to 010b, then just the data is returned. If it is set to 011b, just the descriptor is returned.

If the Mode is set to 0111b and the Buffer ID is 0, the descriptor returned is for the Main Data buffer. The format of the 4-byte descriptor is shown in Table 64. The Buffer ID indicates which buffer is to be read. The Buffer Offset field may be set to any address in the buffer.

Note: The Main Data buffer is larger than capacity of the read buffer offset and capacity fields to express (32 megabytes). To compensate for this, the buffer offset and capacity fields for the Main Buffer (buffer ID = 0) are interpreted and expressed such that each unit represents 64 bytes. This is only true for buffer modes 000b, 001b, 010b, 011b, and 111b.

Table 64. READ BUFFER Descriptor

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

Table 65. Drive Buffers

Supported Buffers	ID	Offset Boundary
Main Data	0	4
Dump Data (Read Only)	1	4
Test	2	4
VPD	3	4
Firmware	4	4
Cartridge Memory (Read Only)	5	4
Error Log (Read Only)	6	4

Error Log Buffer

The error log buffer contains zero or more entries described in Table 66.

Table 66. Error Log Buffer Command

	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				

READ POSITION

Table 67. READ POSITION Command

	7	6	5	4	3	2	1	0
0	Operation Code (34h)							
1	Logical Unit Number (0)			Reserved				BT(0)
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	Reserved							
8	Reserved							
9	Control							

The READ POSITION command returns current position information to the initiator. The data returned has the format in Table 68.

Table 68. READ POSITION Data

	7	6	5	4	3	2	1	0
0	BOP	EOP(0)	Reserved			BPU(0)	Reserved	
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 (0)							
16 : 19	Number of bytes in buffer (0)							

The First Block Location and the Last Block Location are both set to the number of blocks and file marks between BOM and current logical position. If the tape is at BOM, 0 is returned in these fields. The Beginning of Partition (BOP) flag is set if the Block Location fields are 0. The End of Partition flag is not supported and is set to 0. The Block Position Unknown flag is always set to 0, since the position is always known. The Partition Number, Number of Blocks in Buffer, and Number of Bytes in Buffer are not supported and are returned as 0.

RECEIVE DIAGNOSTIC RESULTS

Table 69. RECEIVE DIAGNOSTIC RESULTS Command

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

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 65.

RELEASE UNIT

Table 70. Byte RELEASE UNIT Command

	7	6	5	4	3	2	1	0
0	Operation Code (17h)							
1	Logical Unit Number (0)			3rdPty	Third Party Device ID (0)			Element
2	Reservation Identification							
3	Reserved							
4	Allocation Length (0)							
5	Control							

Table 71. Byte Release Unit Command

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

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.

REPORT DENSITY SUPPORT

Table 72. REPORT DENSITY SUPPORT Command

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

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

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

Table 73. REPORT DENSITY SUPPORT Header

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

The Available Density Descriptor Length gives the total amount of data that is available to be returned.

The header is followed by one or more REPORT DENSITY SUPPORT descriptor blocks with the format in Table 74.

Table 74. REPORT DENSITY SUPPORT Descriptor Block

	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							
24 : 31	Density Name							
32 : 51	Description							

The values reported for the Ultrium format are as follows:

Table 75. Density Information for LTO Formats

Field	Ultrium 1
Primary density code	40h
Secondary density code	40h
Bits per mm	4880
Media width (in tenths of mm)	127
Tracks	384
Capacity (in megabytes)	95367
Assigning organization	LTO-CVE
Density name	U-18
Description	Ultrium 1/8T

The Write Okay (WRTOK) flag is clear if the drive does not support writing to this format, but does support reading it. This is always 1 for first-generation drives. The Duplicate (DUP) flag is set to 0 for every descriptor block, indicating that each density is only reported once. The Default (DEFLT) flag is set for the density for which the currently mounted medium is formatted and is clear for all other densities. This is always 1 for first-generation drives, since any given piece of media only has one possible format.

The capacity values in the table are the maximum values possible and are reported if the Media flag is clear. If the Media flag is set, the actual capacity for the loaded tape is reported, which may be less than the value in the table.

Note: For this command, a megabyte is equal to 1 048 576 bytes. Therefore, a reported capacity of 95 367 megabytes is equal to 100 000 000 000 bytes.

REPORT LUNs

Table 76. REPORT LUNs Command

	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 server uses this command to retrieve information about the Logical Units that the drive supports.

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 77 shows the data that is returned:

Table 77. Logical Unit Numbers Data

	7	6	5	4	3	2	1	0
0 : 3	LUN List Length							
4 : 7	Reserved							
8 : 15	LUN 0 (0)							
16 : 23	LUN 1 (0001000000000000h)							

REQUEST SENSE

Table 78. REQUEST SENSE Command

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

The sense data returned is described in Table 79 on page 60.

Sense Data Format

Table 79. Sense Data Format

	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	ISKSV (1: Field Pointer) SKSV (0: Error Fault Symptom Code)							
18 : 19	Error Flag Data							
20	Reserved (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 flag 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 standards.

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, since the COPY, COMPARE, and COPY and VERIFY commands are not supported.

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

The End of Medium (EOM) flag is set if a WRITE or WRITE FILE MARKS command completed in the early warning area. Spacing into BOM also causes this flag 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) flag 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 4. Sense Keys and Additional Sense" on page 89.

The Information Bytes are only valid if the Valid flag 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.

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

For supported Additional Sense Codes and Additional Sense Code Qualifiers, see "Chapter 4. Sense Keys and Additional Sense" on page 89.

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 flag is set and the following fields are set:
- The Command/Data (C/D) flag is set if the illegal parameter was detected in the Command Descriptor Block, and is clear if it was detected in the Data phase.
- If a bit within a byte was invalid, the Bit Pointer Valid (BPV) flag 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) flag is set if the drive needs cleaning, and is clear otherwise.

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

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

The Volume Label field reports the volume label if a cartridge is loaded in the drive and Volume Label Fields Valid is set.

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

Table 80. Byte RESERVE UNIT Command

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

Table 81. Byte Reserve Unit Command

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

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

REWIND

Table 82. REWIND Command

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

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

If the Immediate (Immed) flag 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) flag is set to 0, status is not returned until after the command has completed.

SEND DIAGNOSTIC

Table 83. SEND DIAGNOSTIC Command

	7	6	5	4	3	2	1	0
0	Operation Code (1Dh)							
1	Logical Unit Number (0)			PF	Reserved	SelfTest	DevOfL	UnitOfL
2	Reserved							
3	Parameter List Length							
4								
5	Control							

Self-Test

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

- PF - 1
- SelfTest - 1
- DevOfl - Any value allowed and ignored
- UnitOfl - Any value allowed and ignored
- Parameter List Length - X0000

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

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 84. SIM Data Structure

	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)							
30 : 33	Error Code							
34 : 37	First FSC							
38 : 41	Last FSC							

Table 84. SIM Data Structure (continued)

	7	6	5	4	3	2	1	0
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 85. MIM Data Structure

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

Table 85. MIM Data Structure (continued)

	7	6	5	4	3	2	1	0
30 : 33				Error Code				
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)

Force Dump

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 - X0008

Table 86 shows the parameter data to be sent with the Force Dump diagnostic.

Table 86. Force Dump Diagnostic Parameter Data

	7	6	5	4	3	2	1	0
0	Page Code (80h)							
1	Reserved							
2	Page Length (0004h)							
3								
4	Diagnostic ID (0160h)							
5								
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

Table 87. Write Dump to Cartridge Send Diagnostic Parameter Data

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

Table 88. Write Dump to Cartridge Receive Diagnostic Parameter Data

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

Post A Self Test Diagnostic

Table 89. Post A Self Test Send Diagnostic Parameter Data

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

Table 90. Post A Self Test Receive Diagnostic Parameter Data

	7	6	5	4	3	2	1	0
0	Page Code (80h)							
1	Reserved							
2	Page Length (0004Dh)							
3								
4	Diagnostic ID (0100h)							
5								
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 91. Post B Tape Test Send Diagnostic Parameter Data

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

Table 92. Post B Tape Test Receive Diagnostic Parameter Data

	7	6	5	4	3	2	1	0
0	Page Code (80h)							
1	Reserved							
2	Page Length (0004Dh)							
3								
4	Diagnostic ID (0101h)							
5								
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 93. Post C Media Test Send Diagnostic Parameter Data

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

Table 94. Post C Media Test Receive Diagnostic Parameter Data

	7	6	5	4	3	2	1	0
0	Page Code (80h)							
1	Reserved							
2	Page Length (004Dh)							
3								
4	Diagnostic ID (0102h)							
5								
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 95. Post D Head Test Send Diagnostic Parameter Data

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

Table 96. Post D Head Test Receive Diagnostic Parameter Data

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

Set Traps

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 - X000A

Table 97 shows the parameter data to be sent with the Set Traps diagnostic.

Table 97. Set Traps Diagnostic Parameter Data

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

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

Remove Traps

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 - X000A

Table 98 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 X0000 will set up diagnostic results showing which traps are currently set without changing the state of any traps.

Table 98. Remove Traps Diagnostic Parameter Data

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

Receive Diagnostics Results - Table 99 shows the diagnostic results data returned for the Remove Traps diagnostic.

Table 99. Reset Drive Diagnostic Results Data

	7	6	5	4	3	2	1	0
0	Page Code (80h)							
1	Reserved							
2	Page Length (n - 4)							
3								
4	Diagnostic ID (0191h)							
5								
6	Flags (0)							
7	Reserved							
8	Reserved					Diagnostic Blocked	Reserved	Error
9 : n	List of Fault Symptom Codes with Trap Still Set							

Reset Drive

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 100 shows the parameter data to be sent with the Reset Drive.

Table 100. Reset Drive Diagnostic Parameter Data

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

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

SPACE

Table 101. SPACE Command

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

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.

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

Table 102. TEST UNIT READY Command

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

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

VERIFY

Table 103. VERIFY Command

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

The VERIFY command is supported by all drives.

The VERIFY command causes data to be read from the tape and passed through the drive's error detection and correction hardware to determine whether it can be recovered from the tape. The amount of data to be read is indicated by the Verification Length field and the Fixed flag in the same manner as is used in a READ command. (See "READ" on page 42.)

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

WRITE

Table 104. WRITE Command

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

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

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

If the Fixed flag is set, 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 29).

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 FFFFFFF0h, rules for physical end of tape processing are applied.

WRITE ATTRIBUTE

Table 105. WRITE ATTRIBUTE Command

	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							

Until the *SCSI Primary Commands-3 (SPC-3)* is published, refer to SCSI proposal
T10/99-148r7 for support for the WRITE ATTRIBUTE command.

For information about attributes that are supported, see "READ ATTRIBUTE" on
page 43.

Table 106 gives the format of the data that is returned for an Attribute Values
service action request.

Table 106. Parameter Data for Attribute Values Service Action Request

	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

Table 107. WRITE BUFFER Command

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

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

If the Mode field is 000b, then the data to be written is sent with a 4-byte header, which must be set to all zeroes. If the Mode field is 010b, then just the data to be written is sent.

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

To download firmware, Modes 100b, 101b, 110b, and 111b 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.

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 49).

WRITE FILE MARKS

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

Table 108. WRITE FILE MARKS Command

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

The WRITE FILE MARKS command causes a sequence of file marks to be written at the current logical position. The number of file marks to be written is indicated in the Count field. If the Immed flag is set, status is returned immediately, before the file marks are written to tape. If the Immed flag is clear, the file marks and any buffered data is written to tape before status is returned.

If the Immed flag is clear and the Count field is 0, then all buffered data is flushed to tape before the command is reported.

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 FFFFFFF0h, rules for physical end of tape processing are applied.

Chapter 3. Error Sense Information

Sense Data

For a description of Sense data, see "Sense Data Format" on page 60.

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 87.) 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.

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 1 on page 5). The error may or may not be reported as Deferred.

Chapter 4. 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 109. 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.

Table 109. Sense Keys and Additional Sense (continued)

Sense Key	Additional Sense (ASC/ASCQ)	Explanation
Medium Error (3h)	Write Error (0C00h)	A WRITE operation has failed. This is probably due to bad media, but may be related to hardware.
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.

Table 109. Sense Keys and Additional Sense (continued)

Sense Key	Additional Sense (ASC/ASCQ)	Explanation
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.
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.

Table 109. Sense Keys and Additional Sense (continued)

Sense Key	Additional Sense (ASC/ASCQ)	Explanation
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 5. 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 94.
- 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

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 110 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 110 on page 94 is carried out.

Table 110. 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 110. 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 a minimum of two initiators.

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 87 for more details of sense data management.

Status Codes

Table 111. Status Codes

Description	Value	When returned
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 96.) 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 112. Supported Outbound Messages

Name	Code	Support
Abort	06h	An abort condition is generated (see "Abort Handling" on page 94).
Bus Device Reset	0Ch	A reset condition is generated (see "Abort Handling" on page 94).
Extended Message	01h	See "Unit Attention Conditions" on page 87 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 97). 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 97). 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 113. 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 100 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 114. 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 Tape Drive Model T200F (Fibre Channel 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.

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

The IBM Ultrium Tape Drive is compliant with the FC-Tape standard that is proposed for the Technical Report of Accredited Standard Committee NCITS. IBM recommends that your server's software use the Class 3 Error Recovery of this proposed standard.

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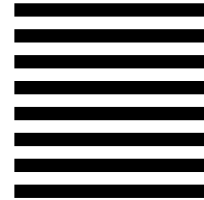
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