GA32-0928-00

14 April 2011

IBM® TotalStorage® LTO Ultrium Tape Drive

SCSI Reference

Note
Before using this manual and the product it supports, read the information under Appendix B. Notices.

First Edition (April 2011)

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

Copyright International Business Machines Corporation 2011.

US Government Users Restricted Rights -- Use, duplication or disclosure restricted by GSA ADP Schedule Contract with IBM Corp.

0. Read This First

This is the first edition of the *IBM System Storage LTO Tape Drive SCSI Reference*.

0.1 Summary of Changes

0.1.1 First Edition, April 2011

The *IBM System Storage LTO Ultrium Tape Drive SCSI Reference* describes the SCSI interface for the IBM LTO 1 tape drive through the IBM LTO 4 tape drive. This document is the first edition of the *IBM System Storage LTO Tape Drive SCSI Reference* which describes the SCSI interface for the IBM LTO 5 tape drive and does not describe the previous generation tape drives that are described in the *IBM System Storage LTO Ultrium Tape Drive SCSI Reference*.

The list of Functional Change Requests (FCR) applied to the previous generation device (i.e., LTO4) that are included follow:

FCR 3163r3 - IP Address Information Configuration;
FCR 3164 - LTO Engineering Log (Buffer ID 06h);
FCR 3165 - LTO5 - TapeAlert 10h behavior;
FCR 3167 - Persistent Reserve Out SCOPE field;
FCR 3173 - Device Attributes Mode Pages;
FCR 3174r2 - LTO5 - Sleep Mode (Mode Page 1Ah);
FCR 3175r3 - LTO5 - Partitioning SCSI changes;
FCR 3176r1 - Encryption Selection mode page;
FCR 3177 - LTO5 - SCSI Identifier updates;
FCR 3178r2 - LTO5 - SkipSync;
FCR 3179r2 - LTO5 - Append-only mode (data-safe);
FCR 3180r2 - LTO5 - Transport Log & Mode pages;
FCR 3181 - LTO5 Report Supported OpCode;
FCR 3183r1 - LTO5 Programmable Early Warning;
FCR 3184 - LTO5 Volume Statistics log page (17h);
FCR 3185 - LTO5 Device Statistics log page (14h);
FCR 3186 - LTO5 Data Compression log page (1Bh);
FCR 3187 - SPIN & SPOUT (OOBE-KMIP-SSC-4);
FCR 3188r1 - LTO5 Engineering & Speed log pages;
FCR 3189 - Extended Write-Read Diagnostics;
FCR 3192r1 - Tape map control mode page;
FCR 3193 - End of partition behavior control;
FCR 3194 - SAS TLR count in log pages;
FCR 3195 - LTO5 ITD;
FCR 3197 - Update standard inquiry version field;
FCR 3199 - LTO5 Engr Diags for Manufacturing;
FCR 3202 - CM from EOD dataset Read Buffer;
FCR 3205 - Drive Type in Inquiry C0h;
FCR 3208 - Logical block protection;
FCR 3211r1 - LUN1 licenses IBM general + OEM;

FCR 3212 - LOAD ID for LTO HH V2 drives;

Contents

Page

0. Read This First ..... a
0.1 Summary of Changes ..... a
0.1.1 First Edition, April 2011 ..... a

1. Preface 1
1.1 Organization 1
1.2 Related Publications 1

2. Definitions, symbols, abbreviations, and conventions 3
2.1 Definitions 3
2.2 Conventions 15
2.2.1 Bit Numbering 16
2.2.2 Units of measure for data storage 17
2.2.3 Subpages 18
2.2.4 Text Markers 19
2.2.5 Hyperlinks 20
2.3 Tape Drive Model Names 20

3. Introduction 21
3.1 Drive Overview 21
3.2 Supported Servers and Operating Systems 22
3.2.1 Primary Interface Attachment 22
3.3 Supported Device Drivers 22
3.4 Supported Tape Cartridges 23
3.5 Microcode Detection of Errors 24
3.5.1 Fencing Behavior 24

4. Implementation Considerations 25
4.1 Write modes 25
4.1.1 Write mode introduction 26
4.1.2 Write-anywhere mode 27
4.1.3 Append-only mode (also known as Data-safe mode) 28
4.2 Programmable early warning 30
4.3 Multiple Port Behavior 31
4.4 Data Transfer, Block Limits, and Fixed Block Option 31
4.5 Request Sense Information, ILI, and Command Interactions 32
4.5.1 General Read-Type Handling 33
4.5.2 Interactions Summary 35
4.6 Cleaning the Drive in a Library 37
4.7 Drive Cleaning Indicators 37
4.7.1 Panel Cleaning Indication 39
4.7.2 Host Interface - Dynamic Cleaning Indicators 40
4.7.3 Host Interface - Static Cleaning Indicator (Sense Data Byte 70) 41
4.8 WORM Behaviors 41
4.8.1 Conditions for Writing 42
4.8.2 Command Behavior When WORM Medium Has Been Tampered With 43
4.9 Device Hardware Encryption 43
4.9.1 Encryption Control - IBM Proprietary Protocol (IPP) 44
4.9.2 Encryption Control - T10 Standards 45
4.10 Attachment Features 45
4.10.1 Types of Interface Attachments 46
4.10.2 Common Tape LUN Behaviors 47
4.10.2.1 Power-On 47
4.10.2.2 Reset Strategy 47

4.10.2.3 Abort Handling 47
4.10.2.4 Multi-initiator Support 49
4.10.2.5 Status Codes 49
4.10.3 Features of the Fibre Channel Interface 51
4.10.3.1 Topology 51
4.10.3.1.1 Two-Node Switched Fabric Topology 52
4.10.3.1.2 Two-Node Direct Connection Topology 52
4.10.3.2 Speed 52
4.10.3.3 Addressing Assignments 53
4.10.4 Features of the Serial Attached SCSI (SAS) Interface 54
4.11 Device Clocks 54
4.12 Error Information 54
4.12.1 Sense Data 55
4.12.2 Sense Data Management 56
4.12.3 Unit Attention Conditions 57
4.12.4 Persistent Errors 58
4.12.4.1 Fencing Behavior 58
4.12.4.1.1 ALLOW_NO_OPERATION 58
4.12.4.1.2 ALLOW_LOCATE 58
4.12.4.1.3 ALLOW_UNLOAD 59
4.12.4.1.4 MID-TAPE RECOVERY 59
4.12.4.1.4.1 Normal operation (i.e., MTR Fence) 59
4.12.4.1.4.2 Panic Fence operation 59
4.13 Medium auxiliary memory 60
4.14 Volume Coherency 61

5. SCSI Commands 63
5.1 SCSI Commands Overview 63
5.1.1 Unsupported SCSI Commands 64
5.1.2 Supported SCSI Commands 65
5.1.2.1 Supported SCSI Commands on LUN 1 65
5.1.2.2 Supported SCSI Commands on LUN 0 65
5.1.2.3 Control Byte Definition 67
5.2 SCSI Commands Listing 68
5.2.1 ALLOW OVERWRITE - (82h) 68
5.2.2 ERASE - 19h 69
5.2.3 FORMAT MEDIUM command 70
5.2.4 INQUIRY - 12h 72
5.2.4.1 Standard Inquiry Data 72
5.2.5 LOAD/UNLOAD - 1Bh 78
5.2.6 LOCATE(10/16) - 2Bh/92h 80
5.2.7 LOG SELECT - 4Ch 82
5.2.8 LOG SENSE - 4Dh 83
5.2.9 MODE SELECT (6/10) - 15h/55h 84
5.2.10 MODE SENSE (6/10) - 1Ah/5Ah 86
5.2.11 PERSISTENT RESERVE IN (PRIN)- 5Eh 88
5.2.11.1 READ KEYS service action 88
5.2.11.2 READ RESERVATION service action 89
5.2.11.3 REPORT CAPABILITIES service action 90
5.2.11.4 READ FULL STATUS service action 92
5.2.11.4.1 Full status descriptors 93
5.2.12 PERSISTENT RESERVE OUT - 5Fh 94
5.2.12.1 Basic PERSISTENT RESERVE OUT parameter list 95
5.2.12.2 PERSISTENT RESERVE OUT command with REGISTER AND MOVE service action parameters 96
5.2.13 PREVENT ALLOW MEDIUM REMOVAL - 1Eh 97
5.2.13.1 Medium removal 97

5.2.14 READ - 08h 98
5.2.15 READ ATTRIBUTE - 8Ch 99
5.2.15.1 ATTRIBUTE VALUES service action 100
5.2.15.2 ATTRIBUTE LIST service action 101
5.2.15.3 LOGICAL VOLUME LIST service action 101
5.2.15.4 PARTITION LIST service action 102
5.2.15.5 SUPPORTED ATTRIBUTES service action 102
5.2.16 READ BLOCK LIMITS - 05h 103
5.2.17 READ BUFFER - 3Ch 104
5.2.18 READ POSITION - 34h 105
5.2.18.1 READ POSITION command description 105
5.2.18.2 READ POSITION data format, short form 105
5.2.18.3 READ POSITION data format, long form 108
5.2.18.4 READ POSITION data format, extended form 109
5.2.19 RECEIVE DIAGNOSTIC RESULTS - 1Ch 112
5.2.20 RELEASE UNIT - 17h/57h 113
5.2.21 REPORT DENSITY SUPPORT - 44h 114
5.2.21.1 Report Density Support data format 114
5.2.21.1.1 Density descriptor overview 114
5.2.21.1.2 Density information 116
5.2.22 REPORT LUNS - A0h 117
5.2.22.1 Report LUNs data format 117
5.2.23 REPORT SUPPORTED OPERATION CODES - A3h[0Ch] 119
5.2.23.1 All_commands parameter data format 120
5.2.23.2 One_command parameter data format 122
5.2.23.3 Command timeouts descriptor 123
5.2.23.3.1 Overview 123
5.2.23.3.2 WRITE BUFFER command timeouts descriptor command specific field usage 125
5.2.24 REPORT SUPPORTED TASK MANAGEMENT FUNCTIONS - A3h[0Dh] 127
5.2.24.1 REPORT SUPPORTED TASK MANAGEMENT FUNCTIONS parameter data 127
5.2.25 REPORT TIMESTAMP - A3h[0Fh] 129
5.2.25.1 REPORT TIMESTAMP parameter data 129
5.2.26 REQUEST SENSE - 03h 131
5.2.26.1 Sense Data Format 132
5.2.27 RESERVE - 16h/56h 138
5.2.28 REWIND - 01h 139
5.2.29 SECURITY PROTOCOL IN (SPIN) - A2h 140
5.2.30 SECURITY PROTOCOL OUT (SPOUT) - B5h 141
5.2.31 SEND DIAGNOSTIC - 1Dh 142
5.2.32 SET CAPACITY - 0Bh 144
5.2.33 SET TIMESTAMP - A4h[0Fh] 146
5.2.33.1 SET TIMESTAMP Parameter List 146
5.2.34 SPACE (6/16) - 11h/91h 148
5.2.35 TEST UNIT READY - 00h 150
5.2.36 VERIFY(6) - 13h 151
5.2.37 WRITE - 0Ah 152
5.2.38 WRITE ATTRIBUTE - 8Dh 153
5.2.39 WRITE BUFFER - 3Bh 156
5.2.40 WRITE FILEMARKS - 10h 157

6. Parameters for SCSI Commands 159
6.1 Diagnostic Parameters (Diag) 161
6.1.1 Diag Page Formats 161
6.1.1.1 Page 00h 161
6.1.1.2 SendDiag Data - Page 00h 161
6.1.1.3 RcvDiag Data - Page 00h 161
6.1.1.4 Page 80h 161

6.1.1.4.1 SendDiag - Page 80h 161
6.1.1.5 RcvDiag - Page 80h 162
6.1.1.5.1 SIM/MIM Definition 162
6.1.1.5.1.1 SIM/MIM Header Data 163
6.1.1.5.1.2 SIM Messages 164
6.1.2 Supported Page 80h Diags 169
6.1.3 Diag - SelfTest: Self Test 170
6.1.3.1 SendDiag Command - Self Test 170
6.1.3.2 RcvDiag Data - Self Test 170
6.1.4 Diag - 0090h: Primary port wrap test 171
6.1.4.1 SendDiag Parm Data - Primary port wrap test 171
6.1.4.2 RcvDiag Data - Primary port wrap test 171
6.1.5 Diag - 0100h: POST A 172
6.1.5.1 SendDiag Parm Data - POST A 172
6.1.5.2 RcvDiag Data - POST A 173
6.1.6 Diag - 0101h: POST B Performance 174
6.1.6.1 SendDiag Parm Data - POST B Performance 174
6.1.6.2 RcvDiag Data - POST B Performance 175
6.1.7 Diag - 0102h: POST C Media Test 176
6.1.7.1 SendDiag Parm Data - POST C Media Test 176
6.1.7.2 RcvDiag Data - POST C Media Test 176
6.1.8 Diag - 0103h: POST D Head Test 177
6.1.8.1 SendDiag Parm Data - POST D Head Test 177
6.1.8.2 RcvDiag Data - POST D Head Test 177
6.1.9 Diag - 0160h: Force Dump 178
6.1.9.1 SendDiag Parm Data - Force Dump 178
6.1.9.2 RcvDiag Data - Force Dump 178
6.1.10 Diag -0161h: Write Dump to Cartridge 179
6.1.10.1 SendDiag Parm Data - Write Dump to Cartridge 179
6.1.10.2 RcvDiag Data - Write Dump to Cartridge 180
6.1.11 Diag - 0190h: Set Traps 181
6.1.11.1 SendDiag Parm Data - Set Traps 181
6.1.11.2 RcvDiag Data - Set Traps 181
6.1.12 Diag - 0191h: Remove Traps 182
6.1.12.1 SendDiag Parm Data - Remove Traps 182
6.1.12.2 RcvDiag Data - Remove Traps 183
6.1.13 Diag - 1002h: Read Thermal Sensor 184
6.1.13.1 SendDiag Parm Data - Read Thermal Sensor 184
6.1.13.2 RcvDiag Data - Read Thermal Sensor 185
6.1.14 Diag - 2002h: Reset Drive 186
6.1.14.1 SendDiag Parm Data - Reset Drive 186
6.1.14.2 RcvDiag Command - Reset Drive 186
6.1.15 Cryptographic Diagnostics 187
6.2 Inquiry Vital Product Data Parameters (IP) 189
6.2.1 IP 00h: Supported Vital Product Data Pages 190
6.2.1.1 Returned Data - Inquiry Page 00h: Supported Inquiry Pages 190
6.2.2 IP 03h: Firmware Designation 192
6.2.2.1 Returned Data - IP 03h: Firmware Designation 192
6.2.3 IP 80h: Unit Serial Number 194
6.2.3.1 Returned Data - IP 80h: Unit Serial Number 194
6.2.4 IP 83h: Device Identification 195
6.2.4.1 Returned Data - Inquiry Page 83h: Device Identification 195
6.2.4.1.1 T10 vendor ID designation descriptor 196
6.2.4.1.2 Logical Unit (NAA) - WWNN designation descriptor 197
6.2.4.1.3 Relative target port identifier designation descriptor 198
6.2.4.1.4 Port Name (NAA) - WWPN designation descriptor 199
6.2.4.1.5 Target Device Name (NAA) designation descriptor (SAS only) 199

6.2.5 IP 86h: Extended INQUIRY Data 201
6.2.6 IP 87h: Mode Page Policy 204
6.2.6.1 Returned Data - IP 87h: Mode Page Policy 204
6.2.7 IP 88h: SCSI ports 207
6.2.7.1 Returned Data - IP 88h: SCSI ports 207
6.2.8 IP 90h: Protocol-Specific Logical Unit Information 209
6.2.8.1 Returned Data - IP 88h: SCSI ports 209
6.2.8.2 Logical unit information descriptor 210
6.2.9 IP B0h - Sequential-Access device capabilities 211
6.2.9.1 Returned Data - IP B0h: Sequential-Access device capabilities 211
6.2.10 IP C0h: Drive Component Revision Levels 212
6.2.10.1 Returned Data - IP C0h: Drive Component Revision Levels 212
6.2.11 IP C1h: Drive Serial Numbers 214
6.2.11.1 Returned Data - IP C1h: Drive Serial Numbers 214
6.2.12 IP C7h: Device Unique Configuration Data 215
6.2.12.1 Returned Data - IP C7h: Device Unique Configuration Data 215
6.2.13 IP C8h: Mode Parameter Default Settings 216
6.2.13.1 Returned Data - IP C8h: Mode Parameter Default Settings 216
6.3 Log Parameters (LP) 217
6.3.1 Log Page Format 217
6.3.2 Log Parameter Format 218
6.3.2.1 Log Parameter Byte 2 — Control Byte 218
6.3.3 General Log Parameter Reset Behavior 219
6.3.4 LP 00h: Supported Log Pages 220
6.3.4.1 Parameter Reset Behavior (00h) 220
6.3.4.2 Parameter Definitions (00h) 220
6.3.5 LP 02h: Write Error Counters 221
6.3.5.1 Parameter Reset Behavior (02h) 221
6.3.5.2 Parameter Definitions (02h) 221
6.3.6 LP 03h: Read Error Counters 222
6.3.6.1 Parameter Reset Behavior (03h) 222
6.3.6.2 Parameter Definitions (03h) 222
6.3.7 LP 06h: Non-Medium Errors 223
6.3.7.1 Parameter Reset Behavior (06h) 223
6.3.7.2 Parameter Definitions (06h) 223
6.3.8 LP 0Ch: Sequential-Access Device 224
6.3.8.1 Parameter Reset Behavior (0Ch) 224
6.3.8.2 Parameter Definitions (0Ch) 224
6.3.9 LP 11h: DT Device Status 226
6.3.9.1 Parameter Reset Behavior (11h) 226
6.3.9.2 Parameter Definitions (11h) 226
6.3.9.2.1 Very high frequency data log parameter 227
6.3.9.2.2 Very high frequency polling delay log parameter 231
6.3.9.2.3 Primary port status log parameter(s) 232
6.3.9.2.4 Fibre Channel port status data 233
6.3.9.2.5 Serial Attached SCSI port status data 235
6.3.10 LP 14h: Device Statistics 237
6.3.10.1 Parameter Reset Behavior (14h) 237
6.3.10.2 Parameter Definitions (14h) 238
6.3.10.3 Log parameter formats 242
6.3.10.3.1 Device statistics data counter log parameter format 242
6.3.10.3.2 Device statistics medium type log parameter format 243
6.3.10.3.2.1 Device statistics medium type descriptor 243
6.3.10.3.3 Device statistics string data log parameter format 244
6.3.11 LP 16h: Tape diagnostic data 245
6.3.11.1 Parameter Reset Behavior (16h) 245
6.3.11.2 Parameter Definitions (16h) 245

6.3.12 LP 17h: Volume Statistics 248
6.3.12.1 Parameter reset behavior 248
6.3.12.2 Parameter Definitions 249
6.3.12.3 Parameter formats 253
6.3.12.3.1 Data counter log parameter format 253
6.3.12.3.2 Volume statistics string data log parameter format 253
6.3.12.3.3 Volume statistics partition record log parameter format 254
6.3.13 LP 18h: Protocol-specific port 255
6.3.13.1 Parameter Reset Behavior (18h) 255
6.3.13.2 Parameter Definitions (18h) 255
6.3.14 LP 1Bh: Data Compression 259
6.3.14.1 Parameter reset behavior 259
6.3.14.2 Parameter Definitions 259
6.3.14.3 Parameter format 261
6.3.15 LP 1A: Power Condition Transitions 262
6.3.15.1 Parameter Reset Behavior (1Ah) 262
6.3.15.2 Parameter Definitions (1Ah) 262
6.3.16 LP 2Eh: TapeAlerts 263
6.3.16.1 Parameter Reset Behavior (2Eh) 263
6.3.16.2 Parameter Definitions (2Eh) 263
6.3.17 LP 30h: Tape Usage 266
6.3.17.1 Parameter Reset Behavior (30h) 266
6.3.17.2 Parameter Definitions (30h) 266
6.3.18 LP 31h: Tape capacity 267
6.3.18.1 Parameter Reset Behavior (31h) 267
6.3.18.2 Parameter Definitions(31h) 267
6.3.19 LP 32h: Data compression 268
6.3.19.1 Parameter Reset Behavior (32h) 268
6.3.19.2 Parameter Definitions (32h) 268
6.3.20 LP 33h: Write Errors 269
6.3.20.1 Parameter Reset Behavior (33h) 269
6.3.20.2 Parameter Definitions (33h) 269
6.3.21 LP 34h: Read Forward Errors 271
6.3.21.1 Parameter Reset Behavior (34h) 271
6.3.21.2 Parameter Definitions (34h) 271
6.3.22 LP 37h: Performance Characteristics 273
6.3.22.1 Parameter Reset Behavior (37h) 273
6.3.22.2 Parameter Definitions (37h) 273
6.3.23 LP 38h: Blocks/Bytes Transferred 284
6.3.23.1 Parameter Reset Behavior (38h) 284
6.3.23.2 Parameter Definitions (38h) 284
6.3.24 LP 39h: Host Port 0 Interface Errors 286
6.3.24.1 Parameter Reset Behavior (39h) 286
6.3.24.2 Parameter Definitions (39h) 286
6.3.25 LP 3Ah: Drive control verification 287
6.3.26 LP 3Bh: Host Port 1 Interface Errors 288
6.3.26.1 Parameter Reset Behavior (3Bh) 288
6.3.26.2 Parameter Definitions (3Bh) 288
6.3.27 LP 3Ch: Drive usage information 289
6.3.27.1 Parameter Reset Behavior (3Ch) 289
6.3.27.2 Parameter Definitions (3Ch) 289
6.3.28 LP 3Dh: Subsystem Statistics 291
6.3.28.1 Parameter Reset Behavior (3Dh) 291
6.3.28.2 Parameter Definitions (3Dh) 291
6.3.29 LP 3Eh: Engineering Use 293
6.3.30 LP 3Eh[3Ch]: Drive Control Statistics 294
6.4 Medium auxiliary memory attributes (MAM) 295

6.4.1 Attribute format 295
6.4.2 Attribute identifier values 296
6.4.2.1 Attribute identifier values overview 296
6.4.2.2 Device type attributes 297
6.4.2.3 Medium type attributes 299
6.4.2.4 Host type attributes 301
6.4.2.5 Vendor-Specific Medium Type Attributes 303
6.5 Mode Parameters (MP) 305
6.5.1 Mode Parameter List for Mode Select (6/10) 305
6.5.1.1 Mode Parameter Header for Mode Select (6/10) 305
6.5.1.2 Block Descriptor for Mode Select (6/10) 307
6.5.2 Mode Parameter List for Mode Sense (6/10) 308
6.5.2.1 Mode Parameter Header for Mode Sense (6/10) 308
6.5.2.2 Block Descriptor for Mode Sense (6/10) 310
6.5.3 Mode Page Format 311
6.5.4 Supported Mode Pages 312
6.5.5 MP 01h: Read-Write Error Recovery 313
6.5.6 MP 02h: Disconnect-Reconnect 315
6.5.7 MP 0Ah: Control 316
6.5.8 MP 0Ah[01h]: Control Extension 317
6.5.9 MP 0Fh: Data Compression 318
6.5.10 MP 10h: Device Configuration 320
6.5.11 MP 10h[01h]: Device Configuration Extension 323
6.5.12 MP 11h: Medium Partition Page 326
6.5.13 MP 18h: Protocol-Specific Logical Unit 331
6.5.13.1 Fibre Channel Logical Unit (18h) 331
6.5.13.2 SAS Logical Unit (18h) 332
6.5.14 MP 19h: Protocol specific port 333
6.5.14.1 FCP port (19h) 333
6.5.14.2 SAS port (19h) 334
6.5.15 MP 1Ah: Power Condition 336
6.5.16 MP 1Ch: Informational Exceptions Control 338
6.5.17 MP 1Dh: Medium Configuration 340
6.5.18 MP 24h: Vendor-Specific 341
6.5.19 MP 2Fh: Behavior Configuration 343
6.5.20 MP 30h: Device Attribute Settings 347
6.5.20.1 MP 30h: Directory Listing - Device Attribute Settings 347
6.5.20.2 Supported subpage list - Device Attribute Settings 348
6.5.20.3 MP 30h[01h-03h]: Ethernet attributes - Device attribute settings 348
6.5.20.3.1 Ethernet attributes overview 348
6.5.20.3.1.1 Ethernet socket address descriptor 349
6.5.20.3.1.1.1 Sockaddr for an IPv4 IP address 349
6.5.20.3.1.1.2 Sockaddr for an IPv6 address 350
6.5.20.3.2 MP 30h[01h]: Drive MAC address - Device attribute settings 351
6.5.20.3.3 MP 30h[02h]: Drive IP address and subnet mask - Device attribute settings 352
6.5.20.4 MP 30h[40h-42h]: Data processing attributes - Device attribute settings 354
6.5.20.4.1 MP 30h[40h]: SkipSync - Device attribute settings 354
6.5.20.4.2 MP 30h[41h]: Tape map control - Device attribute settings 355
6.5.20.4.3 MP 30h[42h]: End of partition behavior control - Device attribute settings 355
6.5.21 MP 3Eh: Engineering Support 356
6.6 Read/Write Buffers (RB) 357
6.6.1 Buffer modes for READ BUFFER 357
6.6.1.1 00h – Combined header and data mode 357
6.6.1.2 02h – Data mode 357
6.6.1.3 03h – Descriptor mode 358
6.6.1.4 07h – Descriptor with algorithmic offset boundary 358
6.6.1.5 0Ah – Read data from echo buffer mode 359

6.6.1.6 0Bh – Echo buffer descriptor mode 359
6.6.2 Supported Buffers 360
6.6.3 RB 06h: Error Log 361
6.6.4 RB 08h: World Wide Name 362
6.6.5 RB 07h: SCSI Log (aka Error log) 363
6.6.6 RB 50h: Active IP addresses 364
6.6.6.1 Active IP addresses fixed buffer 364
6.6.6.2 Active IP addresses variable buffer 365
6.7 Security Protocol Parameters (SPP) 367
6.7.1 SPIN Pages (00h - Security Protocol Information) 367
6.7.1.1 SPIN (00h[0000h]) - Supported Security Protocols List 367
6.7.1.2 SPIN (00h[0001h]) - Certificate Data 367
6.7.2 SPIN Pages (20h - Tape Data Encryption) 369
6.7.2.1 SPIN (20h[0000h]) - Tape Data Encryption In Support Pages page 369
6.7.2.2 SPIN (20h[0001h]) - Tape Data Encryption Out Support Pages page 370
6.7.2.3 SPIN (20h[0010h]) - Data Encryption Capabilities page 370
6.7.2.3.1 Data Encryption Algorithm Descriptor - Standard Encryption 372
6.7.2.4 SPIN (20h[0011h]) - Supported Key Formats page 375
6.7.2.4.1 Plaintext Key Format (00h) 376
6.7.2.5 SPIN (20h[0012h]) - Data Encryption Management Capabilities 376
6.7.2.6 SPIN (20h[0020h]) - Data Encryption Status page 377
6.7.2.7 SPIN (20h[0021h]) - Next Block Encryption Status page 380
6.7.2.7.1 Key-Associated Data (KAD) Descriptors 383
6.7.2.8 SPIN (20h[0030h]) - Random Number page 383
6.7.3 SPOUT Pages (20h - Tape Data Encryption security protocol) 385
6.7.3.1 SPOUT (20h[0010h]) - Set Data Encryption 385
6.7.3.2 Key-Associated Data (KAD) Descriptors 388
6.7.3.2.1 KAD 00h - UKAD (Unathenticated KAD) 388
6.7.3.2.2 KAD 01h - DKi (Data Key Identifier) 389
6.7.3.2.3 KAD 02h - Nonce 389
6.7.3.2.4 KAD 03h - MKAD (Metadata) 390
Summary of Drive Generation Differences 391
A.1. Differences in Command Timeout Values 393
A.2. Command and Parameter Differences Between Generations 401
A.3. Data Changes Between Generations 401
A.3.1. Standard Inquiry Data 401
A.3.2. REPORT DENSITY SUPPORT Command 402
A.3.3. Mode Pages 402
A.3.4. READ POSITION Command 402
A.3.5. Request Sense Changes 402
A.4. Behavior Changes Between Generations 402
A.4.1. Cartridge Eject for Errors 402
A.4.2. Queuing Issues 402
Error Sense Information 403
B.1. Sense Key 0 (No Sense) 404
B.2. Sense Key 1 (Recovered Error) 404
B.3. Sense Key 2 (Not Ready) 405
B.4. Sense Key 3 (Medium Error) 405
B.5. Sense Key 4 (Hardware Error) 407
B.6. Sense Key 5 (Illegal Request) 408
B.7. Sense Key 6 (Unit Attention) 410
B.8. Sense Key 7 (Data Protect) 412
B.9. Sense Key 8 (Blank Check) 413
B.10. Sense Key B (Aborted Command) 413
B.11. Sense Key D (Volume Overflow) 413
Firmware Download 415

C.1. Identifying Level Hardware of Drive 415
C.2. Identifying the product for which the firmware image is intended 417
C.3. Download Process 418
Sample C program to generate Reed-Solomon CRC 419
Notices 421
E.1. Trademarks 421

Tables

Page
1 Features of the IBM Ultrium Tape Drives and the IBM 3580 Ultrium Tape Drive 21
2 Supported Servers and Operating Systems for Primary Interface Attachment 22
3 Table 3. IBM LTO Ultrium Tape Drive Support of LTO Cartridges 23
4 allow_overwrite variable definition 28
5 Information and ILI Behavior Summary 35
6 ASC/ASCQ Codes Related to Cleaning 40
7 Behavior when the loaded medium has suspect integrity 43
8 Abort Condition Handling 47
9 Status Codes 49
10 Topologies through which this device's port(s) can operate 52
11 TIMESTAMP ORIGIN 54
12 TIMESTAMP Format 54
13 Error to Fence State mapping 58
14 Types of MAM attributes 60
15 MAM attribute states 61
16 Supported Common SCSI Commands 65
17 Control Byte Definition 67
18 ALLOW OVERWRITE command 68
19 allow overwrite field definition 68
20 ERASE CDB 69
21 FORMAT MEDIUM command 70
22 Format field 71
23 INQUIRY CDB 72
24 Standard INQUIRY data valid LUN format 72
25 eServer attachment Standard Inquiry Data Valid LUN 74
26 Product Identification Table 75
27 protocol identifer values 76
28 SAS maximum speed supported values 76
29 Fibre Channel maximum speed supported values 76
30 fips field values 77
31 LOAD/UNLOAD CDB 78
32 LOAD/UNLOAD actions depending on Load and Hold bit settings and medium position 79
33 LOCATE(10) Command 80
34 LOCATE(16) Command 80
35 LOG SELECT command 82
36 LOG SENSE command 83
37 Mode Select (6) CDB 84
38 Mode Select (10) CDB 84
39 MODE SENSE (6) CDB 86
40 MODE SENSE (10) CDB 86
41 PERSISTENT RESERVE IN Command 88
42 PERSISTENT RESERVE IN parameter data for READ KEYS 89
43 PERSISTENT RESERVE IN parameter data for READ RESERVATION 90
44 PERSISTENT RESERVE IN parameter data for REPORT CAPABILITIES 91
45 PERSISTENT RESERVE IN parameter data for READ FULL STATUS 92
46 PERSISTENT RESERVE IN full status descriptor format 93
47 PERSISTENT RESERVE OUT CDB 94
48 PERSISTENT RESERVE OUT parameter list 95
49 PERSISTENT RESERVE OUT with REGISTER AND MOVE service action parameter list 96
50 PREVENT ALLOW MEDIUM Removal Command 97
51 Read CDB 98
52 READ ATTRIBUTE command 99
53 READ ATTRIBUTE with ATTRIBUTE VALUES service action parameter list format 100
54 READ ATTRIBUTE with ATTRIBUTE LIST service action parameter list format 101
55 READ ATTRIBUTE with LOGICAL VOLUME LIST service action parameter list format 101

56 READ ATTRIBUTE with PARTITION LIST service action parameter list format 102
57 READ ATTRIBUTE with SUPPORTED ATTRIBUTES service action parameter list format 102
58 Read Block Limits CDB 103
59 RBL parameter data 103
60 Read Buffer CDB 104
61 READ POSITION command 105
62 READ POSITION data format, short form 106
63 READ POSITION data format, long form 108
64 READ POSITION data format, extended form 109
65 RECEIVE DIAGNOSTIC RESULTS CDB 112
66 6-byte RELEASE UNIT CDB 113
67 10-Byte RELEASE UNIT CDB 113
68 REPORT DENSITY SUPPORT CDB 114
69 REPORT DENSITY SUPPORT data format 115
70 Density support data block descriptor format 115
71 Density information 116
72 REPORT LUNS CDB 117
73 Logical Unit Numbers Data 117
74 REPORT SUPPORTED OPERATION CODES CDB 119
75 REPORT SUPPORTED OPERATION CODES reporting options field 120
76 All_commands parameter data 120
77 Command descriptor format 121
78 One_command parameter data 122
79 support values 122
80 Command timeouts descriptor format 123
81 Command timeouts descriptor command specific field usage 123
82 Command timeout values at time document was published 124
83 REPORT SUPPORTED TASK MANAGEMENT FUNCTIONS CDB 127
84 REPORT SUPPORTED TASK MANAGEMENT FUNCTIONS parameter data 127
85 REPORT TIMESTAMP CDB 129
86 Timestamp Descriptor 129
87 REQUEST SENSE CDB 131
88 Sense Data Format 132
89 RESERVE(6) CDB 138
90 RESERVE(10) CDB 138
91 REWIND CDB 139
92 SECURITY PROTOCOL IN - A2h CDB 140
93 SECURITY PROTOCOL OUT B5h CDB 141
94 SEND DIAGNOSTIC CDB 142
95 SET CAPACITY Command 144
96 MEDIUM FOR USE PROPORTION VALUE and resultant capacity 145
97 SET TIMESTAMP CDB 146
98 SET TIMESTAMP parameter list format 146
99 Space (6) CDB 148
100 Space(16) command 148
101 Table 355. TEST UNIT READY CDB 150
102 VERIFY (6) CDB 151
103 WRITE CDB 152
104 WRITE ATTRIBUTE CDB 153
105 WRITE ATTRIBUTE parameter list format 154
106 WRITE BUFFER CDB 156
107 WRITE FILEMARKS CDB 157
108 SIM Data Structure 163
109 SIM Data Structure 164
110 MIM Data Structure 167
111 Supported Page 80 Diag Routines 169
112 SendDiag CDB - Self Test 170

113 Primary Port Wrap Test SendDiag Parm Data 171
114 Primary Port Wrap Test Receive Diag Parm Data 171
115 SendDiag Parm Data - POST A 172
116 RcvDiag Data - POST A 173
117 SendDiag Parm Data - POST B 174
118 RcvDiag Data - POST B 175
119 SendDiag Parm Data - POST C Media Test 176
120 Table 325. POST C Media Test Receive Diag Parm Data 176
121 SendDiag Parm Data - POST D Head Test 177
122 Receive Diag Parm Data - POST D Head Test 177
123 SendDiag Parm Data - Force Dump 178
124 SendDiag Parm Data - Write Dump to Cartridge 179
125 RcvDiag Data - Write Dump to Cartridge 180
126 SendDiag Parm Data - Set Traps 181
127 SendDiag Parm Data - Remove Traps 182
128 RcvDiag Data - Remove Traps 183
129 Diag parameter data - Read Thermal Sensor 184
130 Receive Diag parameter data - Read Thermal Sensor 185
131 SendDiag Parm Data - Reset Drive 186
132 Table 14. Supported Vital Product Data Inquiry Page 190
133 Firmware Designation Page 192
134 Table 27. Unit Serial Number Inquiry Page 194
135 Device Identification VPD page 195
136 T10 vendor ID based designation descriptor 196
137 Logical Unit (NAA) - WWNN designation descriptor 197
138 Relative target port identifier designation descriptor 198
139 Port Name (NAA) - WWPN designation descriptor 199
140 Target Device Name (NAA) designation descriptor (SAS only) 199
141 Extended INQUIRY Data VPD page 201
142 Mode Page Policy page 204
143 Mode page policy descriptor 204
144 mode page policy field 205
145 Mode Page Policy for LUN 0 (SSC Device) 205
146 SCSI Ports VPD page 207
147 SCSI port designation descriptor 208
148 Target port descriptor 208
149 Protocol-Specific Logical Unit Information VPD page for SAS SSP 209
150 Logical unit information descriptor for SAS SSP 210
151 Table 23. Sequential-Access Device Capabilities Page 211
152 IP C0h: Drive Component Revision Levels 212
153 PLATFORM definition 213
154 Inquiry Page C1h: Drive Serial Numbers 214
155 Log page format 217
156 Log Parameter Format 218
157 LP 02h: Write Error Log Parameters 221
158 LP 03h: Read Error Log Parameters 222
159 LP 06h: Non-Medium Errors log parameter codes 223
160 LP 0Ch: Sequential-Access Device log parameters 224
161 LP 11h: DT Device Status log page 226
162 DT Device Status log parameters 226
163 Very high frequency data log parameter format 227
164 VHF data descriptor 227
165 Very high frequency polling delay log parameter format 231
166 Primary port status log parameter(s) format 232
167 Fibre Channel port status data format 233
168 Serial Attached SCSI port status data format 235
169 NEGOTIATED PHYSICAL LINK RATE values 235

170 LP 14h: Device Statistics log page 237
171 LP14h: Device Statistics log parameter codes 238
172 Device statistics data counter log parameter format 242
173 Device statistics medium type log parameter format 243
174 Device statistics medium type descriptor format 243
175 Device statistics string data log parameter format 244
176 LP 16h: Tape diagnostic data log page format 245
177 Tape diagnostic data log parameter format 246
178 Volume Statistics log page 248
179 Volume Statistics log subpage codes 248
180 LP 17h: Volume statistics log parameters 249
181 Volume statistics data counter log parameter format 253
182 Volume statistics string data log parameter format 253
183 Volume statistics partition log parameter format 254
184 Volume statistics partition record descriptor format 254
185 Protocol-Specific log page for SAS 255
186 Protocol-Specific Port log parameter for SAS 255
187 Parameter control byte in the Protocol-Specific Port log parameter for SAS 257
188 attached device type field 257
189 NEGOTIATED PHYSICAL LINK RATE 258
190 Data Compression log page 259
191 LP 1Bh: Data compression log parameters 260
192 Data compression counter log parameter format 261
193 Parameter codes for the Power Condition Transitions log page 262
194 Supported TapeAlerts 264
195 LP 30h: Tape Usage log parameter codes 266
196 LP 31h: Tape capacity log parameters 267
197 LP 33h: Data Compression Log Parameters 268
198 LP 33h: Write Errors log parameter codes 269
199 LP 34h: Read Error Counters log parameter codes 271
200 LP 37h: Performance Characteristics: Quality Summary 275
201 LP 37h: Performance Characteristics: Device Usage 275
202 LP 37h: Performance Characteristics: Host Commands 276
203 LP 37h: Performance Characteristics: Host Initiators 279
204 LP 37h: Performance Characteristics: Host Recovery (by port) 280
205 LP 37h: Performance Characteristics: Mode Phase Timing Windows 280
206 LP 37h: Performance Characteristics: Servo Speed Characteristics 282
207 LP 37h: Performance Characteristics: Static Capacity 283
208 LP 37h: Performance Characteristics: Active Capacity 283
209 Log Page 37h: Performance Characteristics: Static Capacity per Partition 283
210 LP 38h: Blocks/Bytes Transferred log parameter codes 284
211 LP 39h: Host Port Interface Errors log parameter codes 286
212 LP 3Ch: Drive usage information log parameters 289
213 LP 3Dh: Subsystem Statistics log parameter codes 291
214 MAM ATTRIBUTE format 295
215 MAM attribute format field 295
216 MAM attribute identifier range assignments 296
217 Device type attributes 297
218 DEVICE VENDOR/SERIAL NUMBER attribute format 298
219 Medium type attributes 299
220 MEDIUM TYPE and MEDIUM TYPE INFORMATION attributes 300
221 Host type attributes 301
222 TEXT LOCALIZATION IDENTIFIER attribute values 302
224 Vendor-Specific Medium Type Attributes 303
225 Mode Parameter List for Mode Select (6) 305
226 Mode Parameter List for Mode Select (10) 305
227 Mode Parameter Header for Mode Select (6) 305

228 Mode Parameter Header for Mode Select (10) 306
229 Block Descriptor for Mode Select 307
230 Mode Parameter List for Mode Sense (6) 308
231 Mode Parameter List for Mode Sense (10) 308
232 Mode Parameter Header for Mode Sense (6) 308
233 Mode Parameter Header for Mode Sense (10) 309
234 Block Descriptor for Mode Sense (10) or Mode Sense (6) 310
235 Mode Page Format 311
236 Mode Page Subpage Format 311
237 Read-Write Error Recovery mode page 313
238 Disconnect-Reconnect mode page 315
239 Control Extension mode page 317
240 Data Compression mode page 318
241 Device Configuration mode page 320
242 Device Configuration Extension mode page 323
243 short erase mode field 324
244 write mode field 324
245 vcelbre behavior related to encryption modes 325
246 Medium Partition mode page 326
247 Partition sizes defined by fdp, sdp, and idp bits 329
248 Fibre Channel Logical Unit mode page 331
249 SAS Logical Unit mode page 332
250 Fibre Channel Port mode page 333
251 SAS Port mode page 334
252 MP 1Ah: Power Condition mode page format 336
253 Informational Exceptions Control mode page 338
254 Medium Configuration mode page 340
255 Vendor-Specific mode page 341
256 Behavior Configuration Mode Page 343
257 Periodic Clean Notification Criteria 344
258 MP 30h: Directory Listing - Device Attribute Settings mode page format 347
259 Ethernet socket address descriptor 349
260 Sockaddr format for IPv4 349
261 Sockaddr format for IPv6 350
262 Drive MAC address 351
263 Drive port MAC address descriptor 352
264 Drive IP address and subnet mask subpage 352
265 Drive Ethernet port descriptor 353
266 SkipSync - Device attribute settings mode page format 354
267 End of partition behavior control - Device attribute settings mode page format 355
268 MP 3Eh: Engineering Support mode page 356
269 READ BUFFER header 357
270 READ BUFFER descriptor 358
271 Echo buffer descriptor 359
272 Supported Buffer IDs 360
273 Error Log Buffer (06h) 361
274 World Wide Name Buffer (08h) 362
275 SCSI Log Buffer (07h) 363
276 Active IP addresses fixed buffer format 364
277 Ethernet port fixed descriptor format 364
278 Active IP addresses variable buffer format 365
279 Ethernet port variable descriptor format 366
280 Security Protocol Specific Definitions for Security Protocol 00h 367
281 Supported Security Protocols List Structure 367
282 0001h - Certificate Data Structure 368
283 Security Protocol Specific Definitions for Security Protocol 20h 369
284 0000h - Tape Data Encryption In Support Pages Structure 369

285 Tape Data Encryption In page codes 369
286 0001h - Tape Data Encryption Out Support Pages Structure 370
287 Tape Data Encryption Out page codes 370
288 0010h - Data Encryption Capabilities page 370
289 extdecc field 371
290 cfg_p field 371
291 Data Encryption Algorithm Descriptor - Standard Encryption Structure 372
292 decrypt_c field 373
293 encrypt_c field 373
294 AVFCLP field values 373
295 nonce_c field 373
296 dkad_c field 374
297 eemc_c field 375
298 rdmc_c field 375
299 0011h - Supported Key Formats page Structure 376
300 Supported Key Formats 376
301 00h - Plaintext Key Format Structure 376
302 0012h - Data Encryption Management Capabilities page 377
303 0020h - Data Encryption Status page 378
304 parameters control field 379
305 0021h - Next Block Encryption Status page 380
306 compression status field 381
307 encryption status field 381
308 SPIN (20h[0021h]) - KAD Parameters by Mode 383
309 Random Number page 383
310 Security Protocol Specific Definitions for Security Protocol 20h 385
311 0010h - Set Data Encryption page 385
312 SPOUT (20h[0010h]) - KAD Parameters by Mode 388
314 KAD 01h - DKi (Data Key Identifier) 389
315 KAD 02h - Nonce 390
316 KAD 03h - MKAD (Metadata) 390
317 Features of the IBM Ultrium Tape Drives and the IBM 3580 Ultrium Tape Drive 393
318 Command Timeout Values (Ultrium 1, 2, and 3 Full-Height) - OpCode Sort 394
319 Command Timeout Values (Ultrium 3 Half-Height and Ultrium 4) - OpCode Sort 396
320 Command Timeout Values (Ultrium 1, 2, and 3 Full-Height) - Alphabetic Sort 397
321 Command Timeout Values (Ultrium 3 Half-Height and Ultrium 4) - Alphabetic Sort 399
322 ASC, and ASCQ Summary for Sense Key 0 (No Sense) 404
323 ASC, and ASCQ Summary for Sense Key 1 (Recovered Error) 404
324 ASC, and ASCQ Summary for Sense Key 2 (Not Ready) 405
325 ASC, and ASCQ Summary for Sense Key 3 (Medium Error) 405
326 ASC, and ASCQ Summary for Sense Key 4 (Hardware Error) 407
327 ASC, and ASCQ Summary for Sense Key 5 (Illegal Request) 408
328 ASC, and ASCQ Summary for Sense Key 6 (Unit Attention) 410
329 ASC, and ASCQ Summary for Sense Key 7 (Data Protect) 412
330 ASC, and ASCQ Summary for Sense Key 8 (Blank Check) 413
331 ASC, and ASCQ Summary for Sense Key B (Aborted Command) 413
332 ASC, and ASCQ Summary for Sense Key D (Volume Overflow) 413
333 Load ID and RU Name Designation for LTO2 415
334 Load ID and RU Name Designation for LTO3 416
335 Load ID and RU Name Designation for LTO4 417
336 Load ID and RU Name Designation for LTO5 417
337 Firmware Image 418

Figures

Page
Figure 1 — IBM System Storage Ultrium Tape Drive Models. 21
Figure 2 — Append-only mode flowchart 29
Figure 3 — Programmable early warning example 30

1. Preface

This publication contains information about how to use and program LTO5 models of the IBM® LTO Ultrium Tape Drive.

1.1 Organization

The information in this book is organized as follows:

Read This First (see clause 0. beginning on page a)
“Contents” (see page i)
“Tables” (see page xiii)
“Figures” (see page xxi)
Preface (see clause 1. beginning on page 1)
Definitions, symbols, abbreviations, and conventions (see clause 2. beginning on page 3)
Introduction (see clause 3. beginning on page 21)
Implementation Considerations (see clause 4. beginning on page 25)
SCSI Commands (see clause 5. beginning on page 63)
Parameters for SCSI Commands (see clause 6. beginning on page 159)
Summary of Drive Generation Differences (see Annex A. on page 391)
Error Sense Information (see Annex B. on page 403)
Firmware Download (see Annex C. on page 415)
Sample C program to generate Reed-Solomon CRC (see Annex D. on page 419)
Notices (see Annex E. on page 421)
“Index Of Counters (log parameters not in counter format are not included)” (see page 561)

1.2 Related Publications

a) *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.
b) *IBM Ultrium Device Drivers Programming Reference*, GC35-0483, supplies information to application owners who want to integrate their open-systems applications with IBM-supported Ultrium hardware. The reference contains information about the application programming interfaces (APIs) for each of the various supported operating-system environments.
c) *Fibre Channel Arbitrated Loop (FC-AL-2)*, published by the American National Standards Institute (ANSI) as NCITS 332:1999.
d) *Fibre Channel Tape and Tape Medium Changers (FC-TAPE)*, published by the American National Standards Institute. Final draft available as T11/99-069v4 on the web at http://www.t11.org; actual document available from ANSI as NCITS TR-24:1999.
e) *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.
f) *SCSI Parallel Interface-3 (SPI-3)*, published by InterNational Committee on Information Technology Standards (INCITS) and available on the web at http://www.t10.org.
g) *SCSI-3 Stream Commands (SSC)*, published by the American National Standards Institute and available on the web at http://www.t10.org.
h) *SCSI Stream Commands-2 (SSC-2)*, published by the American National Standards Institute and available on the web at http://www.t10.org.
i) *SCSI Primary Commands-2 (SPC-2)*, published by the American National Standards Institute and available on the web at http://www.t10.org.
j) *SCSI Primary Commands-3 (SPC-3)*, published by the American National Standards Institute and available on the web at http://www.t10.org.

k) *SCSI Primary Commands-4 (SPC-4)*, published by the American National Standards Institute and available on the web at http://www.t10.org.
l) *Automation/Drive Interface - Commands (ADC*), published by the American National Standards Institute and available on the web at http://www.t10.org.
m) *Automation/Drive Interface - Commands (ADC-2)*, published by the American National Standards Institute and available on the web at http://www.t10.org.
n) *IBM System Storage Ultrium 4 Tape Drive Setup, Operator, and Service Guide, GC27-2102*, tells how to install and run the IBM System Storage Ultrium 4 Tape Drive. The guide also describes how to administer basic service procedures.

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

2. Definitions, symbols, abbreviations, and conventions

2.1 Definitions

This clause defines the special terms, abbreviations, and acronyms that are used in this publication. If the term being looked for is not found, refer to http://www-01.ibm.com/software/globalization/terminology/index.jsp.

2.1.1 2:1 compression The relationship between the quantity of data that can be stored with compression as compared to the quantity of data that can be stored without compression. In 2:1 compression, twice as much data can be stored with compression as can be stored without compression.

2.1.2 ABEND Abnormal end of task.

2.1.3 access method A technique for moving data between processor storage and input/output devices.

2.1.4 adapter adapter card (see 2.1.5).

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

2.1.6 ADC Automation/Drive Interface Commands (see 2.1.22).

2.1.7 ADI Automation/Drive Interface (see 2.1.23).

2.1.8 ADT Automation/Drive Interface Transport (see 2.1.24).

2.1.9 AES Advanced Encryption Standard.

2.1.10 AK Authentication Key

2.1.11 AL_PA Arbitrated Loop Physical Address (see 2.1.15).

2.1.12 ALPA Arbitrated Loop Physical Address (see 2.1.15).

2.1.13 ANSI American National Standards Institute.

2.1.14 Arbitrated Loop A Fibre Channel Loop topology protocol, also known as L-port.

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

2.1.16 archiving The storage of backup files and associated journals, usually for a given period of time.

2.1.17 archiving application The retention of records, in machine-readable form, for historical purposes.

2.1.18 argument Any value of an independent variable.

2.1.19 ASC Additional Sense Code.

2.1.20 ASCQ Additional Sense Code Qualifier.

2.1.21 ASN.1 Abstract Syntax Notation One - OSI's encoding (see X.208 standard)

2.1.22 Automation/Drive Interace Commands (ADC) A T10 standard that describes the commands that are used for communication between an Automation device (i.e., Library) and a Drive (i.e., tape drive). This

command set standard is on the third generation at the time of this publication. See Project T10/1895-D, Information technology - Automation/Drive Interface Commands - 3 (ADC-3).

2.1.23 Automation/Drive Interface (ADI) The umbrella under which the T10 standards address the interface between removable media library controllers and the physical drives resident in those libraries. The standards defined are the *Automation/Drive Interface Commands* (see 2.1.22) and the *Automation/Drive Interface - Transport Protocol(see 2.1.24).*

2.1.24 Automation/Drive Interface Transport Protocol (ADT) The standard covering the Automation Drive Interface - Transport Protocol. This specific document covers the transport mechanisms between removable media library controllers and the physical drives resident in those libraries, specifically the encapsulation, logical transmission, and end-point delivery and reception of the commands associated with the ADI effort. At the time this document was published this standard was in it's second revision. T10/1742-D, Information technology - Automation/Drive Interface - Transport Protocol -2 (ADT-2)

2.1.25 backups The short-term retention of records used for restoring essential business and server files when vital data has been lost.

2.1.26 beginning of tape (BOT) The location on a magnetic tape that indicates the beginning of the permissible recording area.

2.1.27 BER Basic Encoding Rules - used with ASN.1 (see X.209 standard)

2.1.28 bezel The frame that fits over the front of the tape drive. This includes a button and a message display.

2.1.29 bit The smallest unit of data in a computer. A bit (short for binary digit) has a single binary value or either 0b or 1b.

2.1.30 block A collection of contiguous records recorded as a unit. Blocks are separated by interblock gaps, and each block may contain one or more records.

2.1.31 BOP Beginning of Partition - logical beginning of a data area (logical block 0)

2.1.32 BOT Beginning of tape.

2.1.33 bpi Bits per inch.

2.1.34 BPI Bytes per inch.

2.1.35 buffer A routine or storage used to compensate for a difference in rate of flow of data, or time of occurrence of events, when transferring data from one device to another.

2.1.36 buffered mode The buffered mode allows a number of logical blocks to accumulate in the control unit buffer before the data is transferred to the device or channel. This mode is suppressed automatically, if the record exceeds the maximum buffered capacity.

2.1.37 byte A storage unit that contains a certain number of bits (usually 8) which are treated as a unit an represent a character. A byte is a fundamental unit of data.

2.1.38 CA Contingent allegiance.

2.1.39 capacity See media capacity .

2.1.40 cartridge See tape cartridge .

2.1.41 cartridge loader A standard function for the tape drive that allows the manual loading of single tape cartridges.

2.1.42 cartridge memory An embedded non-contact electronics and interface module that can store and retrieve information relevant to the cartridge.

2.1.43 CC Check Condition.

2.1.44 CDB Command description block.

2.1.45 cleaning cartridge A tape cartridge that is used to clean the heads of a tape drive. Contrast with *data cartridge*(see 2.1.58).

2.1.46 command A control signal that initiates an action or the beginning of a sequence of actions.

2.1.47 command timeout A host controlled period of time, following the issuance of a command, after which it is determined that a bad connection or severe failing condition exists between the host and drive.

2.1.48 compaction See data compression .

2.1.49 compression See data compression .

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

2.1.51 contingent allegiance (1) A condition in which a drive owes a response to a specific channel path because of a unit check. (2) A condition generated by a check condition status during which a target preserves sense data.

2.1.52 control unit A device attached between the tape drive and one or more host systems, often to provide special protocol or attachment features or other advanced function.

2.1.53 conversion The process of changing from one method of data processing to another or from one data-processing system to another.

2.1.54 CU Control Unit - a tape controller subsystem, such as J70 (ESCON/FICON bridge)

2.1.55 DASD Direct-access storage device.

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

2.1.57 data base A set of data, consisting of at least one file, that is sufficient for a given purpose or for a given data-processing system.

2.1.58 data cartridge A tape cartridge that is dedicated to storing data. Contrast with *cleaning cartridge*(see 2.1.45).

2.1.59 data compression An algorithmic data-reduction technique that encodes data from the host and stores it in less space than unencoded data. The original data is recovered by an inverse process called decompression.

2.1.60 data compression ratio The number of host data bytes divided by the number of encoded bytes. It is variable depending on the characteristics of the data being processed. The more random the data stream, the lower the opportunity to achieve compression.

2.1.61 data transfer rate The amount of data that can be stored on a tape cartridge with respect to time.

2.1.62 dataset The major unit of data storage and retrieval, consisting of a collection of data in one of several prescribed arrangements and described by control information to which the system has access.

2.1.63 DCC Deferred Check Condition, also known as deferred unit check .

2.1.64 DDR Device Data Recovery - a write perm recovery operation performed by a control unit

2.1.65 deferred unit check A condition in which a drive returns a unit check indication for an event that occurred asynchronously with the channel commands. The deferred unit check may not refer to the command that receives the indication.

2.1.66 DER Distinguished Encoding Rules - a subset of BER

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

2.1.68 device driver An executable file or program installed on a host system used to control or access a device.

2.1.69 diagnostic A test or procedure designed to detect, recognize, locate, isolate or explain faults in equipment or errors in programs.

2.1.70 diagnostic cartridge A tape cartridge used to perform a diagnostic.

2.1.71 digest a cryptographically strong hash (i.e., SHA-x, MD-x)

2.1.72 DK Data Key - key used for encryption/decryption

2.1.73 DKI Data Key Index - a field in the EEDK(s)/SEDK and part of the DKi/IV recorded on media which associates the encryption of the record to EEDK(s) and ultimately a DK

2.1.74 DKi/IV Combined DKi and IV prepended to each record in the meta format

2.1.75 DKi=0 Data Key Index Zero - a special DKi (value of 0) which indicates that the data is encrypted with a well known method (key of all zeroes). This is used to write “non-encrypted” data in a format consistent with encryption for intermix cases

2.1.76 DKv Data Key Validator - a hash or signature which verifies a DK matches that used for data without requiring data decryption and validation via MAC. Could be an arbitrary clear text constant encrypted with the DK

2.1.77 drive A device used to store data to media and subsequently restore data from media.

2.1.78 drive dump The recording, at a particular instant, of the contents of debuf information into a buffer or onto medium for the purpose of retrieval for debug purposes.

2.1.79 drive head The component of a tape drive which converts and records an electrical signal to a magnetic signal on tape, and subsequently detects and converts such signals.

2.1.80 drive loaded A condition of a tape drive in which a tape cartridge has been inserted in the drive, and the tape has been threaded to the beginning-of-partition 0 position.

2.1.81 dump To write the contents of storage, or of a part of storage, usually from an internal storage to a external medium, for a specific purpose such as to allow other use of storage, as a safeguard against faults or errors, or in connection with debugging.

2.1.82 effective data rate The average number of bits, bytes, characters, or blocks per unit time transferred from a data source to a data sink and accepted as valid. The rate is expressed in bits, bytes, characters, or blocks per second, minute, or hour.

2.1.83 effective recording density The number of user bytes per unit of length of the recording medium.

2.1.84 eject To remove or force from within. Generally refers to the last part of the unload process to allow removal of a tape cartridge from the drive.

2.1.85 EKM External Key Manager

2.1.86 enable To provide the means or opportunity. The modification of system, control unit, or device action through the change of a software module or a hardware switch (circuit jumper) position.

2.1.87 enclosure A device, such as a desktop unit, tape cartridge autoloader, or tape library, into which a tape drive may be installed.

2.1.88 EOD End Of Data - a dataset denoting the end of user data

2.1.89 EOP End of partition.

2.1.90 EOT End of tape.

2.1.91 ERA Error-recovery action performed by the host.

2.1.92 ERP See error-recovery procedures (ERP)

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

2.1.94 error-recovery procedures (ERP) (1) Procedures designed to help isolate and, where possible, to recover from errors in equipment. The procedures are often used in conjunction with programs that record the statistics of machine malfunctions. (2) Error-recovery procedures performed by the subsystem.

2.1.95 explicitly activated A process in which the attributes of an identifier are specified. Contrast with implicitly activated .

2.1.96 extended contingent allegiance (1) A condition caused by a permanent buffered-write error in which the drive responds only to the channel path group from which the write command was received. The extended contingent allegiance continues until a controlling computer in the channel path group retrieves the unwritten data from the buffer or issues a tape motion command. (2) A condition generated by an initiate recovery message to assist in extended error recovery procedures in multi-initiator systems.

2.1.97 F-port Fabric port.

2.1.98 FC Fibre Channel .

2.1.99 FCP Fibre Channel Protocol - the SCSI mapping to fibre channel

2.1.100 fiber A physical communications cable or connection used to attach two or more Fibre Channel devices.

2.1.101 Fibre Channel A standard interconnection interface used to attach host systems and/or peripheral devices.

2.1.102 FID Format Identification Dataset.

2.1.103 field replaceable unit (FRU) An assembly that is replaced in its entirety when any one of its components fails.

2.1.104 file A set of related records, treated as a unit; for example, in stock control, a file could consist of a set of invoices.

2.1.105 file protected Pertaining to a tape volume from which data can be read only. Data cannot be written on or erased from the tape.

2.1.106 filemark A logical demarcation, recorded on media, often used to separate files or provide other organizational structure to recorded data. Usage and convention of filemarks is controlled by the attached host system(s).

2.1.107 FIPS Federal Information Processing Standards

2.1.108 firmware Proprietary code that is usually delivered as part of an operating system or device. Firmware is more efficient than software loaded from an alterable medium, and is more adaptable to change than hardwired embedded logic.

2.1.109 FL-port Fabric loop port.

2.1.110 FMR Field microcode replacement.

2.1.111 format The arrangement or layout of data on a data medium.

2.1.112 FRU Field replaceable unit (see 2.1.103).

2.1.113 GB See gigabyte (GB).

2.1.114 Gb See gigabit (Gb).

2.1.115 GCM Galois Counter Mode

2.1.116 gigabit (Gb) 1 000 000 000 bits of storage.

2.1.117 gigabyte (GB) 1 000 000 000 bytes of storage.

2.1.118 hard addressing A method of specifying a fixed address for a device in a Fibre Channel loop configuration.

2.1.119 hardware The physical equipment or components that form a device or system.

2.1.120 HBA host bus adapter .

2.1.121 head See drive head

2.1.122 host bus adapter A specific type of adapter card which provides the connection to a physical device interconnect such as Fibre Channel.

2.1.123 host system A data-processing system that is used to prepare programs and the operating environments for use on another computer or controller.

2.1.124 IBM Proprietary Protocol (IPP) IBM vendor-specific method of configuring and controlling encryption

2.1.125 IBM Tape Diagnostic Tool (ITDT) The ITDT Tool offers multiple functional capabilities that simplify the task of updating tape and library firmware. It is available for most major platforms and requires no special device drivers. See
http://www-933.ibm.com/support/fixcentral/options?productGroup0=ibm/StorageSystems&productGroup1=ibm/Storage_Tape&productGroup2=ibm/ST/Tapedevicedriversandsoftware&productGroup3=ibm/Storage_Tape/IBM+Tape+Diagnostic+Tool+ITDT

2.1.126 ID identifier

2.1.127 implicitly activated A process in which the attributes of an identifier are determined by default. Contrast with explicitly activated .

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

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

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

2.1.131 interchange application The preparation of tapes for use on other systems or devices, either local or remote, or the use of tape data prepared by another system.

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

2.1.133 invoke To petition for help or support. The request for a feature or function to be utilized in future processing activities through the use of software or hardware commands.

2.1.134 I/O Input/output (see 2.1.129).

2.1.135 IPP IBM Proprietary Protocol (IPP).

2.1.136 ITDT IBM Tape Diagnostic Tool (see 2.1.125).

2.1.137 IV Initialization Vector - a value also called a nonce, used with a key for AES block ciphers

2.1.138 journaling Recording transactions against a dataset so that the dataset can be reconstructed by applying transactions in the journal against a previous version of the dataset.

2.1.139 KB See kilobyte .

2.1.140 Kb See kilobit .

2.1.141 kilobit 1024 bits of storage.

2.1.142 kilobyte 1024 bytes of storage.

2.1.143 L-port Arbitrated Loop Fibre Channel host connection. May attach to a fabric (switch) FL-port.

2.1.144 LDI Library Drive Interface - a specific interface protocol for tape device to automation interface (over RS422)

2.1.145 LEOT logical end of tape

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

2.1.147 LN-port Fibre Channel host attachment which attempts to negotiate first to Arbitrated Loop, then Point-to-Point. May attach to a fabric (switch) FNL-port.

2.1.148 load Following the insertion of a tape cartridge into the device, the act of positioning the tape (performed by the drive) for subsequent reading or writing.

2.1.149 load point The beginning of the recording area on magnetic tape.

2.1.150 loader See cartridge loader

2.1.151 logical end of tape A point on the tape where written data normally ends.

2.1.152 LPOS Longitudinal Position.

2.1.153 LSB Least significant byte.

2.1.154 lsb Least significant bit.

2.1.155 LTO Linear Tape Open (see 2.1.146).

2.1.156 LTO-DC LTO Data Compression (see 2.1.157).

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

2.1.158 LUN Logical unit number.

2.1.159 MAC Message Authentication Code - a digest which validates encrypted data. Appended to the record in the meta format for encryption integrity validation

2.1.160 magnetic recording A technique of storing data by selectively magnetizing portions of a magnetizable material.

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

2.1.162 magnetic tape drive A mechanism for moving magnetic tape and controlling its movement.

2.1.163 MAM Medium Auxiliary Memory (see 2.1.173).

2.1.164 Management Information Base (MIB) A computing information repository used by Simple Network Management Protocol (SNMP)

2.1.165 manual mode A mode of operation that can be selected on a cartridge loader or library. This mode allows a single tape cartridge feed, performed by the operator.

2.1.166 MB See megabyte (MB).

2.1.167 Mb See megabit (Mb).

2.1.168 mebibit (Mib) 1 048 576 bits of storage

2.1.169 mebibyte (MiB) 1 048 576 bytes of storage

2.1.170 media Plural of medium.

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

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

2.1.173 Medium Auxiliary Memory (MAM) A non-volatile memory. MAM is used to store data that describes the media and its contents.

2.1.174 megabit (Mb) 1 000 000 bits of storage.

2.1.175 megabyte (MB) 1 000 000 bytes of storage.

2.1.176 Mib mebibit (see 2.1.168).

2.1.177 MIB management information base (see 2.1.164).

2.1.178 MiB mebibyte (see 2.1.169).

2.1.179 microcode Embedded device programming which controls the behavior and functioning of the device.

2.1.180 microprocessor An integrated circuit that accepts coded instructions for execution; the instructions may be entered, integrated, or stored internally.

2.1.181 microsecond (us) One millionth of a second (0.000 001 s).

2.1.182 migration See conversion .

2.1.183 millisecond (ms) One thousandth of a second (0.001 s)

2.1.184 MIM Medium Information Message.

2.1.185 msb Most significant bit.

2.1.186 MSB Most significant byte.

2.1.187 N-port Point-to-Point Fibre Channel host connection. May attach to a fabric (switch) FL-port.

2.1.188 N/A Not Applicable.

2.1.189 native data transfer rate The amount of data that can be stored without compression on a tape cartridge with respect to time.

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

2.1.191 NL-port Fibre Channel host attachment which attempts to negotiate first to Point-to-Point, then Arbitrated Loop. May attach to a fabric (switch) FL-port.

2.1.192 node Fibre channel term for the logical connection to a device.

2.1.193 nonce number used once - a value used in conjunction with the key for AES block ciphers (also IV)

2.1.194 OEM Original equipment manufacturer.

2.1.195 offline An operating condition where the host system cannot interact with the drive through the specified interface.

2.1.196 online An operating condition where the host system can interact normally with the drive through the specified interface.

2.1.197 OOB Out-Of-Band

2.1.198 open system Computer systems whose operating standards and methods are not proprietary.

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

2.1.200 OSI Open Systems Interconnection - (see X.200 standard)

2.1.201 overwrite A write operation that records a logical object in a logical position that is not an append point (see 4.1.3).

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

2.1.203 PEOT physical end of tape (PEOT)

2.1.204 physical end of tape (PEOT) A point on the tape beyond which the tape is not permitted to move.

2.1.205 PKCS Public-Key Cryptography Standards

2.1.206 POR Power-on reset.

2.1.207 port Fibre channel or SAS term for the physical connection to a device.

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

2.1.209 power-on To apply electrical power to a device.

2.1.210 powered-on The state of a device when power has been applied to it.

2.1.211 primed Pertaining to a condition of a tape drive when the controlling computer addresses the drive but the drive is not in a ready state.

2.1.212 PRNG Pseudo Random Number Generator

2.1.213 processing application The execution of a systematic sequence of operations performed on data to accomplish a specific purpose.

2.1.214 Program Temporary Fix A temporary solution to a problem in the microcode.

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

2.1.216 PTF Program Temporary Fix

2.1.217 quiesce To bring a device or system to a halt by a rejection of new requests for work.

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

2.1.219 read-type commands Any commands that cause data to be read from tape.

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

2.1.221 record A collection of related data or words, treated as a unit; for example, in stock control, each invoice could constitute one record.

2.1.222 recording density The number of bits in a single linear track measured per unit of length of the recording medium.

2.1.223 reset To return a device, circuit, or value to a clear state.

2.1.224 retension (or refresh) The process or function of tightening the tape onto the cartridge, if it is sensed that the tape has a loose wrap on the cartridge.

2.1.225 RS-422 connector Located at the rear of the device, the connector to which the internal RS-422 cable of an enclosure connects. The connection enables serial devices to communicate with the drive.

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

2.1.227 RSA Method authored by Rivest, Shamir, Adleman

2.1.228 s second

2.1.229 SAN Storage Area Network.

2.1.230 SAS Serial Attached SCSI

2.1.231 SCSI Small Computer System Interface.

2.1.232 SCSI address The octal representation of the unique address (0-F) assigned to a SCSI device. This address would normally be assigned and set in the SCSI device during system installation.

2.1.233 SCSI device A host adapter or a target controller that can be attached to the SCSI bus.

2.1.234 SCSI ID The identifier used to uniquely identify the address on the bus. When used on Fibre Channel devices this refers to the AL_PA.

2.1.235 SCSI Sense Data In response to a command from the server, a packet of SCSI sense bytes that contains information about the error that is sent back to the server by the drive in autosense. SCSI Sense Data may also be returned by the REQUEST SENSE command, but that sense data is usually no sense.

2.1.236 sense data See SCSI sense data (see 2.1.235).

2.1.237 Serial Attached SCSI (SAS) A transport for exchanging information between SCSI devices using a serial interconnect.

2.1.238 server A functional unit that provides services to one or more clients over a network. Synonymous with host system (see 2.1.123).

2.1.239 SHA Secure Hash Algorithm (can be SHA-256, SHA-384, SHA-512, for bit size)

2.1.240 SIM Service Information Message.

2.1.241 Small Computer Systems Interface (SCSI) A standard used by computer manufacturers for attaching peripheral devices (such as tape drives, hard disks, CD-ROM players, printers, and scanners) to computers (servers). Pronounced "scuzzy."

2.1.242 soft addressing A method of specifying a standard arbitration method for assigning an address for a device in a Fibre Channel loop configuration.

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

2.1.244 special feature A specific design addition to an IBM product that is quoted in the IBM Sales Manual and ordered separately.

2.1.245 standard function The significant design elements of an IBM product that are included as part of the basic standard product.

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

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

2.1.248 synchronization The process of coordinating the activities of the controlling computer and the magnetic tape subsystem to obtain the condition in which the buffer is empty and the tape is in the correct position for the next operation.

2.1.249 T10 ANSI group responsible for SCSI model and command sets, see http://www.t10.org

2.1.250 T11 ANSI group responsible for FCP/fibre channel protocols, see http://www.t11.org

2.1.251 tape Commonly refers to magnetic tape or the tape cartridge.

2.1.252 tape cartridge A container holding magnetic tape that can be processed without separating it from the container.

2.1.253 tape drive A device that is used for moving magnetic tape and includes the mechanisms for writing and reading data to and from the tape.

2.1.254 tape unit A device that contains tape drives and their associated power supplies and electronics.

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

2.1.256 TapeAlert flags Status and error messages that are generated by the TapeAlert utility and are reported to a host system.

2.1.257 target A SCSI device that performs an operation requested by the initiator.

2.1.258 target routine A target routine is an I/O process directed to a target, and not to a logical unit.

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

2.1.260 transfer rate See data transfer rate (see 2.1.61).

2.1.261 TRNG True Random Number Generator

2.1.262 TSM Tivoli Storage Manager

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

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

2.1.265 URL See uniform resource locator (see 2.1.263).

2.1.266 universal time (UT) The time at longitude zero, colloquially known as Greenwich Mean Time. See http://www.usno.navy.mil/USNO/time/master-clock/systems-of-time.

2.1.267 vital product data Non-volatile information including configuration, calibration, etc., used to control the behavior and operation of the device.

2.1.268 volume (1) A certain portion of data, together with its data carrier, that can be handled conveniently as a unit. (2) A data carrier that is mounted and demounted as a unit, for example, a reel of magnetic tape, a disk pack.

2.1.269 volume coherency set: A set of information contained in logical objects including a volume coherency count (see 4.13) for which coherency across an entire volume is desired.

2.1.270 VPD Vital Product Data - information stored in drive nonvolatile memory

2.1.271 web See World Wide Web (see 2.1.273).

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

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

2.1.274 WORM (Write Once, Read Many) A write or append methodology for allowing data to be written only once, disallowing overwriting.

2.1.275 write To store or encode data to a storage device, to data medium, or to another source.

2.1.276 Write Once, Read Many (WORM) A write or append methodology for allowing data to be written only once, disallowing overwriting.

2.1.277 write protected A state disallowing write operations to a device or medium.

2.1.278 write-type commands Any commands that cause data to be written on tape or affect buffered write data.

2.2 Conventions

2.2.1 Bit Numbering

Bit numbering follows ANSI standards as follows:

- Bit 7 is the most significant bit (MSB) occupying the leftmost bit position in the diagrams
- Bits 6 through 1 continue from left to right in descending order
- Bit 0 is the least significant bit (LSB) occupying the rightmost bit position in the diagrams

2.2.2 Units of measure for data storage

This document uses MB and GB as powers of ten (i.e., MB = 1 000 000 and GB = 1 000 000 000) unless explicitly stated otherwise. This document uses powers of 2 for KB (i.e., KB = 1024).

2.2.3 Subpages

When pages have subpages (e.g., Mode Pages, Log Pages) the convention used for Page XXh Subpage YYh is Page XXh[YYh].

When describing Security Protocol XXh with Security Protocol Specific YYYYh in the Security Protocol In command or the Security Protocol Out command XXh[YYYYh] is used.

2.2.4 Text Markers

The source files of this document contains conditional text to aid in maintaining the various versions that are generated from these files. During editing and review, these conditional texts have specific markers that delineate which condition they relate to. These markers include color, underlines, overlines, etc. Those markers contained in this version of the document are:

a) Text contained in all versions of the document (Unconditional)
b) Text contained in the external version that is replaced by text in the encryption version of the document (Crypto-Removed)
c) Text in the external version that is replaced by text in the Internal version of the document (Internal-Removed)
d) Text that is removed due to an FCR that had not yet been implemented in code (Future-Removed)

2.2.5 Hyperlinks

This document contains many hyperlinks. Every place the text says “see clause number” should be a hyperlink. Hyperlinks have been given a special font to offset them from the rest of the text. That font is demonstrated in this following link (see 2.2.5)

2.3 Tape Drive Model Names

From this section forward, through the remainder of this book, LTO5 Tape Drive models are referred to collectively as the LTO tape drive, the Ultrium tape drive or the 3580 tape drive. LTO5 has both a Full-High version and a Half-High version, they will be referred to as FH for Full-High and HH for Half-High.

3. Introduction

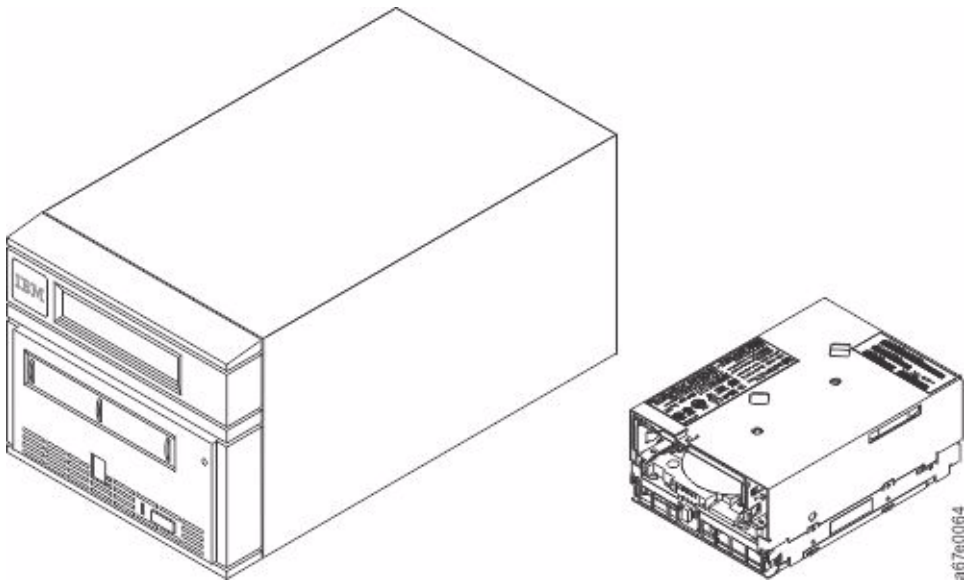
3.1 Drive Overview

The products that are discussed in this book are high-performance, high-capacity data-storage devices that connect to and provide additional storage for supported servers. They include the LTO5 models of the IBM® LTO Ultrium Tape Drive.

All products use the Small Computer Systems Interface (SCSI) Architecture Model. The transports used are shown in table 1.

Figure 1 shows the IBM 3580 Ultrium Tape Drive and the IBM System Storage LTO Ultrium Tape Drive Model T200. The IBM System Storage TS2350 Tape Drive Express is similar to the IBM System Storage LTO Ultrium Tape Drive Model T200 and the IBM System Storage TS2250 Tape Drive Express is half the height.

Figure 1 — IBM System Storage Ultrium Tape Drive Models.



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

Table 1 — Features of the IBM Ultrium Tape Drives and the IBM 3580 Ultrium Tape Drive (part 1 of 2)

Feature	Ultrium 5	Ultrium 5 Half-Height
Native storage capacity	1500 GB	1500 GB
Storage capacity at 2:1 compression	3.0 TB	3.0 TB
Native sustained data transfer rate	140 MB/s	140 MB/s
Data transfer rate at 2:1 compression	280 MB/s	280 MB/s
Burst data transfer rate (1GFC)	100 MB/s	100 MB/s
Burst data transfer rate (2GFC)	200 MB/S	200 MB/S

Table 1 — Features of the IBM Ultrium Tape Drives and the IBM 3580 Ultrium Tape Drive (part 2 of 2)

Feature	Ultrium 5	Ultrium 5 Half-Height
Burst data transfer rate (4GFC)	400 MB/s	400 MB/s
Burst data transfer rate (8GFC)	800 MB/s	800 MB/s
Burst data transfer rate (3G SAS)	300 MB/s	300 MB/s
Burst data transfer rate (6G SAS)	600 MB/s	600 MB/s
Type of interface	LC-D[a] SAS[b]	LC-D[a] SAS[b]

Note - All sustained data rates are dependent on the capabilities of the interconnect (for example, a 8GFC link is limited to less than 800MB/sec).
[a] LC-D: LC-Duplex Fibre Channel, with the use of SCSI protocol
[b] SAS: Serial-Attached SCSI

3.2 Supported Servers and Operating Systems

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

3.2.1 Primary Interface Attachment

The Ultrium Tape Drives attach to servers and operating systems shown in table 2. An attachment includes (but is not limited to) the servers and operating systems in the table.

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

a) IBM System Storage TS2350 Tape Drive Setup, Operator, and Service Guide, GC27-2277-00.

Table 2 — Supported Servers and Operating Systems for Primary Interface Attachment

Supported Servers	Supported Operating Systems
IBM Power Systems	IBM i®
IBM Power Systems	AIX®
IBM Power Systems	Linux®
Hewlett-Packard	HP-UX
Sun Microsystems	Solaris
32-bit, Intel-compatible servers	Microsoft Windows 2000 or Windows NT®
	Red Hat Linux
64-bit, Intel® Itanium® servers	Red Hat Linux
Supported SAN Components for Fibre Channel Attachment Visit the web at:http://www-03.ibm.com/systems/support/storage/ssic/interoperability.wss	

3.3 Supported Device Drivers

IBM maintains the latest levels of device drivers and driver documentation for the IBM Ultrium Tape Drives on the Internet. You can access this material from your browser or through the IBM FTP site by performing one of the

following procedures. **(Note: If you do not have Internet access and you need information about device drivers, contact your Marketing Representative.)**

Using a browser, go to one of the following websites:

a) The IBM storage website at http://www.ibm.com/storage; or
b) The IBM Fix Central website at http://www.ibm.com/support/fixcentral. This is a portal to enter the download area. There are a few pull down menus to get you to the correct download as follows:
   1) in menu labeled "Product Group" select "Storage Systems";
   2) in menu labeled "Product Family" select "Tape Systems";
   3) in menu labeled "Product Type" select "Tape Device Drivers and Software";
   4) in menu labeled "Product" select "Tape Device Drivers";
   5) in menu labeled “Platform” select the correct operating system. You can select the generic form of the platform (e.g., Linux) and all device drivers for that platform will come up;
   6) click continue; and
   7) select the checkbox(es) of the fix pack(s) needed and click continue.

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

a) IBM_Tape_Driver_IUG.pdf contains the current version of the *IBM Tape Device Drivers Installation and User’s Guide*
b) IBM_Tape_Driver_PROGREF.pdf contains the current version of the *IBM Tape Device Drivers Programming Reference*

3.4 Supported Tape Cartridges

The IBM LTO Ultrium Tape Drives support LTO Cartridges as described in table 3

Table 3 — Table 3. IBM LTO Ultrium Tape Drive Support of LTO Cartridges

LTO Generation	Type	Data Capacity Native	Data Capacity Compressed	Supported by
				Ultrium 5 Drive
5	A	1600 GB	3200 GB	Write and Read
4	A	800 GB	1600 GB	Write and Read
3	A	400 GB	800 GB	Read Only
Ultrium Tape Drives reads tapes that have been written by other licensed Ultrium drives. Ultrium Tape Drives write tapes that can be read by other licensed Ultrium drives. Ultrium Tape Drives offer read/write capability for certified LTO Ultrium tape cartridges as specified in this table. The tape cartridges define the format to which it is written. (for example Ultrium 4 cartridges can only be written to Ultrium 4 format regardless of which generation drive writes it.				

The Ultrium 5 Tape Drive (Generation 5) uses the IBM TotalStorage 1600 GB Data Cartridge, and is compatible with the cartridges of its predecessors (called Generation 3 and Generation 4). The Ultrium 5 Tape Drive performs the following functions:

a) Reads and writes Generation 5 cartridges to Generation 5 format
b) Reads and writes Generation 4 cartridges to Generation 4 format
c) Reads Generation 3 cartridges in Generation 3 format
d) Does not write Generation 5 cartridges to other generations' format
e) Does not write Generation 4 cartridges to other generations' format
f) Does not write Generation 3 cartridges to other generations' format
g) Does not write or read Generation 1 cartridges or Generation 2 cartridges in any format

3.5 Microcode Detection of Errors

The drive microcode is designed to check for logic errors, to handle hardware-detected errors, and to detect and report microcode-related errors.

3.5.1 Fencing Behavior

For a description of the Fencing Behavior and Persistent Error handling, see Persistent Errors.

4. Implementation Considerations

4.1 Write modes

4.1.1 Write mode introduction

Write modes of the device entity specify the allowable behaviors for altering logical objects on a mounted volume. When the write mode rules allow altering of logical objects then the operation shall be processed following the write protection rules defined in SSC-4 clause 4.2.14 (i.e., Write Protection).

4.1.2 Write-anywhere mode

Write-anywhere mode is used to allow alteration of any logical object on the medium. Write-anywhere mode is enabled or disabled using the WRITE MODE field of the Device Configuration Extension mode page (see 6.5.11). This mode is set in the device entity to enable device server behaviors. The write-anywhere mode does not modify the volume. When the volume is removed from the device no indication of whether write-anywhere mode is enabled or disabled is carried with the volume.

When write-anywhere mode is enabled in the drive, then any command that would result in a write shall be processed normally. If the mounted volume is a WORM volume, then a write type command shall be processed following the WORM rules.

4.1.3 Append-only mode (also known as Data-safe mode)

Append-only mode is used to protect data from being accidently overwritten. Sometimes, due to errors in the configuration of the environment an application client attempts to rewind a drive that it is not transferring data to. Without append-only mode, if the application client writing to the logical unit has not reserved the logical unit, then a different application client is allowed to rewind the volume causing an accidental overwrite of the medium. With append-only mode enabled, the medium is not allowed to be overwritten.

Append-only mode is enabled or disabled using the WRITE MODE field of the Device Configuration Extension mode page (see 6.5.11).This mode is set in the device server to enable device server behaviors. The append-only mode does not modify the volume. When the volume is removed from the device it behaves as a normal volume.

When append-only mode is enabled in the drive, then any command that would result in a write to a location that is not an append point shall be rejected with a CHECK CONDITION, DATA PROTECT, OPERATOR SELECTED WRITE PROTECT (7h / 5A02h) and TapeAlert 09h shall be set. An append point shall be:

a) the logical position zero if there are no logical objects beyond BOP;
b) the current logical position if:
   A) the current logical position is at BOP; and
   B) there are only filemarks between the current logical position and EOD;
c) the current logical position if:
   A) the current logical position is between BOP and EOD;
   B) there are only filemarks from the current logical position to EOD; and
   C) there is at least one filemark immediately before the current logical position;

or

d) the current logical position if the current logical position is at EOD.

The device server maintains an allow_overwrite variable. The allow_overwrite variable defines what operation is currently allowed when in append-only mode. The allow_overwrite variable values are defined in table 4.

Table 4 — allow_overwrite variable definition

Name	Description
Disabled	A write type operation at a position that is not an append point is not allowed.
Current Position	A write type operation is allowed at the position specified by the allow_overwrite_position variable.
Format	An operation that modifies the format of the medium is allowed

The allow_overwrite_position variable specifies the position (i.e., partition and logical object identifier) at which a write to a position that is not an append point is allowed.

Append-only mode is a function of the device server and is not a function of the volume. Append-only mode may be used when accessing Data Volumes or WORM volumes. An application client may overwrite data by using a special command called the ALLOW OVERWRITE command (see 5.2.1). The ALLOW OVERWRITE command specifies the logical position where the overwrite is to occur. After succesfully processing an ALLOW OVERWRITE command, a write type command at the specified position is processed normally. If the position of the medium is changed or the volume is unmounted, then the device server shall set the allow_overwrite variable to Disabled (i.e., 0h) and the allow_overwrite_position variable to invalid. The ALLOW OVERWRITE command requires the partition number and the logical position to be passed in the CDB. If the position information passed in the ALLOW OVERWRITE command does not specify the current position of the medium, then the command is terminated with CHECK CONDITION status with the sense key set to ILLEGAL REQUEST and the additional sense code set to SEQUENTIAL POSITIONING ERROR. If there is no volume loaded and the device server processes an ALLOW OVERWRITE command, then the command is terminated with CHECK CONDITION status with sense key set to NOT READY.

An ALLOW OVERWRITE command that returns GOOD status shall:

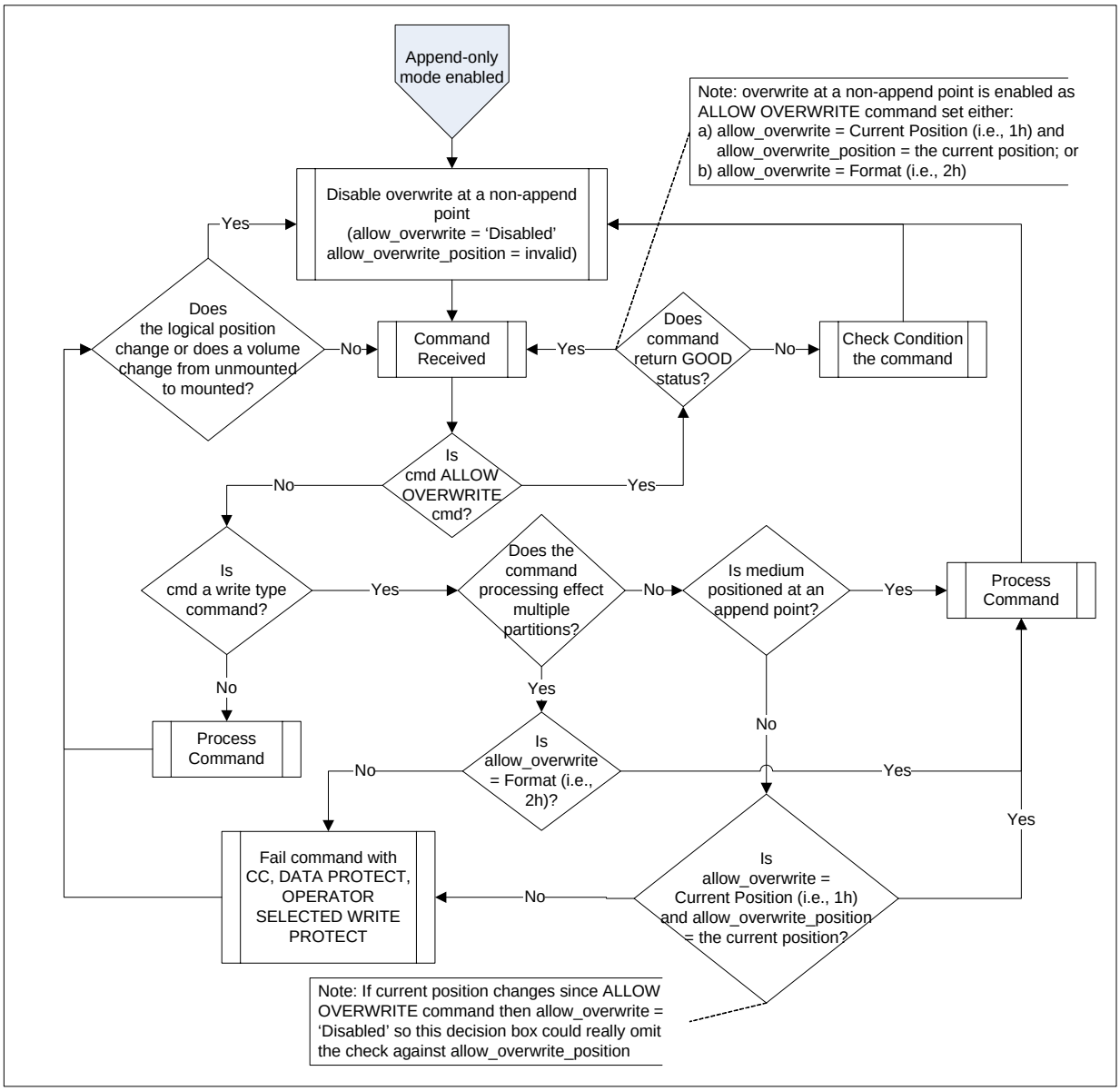
a) set the allow_overwrite variable to the value in the ALLOW OVERWRITE field of the ALLOW OVERWRITE command; and
b) set the allow_overwrite_position variable to the current position.

An ALLOW OVERWRITE command that returns a CHECK CONDITION shall:

a) set the allow_overwrite variable to Disabled (i.e., 0h); and
b) set the allow_overwrite_position to invalid.

If append-only mode is enabled, the mounted volume is a WORM volume, and the allow_ovewrite variable is not set to Disabled, then a write type command shall be processed following the WORM rules. Figure 2 shows a representative flowchart of append-only mode behavior.

Figure 2 — Append-only mode flowchart



If the ALLOW OVERWRITE command is received by the device server and append-only mode is not enabled, the command will be rejected with CHECK CONDITION, ILLEGAL REQUEST, ILLEGAL COMMAND WHEN NOT IN APPEND-ONLY MODE.

When in append-only mode the allow_overwrite variable shall be set to Disabled (i.e., 0h) and the allow_overwrite_position variable shall be set to invalid if:

a) the WRITE MODE field of the Device Configuration Extension mode page changes to a value of 01h (i.e., The write-type operation shall only allow appends as specified for the append-only mode in 4.1.3);
b) a change in logical position occurs;
c) a volume changes state from unmounted to mounted;
d) the CDB of a write type command is validated and the write processing begins; or
e) an ALLOW OVERWRITE command returns a CHECK CONDITION.

4.2 Programmable early warning

When writing, the application client may need an indication prior to early warning to allow for the application client to prepare to be ready for early warning (e.g., flush buffers in the application client).

Application clients that need this indication may request the device server to create a zone called the programmable-early-warning zone (PEWZ) by setting the PEWS field (see 6.5.8) to the requested size of the PEWZ. The EOP side of PEWZ is established at early-warning and extends towards BOP for a distance indicated by the PEWS field. See figure 3.

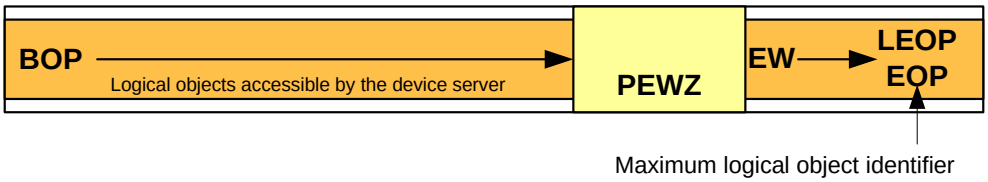


Figure 3 — Programmable early warning example

WARNING WARNING

If PEWZ is used, all applications that may access the drive when a PEWZ exists, should support PEWZ or there is a risk of the application that does not support PEWZ detecting an unknown error or a diminished capacity when the PROGRAMMABLE EARLY WARNING error is reported.

WARNING WARNING

The REW bit in the Device Configuration mode page (see 6.4.10) shall have no effect on the device server behavior in the PEWZ.

The device server shall return CHECK CONDITION status, with the sense key set to NO SENSE, the EOM bit set to one and the additional sense code set to PROGRAMMABLE EARLY WARNING DETECTED at the completion of a command that caused the medium to transition into the PEWZ if that command is:

a) WRITE(6);
b) WRITE(16);
c) WRITE FILEMARKS(6); or
d) WRITE FILEMARKS(16).

Encountering the PEWZ shall not cause the device server to perform a synchronize operation or terminate the command. If processing this command results in any other exception condition except early-warning, the CHECK CONDITION status associated with that exception condition shall be reported instead. If early-warning is crossed prior to the PROGRAMMABLE EARLY WARNING DETECTED additional sense being reported, the PROGRAMMABLE EARLY WARNING DETECTED additional sense shall be reported before the early-warning CHECK CONDITION.

If the PROGRAMMABLE EARLY WARNING DETECTED additional sense code was not reported, the next write in PEWZ or beyond early-warning that would otherwise complete with GOOD status, shall return the programmable-early-warning CHECK CONDITION instead.

If the PEWZ is entered and exited on the BOP side before the PROGRAMMABLE EARLY WARNING DETECTED additional sense code is returned, the device server shall not report CHECK CONDITION status with the additional sense code set to PROGRAMMABLE EARLY WARNING DETECTED.

4.3 Multiple Port Behavior

There are two primary ports in the device and may be either Fibre Channel ports or SAS ports. The two primary ports provide alternate paths through which the logical unit(s) of the device may be reached. The ports are referred to as Port 0 (or alternately, Relative Target Port 1) and Port 1 (or alternately, Relative Target Port 2). Each port maintains its own unique settings and address.

If the device is contained in a library or medium changer, the library may enable (also known as online) or disable (also known as offline) each port independently.

When an offline port is set online, all initiators on that port receive a Unit Attention condition.

Offline ports do not generate or maintain Unit Attention conditions for initiators while the port is in an offline state.

Usage of the device with both ports online is required for dual port failover to function correctly. Generally, all initiators, regardless of port, are treated the same as multiple initiators on the same port. The exception to this is the handling of mode pages and reservations when a hard port reset condition occurs (such as loss of light, etc). The following rules are described with respect to a local interface (the host port on which the hard reset condition occurred) and a remote interface (the other host port to which the device is attached).

e) If there are no reservations when a hard reset condition occurs, all mode pages are reset. All initiators on the local interface receive a Unit Attention condition for Power On, Reset, or Device Reset Occurred. All initiators on the remote interface receive a Unit Attention condition for Mode Parameters Changed.
f) If there are one or more reservations when a hard reset condition occurs and all reservations were granted to initiators on the local interface, all mode pages are reset and all SPC-2 reservations are reset. All persistent reservations remain in effect. All initiators on the local interface receive a Unit Attention condition for Power On, Reset, or Device Reset Occurred. All initiators on the remote interface receive a Unit Attention condition for Mode Parameters Changed.
g) If there are one or more reservations when a hard reset condition occurs and one or more of the reservations were granted to an initiator on the remote interface, only those mode pages and SPC-2 reservations unique to each initiator on the local interface are reset. Mode pages and reservations unique to each initiator on the remote interface are not reset. Mode pages which are defined as common to all initiators are not reset. All initiators on the local interface receive a Unit Attention condition for Power On, Reset, or Device Reset Occurred. All initiators on the remote interface see no effects of the hard reset condition on the other interface.

4.4 Data Transfer, Block Limits, and Fixed Block Option

This device is designed to buffer multiple records. Logical blocks may be prefetched to the buffer before they are requested by a READ command or held in the buffer after they are written by a WRITE command. For successive sequential-motion operations, the presence of the buffering in the device does not adversely affect the performance of the subsystem. Non-sequential motion does not result in errors, but may result in delays because of requirements to synchronize buffers or discard read ahead data. Buffer management in the device determines when to read additional data from the medium into the buffer, or when to write data from the buffer to the medium. A logical block is not written to tape until the block is entirely received into the buffer.

When the FIXED bit of the command is set to 1b,each command transfers zero or more logical blocks. The subsystem takes appropriate action to assemble or disassemble the logical blocks being transferred over the interface so that they remain independent blocks on the medium. There is no guarantee that the group of blocks transferred by the Write command is requested as a group by a subsequent Read command, so the device must be prepared to assemble and disassemble on a block boundary. This is managed by treating all blocks and filemarks as independent from one another, both for data compaction and for recording.

When the FIXED bit of the command is set to 0b, each command transfers a single logical block.

After EOP is reached on any WRITE command, only a single block is transferred before terminating the command with check condition status 0/0000 (NO SENSE, NO ADDITIONAL SENSE INFORMATION) and EOM set to 1b.The same is true for WRITE FILEMARK commands.

The device supports a minimum logical block length of 1 and a maximum logical block length of 16 777 215 (FF FFFFh) bytes if encryption is not being used and 8 388 608 (80 0000h) bytes if encryption is being used. Any block length between the limits is also supported. Refer also to READ BLOCK LIMITS - 05h (see 5.2.16 on page 103) for further information on block sizes and limitations. The READ BLOCK LIMITS command may report a lowe maximum value depending on the devices support of Encryption and Logical Block Protection. This is done to ensure that an application will not attempt to write a larger block size than can be read when one of these features is enabled.

For read type commands, including READ and VERIFY, transfer lengths larger than the maximum device supported block size are accepted and the underlength condition rules are applied for transfer requests bigger than the actual block size. A transfer Length of 000000h indicates that no bytes/blocks are transferred. This condition is not considered an error and the logical position is not changed.

For write type commands, including WRITE, and WRITE FILEMARKS, a transfer Length of 000000h indicates that no bytes/blocks are transferred. This condition is not considered an error and the logical position is not changed.

4.5 Request Sense Information, ILI, and Command Interactions

The behavior and interactions between some of the commands and the INFORMATION and ILI fields in Request Sense are rather complicated. This section details the various commands which may set the information or ILI fields, and summarizes the relationship between such commands, their parameters, the encountered conditions, the reported status, and the expected behavior of these fields and the resulting device position.

4.5.1 General Read-Type Handling

Commands which return block data from media or the buffer to the host have the same general behavior. These commands include READ and VERIFY. The major difference between these is whether or not data is returned to the host.

The block at the current position is processed first, and subsequent blocks are processed in the order they were written (proceeding towards logical end of partition). The ending position is after the last block processed. For these commands, “after” will refer to the start of the next block towards the logical end of partition, and “before” will refer to the start of referenced block.

To illustrate this, from location 'N', a Read operation will return block 'N', and be positioned at 'N+1' (“after” N).

A successful command with a FIXED bit of 1b transfers the requested Transfer Length, times the current block length in bytes to the initiator. A successful command with a FIXED bit of 0b transfers the requested Transfer Length in bytes to the initiator. Upon completion, the logical position is “after” the last block transferred.

If SILI bit is 1b and the FIXED bit is 0b, the target performs one of the following actions:

a) Reports CHECK CONDITION status for an incorrect block length condition only if the overlength condition exists and the BLOCK LENGTH field in the mode parameter block descriptor is nonzero. The associated sense data is 0/0000 (INCORRECT LENGTH, NO SENSE DATA).
b) Does not report CHECK CONDITION status if the only error is the underlength condition, or if the only error is the overlength condition and BLOCK LENGTH field of the mode parameters block descriptor is 0b. (See note 2 on page 34.)

If the SILI bit is 1b and the FIXED bit is 1b, the target terminates the command with CHECK CONDITION status with associated sense data of 5/2400 (ILLEGAL REQUEST, INVALID FIELD IN CDB).

If the SILI bit is 0b and an incorrect length block is read, CHECK CONDITION status is returned and the ILI and VALID bits are set to 1b in the sense data. Upon termination, the logical position is “after” the incorrect length block. If the FIXED bit is 1b, the INFORMATION field is set to the requested Transfer Length, minus the actual number of blocks read (not including the incorrect length block).

If the FIXED bit is 0b, the INFORMATION field is set to the requested Transfer Length, minus the actual block length in two's complement format.

If the logical unit encounters a filemark during a command, CHECK CONDITION status is returned and the FILEMARK and VALID bits are set to 1b in the sense data. The associated sense data is set to 0/0001 (NO SENSE, FILEMARK DETECTED). Upon termination, the logical position is “after” the filemark. If the FIXED bit is 1b, the INFORMATION field is set to the requested Transfer Length, minus the actual number of blocks read (not including the filemark). If the FIXED bit is 0b the INFORMATION field is set to the requested Transfer Length.

If the logical unit encounters end-of-partition during a command, CHECK CONDITION status is returned and the EOM and VALID bits are set to 1b in the sense data. Associated sense data is set to 3/0002 (MEDIUM ERROR, END OF PARTITION/MEDIUM).

If the logical unit encounters early warning and the REW bit is set to 1 in the Device Configuration mode page, CHECK CONDITION status is returned and the EOM and VALID bits are set to 1b in the sense data. Associated sense data is set to D/0002 (OVERFLOW, END-OF-PARTITION/MEDIUM DETECTED). If the FIXED bit is 1b, the INFORMATION field is set to the requested Transfer Length, minus the actual number of blocks transferred. If the FIXED bit is 0b, the INFORMATION field is set to the requested Transfer Length.

If the drive encounters End-of-Data (EOD) while processing this command, the command is terminated at the EOD position and CHECK CONDITION status is returned with associated sense data of 8/0005 (BLANK CHECK, END-OF-DATA DETECTED).

If the logical unit encounters beginning-of-partition during a command, CHECK CONDITION status is returned and the EOM and VALID bits are set to 1b in the sense data. Associated sense data is set to 0/0004 (NO SENSE, BEGINNING OF PARTITION/MEDIUM).

NOTE 1 - Because the residue information normally provided in the INFORMATION field of the sense data may not be available when the SILI bit is set, use other methods to determine the actual block length. For example:

include length information in the data block itself, or in the case of underlength transfers, the host adapter or device driver may return accurate transfer length information.

NOTE 2 - In the case of the FIXED bit of 1b with an overlength condition, only the position of the incorrect-length logical block can be determined from the sense data. The actual length of the incorrect block is not reported, and also cannot be derived from the transfer length (the device truncates the overlength block to match the current block length from the mode header). Other means may be used to determine the actual length (for example, backspace and read it again with FIXED bit set to 0b).

4.5.2 Interactions Summary

The following table summarizes various commands with the specified options, the encountered conditions, and the expected results.

Table 5 — Information and ILI Behavior Summary (part 1 of 3)

Scenario	Fixed	SILI	Block Length	Sense Error[1]	Information[1 2]	Flags IFE[1]	Position[1]
reportable UA	X	X	X	UA	not valid (0)	-	unchanged (no command)
reportable DCC	X	X	X	DCC	not valid (0)	-	unchanged (no command)
Read (any)	1	1	0	5/2400	transfer length	-	unchanged (no read)
	1	0	0	5/2400	transfer length	-	unchanged (no read)
Read transfer length 0	X	X	X	good	-	-	unchanged (no read)
Read (correct length(s))	X	X	X	good	-	-	after last block
Read Underlength	0	0	X	0/0000	transfer length - block size (+)	I	after block
	0	1	X	good	-	-	after block
	1	0	non-0	0/0000	transfer length - blocks read not including incorrect block (+)	I	after incorrect block
Read Overlength	0	0	X	0/0000	transfer length - block size (-)	I	after block
	0	1	0	good	-	-	after block
	0	1	non-0	0/0000	transfer length - block size (-)	I	after block
	1	0	non-0	0/0000	transfer length - blocks read not including incorrect block (+)	I	after incorrect block
Read FM	0	X	X	0/0001	transfer length	F	after filemark
	1	0	non-0	0/0001	transfer length - blocks read not including filemark (+)	F	after filemark
Read EOD	0	X	X	8/0005	transfer length	E[7]	unchanged (at EOD)
	1	0	non-0	8/0005	transfer length - blocks read (+)	E[7]	after last block (at EOD)
Read Perm	0	X	X	perm	transfer length	-	unchanged (at perm)
	1	0	non-0	perm	transfer length - blocks read (+)	-	after last block (at perm)

Table 5 — Information and ILI Behavior Summary (part 2 of 3)

Scenario	Fixed	SILI	Block Length	Sense Error[1]	Information[1 2]	Flags IFE[1]	Position[1]
Read after EOD/Perm	0	X	X	3/1404	transfer length	-	crossed EOD (position may change in non-predictable fashion, limited commands available)
	1	0	non-0	3/1404	transfer length - blocks read (+)	-	
Read (reverse) BOP	0	X	X	0/0004	transfer length	E	at BOP (0)
	1	0	non-0	0/0004	transfer length - blocks read (+)	E	at BOP (0)
Write (any)	1	-	0	5/2400	transfer length	-	unchanged (no write)
Write transfer length 0	X	-	X	-	-	-	unchanged (no write)
Write in Early Warning	0	-	X	0/0000 0/0002	0	E	after block
	1	-	non-0	0/0000 0/0002	transfer length - blocks written (usually 1)	E	after blocks written
Write at EOM	X	-	X	D/0002	transfer length	E	unchanged (no write)
Write Perm	0	-	X	perm	transfer length or 0 (if data is in buffer)	-	after last block in buffer
	1	-	non-0	perm	transfer length - blocks transferred into buffer	-	after last block in buffer
Write after Perm	X	-	X	3/3100	transfer length	-	unchanged (no write)
Locate (target after EOD)	encountered EOD			8/0005	not valid (0)[5]	E[7]	at EOD[5]
Locate	encountered Perm			perm	not valid (0)[5]	-	indeterminate (unchanged or at perm)[5]
Space blocks	encountered FM			0/0001	Count - blocks traversed[3]	F	after FM
	encountered EOD			8/0005		E[6]	at EOD
	encountered BOP			0/0004		E	at BOP (0)
	encountered perm			perm		-	indeterminate (unchanged or at perm)[3]
Space filemarks	encountered EOD			8/0005	Count - FMs traversed[4]	E[6]	at EOD[4]
	encountered BOP			0/0004		E	at BOP (0)
	encountered perm			perm		-	indeterminate (unchanged or at perm)[4]

Table 5 — Information and ILI Behavior Summary (part 3 of 3)

Scenario	Fixed	SILI	Block Length	Sense Error[1]	Information[1 2]	Flags IFE[1]	Position[1]
Space sequential filemarks	encountered EOD			8/0005	Count - sequential FMs traversed immediately prior to ending position[5]	E[6]	at EOD[5]
	encountered BOP			0/0004		E	at BOP (0)
	encountered perm			perm		-	indeterminate (unchanged or at perm)[5]
Space EOD	encountered EOD			good	-[5]	-	at EOD[5]
	encountered perm			perm	not valid (0)[5]	-	indeterminate (unchanged or at perm)[5]

Legend:

Flags:

I	ILI bit	#/####	CC, sense of Sense Key/ASC ASCQ
E	EOM bit	perm	CC, sense as per perm
F	Filemark bit	good	No CC (no sense)
-	None set		
-	Not applicable		

Notes:

1. These fields are outputs (results) from the scenario operation.
2. Partial blocks are not considered read, written or traversed.
3. Information field will accurately reflect the ending position.
4. Information field will accurately reflect the ending position but it is not in units of logical blocks, so additional means of determining absolute location, such as Read Position, must be used.
5. Information field does not accurately reflect the ending position, another means of determining absolute location, such as Read Position, must be used.
6. The EOM bit may be set only if the current position is in the early warning region or if the end of partition is encountered.
7. The EOM bit will only be set if end of partition is encountered (this condition should never occur), so EOM should not be set in this case. The standard specifies that EOM bit shall be set only if the current position is in the early warning region or if the end of partition is encountered.

4.6 Cleaning the Drive in a Library

In a library, the drive may be automatically cleaned. If the library configures the drive for automatic cleaning, then the drive behaves as follows:

When the drive determines that either maintenance cleaning is required, or that the SARS thresholds have been reached, a message is sent to the library (via the Library/Drive interface) to request cleaning. This occurs when the Cleaning message is normally sent to the SCD (Single Character Display). The library schedules the mounting of the cleaning cartridge. Thus, the host operating system and application are freed of any responsibility to facilitate the cleaning.

4.7 Drive Cleaning Indicators

For stand-alone drive models, automatic cleaning of the drive is not possible. For library models, automatic cleaning of the drives by the library may be disabled (although it is not recommended). For either case, cleaning of the drives must be managed by the host application or manually, by the operator.

NOTE 3 - Failure to clean a drive may result in data loss.

This section describes how cleaning indicators are presented from the drive. The cleaning indicators may be presented even with automatic cleaning enabled in a library environment. The cleaning indicators can be presented through the following:

a) Panel Cleaning Indication (see 4.7.1)
b) Host Interface - Dynamic Cleaning Indicators (see 4.7.2)
c) Host Interface - Static Cleaning Indicator (Sense Data Byte 70) (see 4.7.3)

4.7.1 Panel Cleaning Indication

A CLEAN message is displayed on the SCD (Single Character Display) when cleaning with a cleaning cartridge is required. For additional details, see the Operator Guide for this product.

4.7.2 Host Interface - Dynamic Cleaning Indicators

Dynamic cleaning indicators that are sent across the host interface include:

a) ASC/ASCQ codes related to cleaning in Error Sense Information (see Annex B. on page 403). Cleaning Indicators reported with Sense Key 1 may only be reported in certain situations, see MP 01h: Read-Write Error Recovery (see 6.5.5 on page 313).

Table 6 — ASC/ASCQ Codes Related to Cleaning

Code Description	Sense Key	ASC ASCQ
Drive Requires Cleaning	0	82 82
Cleaning in Progress (cleaner cartridge)	2	30 03

b) TapeAlert codes related to cleaning as described in LP 2Eh: TapeAlerts (see 6.3.16 on page 263).

NOTE 4 - If the device driver shields the application from dynamic notifications, the information is usually available from the system error log.

4.7.3 Host Interface - Static Cleaning Indicator (Sense Data Byte 70)

The bit significance of sense data byte 21 follows:

Bit	Description
3	Set to 1b "Cleaning Required: Normal Maintenance” when cleaning is required because of the normal preventive maintenance guideline (see MP 2Fh: Behavior configuration<<XREF>>). Reset to 0b when the cleaning cartridge is loaded.

4.8 WORM Behaviors

4.8.1 Conditions for Writing

If the following condition is met, writing is allowed:

c) the cartridge is uninitialized

If all the following conditions are met, writing is allowed:

a) the current logical position is at BOP
b) there are only filemarks between here and EOD

If all of the following conditions are met, writing is allowed:

a) if the current logical position is at BOP
b) there are exactly 1 or 2 data records, followed by 0 to infinite number of filemarks, followed by no data records, followed by EOD

If all of the following conditions are met, writing is allowed:

a) the current logical position is **between** BOP and EOD:
b) there are only filemarks from the current logical position to EOD
c) there is at least one filemark **immediately** before the current logical position

If the following condition is met, writing is allowed:

a) the current logical position is AT EOD

4.8.2 Command Behavior When WORM Medium Has Been Tampered With

Table 379 specifies the behavior of the device when it has detected the WORM medium that is loaded in the drive has been tampered with (See Sequential Access Drive Configuration mode page<XREF>).

Table 7 — Behavior when the loaded medium has suspect integrity

Command	WTRE=01b	WTRE=00b or 10b
WRITE	7/300Dh	7/300Dh
WRITE FILEMARK n (n !=0)	7/300Dh	7/300Dh
WRITE FILEMARK 0 (buffered data)	7/300Dh	7/300Dh
WRITE FILEMARK 0 (no buffered data)	GOOD	GOOD
ERASE	7/300Dh	7/300Dh
READ	GOOD	3/300Dh
VERIFY	GOOD	3/300Dh
SPACE	GOOD	3/300Dh
LOCATE to (block !=0)	GOOD	3/300Dh
LOCATE to 0	GOOD	GOOD
REWIND	GOOD	GOOD
UNLOAD	GOOD	GOOD
LOAD	GOOD	GOOD

4.9 Device Hardware Encryption

This device contains hardware which performs user data write encryption and read decryption, protecting all user data written to the medium from unauthorized use [provided it is integrated into a secure system design]. Device support for encryption may be determined by reading MP 24h: Vendor-Specific (see 6.5.18 on page 341) with the MODE SENSE command.

This device supports multiple ways of controlling encryption settings. These encryption control methodologies are called:

a) Encryption Control - IBM Proprietary Protocol (IPP) (see 4.9.1 on page 44); and
b) Encryption Control - T10 Standards (see 4.9.2 on page 45).

4.9.1 Encryption Control - IBM Proprietary Protocol (IPP)

The following terms are used to describe the methods of control that fall into the IPP:

a) Library Managed Encryption (LME);
b) System Managed Encryption (SME); and
c) Application Managed Encryption - IBM (AME-IBM).

Please see IBM for additional information on IPP.

4.9.2 Encryption Control - T10 Standards

The T10 standards method of controlling encryption are described in SSC-3 as well as in this document. Note that not all methods described in SSC-3 are supported.

This device uses the term Application Managed Encryption - T10 (AME-T10) to signify that it is using this standards based method.

This device supports the T10 method of passing the key in clear text as well as using ESP-SCSI. For specifics on support refer to SECURITY PROTOCOL IN (SPIN) - A2h (see 5.2.29 on page 140), SECURITY PROTOCOL OUT (SPOUT) - B5h (see 5.2.30 on page 141), and Security Protocol Parameters (SPP) (see 6.7 on page 367).

4.10 Attachment Features

4.10.1 Types of Interface Attachments

This device communicates with servers that use Fibre Channel or SAS interfaces. The interfaces share certain tape LUN behaviors, but also possess unique features. This chapter describes the common and unique features of these interfaces.

4.10.2 Common Tape LUN Behaviors

Fibre Channel and SAS attached devices share the following tape LUN behaviors:

a) Power-On (see 4.10.2.1 on page 47);
b) Reset Strategy (see 4.10.2.2 on page 47);
c) Abort Handling (see 4.10.2.3 on page 47);
d) Multi-initiator Support (see 4.10.2.4 on page 49); and
e) Status Codes (see 4.10.2.5 on page 49).

4.10.2.1 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 additional sense code 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 additional sense code of DRIVE IN PROCESS OF BECOMING READY (0401).

4.10.2.2 Reset Strategy

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

f) The current I/O process is aborted, as in Abort Handling.
g) Any queued I/O processes from other initiators are removed.
h) All SPC-2 reservations are cleared, but Persistent Reservations remain in effect.
i) All mode values are reset to their defaults.
j) A unit attention condition is set.
k) 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.
l) 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.

4.10.2.3 Abort Handling

Table 8 specifies the abort processing for this device.

Table 8 — Abort Condition Handling (part 1 of 3)

Command	Abort Processing
ALLOW OVERWRITE	The Command completes
ERASE	Long erase is aborted as quickly as possible without corrupting tape format. Short erase completes.
FORMAT	If modification to medium has started then the command is completed; otherwise, no action is taken.
INQUIRY	None.
LOAD/UNLOAD	Load completes and logically positions tape at BOP 0. Unload is aborted, leaving logical position at BOP 0 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.

Table 8 — Abort Condition Handling (part 2 of 3)

Command	Abort Processing
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.
RECEIVE DIAGNOSTIC RESULTS	None.
RELEASE UNIT	The command completes.
REPORT DENSITY SUPPORT	None.
REPORT LUNs	None.
REPORT SUPPORTED OPERATION CODE	None.
REPORT SUPPORTED TASK MANAGEMENT FUNCTIONS	None.
REQUEST SENSE	Sense data is discarded.
RESERVE UNIT	The command completes.
REWIND	The command completes.
SECURITY PROTOCOL IN	None.
SECURITY PROTOCOL OUT	If data transfer is completed, the command is completed; otherwise, no action is taken.
SEND DIAGNOSTIC	Vendor unique.
SET CAPACITY	If modification to medium has started then the command is completed; otherwise, no action is taken.
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.

Table 8 — Abort Condition Handling (part 3 of 3)

Command	Abort Processing
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 ATTRIBUTE	If data transfer is completed, the command is completed; otherwise, no action is taken.
WRITE BUFFER	If data transfer is completed, the command is completed; otherwise, no action is taken.
WRITE FILE MARKS	The command completes.

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.

4.10.2.4 Multi-initiator Support

This device supports an infinite number of I_T nexuses, but the device has a limit on how many I_T nexuses can be logged in processing commands concurrently. If this limit is exceeded, then the device implicitly logs out the least recently used (LRU) I_T nexus that:

a) is not reserved;
b) is not registered;
c) is not the I_T nexus that last processed a medium access command; and
d) does not have an outstanding command.

The device 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. Media access commands (for example, WRITE, WRITE FILEMARKS, READ, VERIFY, REWIND, MODE SELECT that changes block size) are always processed in strict order of receipt.

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. If an additional initiator connects to the drive and causes an initiator to be implicitly logged out, the drive erases all sense data for that initiator before processing the command for the new initiator. See Sense Data Management for more details of sense data management.

4.10.2.5 Status Codes

Table 9 — Status Codes

Status Code	Value	Circumstance
GOOD	00h	The command completed without problems.

Table 9 — Status Codes

Status Code	Value	Circumstance
CHECK CONDITION	02h	A problem occurred during command processing. The sense data should be examined to determine the nature of the problem.
BUSY	08h	The drive is unable to accept the command at this time. This status is returned during the power-on sequence or if there are commands from too many I_T nexuses outstanding. (See Multi-initiator Support.)
RESERVATION CONFLICT	18h	This status is returned if the drive is reserved for an I_T nexus other than the one sending the command.
QUEUE FULL	28h	Not normally returned.

4.10.3 Features of the Fibre Channel Interface

This device is compliant with the American National Standard, Project T10/Project 1828-D, Information Technology - Fibre Channel Protocol for SCSI, Fourth Version (FCP-4), Revision 02b, January 3, 2011. The key features of the FC-Tape Technical Report of the Accredited Standard Committee NCITS that were found useful are included in FCP-4. IBM recommends that a server's device driver and host bus adapter (HBA) use:

a) Precise delivery of commands;
b) Confirmed completion of FCP I/O operations;
c) Retransmission of unsuccessfully transmitted IUs; and
d) Task retry identification as defined in FCP-4.

These features may be listed in HBA settings either individually or as a group and called:

a) FCP-2 support;
b) Class-3 Error Recovery;
c) FC-Tape;
d) Confirmed Completion; or
e) Task retry identification.

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

4.10.3.1 Topology

Fibre Channel devices (such as this device and a server) are known as nodes and have at least one port through which to receive and send data. The collection of components that connect two or more nodes is called a topology. Fibre Channel systems consist solely of two components: nodes with ports and topologies.

Each port uses a pair of fibers: one fiber carries data into the port, and the other carries data out of the port. The fibers in the channel are optical strands. The fiber pair is called a *link* and is part of the topology. Data is transmitted over the links in units known as *frames*. A frame contains an address identifier that gives the fabric and node for which the frame is destined.

This device can be attached in a two-node configuration, either directly to a switch as a public device (switched fabric) or directly to a host bus adapter (HBA) as a private device (direct connection). This device may be configued to any supported topology via a library interface, or configured by using vital product data (VPD) settings. The type of connection also depends on whether the drive recognizes the connection as a loop or a fabric connection:

a) An L_port supports a Fibre Channel Arbitrated Loop connection to an L_port or FL_port.
b) An N_port supports direct connection to an F_port (for example, a director-class switch) in a fabric topology.

Regardless of the port to which this device is connected, it automatically configures to a public device (through an F_port or FL_port to a switch) or to a private device (through an L_port by using direct attachment to a server). This device supports two topologies:

a) Two-Node Switched Fabric Topology (see 4.10.3.1.1 on page 52); and
b) Two-Node Direct Connection Topology (see 4.10.3.1.2 on page 52).

Table 10 lists the topologies in which this device is able to operate, the Fibre Channel server connections that are available, and the port (NL, N, FL, or F) through which communication must occur. The sections that follow describe each topology.

Table 10 — Topologies through which this device's port(s) can operate

Drive Port Configuration	Type of Fibre Channel Port to Which the Drive Port Connects			
	Server Port (HBA) (Private - Direct Connection)		Switch Port (Public - Switched Fabric)	
	Point-to-Point Topology (N_Port)	Arbitrated Loop Topology (FC-AL)		Fabric Topology (F_Port)
		L_Port	FL_Port	
Drive port configured to operate as L_Port	Invalid system configuration	L_Port	L_Port	Invalid system configuration
Drive port configured to operate as N_Port	N_Port (not supported)	Invalid system configuration	N_Port (switched fabric)	N_Port
Drive port configured to operate as LN_Port	N_Port (not supported; attempts L_Port)	L_Port	L_Port	N_Port
Drive port configured to operate as NL_Port	N_Port (not supported; attempts L_Port)	L_Port	N_Port	N_Port

4.10.3.1.1 Two-Node Switched Fabric Topology

The two-node switched fabric topology supports two protocols:

a) Use the two-node switched fabric loop protocol when attaching the device to an FL_port; and
b) Use the two-node switched fabric protocol when attaching the library to an F_port.

4.10.3.1.2 Two-Node Direct Connection Topology

A two-node direct connection occurs when two Fibre Channel end points are connected together. Either Arbitrated Loop or Point-to-Point topology is defined as usable in the standards, but both end points must use the same topology. Most Fibre Channel adapters have settings that allow selection of the topology or they default to the loop topology when they are not directly connected to a fabric. While this device allows you to set the port to any of these topologies (see the instructions of the library in which this device is contained) this device requires the use of the Arbitrated Loop (L_port) topology in a two-node direct connection. Use of the Point-to-Point topology in a two-node direct connection to an N_port is not supported.

4.10.3.2 Speed

This device is an 8GFC device meaning that it can operate at 8.500 MBd. This device also allows operation using previous Fibre Channel generations: 1GFC, 2GFC, and 4GFC. Each Fibre Channel generation transfers data at the following rates:

a) 1GFC transfers data at a max burst rate of 100 MB/s;
b) 2GFC transfers data at a max burst rate of 200 MB/s;
c) 4GFC transfers data at a max burst rate of 400 MB/s;
d) 5GFC transfers data at a max burst rate of 800 MB/s;

This device may be configured via a library interface or vital product data (VPD) in one of the following speed configurations:

a) 1GFC;
b) 2GFC;
c) 4GFC;
d) 8GFC; or

e) speed negotiate

4.10.3.3 Addressing Assignments

Each Fibre Channel interface port for this device can be independently assigned a specific speed and topology, or may be set to auto-negotiate.

When the topology is set to or negotiates to L-port, a hard or soft ALPA ID may be assigned. The hard ALPA ID is in the range of 01h to EFh with only certain valid values (a total of 126 addresses). Validity is enforced by the entry process. This value should be unique to each device on the Fibre Channel loop. Fibre Channel loop protocol will detect an addressing conflict on the loop, and one of the conflicting drives will not be available for use.

4.10.4 Features of the Serial Attached SCSI (SAS) Interface

The World Wide Node Name and Port Name that are used by this device follow the format of the Institute of Electrical and Electronics Engineers (IEEE).

This device is compliant with the American National Standard, Project T10/1760-D, Information technology - Serial Attached SCSI - 2 (SAS-2), Revision 16, 18 April 2009.

4.11 Device Clocks

The drive supports a Device Clock that maintains a timestamp for various items. This timestamp gets recorded in drive error logs.

The TIMESTAMP ORIGIN is one of those specified in table 11.

Table 11 — TIMESTAMP ORIGIN

Value	Definition
000b	Timestamp initialized to zero at power-on
001b	Reserved
010b	Timestamp initialized by the SET TIMESTAMP command
011b	Timestamp initialized by the Library over the Library Drive Interface (i.e. RS-422)
100b - 111b	Reserved

Once a timestamp is initialized it begins counting from that time forward. Once the timestamp is initialized it remains in effect until one of the following occurs:

a) A SET TIMESTAMP command (see 5.2.33) is processed;
b) An LDI command is processed that modifies the timestamp; or
c) A Hard Reset event occurs.

The method used is indicated in the Extended Control mode page.

The Timestamp is not affected by an I_T nexus loss or a Logical Unit reset.

The TIMESTAMP is specified in table 12.

Table 12 — TIMESTAMP Format

Byte	Bit							
	7	6	5	4	3	2	1	0
0	(MSB)							
	TIMESTAMP							
5								(LSB)

The TIMESTAMP field contains the value established at the last action that set the timestamp incremented by one for every millisecond that has elapsed since the timestamp was set.

4.12 Error Information

4.12.1 Sense Data

For a description of Sense data, see Sense Data Format.

4.12.2 Sense Data Management

Sense data returned by the device contains one of two types of errors. These errors are:

Type	Description
Current	The error condition associated with the command that is currently being processed (i.e., SCSI Status for the currently processing command is the status being returned); and
Deferred	The error condition resulting 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 bit set or may be a buffered write. A command with the Immediate bit set generates sense for the server that sent the command. A buffered write may generate sense for all servers.

Sense data returned is described by the Sense Key (i.e., bits 3-0 of byte 2 of Sense data). Commands that terminate in an error generate Sense data and set the Sense Key depending on the the specifics of the error. Table 8. Supported Common SCSI commands, indicates which commands are allowed to be processed in the presence of specific error conditions and which return an error.

This device communicates on transports that use the autosense protocol. This means that any Sense data generated for return to a command is returned with the SCSI status. Once a particular set of sense data has been returned, that sense data is cleared and a REQUEST SENSE command is not required to be issued to collect the Sense data. Any other sense data that is still pending may still cause CHECK CONDITION status for subsequent commands. When a REQUEST SENSE command is received, typically the only Sense data available will be the default Sense data. While it is possible that a Deferred error may have generated Sense data or that a Unit Attention (see 4.12.3) has been established since the status to the last command, Sense data is not likely to exist.

4.12.3 Unit Attention Conditions

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

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

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

4.12.4 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 4). The error may or may not be reported as Deferred.

4.12.4.1 Fencing Behavior

The device fences the drive (i.e., prevents certain operations) when errors are detected that could endanger customer data if further usage is allowed. The operations that are prevented depend on the nature of the error encountered and the current drive state. The drive will post an FSC (see bytes 16 and 17 of REQUEST SENSE data) for the original error that caused the fence condition. Then, CHECK CONDITION status, with the fencing FSC in the sense data is reported to an attempted host commands that is not allowed due to the fence condition.

Table 13 lists which errors trigger which fence state.

Table 13 — Error to Fence State mapping

Error that triggers Fence State	Fence State
Severe Drive Hardware problem Severe Media Hardware problem Temperature Overrange Load or Unload Hardware problem Severe Firmware Problem	ALLOW_NO_OPERATION (see 4.12.4.1.1 on page 58)
Hardware Problem detected that could affect Writing Hardware Problem detected that could affect Reading	ALLOW_LOCATE (see 4.12.4.1.2 on page 58)
Serious Drive Hardware problem -- May be recovered on a different mount Serious Media problem -- Drive may be recovered on different mount Serious Firmware problem -- May be recovered on different mount	ALLOW_UNLOAD (see 4.12.4.1.3 on page 59)
Power on occurs and the device detects a volume is loaded. This may be due to a device panic/exception.	MID-TAPE RECOVERY (see 4.12.4.1.4 on page 59)

4.12.4.1.1 ALLOW_NO_OPERATION

a) All medium access commands (Read/Write/Motion) are rejected.
b) (SCSI/Panel/LDI) Unload is accepted.
c) After the cartridge is ejected:
   A) When load is attempted, the cartridge stays at mount position and Good status is returned for TUR.
   B) From the above state, the cartridge can be ejected normally.
   C) Other medium access commands are rejected.

4.12.4.1.2 ALLOW_LOCATE

a) All medium access commands (Read/Write/Motion) are rejected.
b) (SCSI/Panel/LDI) Unload is accepted.
c) Once a cartridge is ejected, Fence state is cleared. You can load a new cartridge and perform all medium access commands.
d) Space command is rejected while in Fence state.

4.12.4.1.3 ALLOW_UNLOAD

a) All medium access commands (Read/Write/Motion) are rejected.
b) (SCSI/Panel/LDI) Unload is accepted.
c) Once a cartridge is ejected, Fence state is cleared. You can load a new cartridge and perform all medium access commands.

4.12.4.1.4 MID-TAPE RECOVERY

The Mid-Tape Recovery (MTR) fence behavior is configured in Mode Page 2Fh: Behavior Configuration Mode Page. There are two different behaviors:

a) Normal operation (i.e., MTR Fence) (see 4.12.4.1.4.1 on page 59); and
b) Panic Fence operation (see 4.12.4.1.4.2 on page 59).

4.12.4.1.4.1 Normal operation (i.e., MTR Fence)

When the device powers up and no cartridge is detected, no special behavior is required and the device:

1) responds to the first UNIT ATTENTION eligible command with 6/2900;
2) responds to a CHECK CONDITION eligible command, if any, with 2/3e00 during POST; and
3) enters normal operation when POST is completed successfully.

When the device powers up and detects a cartridge, Mid-Tape Recovery (MTR) is required and the device:

1) responds to the first UNIT ATTENTION eligible command with 6/2900;
2) responds to a CHECK CONDITION eligible command, if any, with 2/3e00 until POST is complete;
3) responds to a CHECK CONDITION eligible command, if any, with 2/0401 during MTR/Unload;
4) responds to a CHECK CONDITION eligible command, if any, with 2/0401 during MTR/Load; and then
5) enters the MTR Fence State when the MTR/Load has completed. In the MTR Fence State, the device:
   A) responds to the first UNIT ATTENTION eligible command received after entering the MTR Fence State (i.e., after cartridge is loaded) with 6/2800;
   B) responds to TUR commands, if any, with GOOD status;
   C) responds to any medium access command not listed in the next step, if any, with 5/2C00; and
   D) exits the MTR Fence State if an explicit positioning command completes successfully (i.e., LOCATE, REWIND, LOAD).

4.12.4.1.4.2 Panic Fence operation

When the device powers up after a Panic or Exception and no cartridge is detected the device:

1) responds to the first UNIT ATTENTION eligible command with 6/2900;
2) responds to a CHECK CONDITION eligible command, if any, with 2/3e00 during POST; and
3) when POST is complete, enters into the Panic Fence state. In the Panic Fence state the device:
   A) rejects SCSI commands other than RSNS/INQ/RLUNs/Read Buffer with 5/2904 sense, indicating Panic Fence state;
   B) rejects a TUR command with 5/2904;
   C) rejects attempts to Load a cartridge through any means;
   D) accepts, at any time, a SCSI Read Buffer to read dump data;
   E) exits the Panic Fence state after a dump has been successfully read and transitions to normal mode.

When the device powers up and detects a cartridge, Mid-Tape Recovery (MTR) is required and the device:

1) responds to the first UNIT ATTENTION eligible command with 6/2900;
2) responds to a CHECK CONDITION eligible command, if any, with 2/3e00 until POST is complete;
3) responds to a CHECK CONDITION eligible command, if any, with 2/0401 during MTR/Unload;
4) responds to a CHECK CONDITION eligible command, if any, with 2/0401 during MTR/Load; and then
5) enters the Panic Fence State when the MTR/Load has completed. In the Panic Fence state the device:
   A) responds to the first UNIT ATTENTION eligible command received after entering the Panic Fence State (i.e., after cartridge is loaded) with 6/2800;

B) rejects SCSI commands other than RSNS/INQ/RLUNs/Read Buffer with 5/2904 sense, indicating Panic Fence state;
C) returns GOOD status to a TUR command while cartridge is loaded;
D) rejects a TUR command with 5/2904;
E) allows processing of Unload command through SCSI/LDI/Button;
F) rejects attempts to Load a cartridge through any means;
G) accepts, at any time, a SCSI Read Buffer to read dump data;
H) exits the Panic Fence state after a dump has been successfully read and:
    a) if there is no cartridge loaded, then transitions to normal mode; or
    b) if there is a cartridge loaded, then transitions to the MTR Fence State. In the MTR Fence State, the device:
        A) responds to TUR commands, if any, with GOOD status;
        B) responds to any medium access command not listed in the next step, if any, with 5/2C00; and
        C) exits the MTR Fence State if an explicit positioning command completes successfully (i.e., LOCATE, REWIND, LOAD).

4.13 Medium auxiliary memory

Some types of media, especially removable media, include a non-volatile memory referred to as MAM (medium auxiliary memory). Medium auxiliary memory is used to store data describing the media and its contents. This standard supports medium auxiliary memory with the READ ATTRIBUTE command (see 5.2.15) and the WRITE ATTRIBUTE command (see 5.2.38). These commands are used to retrieve and store information in the medium auxiliary memory in the form of MAM attributes.

A MAM attribute is represented in a format described in Attribute format (see 6.4.1 on page 295) and is composed of:

a) an attribute identifier;
b) an attribute format code;
c) a bit indicating whether the identified attribute is read only;
d) an attribute length specifying the number of bytes in the identified attribute value; and
e) the value of the identified attribute.

There are three types of MAM attributes (see table 14).

Table 14 — Types of MAM attributes

Attribute Type	Attribute Source	Example	Readable with READ ATTRIBUTE	Writable with WRITE ATTRIBUTE
Medium	Permanently stored in the medium auxiliary memory during manufacture.	Media Serial Number	Yes	No
Device	Maintained by the device server.	Load Count	Yes	No
Host	Maintained by the application client.	Backup Date	Yes	Yes

Depending on that attribute type, MAM attributes have the states shown in table 15.

Table 15 — MAM attribute states

Attribute Type	Attribute State	Description
Medium or Device	Read Only	An application client may read the contents of the MAM attribute with the READ ATTRIBUTE command, but an attempt to clear or change the MAM attribute using the WRITE ATTRIBUTE command shall result in the command being terminated with CHECK CONDITION status. When the READ ONLY bit (see 6.4.1) is one, the attribute is in the read only state.
	Unsupported	The device server does not support the MAM attribute and shall not return it in response to a READ ATTRIBUTE command.
Host	Nonexistent	A host attribute does not exist in the medium auxiliary memory until a WRITE ATTRIBUTE command creates it.
	Read/Write	The MAM attribute has been created using the WRITE ATTRIBUTE command. After the MAM attribute has been created, the contents may be altered using subsequent WRITE ATTRIBUTE commands. A read/write MAM attribute may be returned to the nonexistent state using a WRITE ATTRIBUTE command with the attribute length set to zero. When the READ ONLY bit (see 6.4.1) is zero, the MAM attribute is in the read/write state.

4.14 Volume Coherency

An application client may need to be able to determine if all logical objects on a volume are coherent with the last time an application client wrote to this volume. The VOLUME COHERENCY INFORMATION attribute (see 6.4.2.4.11) of MAM is provided for an application client to collect and save information necessary for this determination.

The VOLUME COHERENCY INFORMATION attribute for each partition is written to MAM by the application client when it has completed a write job (e.g., the volume is demounted). The VOLUME COHERENCY INFORMATION attribute contains references to a volume coherency set that the application client has written to logical objects on a partition. An application client should not create a VOLUME COHERENCY INFORMATION attribute unless it has written a volume coherency set to that partition. The volume coherency set shall include a volume coherency count. The application client shall maintain one volume coherency count for an entire volume and shall monotonically increase the volume coherency count when the state of the volume coherency set changes (e.g., writing identical volume coherency sets on each partition does not force a change of volume coherency count). When the application client writes the VOLUME COHERENCY INFORMATION attribute to MAM for a specific partition the VOLUME CHANGE REFERENCE VALUE field of the VOLUME COHERENCY INFORMATION attribute for a partition shall contain the value returned in the ATTRIBUTE VALUE field of the VOLUME CHANGE REFERENCE attribute after the last volume coherency set was written to the volume. The VOLUME COHERENCY COUNT field of the VOLUME COHERENCY INFORMATION attribute shall contain the volume coherency count that was written to the last volume coherency set written to that partition. The VOLUME COHERENCY SET IDENTIFIER field of the VOLUME COHERENCY INFORMATION attribute for a partition contains the logical object identifier of the first byte of the last volume coherency set written to that partition. The APPLICATION CLIENT SPECIFIC INFORMATION field of the VOLUME COHERENCY INFORMATION attribute for a partition contains information the application client binds with the coherency set referenced by the VOLUME COHERENCY SET IDENTIFIER field.

NOTE 5 - The application client needs to guarantee that no other application client updates the logical objects on the volume between the time it completes writing and the time it updates the MAM parameter (e.g., use reservations)

An application client may verify that the volume coherency set written in a partition has not changed since the VOLUME COHERENCY INFORMATION attribute was written when the application client reads the VOLUME COHERENCY INFORMATION attribute for a partition (e.g., when a volume is mounted) and compares the value

in the VOLUME CHANGE REFERENCE VALUE field with the value returned in the ATTRIBUTE VALUE field of the VOLUME CHANGE REFERENCE attribute. If the values match, then the volume coherency set written in that partition is unchanged.

To find the most recently written volume coherency set, the application client searches the VOLUME COHERENCY INFORMATION attributes of the partitions for which the volume coherency set is unchanged and finds the largest value in the VOLUME COHERENCY COUNT field. The application client then verifies the largest value in the VOLUME COHERENCY COUNT field with the volume coherency count stored in the volume coherency set beginning at the logical object specified by the VOLUME COHERENCY SET IDENTIFIER field. If this matches, then this is the volume coherency set that was most recently written.

The APPLICATION CLIENT SPECIFIC INFORMATION field may also be used by the application client as part of this coherency check. If the information verifies for a partition, then the volume is coherent with the last access by this application. If the information does not verify for a partition, then the volume is not coherent with the last access by this application.

5. SCSI Commands

5.1 SCSI Commands Overview

This chapter describes the SCSI commands supported (LUN 0).

The following SCSI command descriptions have a table describing the fields in the Command Descriptor Block (CDB), similar to the style used in the *American National Standard of the National Committee for Information Technology Standards (NCITS)* documents.

Any data required by each command follow these descriptions and are described in a “term-definition” format. In this format, the bits or bytes to be described are highlighted and listed on the left. The definition for the bits or bytes is to the right (not highlighted).

Parameters are described in Parameters for SCSI Commands (see 6. on page 159).

5.1.1 Unsupported SCSI Commands

Certain commands or features of some commands defined in SPC-4 or SSC-3 are not currently supported but may be in the future.

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

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.

The *Read Buffer* and *Write Buffer* commands are supported but not all buffers are described in this document because many buffers are intended only to be read or written by the Service Representative or by Manufacturing. OEM customers who intend to support host microcode download on a new platform should contact IBM for a complete description of the *Write Buffer* command for this purpose. Note that new microcode may also be loaded without requiring the use of the SCSI *Write Buffer* command, by using the Field Microcode Replacement (FMR) tape process described in the maintenance information manual for this product.

5.1.2 Supported SCSI Commands

This device accepts commands on LUN 0 for drive related commands (i.e., Peripheral Device Type returned in Standard Inquiry is Sequential Access Device). When in a library this device also accepts commands on LUN 1 for library related commands (i.e., Peripheral Device Type returned in Standard Inquiry is Medium Changer Device).

5.1.2.1 Supported SCSI Commands on LUN 1

The list of commands supported on LUN 1 is dependant on the Library in which the drive is contained. To determine the model of the library in which the drive is contained, use the INQUIRY command. Bytes 8-15 contain the T10 VENDOR IDENTIFICATION. Bytes 16 - 31 contain the PRODUCT IDENTIFICATION.

This document contains no additional information about commands supported on LUN 1. For a list of all commands supported please see the appropriate Library SCSI Reference.

5.1.2.2 Supported SCSI Commands on LUN 0

Table 16 provides a list of all commands supported by this product for the sequential access device (i.e., LUN 0). For each command, the operation code, reference page for this specification, and applicability of certain conditions to the command are shown in Table 16.

It is strongly recommended that device drivers or host software implement device reservations using the RESERVE/RELEASE commands or the PERSISTENT RESERVE OUT/PERSISTENT RESERVE IN commands. It is also strongly recommended that host software use the Append-only mode (also known as Data-safe mode) (see 4.1.3 on page 28) as it helps cover the cases where reservations are lost or the drive reboots unexpectedly.

Table 16 — Supported Common SCSI Commands (part 1 of 3)

Command Name	Operation Code	Page	Applicable Conditions[b]					
			RVC	UAT	NRD	WRP	MFC	DCC
ALLOW OVERWRITE	82h	68	y	y	y	-	-	y
ERASE	19h	69	y	y	y	y	y	y
FORMAT MEDIUM	04h	70	y	y	y	y	y	y
INQUIRY	12h	72	-	-	-	-	-	-
LOAD/UNLOAD	1Bh	78	y	y	-	-	y	y
LOCATE(10/16)	2Bh/92h	80	y	y	y	-	y	y
LOG SELECT	4Ch	82	y	y	-	-	-	y
LOG SENSE	4Dh	83	-	-	-	-	-	-
MODE SELECT (6/10)	15h/55h	84	y	y	-	-	-	y
MODE SENSE (6/10)	1Ah/5Ah	86	-	y	-	-	-	-
PERSISTENT RESERVE IN	5Eh	88	y	y	-	-	-	-
PERSISTENT RESERVE OUT	5Fh	94	y[c]	y	-	-	-	-
PREVENT ALLOW MEDIUM REMOVAL	1Eh	97	-	y	-	-	-	-
READ	08h	98	y	y	y	-	y	y
READ ATTRIBUTE	8Ch	99	y	y	-	-	-	y
READ BLOCK LIMITS	05h	103	-	y	-	-	-	-
READ BUFFER	3Ch	104	y	-	-	-	-	-
READ POSITION	34h	105	y	y	y	-	-	-

Table 16 — Supported Common SCSI Commands (part 2 of 3)

Command Name	Operation Code	Page	Applicable Conditions[b]					
			RVC	UAT	NRD	WRP	MFC	DCC
RECEIVE DIAGNOSTIC RESULTS	1Ch	112	y	y	-	-	-	-
RELEASE UNIT (6/10)[a]	17h/57h	113	-[d]	y	-	-	-	-
REPORT DENSITY SUPPORT	44h	114	-	y	-	-	-	-
REPORT LUNs	A0h	117	-	-	-	-	-	-
REPORT SUPPORTED OPERATION CODE	A3h[0Ch]	119	-	y	-	-	-	-
REPORT SUPPORTED TASK MANAGEMENT FUNCTIONS	A3h[0Dh]	127	-	y	-	-	-	-
REPORT TIMESTAMP	A3h[0Fh]	129	-	y	-	-	-	-
REQUEST SENSE	03h	131	-	-	-	-	-	-
RESERVE UNIT (6/10)[a]	16h/56h	138	y[d]	y	-	-	-	-
REWIND	01h	139	y	y	y	-	y	y
SECURITY PROTOCOL IN (SPIN)	A2h	140	y	y	-	-	-	-
SECURITY PROTOCOL OUT (SPOUT)	B5h	141	y	y	-	-	y	-
SEND DIAGNOSTIC	1Dh	142	y	y	-	-	y	y
SET CAPACITY	0Bh	144	y	y	y	y	y	y
SET TIMESTAMP	A4h[0Fh]	146	y	y	-	-	-	y
SPACE (6/16)	11h/91h	148	y	y	y	-	y	y
TEST UNIT READY	00h	150	y	y	y	-	-	y
VERIFY	13h	151	y	y	y	-	y	y
WRITE	0Ah	152	y	y	y	y	y	y

Table 16 — Supported Common SCSI Commands (part 3 of 3)

Command Name	Operation Code	Page	Applicable Conditions[b]					
			RVC	UAT	NRD	WRP	MFC	DCC
WRITE ATTRIBUTE	8Dh	153	y	y	y	y	-	y
WRITE BUFFER	3Bh	156	y	y	-	-	-	-
WRITE FILEMARKS (6)	10h	157	y	y	y	y	y	y

Note 1 - The behavior for all commands is as defined in the following SCSI-3 specifications unless otherwise indicated:
SSC-4 (*SCSI Stream Commands - 4)*
SPC-4 (*SCSI Primary Commands-4)*

[a] The RESERVE/RELEASE commands are defined in SPC-2 (*SCSI Primary Commands-2)*

[b] Applicable Conditions are as follows:
y = condition applies to the command
- = condition does not apply to the command
RVC = reservation conflict
UAT = unit attention
NRD = not ready
WRP = write protect. These are also referred to as “write-type” commands.
MFC = medium format corrupted. These commands are also considered Medium Access Commands
DCC = deferred check condition

[c] Reported as appropriate for the type of Service Action and Reservation Type requested and the current reservation state of the drive.

[d] The drive sets the CRH bit to one in the parameter data returned by the REPORT CAPABILITIES service action of the PERSISTENT RESERVE IN command. This indicates that in the presence of a Persistent Reservation, a RELEASE(6) or RELEASE(10) command will complete with GOOD status, but the persistent reservation will not be released, if the command is received from:

a) An I_T nexus that is a persistent reservation holder; or
b) An I_T nexus that is registered if a registrants only type persistent reservation is present.

In all other cases, the RELEASE(6)/RELEASE(10) command will be rejected with a RESERVATION CONFLICT.
The drive sets the CRH bit to one in the parameter data returned by the REPORT CAPABILITIES service action of the PERSISTENT RESERVE IN command. This indicates that in the presence of a Persistent Reservation, A RESERVE(6) or RESERVE(10) command will complete with GOOD status, but no reservation will be established and the persistent reservation will not be changed, if the command is received from:

a) An I_T nexus that is a persistent reservation holder; or
b) An I_T nexus that is registered if a registrants only type persistent reservation is present.

In all other cases, the RESERVE(6)/RESERVE(10) command will be rejected with a RESERVATION CONFLICT.

5.1.2.3 Control Byte Definition

This description of the control byte fields is to be used for all of the supported commands. The control byte occurs in the last byte of a command, that is, byte 5 (6-byte commands), byte 9 (10-byte commands), byte 11 (12-byte commands), or byte 15 (16-byte commands). Table 17 shows the bit significance of the control byte.

Table 17 — Control Byte Definition

Byte	Bit							
	7	6	5	4	3	2	1	0
5, 9, or 11	Vendor specific		Reserved			NACA	Obsolete	Obsolete

Bit	Description
1-6	Vendor specific: 00b
5-3	Reserved: 000b
2	NACA (Normal ACA): 0b
1	Obsolete: 0b
0	Obsolere: 0b

5.2 SCSI Commands Listing

5.2.1 ALLOW OVERWRITE - (82h)

When append-only mode is enabled an application client may issue the ALLOW OVERWRITE command to enable the overwrite of the medium at a non-append point. The processing of the ALLOW OVERWRITE command sets the allow_overwrite and allow_overwrite_position variables as specified in Append-only mode (also known as Data-safe mode) (see 4.1.3 on page 28).

Table 18 — ALLOW OVERWRITE command

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	OPERATION CODE (82h)							
1	Reserved							
2	Reserved				ALLOW OVERWRITE			
3	PARTITION							
4	(MSB)	LOGICAL OBJECT IDENTIFIER						
11								(LSB)
12	Reserved							
14								
15	Control Byte (see 5.1.2.3)							

The ALLOW OVERWRITE field specifies what type of overwrite is allowed. Table 19 defines the actions for the value specified in the ALLOW OVERWRITE field.

Table 19 — ALLOW OVERWRITE field definition

Value	Definition
0h	The allow_overwrite variable shall be set to Disabled
1h	The allow_overwrite variable shall be set to Current Position
2h	The allow_overwrite variable shall be set to Format
3h-Fh	The command shall be rejected with CHECK CONDITIONstatus with the sense key set to ILLEGAL REQUEST and the additional sense code set to INVALID FIELD IN CDB.

If the ALLOW OVERWRITE field is set to Current Position (i.e., 1h), then:

a) the PARTITION field shall be set to the active partition; and
b) the LOGICAL OBJECT IDENTIFIER field shall be set to the current position.

If the ALLOW OVERWRITE field is set to Current Position (i.e., 1h), then the allow_overwrite_position variable shall be set to the current position.

If the ALLOW OVERWRITE field is not set to Current Position (i.e., 1h), then the PARTITION field and LOGICAL OBJECT IDENTIFIER field shall be ignored.

The device server shall terminate the command with CHECK CONDITION status with the sense key set to ILLEGAL REQUEST and the additional sense code set to SEQUENTIAL POSITIONING ERROR if:

a) the ALLOW OVERWRITE field is set to Current Position (i.e., 1h); and
b) the logical position of the medium is not at the location specified by the PARTITION field and LOGICAL OBJECT IDENTIFIER field.

If the device server terminates that command with any status other than GOOD, then the allow_overwrite variable shall be set to Disabled and the allow_overwrite_position variable shall be set to invalid.

5.2.2 ERASE - 19h

Table 20 — ERASE CDB

Byte	Bit							
	7	6	5	4	3	2	1	0
0	OPERATION CODE (19h)							
1	Reserved						IMMED	LONG
2	Reserved							
3	Reserved							
4	Reserved							
5	Control Byte (see 5.1.2.3)							

EOD is written at the current position, which marks it as end of data. After the command is successfully completed, the drive is positioned immediately before End Of Data (not End Of Tape).

The following parameters apply:

- LONG:

Value	Description
0b	No further writing occurs after EOD is written.
1b	The Data Set Separator (DSS) pattern is written from the new EOD to the end of the current partition to overwrite any data that is currently on the tape after the current logical position.

  WARNING WARNING

  A long erase of a partitioned volume from BOP does not erase all data on the volume. It erases all data on the current partition but does not affect any other partitions. To erase all logical objects on the volume, issue a FORMAT MEDIUM command with the FORMAT field set to 0h then issue a long erase when positioned at BOP.

  WARNING WARNING

- IMMED (Immediate):

Value	Description
0b	Status is not returned until after the command has completed.
1b	The device 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 any. If there is no deferred error, the drive reports GOOD status and initiates processing the command.

5.2.3 FORMAT MEDIUM command

The FORMAT MEDIUM command (see table 21) is used to prepare the medium for use by the logical unit. If there are logical objects in the buffer when processing of a FORMAT MEDIUM command begins, or if the medium is not at beginning-of-partition 0 (BOP 0), then the command is rejected with CHECK CONDITION status with the sense key set to ILLEGAL REQUEST and the additional sense code set to POSITION PAST BEGINNING OF MEDIUM.

The FORMAT MEDIUM command shall function in the constraints dictated by any capacity changes resulting from a previous SET CAPACITY command that was performed on the mounted volume (i.e., The Set Capacity command controls the maximum capacity allowed for the volume and the Format Medium command works inside those constraints).

The FORMAT MEDIUM command is not allowed against a WORM cartridge. If a WORM cartridge is loaded when the FORMAT MEDIUM command is received, then the command will be rejected with CHECK CONDITION status. The sense key shall be set to DATA PROTECT and the additional sense code shall be set to WORM MEDIUM - OVERWRITE ATTEMPTED.

Table 21 — FORMAT MEDIUM command

Byte	Bit							
	7	6	5	4	3	2	1	0
0	OPERATION CODE (04h)							
1	Reserved						VERIFY	IMMED
2	Reserved				FORMAT			
3	(MSB)	TRANSFER LENGTH						
4								(LSB)
5	Control Byte (see 5.1.2.3)							

At the successful completion of a FORMAT MEDIUM command, the medium shall be positioned at BOP 0.

During the format operation, the device server shall respond to commands as follows:

a) in response to all commands except REQUEST SENSE and INQUIRY, the device server shall return CHECK CONDITION unless a reservation conflict exists. In that case RESERVATION CONFLICT status shall be returned; or
b) in response to the REQUEST SENSE command, assuming no error has occurred, the device server shall return a sense key of NOT READY and the additional sense code shall be set to LOGICAL UNIT NOT READY, FORMAT IN PROGRESS, with the sense key specific bytes set for process indication (see SPC-4).

An immediate (IMMED) bit of zero specifies the device server shall not return status until the FORMAT MEDIUM command has completed. An IMMED bit of one specifies the device server shall return status as soon as the valid medium location has been verified and the command descriptor block of the FORMAT MEDIUM command has been validated. If CHECK CONDITION status is returned for a FORMAT MEDIUM command with an IMMED bit of one, the format operation shall not be performed.

The VERIFY bit shall be set to zero. The drive does not perform any verification of the format.

The FORMAT field is specified in table 22.

Table 22 — FORMAT field

Code	Description	Cartridge Support
0h	Use default format	Ultrium 4 and later Data cartridge
1h	Partition medium	Ultrium 5 and later Data cartridge
2h	Default format then partition	Ultrium 5 and later Data cartridge
3h-7h	Reserved	
8h-Fh	Vendor specific	Not Supported

If the FORMAT field is 0h, the logical unit shall format the volume to a single partition. A valid FORMAT MEDIUM command with 0h in the FORMAT field shall cause all data on the entire physical volume to be lost.

If the FORMAT field is 1h, the logical unit shall partition the medium using the current mode data from the Medium Partition mode page (see 6.5.12). If none of the mode bits SDP, FDP, or IDP are set to one, the device server shall return CHECK CONDITION. The sense key shall be set to ILLEGAL REQUEST with the addition sense code set to PARAMETER VALUE INVALID. If insufficient space exists on the medium for the requested partition sizes, the device server shall return CHECK CONDITION status. The sense key shall be set to MEDIUM ERROR and the additional sense code shall be set to VOLUME OVERFLOW. A valid FORMAT MEDIUM command with 1h in the FORMAT field causes all data on the entire physical volume to be lost.

If the FORMAT field is 2h, the logical unit shall perform the operations equivalent to a FORMAT field of 0h followed by a FORMAT field of 1h. A valid FORMAT MEDIUM command with 2h in the FORMAT field causes all data on the entire physical volume to be lost.

When the FORMAT field contains 1h or 2h, some errors related to mode page field contents may not be detected until the FORMAT MEDIUM command is processed. Therefore, some error conditions described in MP 11h: Medium Partition Page (see 6.5.12 on page 326) may be returned in response to a FORMAT MEDIUM command with 1h or 2h in the FORMAT field.

The TRANSFER LENGTH shall be zero.

5.2.4 INQUIRY - 12h

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

Table 23 — INQUIRY CDB

Byte	Bit						
	7	6	5	4	3	2	1
0	OPERATION CODE (12h)						
1	Reserved						EVPD
2	PAGE CODE						
3	Reserved						
4	ALLOCATION LENGTH						
5	Control Byte (see 5.1.2.3)						

If the Enable Vital Product Data (EVPD) field is set to 0 and the PAGE CODE field is set to 00h, then Standard Inquiry Data is returned (see 5.2.4.1).

If the Enable Vital Product Data (EVPD) field is set to one and the PAGE CODE field is set to 00h, then the Supported Vital Product Data Pages page is returned (see 6.2.1). This page lists the VPD pages that are supported by the drive in this configuration.

If the Enable Vital Product Data (EVPD) field is set to one and the PAGE CODE field is not set to 00h, then a VPD page is requested and, if the VPD page is supported in the current configuration, that page is returned. The VPD pages are described in 6.2 Inquiry Vital Product Data Parameters (IP).

If the preceding conditions do not apply, the logical unit returns CHECK CONDITION status with the Sense Key set to ILLEGAL REQUEST and the additional sense code set to INVALID FIELD IN CDB (i.e., 5/2400h).

5.2.4.1 Standard Inquiry Data

In drives that are not configured with the eServer™ attachment feature, Standard Inquiry Data for a valid LUN is described in table 24.

Table 24 — Standard INQUIRY data valid LUN format (part 1 of 2)

Bit Byte	7	6	5	4	3	2	1	0
0	PERIPHERAL QUALIFIER			PERIPHERAL DEVICE TYPE				
1	RMB	Reserved						
2	version (06h)							
3	Obsolete	Obsolete	NACA (0)	HISUP (0)	RESPONSE DATA FORMAT (2h)			
4	ADDITIONAL LENGTH (n-4)							
5	SCCS (0)	ACC (0)	TPGS (00b)		3PC (0)	Reserved		PROTECT
6	Obsolete	ENCSRV (0)	VS(0)	MULTIP	Obsolete	Obsolete	Obsolete	ADDR16(0)
7	Obsolete	Obsolete	WBUS16(0)	SYNC(0)	Obsolete	Obsolete	CmdQue	VS(0)
8	(MSB)	T10 VENDOR IDENTIFICATION("IBM ")						
15								(LSB)
16	(MSB)	PRODUCT IDENTIFICATION						
31								(LSB)
32	(MSB)	PRODUCT REVISION LEVEL (YMDV)						
35								(LSB)

Table 24 — Standard INQUIRY data valid LUN format (part 2 of 2)

Bit Byte	7	6	5	4	3	2	1	0
36	Reserved							AutDis
37	Obsolete							
38	PROTOCOL IDENTIFIER				MAXIMUM SPEED SUPPORTED			
39	Restricted	Reserved					FIPS	
40	Reserved							
41	OEM Specific							
42	Reserved							
55								
56	Reserved				CLOCKING(0)		QAS(0)	IUS(0)
57	Reserved							
58	(MSB)	SAM-4r14 (008Bh)						
59								(LSB)
60	(MSB)	if SAS drive, then SAS-2r16 (0C28h) if Fibre Channel drive, then FCP-4r1 (0A42h)						
61								(LSB)
62	(MSB)	SPC-4, no revision claimed (0460h)						
63								(LSB)
64	(MSB)	SSC-3r04a (0403h)						
65								(LSB)
66	(MSB)	ADT-2r6 (0A22h)						
67								(LSB)
68	(MSB)	ADC-3 no revision claimed (0500h)						
69								(LSB)

In drives configured with the eServer attachment feature, the Standard Inquiry Data for a valid LUN is defined in table 25.

Table 25 — eServer attachment Standard Inquiry Data Valid LUN

Byte	Bit							
	7	6	5	4	3	2	1	0
0	PERIPHERAL QUALIFIER			PERIPHERAL DEVICE TYPE				
1	RMB	Reserved						
2	ISO VERSION (00b)		ECMA VERSION (000b)			VERSION (3h)		
3	AERC(0)	Obsolete	NACA(0)	HISUP(0)	RESPONSE DATA FORMAT (2h)			
4	ADDITIONAL LENGTH							
5	SCCS (0)	ACC (0)	TPGS (00b)		3PC (0)	Reserved		PROTECT
6	Obsolete	ENCSRV(0)	VS(0)	MULTIP	Obsolete			ADR16
7	Obsolete		WBS16	SYNC	Obsolete		CMDQ	VS(0)
8 – 15	VENDOR IDENTIFICATION (in left-aligned ASCII) "IBM"							
16 – 31	PRODUCT IDENTIFICATION (in left-aligned ASCII)							
32 – 35	PRODUCT REVISION LEVEL (in left-aligned ASCII): YMDV							
36 – 43	UNIT SERIAL NUMBER (8 ASCII characters) ["20ssssss" = last 6 characters of the 11S identifier]							
44 – 47	LOAD ID							
48 – 55	IBM DRIVE PART NUMBER (8 ASCII characters) [The first 7 bytes of this field match the 7-character drive P/N printed on the rear drive label]							
56	Reserved				CLOCKING (00b)		QAS (0b)	IUS (0b)
57 – 95	Reserved							
96 – 97	Reserved							
98 – 101	PLANT ID (4 ASCII characters) ("N1øø")							
102 – 112	Reserved							
113	Reserved							LIBR(0)
114 – 125	DRIVE FRU PART NUMBER (12 ASCII characters)							
126 – 135	IBM EC LEVEL (10 ASCII characters)) [The first 6 bytes of this field match the EC level printed on the rear drive label]							

For Valid LUN:

a) PERIPHERAL QUALIFIER is set to 000b.
b) PERIPHERAL DEVICE TYPE is set to 01h.

c) RMB is set to 1b to indicate that the medium is removable.

For Invalid LUN:

a) PERIPHERAL QUALIFIER is set to 011b.
b) PERIPHERAL DEVICE TYPE is set to 1Fh.
c) RMB is set to 0b to indicate that the medium is not removable.

For all devices:

a) The Additional Length field specifies how many bytes follow. This value is subject to change. It is strongly recommended that the user parse the data returned by using the ADDITIONAL LENGTH field.
b) PROTECT:
c) ADR16 field is set to 0.
d) WBS16 field is set to 0.
e) SYNC field is set to 0.
f) CMDQ field is set to 1, which indicates that the drive supports tagged (simple) command queuing.
g) CLOCKING field is set to 0.
h) QAS field is set to 0, which indicates that the drive does not support quick arbitration and selection.
i) IUS field is set to 0, which indicates that the drive does not support information unit transfers.
j) VENDOR IDENTIFICATION returns `IBM` in ASCII with trailing blanks.
k) PRODUCT VENDOR IDENTIFICATION returns `ULTxxxx-TDy` in ASCII with trailing blanks. If the drive is an IBM drive, `xxxx` equals 3580; if it is an OEM drive, `xxxx` equals RIUM. The character `y` indicates the generation of the drive. See the table below for the value returned.

Table 26 — Product Identification Table

Generation [c]	IBM Drive [a]	OEM Drive [a]	eServer Attachment enabled [b]
1	ULT3580-TD1	ULTRIUM-TD1	N/A
2	ULT3580-TD2	ULTRIUM-TD2	N/A
2 Half-height	ULT3580-HH2	ULTRIUM-HH2	N/A
3	ULT3580-TD3	ULTRIUM-TD3	N/A
3 Half-height	ULT3580-HH3	ULTRIUM-HH3	HH LTO Gen 3
4	ULT3580-TD4	ULTRIUM-TD4	N/A
4 Half-height	ULT3580-HH4	ULTRIUM-HH4	HH LTO Gen 4
5	ULT3580-TD5	ULTRIUM-TD5	N/A
5 Half-height	ULT3580-HH5	ULTRIUM-HH5	HH LTO Gen 5

[a] IBM Tape Device Drivers will only configure Product IDs that are found in the columns entitled "IBM Drive" and "OEM Drive".
[b] IBM SCDD will only configure Product IDs that are found in the column entitled "eServer Attachment Enabled".
[c] For description of behaviors of devices prior to generation 5, see the *IBM System Storage LTO Ultrium Tape Drive: SCSI Reference (GA32-0450-10)* which is found at the following URL http://publibfi.dhe.ibm.com/epubs/pdf/32045010.pdf

WARNING WARNING

Drives targeted to be installed in eServer hosts have the eServer Attachment enabled during manufacturing. Drives that have eServer Attachment enabled have several behaviors that are different from the drives without eServer Attachment enabled. Please see the following sections and look for eServer attachment differences: <Mode Page 2Fh: Behavior Configuration Mode Page, REWIND, WRITE FILE MARKS>.

WARNING WARNING

l) PRODUCT REVISION LEVEL has four parts:
   A) Y is the last character of the year (for example, A indicates the year 2010)
   B) M is the month, in the alphanumeric set 1 through 9, A, B, or C
   C) D is the day, in the alphanumeric set 1 through 9, A through V
   D) V is the version, in the alphanumeric set 0 through 9, a through z, and A through Z, with 0 being the earliest and Z the latest (to avoid interpretation errors, the characters i, l, and 0 are not used)

m) Automation Disabled (AutDis) field set indicates that the drive is not capable of full automation function. When this field is 0, it indicates that the drive is capable of full automation function.

n) The OEM Specific field is intentionally not specified. See the documentation from the OEM vendor to determine the field's definition and application.

o) The PROTOCOL IDENTIFIER field is defined by the PROTOCOL IDENTIFIER field defined in SPC-4 and copied in table 27.

Table 27 — PROTOCOL IDENTIFER values

PROTOCOL IDENTIFIER	Description	Protocol Standard
0h	Fibre Channel	FCP-4
6h	SAS Serial SCSI Protocol	SAS-2
7h	Automation/Drive Interface - Transport Protocol	ADT-2

p) The MAXIMUM SPEED SUPPORTED field reports the maximum speed supported on the primary interface. The values for SAS attached devices are defined in table 28. The values for Fibre Channel attached devices are defined in table 29.

Table 28 — SAS MAXIMUM SPEED SUPPORTED values

Value	Physical Link Rate
0h	Unknown
8h	1.5 Gbps
9h	3.0 Gbps
Ah	6.0 Gbps

Table 29 — Fibre Channel MAXIMUM SPEED SUPPORTED values

Value	Physical Link Rate
0h	1 Gb/s
1h	2 Gb/s
2h	4 Gb/s
3h	8 Gb/s
4h	10 Gb/s
others	Reserved

q) The FIPS field indicates information about the code level as it relates to the Federal Information Processing Standards. The FIPS field values are defined in table 30.

Table 30 — FIPS field values

Value	Description
00b	Code level and base have never been certified by FIPS
01b	Code level is built on top of a FIPS 140-2 certified code level but has not been certified since the change.
10b	Reserved
11b	Code level is a FIPS 140-2 certified code level

5.2.5 LOAD/UNLOAD - 1Bh

Table 31 — LOAD/UNLOAD CDB

Byte	Bit							
	7	6	5	4	3	2	1	0
0	OPERATION CODE (1Bh)							
1	Obsolete (LUN) (ignored)			Reserved				IMMED
2	Reserved							
3	Reserved							
4	Reserved				HOLD	EOT (0)	RETEN (0)	LOAD
5	Control Byte (see 5.1.2.3)							

If the LOAD field is set to 1b and there is a tape in the drive, it is positioned to BOP 0. If the LOAD field is set to 1b and there is no tape in the drive, CHECK CONDITION status is returned with Sense Key set to Not Ready and the additional sense code set to MEDIUM NOT PRESENT (2/3A00h).

If the LOAD field is set to 0b, there is a tape in the drive, and medium removal prevention has not been set, then the tape is unloaded and ejected. If the LOAD field is set to 0b, there is a tape in the drive, and medium removal prevention has been set, then CHECK CONDITION status is returned with the Sense Key set to ILLEGAL REQUEST and the additional sense code set to MEDIUM REMOVAL PREVENTED (5/5302h).

If the LOAD field is set to 0b and the tape is in the ejected position, the command is presented with CHECK CONDITION status and associated sense data of 2/0402h (NOT READY, INITIALIZATION REQUIRED). If the LOAD field is set to 0b and there is no cartridge present, the command is presented with CHECK CONDITION status and associated data of 2/3A00h (NOT READY, MEDIUM NOT PRESENT).

If the Immediate (IMMED) field is set to 1b, 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 IMMED field is set to 0b, then status is not returned until after the command has completed.

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

The End Of Tape (EOT) field is not supported and should be set to 0b. If the EOT field is set to 1b, then CHECK CONDITION status is returned with the Sense Key is set to ILLEGAL REQUEST and the additional sense code set to INVALID FIELD IN CDB (5/2400h).

Table 32 describes the behaviors for the command.

Table 32 — LOAD/UNLOAD actions depending on Load and Hold bit settings and medium position

Medium Position on command receipt	Load	Hold	Status	Behavior and Medium Position at command completion
No tape present	0	x	Check Condition Status is returned with Not Ready, Medium Not Present (2/3A00)	No action is taken No tape present
No tape present	1	x	Check Condition Status is returned with Not Ready, Medium Not Present (2/3A00)	No action is taken No tape present
Ejected Position	0	x	Check Condition Status is returned with Not Ready, Initializing Command Required (2/0402)	No action is taken Ejected Position
Ejected Position	1	0	Good Status returned	Seated and tape is threaded and ready for access at LBA 0 of partition 0
Ejected Position	1	1	Good Status returned	Seated with Cartridge Memory (CM) accessible but tape is not threaded
Seated but tape not threaded	0	0	Good Status returned	Ejected Position
Seated but tape not threaded	0	1	Good Status returned	No action taken Position it was at prior to command
Seated but tape not threaded	1	0	Good Status returned	Seated and tape is threaded and ready for access at LBA 0 of partition 0
Seated but tape not threaded	1	1	Good Status returned	No action taken Position it was at prior to command
Seated with tape threaded	0	0	Good Status returned	Ejected Position
Seated with tape threaded	0	1	Good Status returned	Seated with Cartridge Memory (CM) accessible but tape is not threaded
Seated with tape threaded	1	0	Good Status returned	Seated and tape is rewound and ready for access at LBA 0 of partition 0 (i.e. this is equal to issuing a rewind command)
Seated with tape threaded	1	1	Check Condition Status is returned with Illegal Request, Invalid Field in CDB (5/2400)	No action is taken Position it was at prior to command

5.2.6 LOCATE(10/16) - 2Bh/92h

The LOCATE command causes the logical position on tape to be set to the value indicated by the LOGICAL OBJECT IDENTIFIER field. The value indicates the total number of records and marks between BOP and the desired logical position. A value of zero causes the tape to be positioned at BOP.

Table 33 — LOCATE(10) Command

Byte	Bit							
	7	6	5	4	3	2	1	0
0	OPERATION CODE (2Bh)							
1	Reserved					BT	CP	IMMED
2	Reserved							
3	(MSB)	LOGICAL OBJECT IDENTIFIER						
6								(LSB)
7	Reserved							
8	PARTITION							
9	Control Byte (see 5.1.2.3)							

Table 34 — LOCATE(16) Command

Byte	Bit							
	7	6	5	4	3	2	1	0
0	OPERATION CODE (92h)							
1	Reserved			DEST_TYPE		Rsvd	CP	IMMED
2	Reserved							BAM
3	PARTITION							
4	(MSB)	LOGICAL IDENTIFIER						
11								(LSB)
12		Reserved						
14								
15	Control Byte (see 5.1.2.3)							

The following parameters apply:

- BT (block type): 0b
- cp (change partition):

Value	Description
0b	No partition change occurs and the partition field is ignored.
1b	The logical position of the medium is changed to the partition specified in the PARTITION field as part of the locate operation.

- IMMED (Immediate):

Value	Description
0b	Status is not returned until after the command has completed.
1b	The device 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 any. If there is no deferred error, the drive reports GOOD status and initiates processing the command.

- PARTITION: The partition to locate to if the CP bit is 1b.
- DEST_TYPE (destination type): Used in conjunction with the LOGICAL IDENTIFIER field to locate to the appropriate position of the medium.

Value	Description
00b	The LOGICAL IDENTIFIER field is interpreted as a logical object identifier. The Logical Position upon successful completion is on the BOP side of the logical object.
01b	The LOGICAL IDENTIFIER field is interpreted as a logical file identifier. The Logical Position upon successful completion is on the BOP side of the logical file.

- LOGICAL OBJECT IDENTIFIER: The logical object identifier to which the medium is to be positioned.
- LOGICAL IDENTIFIER: The logical object identifier (if the DEST_TYPE is set to 00b) or the logical file identifier (if the DEST_TYPE is sest to 01b) to which the medium is to be positioned.

5.2.7 LOG SELECT - 4Ch

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

Table 35 — LOG SELECT command

Byte	Bit							
	7	6	5	4	3	2	1	0
0	OPERATION CODE (4Ch)							
1	Reserved						PCR	SP
2	PC		PAGE CODE					
3	SUBPAGE CODE							
4	Reserved							
6								
7	(MSB)		PARAMETER LIST LENGTH					
8								(LSB)
9	Control Byte (see 5.1.2.3)							

- Parameter Code Reset (PCR):

  If the Parameter Code Reset (PCR) bit is set to one, then the PARAMETER LIST LENGTH shall be zero. The action taken by the drive is specified for the values of the Page Control (PC) field as follows:

Value	Description
00b	no action is taken and GOOD status is returned.
01b	all resettable logs on the drive are reset to default values.
10b	no action is taken and GOOD status is returned.
11b	all resettable logs on the drive are reset to default values.

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

Value	Description
00b	CHECK CONDITION status is returned with the Sense Key set to ILLEGAL REQUEST and the additional sense code set to INVALID FIELD IN CDB (5/2400h).
01b	data from the server is written to the indicated logs, provided that the logs are writable.
10b	CHECK CONDITION status is returned with the Sense Key set to ILLEGAL REQUEST and the additional sense code set to INVALID FIELD IN CDB (5/2400h).
11b	data from the server is written to the indicated logs, provided that the logs are writable.

- Save Page (SP): (0b)

5.2.8 LOG SENSE - 4Dh

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

Table 36 — LOG SENSE command

Byte	Bit							
	7	6	5	4	3	2	1	0
0	OPERATION CODE (4Dh)							
1	Reserved						PPC	SP
2	PC		PAGE CODE					
3	SUBPAGE CODE							
4	Reserved							
5	(MSB)			PARAMETER POINTER				
6								(LSB)
7	(MSB)			ALLOCATION LENGTH				
8								(LSB)
9	Control Byte (see 5.1.2.3)							

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

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

NOTE 6 - For page 2Eh (TapeAlert) only, the PC field is ignored. Current values are always returned.

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

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

WARNING WARNING

Log parameter data must be dynamically parsed as some parameters may not be present and other parameters may be inserted. The relative location of parameters have changed and are anticipated to continue to change.

WARNING WARNING

5.2.9 MODE SELECT (6/10) - 15h/55h

The MODE SELECT commands are defined in SPC (see the latest version at http://www.t10.org/drafts.htm#SCSI3_CMNDSETS). This clause decribes the specific implementation.

NOTE 7 - In the future, the length of the mode parameter list for Mode Sense Page Code 3Fh (All Pages) may exceed 255 bytes. At that time, use of the Mode Select (10) and Mode Sense (10) commands will be required in order to transfer all mode pages with one command. Some mode pages today exceed 255 bytes. For this reason, use of the Mode Select (6) and Mode Sense (6) commands is not recommended.

Table 37 — Mode Select (6) CDB

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	OPERATION CODE (15h)							
1	Obsolete (LUN)			PF	Reserved			SP
2	Reserved							
3								
4	PARAMETER LIST LENGTH							
5	Control Byte (see 5.1.2.3)							

Table 38 — Mode Select (10) CDB

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	OPERATION CODE (55h)							
1	Obsolete (LUN)			PF	Reserved			SP
2	Reserved							
6								
7	(MSB)							
8	PARAMETER LIST LENGTH							(LSB)
9	Control Byte (see 5.1.2.3)							

The following standards-based mode pages are supported:

MP 01h: Read-Write Error Recovery (see 6.5.5 on page 313)
MP 02h: Disconnect-Reconnect (see 6.5.6 on page 315)
MP 0Ah: Control (see 6.5.7 on page 316)
MP 0Ah[01h]: Control Extension (see 6.5.8 on page 317)
MP 0Fh: Data Compression (see 6.5.9 on page 318)
MP 10h: Device Configuration (see 6.5.10 on page 320)
MP 11h: Medium Partition Page (see 6.5.12 on page 326)
MP 18h: Protocol-Specific Logical Unit (see 6.5.13 on page 331)
MP 19h: Protocol specific port (see 6.5.14 on page 333)
MP 1Ah: Power Condition (see 6.5.15 on page 336)
MP 1Ch: Informational Exceptions Control (see 6.5.16 on page 338)
MP 1Dh: Medium Configuration (see 6.5.17 on page 340)

The following vendor-specific mode pages are also supported:

MP 24h: Vendor-Specific (see 6.5.18 on page 341)
(see on page 342)
MP 2Fh: Behavior Configuration (see 6.5.19 on page 343)
MP 3Eh: Engineering Support (see 6.5.21 on page 356)

NOTE 8 - Mode page 3Eh is for engineering use only.

The following parameters apply:

- PF (Page Format): 1b

  The PF bit is explicitly not checked.

- SP (Save Pages): Only allowed to be set to one when explicitly mentioned in the description of the specific mode page

- PARAMETER LIST LENGTH:

  This field specifies the length in bytes of the mode parameter list that is transferred from the initiator to the target. A parameter list length of zero indicates that no data is transferred. This condition is not considered as an error.

  The target terminates the command with CHECK CONDITION status with associated sense data of 5/1A00 (ILLEGAL REQUEST, PARAMETER LIST LENGTH ERROR) if the parameter list length results in the truncation of the mode parameter header, the mode parameter block descriptor, or any mode page.

NOTE 9 - Issuing a MODE SENSE for current values before a MODE SELECT is generally recommended to avoid accidentally attempting to set fields that are not allowed to be changed by the initiator.

If any of the fields in the mode parameters 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).

NOTE 10 - For Reserved and Vendor-Reserved fields, appropriate values to issue on a MODE SELECT may be non-zero. A MODE SELECT to pages with these fields should use a value obtained by issuing a MODE SENSE just prior to the MODE SELECT.

Mode Parameters (MP) (see 6.5 on page 305) has a listing of all mode parameters.

5.2.10 MODE SENSE (6/10) - 1Ah/5Ah

The MODE SENSE commands are defined in SPC (see the latest version at http://www.t10.org/drafts.htm#SCSI3_CMNDSETS). This clause decribes the specific implementation.

NOTE 11 - In the future, the length of the mode parameter list for Mode Sense Page Code 3Fh (All Pages) may exceed 255 bytes. At that time, use of the MODE SELECT (10) and MODE SENSE (10) commands will be required in order to transfer all mode pages with one command. For this reason, use of the MODE SELECT (6) and MODE SENSE (6) commands is not recommended.

Table 39 — MODE SENSE (6) CDB

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	OPERATION CODE (1A)							
1	Obsolete (LUN)			Reserved	DBD	Reserved		
2	PC		PAGE CODE					
3	SUBPAGE CODE							
4	ALLOCATION LENGTH							
5	Control Byte (see 5.1.2.3)							

Table 40 — MODE SENSE (10) CDB

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	OPERATION CODE (5A)							
1	Obsolete (LUN)			Reserved	DBD	Reserved		
2	PC		PAGE CODE					
3	SUBPAGE CODE							
4	Reserved							
6								
7	(MSB)	ALLOCATION LENGTH						
8								(LSB)
9	Control Byte (see 5.1.2.3)							

The following parameters apply:

- DBD (Disable Block Descriptors): 0b or 1b. (See BLOCK DESCRIPTOR LENGTH, below.)
- PC (Page Control):

Value	Description
00b	current values
01b	changeable bitmap (changeable = 1; unchangeable = 0)
10b	default (power-on) values
11b	saved values. When values that are not saveable are returned the default values are used

- PAGE CODE

The following standards-based mode pages are supported:

MP 01h: Read-Write Error Recovery (see 6.5.5 on page 313)
MP 02h: Disconnect-Reconnect (see 6.5.6 on page 315)
MP 0Ah: Control (see 6.5.7 on page 316)
MP 0Ah[01h]: Control Extension (see 6.5.8 on page 317)
MP 0Fh: Data Compression (see 6.5.9 on page 318)
MP 10h: Device Configuration (see 6.5.10 on page 320)
MP 11h: Medium Partition Page (see 6.5.12 on page 326)
MP 18h: Protocol-Specific Logical Unit (see 6.5.13 on page 331)
MP 19h: Protocol specific port (see 6.5.14 on page 333)
MP 1Ah: Power Condition (see 6.5.15 on page 336)
MP 1Ch: Informational Exceptions Control (see 6.5.16 on page 338)
MP 1Dh: Medium Configuration (see 6.5.17 on page 340)

The following vendor-specific mode pages are also supported:

MP 24h: Vendor-Specific (see 6.5.18 on page 341)
(see on page 342)
MP 2Fh: Behavior Configuration (see 6.5.19 on page 343)
MP 3Eh: Engineering Support (see 6.5.21 on page 356)

NOTE 12 - Mode page 3Eh is for engineering use only and is not included in page 3Fh

- SUBPAGE CODE
- ALLOCATION LENGTH: The maximum number of bytes to be transferred.

  If the allocation length specified is less than the amount available, then the allocated amount is transferred and no error is reported.

Mode Parameters (MP) (see 6.5 on page 305) has a listing of all mode parameters.

5.2.11 PERSISTENT RESERVE IN (PRIN)- 5Eh

The PERSISTENT RESERVE IN command is defined in SPC (see the latest version at http://www.t10.org/drafts.htm#SCSI3_CMNDSETS). This clause decribes the specific implementation.

Table 41 — PERSISTENT RESERVE IN Command

Byte	Bit							
	7 msb	**6**	**5**	**4**	**3**	**2**	**1**	**0 lsb**
0	OPCODE (5Eh)							
1	Reserved			SERVICE ACTION				
2	Reserved							
5								
6	(MSB)							
8	ALLOCATION LENGTH							(LSB)
9	Control Byte (see 5.1.2.3)							

The following parameters apply:

- SERVICE ACTION:

Value	Description
00h	READ KEYS - Reads all registered Reservation Keys (see 5.2.11.1)
01h	READ RESERVATION - Reads all current persistent reservations (see 5.2.11.2)
02h	REPORT CAPABILITIES - Returns capability information (see 5.2.11.3)
03h	READ FULL STATUS - Reads complete information about all registrations and the persistent reservations, if any (see 5.2.11.4)

- ALLOCATION LENGTH: The maximum number of bytes to be transferred.

5.2.11.1 READ KEYS service action

The READ KEYS service action requests that the device server return a parameter list containing a header and a list of each currently registered I_T nexus' reservation key.

The format for the parameter data provided in response to a PERSISTENT RESERVE IN command with the READ KEYS service action is shown in table 42.

Table 42 — PERSISTENT RESERVE IN parameter data for READ KEYS

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	(MSB)							
3				PRGENERATION				(LSB)
4	(MSB)							
7				ADDITIONAL LENGTH (n-7)				(LSB)
	Reservation key list							
8	(MSB)							
15				Reservation key [first]				(LSB)
	⋮							
n-7	(MSB)							
n				Reservation key [last]				(LSB)

Byte Description

0-3 PRGENERATION: Counter for Persistent Reserve Out Command requests
4-7 ADDITIONAL LENGTH: A count of the number of bytes in the Reservation key list
8-15 First Reservation Key
16-n Additional Reservation keys: additional reservation keys are not supported.

5.2.11.2 READ RESERVATION service action

The READ RESERVATION service action requests that the device server return a parameter list containing a header and the persistent reservation, if any, that is present in the device server.

The format for the parameter data provided in response to a PERSISTENT RESERVE IN command with the READ RESERVATION service action is shown in table 43.

Table 43 — PERSISTENT RESERVE IN parameter data for READ RESERVATION

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	(MSB)			PRGENERATION				
3								(LSB)
4	(MSB)			ADDITIONAL LENGTH				
7								(LSB)
If reservation exists (i.e., ADDITIONAL LENGTH > 0000 0000h)								
8	(MSB)			RESERVATION KEY				
15								(LSB)
16				Obsolete				
19								
20	Reserved							
21	SCOPE				TYPE			
22				Obsolete				
23								

Byte Description

0-3 PRGENERATION: Counter for Persistent Reserve Out Command requests

4-7 ADDITIONAL LENGTH: A count of the number of bytes in the Reservation key list.

Value	Description
00000000h	No reservation exists
00000010h	Reservation exists and this much data follows

8-n Reservation descriptor, if any: (defined below)

8-15 Reservation Key

16-19 Obsolete

20 Reserved

21

Bit	Description
7-4	SCOPE: persistent reservation applies to the entire logical unit: 0h
4-0	TYPE:

Value	Description
3h	Exclusive Access
6h	Exclusive Access — Registrants only
8h	Exclusive Access — All Registrants
others	Not supported

22-23 Obsolete

5.2.11.3 REPORT CAPABILITIES service action

The REPORT CAPABILITIES service action requests that the device server return information on persistent reservation features.

The format for the parameter data provided in response to a PERSISTENT RESERVE IN command with the REPORT CAPABILITIES service action is shown in table 44.

Table 44 — PERSISTENT RESERVE IN parameter data for REPORT CAPABILITIES

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	(MSB)							
1				LENGTH (0008h)				(LSB)
2		Reserved		CRH	SIP_C	ATP_C	Reserved	PTPL_C
3	TMV	ALLOW COMMANDS (000b)				Reserved		PTPL_A
	Persistent Reservation Type Mask							
4	WR_EX_AR	EX_AC_RO	WR_EX_RO	Rsvd	EX_AC	Rsvd	WR_EX	Rsvd
5	Reserved							EX_AC_AR
6								
7	Reserved							

Byte Description

0-1 LENGTH: 0008h

2

Bit	Description
7-5	Reserved
4	CRH (Compatible Reservation Handling): 1b
3	SIP_C (Specify Initiator Ports Capable): 1b
2	ATP_C (All Target Ports Capable): 1b
1	Reserved
0	PTPL_C (Persist Through Power Loss Capable): 0b

3

Bit	Description
7	TMV (Type Mask Valid): 1b
6-4	ALLOW COMMANDS: 000b

Value	Description
000b	No information is provided about whether certain commands are allowed through certain types of persistent reservations.
001b-100b	Not Supported. TUR is allowed through Exclusive Access reservations [and info about certain other commands and Write Exclusive reservations].
101b-111b	Reserved

Bit	Description
3-1	Reserved
0	PTPL_A (Persist Through Power Loss Activated): 0b

4 Persistent Reservation Type Mask (byte 4)

Bit	Description
7	WR_EX_AR (Write Exclusive — All Registrants): 0b
6	EX_AC_RO (Exclusive Access — Registrants Only): 1b
5	WR_EX_RO (Write Exclusive — Registrants Only): 0b
4	Reserved
3	EX_AC (Exclusive Access): 1b
2	Reserved
1	WR_EX (Write Exclusive): 0b
0	Reserved

5 Persistent Reservation Type Mask (byte 5)

Bit	Description
7-1	Reserved
0	EX_AC_AR (Exclusive Access — All Registrants): 1b

6-7 Reserved

5.2.11.4 READ FULL STATUS service action

The READ FULL STATUS service action requests that the device server return a parameter list describing the registration and persistent reservation status of each currently registered I_T nexus for the logical unit.

The format for the parameter data provided in response to a PERSISTENT RESERVE IN command with the READ FULL STATUS service action is shown in table 45.

Table 45 — PERSISTENT RESERVE IN parameter data for READ FULL STATUS

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	(MSB)			PRGENERATION				
3								(LSB)
4	(MSB)			ADDITIONAL LENGTH (n-7)				
7								(LSB)
	Full status descriptors							
8				Full status descriptor [first] (see table 46)				
	⋮							
				Full status descriptor [last] (see table 46)				
n								

Byte Description

0-3 PRGENERATION:

4-7 ADDITIONAL LENGTH (n-7)

8-n Full status descriptors (see 5.2.11.4.1).

5.2.11.4.1 Full status descriptors

The format of the full status descriptors is shown in table 46. Each full status descriptor describes one or more registered I_T nexuses. The device returns persistent reservations status information for every registered I_T nexus.

Table 46 — PERSISTENT RESERVE IN full status descriptor format

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	(MSB)							
7	RESERVATION KEY							(LSB)
8								
11	Reserved							
12	Reserved						ALL_TG_PT	R_HOLDER
13	SCOPE				TYPE			
14								
17	Reserved							
18	(MSB)							
19	RELATIVE TARGET PORT IDENTIFIER							(LSB)
20	(MSB)							
23	ADDITIONAL DESCRIPTOR LENGTH (n-23)							(LSB)
24								
n	TRANSPORTID							

Byte Description

0-7 RESERVATION KEY:

8-11 Reserved

12

Bit	Description
7-2	Reserved
1	ALL_TG_PT (All Target Ports)
0	R_HOLDER (Reservation Holder)

13

Bit	Description
7-4	SCOPE
3-0	TYPE

14-17 Reserved

18-19 RELATIVE TARGET PORT IDENTIFIER:

20-23 ADDITIONAL DESCRIPTOR LENGTH (n-23)

24-n TRANSPORTID: TransportID identifying the initiator port that is part of the I_T nexus or I_T nexuses described by this full status descriptor.

5.2.12 PERSISTENT RESERVE OUT - 5Fh

The Persistent Reserve Out command is defined in SPC-4 (see the latest version at http://www.t10.org/drafts.htm#SCSI3_CMNDSETS). This clause decribes the specific implementation.

Table 47 — PERSISTENT RESERVE OUT CDB

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	OPCODE (5Fh)							
1	Reserved			SERVICE ACTION				
2	SCOPE				TYPE			
3	Reserved							
6								
7	(MSB)	PARAMETER LIST LENGTH						
8								(LSB)
9	Control Byte (see 5.1.2.3)							

The following parameters apply:

- SERVICE ACTION:

Value	Description
00h	REGISTER: Register a reservation key with the device server
01h	RESERVE: Create a persistent reservation using a reservation key
02h	RELEASE: Release a persistent reservation
03h	CLEAR: Clear all reservation keys and all persistent reservations
04h	PREEMPT: Preempt persistent reservations and/or removes registrations
05h	PREEMPT AND ABORT: Preempt persistent reservations and/or removes registrations and clear the task set for the preempted initiator
07h	REGISTER AND MOVE: Register And Move the registration to another I_T nexus.
08h-1Fh	Reserved

- SCOPE: 0h

  If the Service Action field is set to RESERVE, RELEASE, PREEMPT, PREEMPT AND ABORT, or REGISTER AND MOVE then SCOPE shall be zero. This field is ignored for other Service Actions.

- TYPE:

Value	Description
3h	Exclusive Access
6h	Exclusive Access — Registrants only
8h	Exclusive Access — All Registrants
others	Not supported

- PARAMETER LIST LENGTH:

Value	Description
0018h	All values of SERVICE ACTION except REGISTER AND MOVE (i.e., 07h)
variable	SERVICE ACTION set to REGISTER AND MOVE (i.e., 07h)

5.2.12.1 Basic PERSISTENT RESERVE OUT parameter list

The PERSISTENT RESERVE OUT command with any service action except the REGISTER AND MOVE service action uses the parameter list format shown in table 48.

Table 48 — PERSISTENT RESERVE OUT parameter list

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	(MSB)	RESERVATION KEY						
7								(LSB)
8	(MSB)	SERVICE ACTION RESERVATION KEY						
15								(LSB)
16		Obsolete						
19								
20	Reserved				SPEC_I_PT	ALL_TG_PT	Reserved	APTPL
21	Reserved							
22		Obsolete						
23								

Byte Description

0-7 RESERVATION KEY

8-15 SERVICE ACTION RESERVATION KEY

16-19 Obsolete

20

Bit	Description
7-4	Reserved
3	SPEC_I_PT(Specify Initiator Ports): 0b
2	ALL_TG_PT(All Target Ports): 0b
1	Reserved
0	APTPL (Activate Persist Through Power Loss): 0b

21 Reserved

22-23 Obsolete

5.2.12.2 PERSISTENT RESERVE OUT command with REGISTER AND MOVE service action parameters

The parameter list format shown in table 49 shall be used by the PERSISTENT RESERVE OUT command with REGISTER AND MOVE service action.

Table 49 — PERSISTENT RESERVE OUT with REGISTER AND MOVE service action parameter list

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	(MSB)							
7				RESERVATION KEY				(LSB)
8	(MSB)							
15				SERVICE ACTION RESERVATION KEY				(LSB)
16	Reserved							
17	Reserved						UNREG	APTPL
18	(MSB)							
19				RELATIVE TARGET PORT IDENTIFIER				(LSB)
20	(MSB)							
23				TRANSPORTID PARAMETER DATA LENGTH (n-23)				(LSB)
24								
n				TRANSPORTID				

Byte Description

0-7 RESERVATION KEY

8-15 SERVICE ACTION RESERVATION KEY

16 Reserved

17

Bit	Description
7-2	Reserved
1	UNREG (Unregister):
0	APTPL (Activate Persist Through Power Loss): 0b

18-19 RELATIVE TARGET PORT IDENTIFIER

20-23 ADDITIONAL DESCRIPTOR LENGTH (n-23)

24-n TRANSPORTID

5.2.13 PREVENT ALLOW MEDIUM REMOVAL - 1Eh

The PREVENT ALLOW MEDIUM REMOVAL command is defined in SSC-3 (see the latest version at http://www.t10.org/drafts.htm#SCSI3_CMNDSETS). This clause decribes the specific implementation.

The Prevent Allow Medium Removal command is supported only for the Prevent Cartridge Removal option. Table 50 shows the command format.

Table 50 — PREVENT ALLOW MEDIUM Removal Command

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	OPERATION CODE (1Eh)							
1	Obsolete (LUN)			Reserved				
2	Reserved							
3								
4	Reserved							PREVENT
5	Control Byte (see 5.1.2.3)							

The following parameters apply:

- PREVENT:

Value	Description
00b	Allow Cartridge Removal: Medium removal is allowed through this I_T nexus
01b	Prevent Cartridge Removal: Medium removal is prevented through this I_T nexus
10b	Obsolete
11b	Obsolete

5.2.13.1 Medium removal

When medium removal is prevented for an I_T nexus requests to eject or unmount the volume via a SCSI LOAD UNLOAD commands through that I_T nexus are rejected with a CHECK CONDITION status with the Sense Key set to ILLEGAL REQUEST and the additional sense code set to MEDIUM REMOVAL PREVENTED (5/5302).

When medium removal is prevented for any I_T nexus, requests to eject the volume via the panel are ignored.

Volume removal is enabled again when each I_T nexus that has prevented medium removal has issued the PREVENT ALLOW MEDIUM REMOVAL command with the PREVENT field set to 00b (Allow Cartridge Removal) or has experienced an I_T nexus loss event. A reset (bus device reset, reset message, or power on reset) also restores the drive to the allow removal state. In the case of the bus device reset or the reset message, the reset restores the allow state only if the reset occurs on the same port that originally set Prevent.

If a persistent reservation or registration is being preempted by a PERSISTENT RESERVE OUT command with PREEMPT AND ABORT service action, then the equivalent of a PREVENT ALLOW MEDIUM REMOVAL command with the PREVENT field set to 00b is processed for each I_T nexus associated with the persistent reservation or registrations being preempted.

NOTE 13 - The PREVENT ALLOW MEDIUM REMOVAL command also prohibits medium removal by any library commands that may be received.

5.2.14 READ - 08h

The READ command is defined in SSC (see the latest version at http://www.t10.org/drafts.htm#SCSI3_CMNDSETS). This clause decribes the specific implementation.

Table 51 — Read CDB

Byte	Bit							
	7 msb	**6**	**5**	**4**	**3**	**2**	**1**	**0 lsb**
0	OPERATION CODE (08h)							
1	Obsolete (LUN)			Reserved			SILI	FIXED
2	MSB							
3				TRANSFER LENGTH				
4								LSB
5	Control Byte (see 5.1.2.3)							

The following parameters apply:

- SILI (Suppress Incorrect Length Indicator): (see 4.5)
- FIXED (see 4.4)
- TRANSFER LENGTH (see 4.4)

General Read-Type Handling (see 4.5.1 on page 33) provides additional information.

5.2.15 READ ATTRIBUTE - 8Ch

The READ ATTRIBUTE command is defined in SPC-4 (see the latest version at http://www.t10.org/drafts.htm#SCSI3_CMNDSETS). This clause decribes the specific implementation. The READ ATTRIBUTE command (see table 52) allows an application client to read attribute values from medium auxiliary memory.

Table 52 — READ ATTRIBUTE command

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	OPERATION CODE (8Ch)							
1	Reserved			SERVICE ACTION				
2	Obsolete							
4								
5	LOGICAL VOLUME NUMBER							
6	Reserved							
7	PARTITION NUMBER							
8	(MSB)			FIRST ATTRIBUTE IDENTIFIER				
9								(LSB)
10	(MSB)			ALLOCATION LENGTH				
13								(LSB)
14	Reserved							
15	Control Byte (see 5.1.2.3)							

If the medium auxiliary memory is not accessible because there is no medium present, the READ ATTRIBUTE command shall be terminated with CHECK CONDITION status, with the sense key set to NOT READY, and the additional sense code set to MEDIUM NOT PRESENT.

If the medium is present but the medium auxiliary memory is not accessible, the READ ATTRIBUTE command shall be terminated with CHECK CONDITION status, with the sense key set to MEDIUM ERROR, and the additional sense code set to LOGICAL UNIT NOT READY, AUXILIARY MEMORY NOT ACCESSIBLE.

If the medium auxiliary memory is not operational, the READ ATTRIBUTE command shall be terminated with CHECK CONDITION status, with the sense key set to MEDIUM ERROR, and the additional sense code set to AUXILIARY MEMORY READ ERROR.

The following parameters apply:

- SERVICE ACTION:

Value	Description
00h	ATTRIBUTE VALUES: Return attribute values as specified in ATTRIBUTE VALUES service action (see 5.2.15.1 on page 100)
01h	ATTRIBUTE LIST: Return a list of available attribute identifiers – identifiers that are in the read only state or in the read/write state (see 4.13) as specified in ATTRIBUTE LIST service action (see 5.2.15.2 on page 101)
02h	LOGICAL VOLUME LIST: Return a list of known logical volume numbers as defined in LOGICAL VOLUME LIST service action (see 5.2.15.3 on page 101)
03h	PARTITION LIST: Return a list of known partition numbers as defined in PARTITION LIST service action (see 5.2.15.4 on page 102)
05h	SUPPORTED ATTRIBUTES: Return a list of supported attribute identifiers – identifiers that are in the read only state, in the read/write state, or in the nonexistent state (see 4.13) as defined in SUPPORTED ATTRIBUTES service action (see 5.2.15.5 on page 102)

- LOGICAL VOLUME NUMBER: 00h
- PARTITION NUMBER: The partition of the attribute to be accessed.
- FIRST ATTRIBUTE IDENTIFIER: The attribute identifier of the first attribute to be returned.
- ALLOCATION LENGTH: The number of bytes allowed to be returned

5.2.15.1 ATTRIBUTE VALUES service action

The READ ATTRIBUTE command with ATTRIBUTE VALUES service action returns parameter data containing the attributes that are in the read state or read/write state (see 4.13) specified by the PARTITION NUMBER, LOGICAL VOLUME NUMBER, and FIRST ATTRIBUTE IDENTIFIER fields in the CDB. The returned parameter data shall contain the requested attributes in ascending numerical order by attribute identifier value and in the format shown in table 53.

Table 53 — READ ATTRIBUTE with ATTRIBUTE VALUES service action parameter list format

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	(MSB)							
3	AVAILABLE DATA (n-3)							(LSB)
	Attribute(s)							
4	Attribute 0 (see 6.4.1)							
	⋮							
n	Attribute x (see 6.4.1)							

The AVAILABLE DATA field shall contain the number of bytes of attribute information in the parameter list.

Attribute format (see 6.4.1 on page 295) describes the format of the attributes.

5.2.15.2 ATTRIBUTE LIST service action

The READ ATTRIBUTE command with ATTRIBUTE LIST service action returns parameter data containing the attribute identifiers for the attributes that are in the read only state or in the read/write state (see 4.13) in the specified partition and volume number. The contents of FIRST ATTRIBUTE IDENTIFIER field in the CDB shall be ignored. The returned parameter data shall contain the requested attribute identifiers in ascending numerical order by attribute identifier value and in the format shown in table 54.

Table 54 — READ ATTRIBUTE with ATTRIBUTE LIST service action parameter list format

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	(MSB)							
3	AVAILABLE DATA (n-3)							(LSB)
	Attribute identifiers							
4	ATTRIBUTE IDENTIFIER 0							
5								
	⋮							
n-1	ATTRIBUTE IDENTIFIER x							
n								

The AVAILABLE DATA field shall contain the number of bytes of attribute identifiers in the parameter list.

An ATTRIBUTE IDENTIFIER field is returned for each attribute that is in the read only state or in the read/write state (see 4.13) in the specified partition and volume number. Attribute identifier values (see 6.4.2 on page 296) provides a description of the attribute identifier values.

5.2.15.3 LOGICAL VOLUME LIST service action

The READ ATTRIBUTE command with LOGICAL VOLUME LIST service action returns parameter data (see table 55) identifying the supported number of logical volumes. The contents of LOGICAL VOLUME NUMBER, PARTITION NUMBER, and FIRST ATTRIBUTE IDENTIFIER fields in the CDB shall be ignored.

Table 55 — READ ATTRIBUTE with LOGICAL VOLUME LIST service action parameter list format

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	(MSB)							
1	AVAILABLE DATA (0002h)							(LSB)
2	FIRST LOGICAL VOLUME NUMBER							
3	NUMBER OF LOGICAL VOLUMES AVAILABLE							

The AVAILABLE DATA field shall contain two.

The FIRST LOGICAL VOLUME NUMBER field indicates the first volume available. Logical volume numbering should start at zero.

The NUMBER OF LOGICAL VOLUMES AVAILABLE field indicates the number of volumes available.

5.2.15.4 PARTITION LIST service action

The READ ATTRIBUTE command with PARTITION LIST service action returns parameter data (see table 56) identifying the number of partitions supported in the specified logical volume number. The contents of PARTITION NUMBER and FIRST ATTRIBUTE IDENTIFIER fields in the CDB shall be ignored.

Table 56 — READ ATTRIBUTE with PARTITION LIST service action parameter list format

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	(MSB)							
1	AVAILABLE DATA (0002h)							(LSB)
2	FIRST PARTITION NUMBER							
3	NUMBER OF PARTITIONS AVAILABLE							

The AVAILABLE DATA field shall contain two.

The FIRST PARTITION NUMBER field indicates the first partition available on the specified logical volume number. Partition numbering should start at zero.

The NUMBER OF PARTITIONS AVAILABLE field indicates the number of partitions available on the specified logical volume number.

5.2.15.5 SUPPORTED ATTRIBUTES service action

The READ ATTRIBUTE command with SUPPORTED ATTRIBUTES service action returns parameter data containing the attribute identifiers for the attributes that are in the read only state, in the read/write state, or in the nonexistent state (see 4.13) in the specified partition and volume number. The contents of FIRST ATTRIBUTE IDENTIFIER field in the CDB shall be ignored. The returned parameter data shall contain the requested attribute identifiers in ascending numerical order by attribute identifier value and in the format shown in table 57.

Table 57 — READ ATTRIBUTE with SUPPORTED ATTRIBUTES service action parameter list format

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	(MSB)							
3	AVAILABLE DATA (n-3)							(LSB)
	Attribute identifiers							
4	ATTRIBUTE IDENTIFIER 0							
5								
	⋮							
n-1	ATTRIBUTE IDENTIFIER X							
n								

The AVAILABLE DATA field shall contain the number of bytes of attribute identifiers in the parameter list.

An ATTRIBUTE IDENTIFIER field is returned for each attribute that is in the read only state, in the read/write state, or in the nonexistent state (see 4.13) in the specified partition and volume number. Attribute identifier values (see 6.4.2 on page 296) describes the attribute identifier values.

5.2.16 READ BLOCK LIMITS - 05h

The READ BLOCK LIMITS command is defined in SSC (see the latest version at http://www.t10.org/drafts.htm#SCSI3_CMNDSETS). This clause decribes the specific implementation.

Table 58 — Read Block Limits CDB

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	OPERATION CODE (05h)							
1	Obsolete (LUN)			Reserved				
2	Reserved							
3								
4								
5	Control Byte (see 5.1.2.3)							

The returned parameter data is in the format shown in table 59.

Table 59 — RBL parameter data

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	Reserved			GRANULARITY				
1	(MSB)	MAXIMUM BLOCK LENGTH LIMIT						
2								
3								(LSB)
4	(MSB)	MINIMUM BLOCK LENGTH LIMIT						
5								(LSB)

The following parameters apply to the Read Block Limits data:

Byte Description

0

Bit	Description
7-5	Reserved
4-0	GRANULARITY: The supported block size granularity. The device supports all block sizes *n* such that *n* minus the MINIMUM BLOCK LENGTH LIMIT is a multiple of $2^{GRANULARITY}$ and *n* is greater than or equal to the MINIMUM BLOCK LENGTH LIMIT and less than or equal to the MAXIMUM BLOCK LENGTH LIMIT.

1-3 MAXIMUM BLOCK LENGTH LIMIT: 80 0000h (8,388,608 bytes) block length limit length limits

4-5 MINIMUM BLOCK LENGTH LIMIT: 0001h (1 byte) minimum block length limit

Any block length in the range of MINIMUM BLOCK LENGTH LIMIT to MAXIMUM BLOCK LENGTH LIMIT is supported.

NOTE 14 - The value reported in the MAXIMUM BLOCK LENGTH LIMIT field is the maximum block length when there is at least one encrypted logical block on the volume. When there are no encrypted logical blocks on the volume a larger block length is allowed but not reported. This difference in maximum block length allowed has the potential to create confusion. Because of that, it is recommended that users limit their maximum block length to the values reported.

Data Transfer, Block Limits, and Fixed Block Option (see 4.4 on page 31) provides further explanation.

5.2.17 READ BUFFER - 3Ch

The Read Buffer command is defined in SPC (see the latest version at http://www.t10.org/drafts.htm#SCSI3_CMNDSETS). This clause decribes the specific implementation.

Table 60 — Read Buffer CDB

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	OPERATION CODE (3Ch)							
1	Obsolete (LUN)			MODE				
2	BUFFER ID							
3	(MSB)			BUFFER OFFSET				
5								(LSB)
6	(MSB)			ALLOCATION LENGTH				
8								(LSB)
9	Control Byte (see 5.1.2.3)							

The following parameters apply:

- MODE:

Value	Description
00h	Combined header and data
02h	Data: returns data contained in the buffer specified by BUFFER ID
03h	Descriptor: returns the OFFSET BOUNDARY and BUFFER SIZE in bytes, for the buffer specified in BUFFER ID
07h	Descriptor with algorithmic OFFSET BOUNDARY (see 6.6.1.4):
0Ah	Echo buffer:
0Bh	Echo buffer descriptor:

- BUFFER ID: The supported buffers are described in Supported Buffers (see 6.6.2 on page 360).
- BUFFER OFFSET: In mode 01h and 02h, this is the starting address in the buffer to be read. For mode 03h, this field must be 000000h.

  NOTE 15 - If the BUFFER OFFSET is not on the boundary specified in 6.6.1.3 on page 358, the device returns CHECK CONDITION status with associated sense data of 5/2400 (Illegal Request, Invalid Field in CDB).

- ALLOCATION LENGTH: The maximum number of bytes to be transferred starting at the offset specified in BUFFER OFFSET.

  The device transfers the number of bytes specified in the ALLOCATION LENGTH field or the number of bytes in the header or buffer being read, whichever is less. This is not an error. The host may use MODE 03h to query the amount of data in the specified buffer prior to reading such data with MODE 01h or 02h.

Each buffer image has its own unique format, describing where certain key data may be found. Certain buffers contain embedded data in the buffer image describing the length of the total buffer image, and a CRC field that checks the total buffer image. Uploading the microcode buffer is one such example.

Supported Buffers (see 6.6.2 on page 360) describes the supported Buffer ID's.

5.2.18 READ POSITION - 34h

5.2.18.1 READ POSITION command description

The Read Position command is defined in SSC (see the latest version at http://www.t10.org/drafts.htm#SCSI3_CMNDSETS). This clause decribes the specific implementation.

The READ POSITION command (see table 61) reports the current position and provides information about logical objects contained in the object buffer. No medium movement shall occur as a result of responding to the command.

Table 61 — READ POSITION command

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
	OPERATION CODE (34h)							
	Reserved			SERVICE ACTION				
2	Reserved							
6								
7	(MSB)			ALLOCATION LENGTH				
8								(LSB)
9	Control Byte (see 5.1.2.3)							

The following parameters apply:

- SERVICE ACTION:

Value	Description
00h	SHORT FORM-- BLOCK ID: Device server shall return 20 bytes of data with the FIRST LOGICAL OBJECT LOCATION and LAST LOGICAL OBJECT LOCATION fields as logical object identifier values, relative to a partition (see 5.2.18.2). The ALLOCATION LENGTH field shall be zero.
	WARNING The SHORT FORM -- BLOCK ID may become obsolete in future standards. WARNING
06h	LONG FORM: Device server shall return 32 bytes of data (see 5.2.18.3). The ALLOCATION LENGTH field shall be zero.
08h	EXTENDED FORM: Device server shall return 32 bytes of data up to the maximum length specified by the ALLOCATION LENGTH field (see 5.2.18.4).
others	The command is terminated with CHECK CONDITION status with the sense key set to ILLEGAL REQUEST, and the additional sense code set to INVALID FIELD IN CDB.

- ALLOCATION LENGTH: Length of the data to return. Shall be set to 0000h if the SERVICE ACTION field is set to 00h or 06h.

5.2.18.2 READ POSITION data format, short form

Table 62 specifies the READ POSITION data that shall be returned if the SERVICE ACTION field is 00h.

The short form is included for legacy applications. It is highly recommended that the LONG FORM (06h) (see 5.2.18.3) or the EXTENDED FORM (08h) (see 5.2.18.4) be used instead.

WARNING WARNING

The short form breaks when there are greater than 2^{32} logical objects on medium and may become obsolete in future standards.

WARNING WARNING

Table 62 — READ POSITION data format, short form

Byte	Bit							
	7 msb	**6**	**5**	**4**	**3**	**2**	**1**	**0 lsb**
0	Position information/validity							
	BOP	EOP	LOCU	BYCU (1)	Rsvd	LOLU (0)	PERR	BPEW
1	PARTITION NUMBER							
2	Reserved							
3	Reserved							
4	(MSB)	FIRST LOGICAL OBJECT LOCATION						
7								(LSB)
8	(MSB)	LAST LOGICAL OBJECT LOCATION						
11								(LSB)
12	Reserved							
13	(MSB)	NUMBER OF LOGICAL OBJECTS IN OBJECT BUFFER						
15								(LSB)
16	(MSB)	NUMBER OF BYTES IN OBJECT BUFFER						
19								(LSB)

Byte Description

0 Position Information/Validity:

Bit Description

7 BOP (beginning of partition):

Value	Description
0b	the current logical position is not at the beginning of partition.
1b	the device is at the beginning of the current partition.

6 EOP (end of partition)

Value	Description
0b	the device is not between early warning and end of partition.
1b	the device is positioned between early warning and end of the current partition.

5 LOCU (logical object count unknown)

Value	Description
0b	block count is exact
1b	block count is an estimate

4 BYCU (byte count unknown)

Value	Description
0b	byte count is exact
1b	byte count is an estimate

3 Reserved

2 LOLU (logical object location unknown)

Value	Description
0b	block position is exact
1b	block position is an estimate

1 PERR (position error):

Value Description

	0b	An overflow has not occurred in any of the returned position data fields.
	1b	An overflow has occurred in at least one of the returned position data fields. The application should use the LONG FORM (06h) (see 5.2.18.3) to obtain the current position or the application should use the EXTENDED FORM (08h) (see 5.2.18.4) to obtain the current position and number of bytes in the object buffer.

0 BPEW (beyond programmable early warning)

Value	Description
0b	The LOLU bit is set to one, the PEWS field of the MP 10h[01h]: Device Configuration Extension (see 6.5.11 on page 323) is set to zero, or the logical object location is not in a PEWZ or on the EOP side of EW.
1b	The logical object location is in a PEWZ or on the EOP side of EW.

1 PARTITION NUMBER:

Reports the partition number for the current logical position. When the volume has only one partition, this field is set to 00h.

2-3 Reserved

4-7 FIRST LOGICAL OBJECT LOCATION:

Specifies the logical object address associated with the current logical position, in the range 0000 0000h to FFFF FFFFh. The value indicates the logical object address of the next data block or filemark to be transferred between the initiator and the target if a READ or WRITE command is issued.

8-11 LAST LOGICAL OBJECT LOCATION:

After a write command, this field specifies the logical object address associated with the next logical object to be transferred from the buffer to the medium, in the range 0000 0000h to FFFF FFFFh. After a read command, this field specifies the logical object address associated with the last (most recent) data block or filemark to be transferred from the medium to the buffer. For any case where the buffer no longer contains a whole block of data or is empty, the value reported for the LAST LOGICAL OBJECT LOCATION is equal to the value reported for the FIRST LOGICAL OBJECT LOCATION.

12 Reserved

13-15 NUMBER OF LOGICAL OBJECTS IN THE OBJECT BUFFER:

The number of data blocks and filemarks in the buffer that have not been written to the medium. (This value is zero if the device is reading rather than writing.)

16-19 NUMBER OF BYTES IN THE OBJECT BUFFER: The total number of write data bytes (before compaction) in the buffer that have not been written to the medium.

5.2.18.3 READ POSITION data format, long form

Table 63 specifies the format of the READ POSITION data that shall be returned if the SERVICE ACTION field is 06h.

Table 63 — READ POSITION data format, long form

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	Position information/validity							
	BOP	EOP	Reserved		MPU	LONU	Rsvd	BPEW
1	Reserved							
3								
4	(MSB)	PARTITION NUMBER						
7								(LSB)
8	(MSB)	LOGICAL OBJECT NUMBER						
15								(LSB)
16	(MSB)	LOGICAL FILE IDENTIFIER						
23								(LSB)
24	(MSB)	Obsolete						
31								(LSB)

Byte Description

0 Position Information/Validity:

Bit	Description
7	BOP (beginning of partition):

Value	Description
0b	the current logical position is not at the beginning of partition.
1b	the device is at the beginning of the current partition.

Bit	Description
6	EOP (end of partition)

Value	Description
0b	the device is not between early warning and end of partition.
1b	the device is positioned between early warning and end of the current partition.

Bit	Description
5-4	Reserved
3	MPU (mark position unknown)

Value	Description
0b	the LOGICAL FILE IDENTIFIER field contains valid position information.
1b	the logical file identifier is not known or accurate reporting is not currently available.

Bit	Description
2	LONU (logical object number unknown)

Value	Description
0b	the LOGICAL OBJECT NUMBER and PARTITION NUMBER fields contain exact information.
1b	The logical object number is an estimate.

Bit	Description
1	Rsvd (Reserved)
0	BPEW (beyond programmable early warning)

Value	Description
0b	The LOLU bit is set to one, the PEWS field in the MP 10h[01h]: Device Configuration Extension (see 6.5.11 on page 323) is set to zero, or the logical object location is not in a PEWZ or on the EOP side of EW.
1b	The logical object location is in a PEWZ or on the EOP side of EW.

1-3 Reserved

4-7 PARTITION NUMBER: The partition number for the current logical position.

8-15 LOGICAL OBJECT NUMBER: The number of logical objects between beginning-of-partition and the current logical position. A filemark counts as one logical object.

16-23 LOGICAL FILE NUMBER: The number of filemarks between beginning-of-partition and the current logical position. This value is the current logical file identifier.

24-31 Obsolete.

5.2.18.4 READ POSITION data format, extended form

Table 64 specifies the format of the READ POSITION data that shall be returned if the SERVICE ACTION field is 08h.

Table 64 — READ POSITION data format, extended form

Byte	Bit							
	7 msb	**6**	**5**	**4**	**3**	**2**	**1**	**0 lsb**
0	Position information/validity							
	BOP	EOP	LOCU	BYCU (1)	Rsvd	LOLU (0)	PERR	BPEW
1	PARTITION NUMBER							
2	(MSB)	ADDITIONAL LENGTH (1Ch)						
3								(LSB)
4	Reserved							
5	(MSB)	NUMBER OF LOGICAL OBJECTS IN OBJECT BUFFER						
7								(LSB)
8	(MSB)	FIRST LOGICAL OBJECT LOCATION						
15								(LSB)
16	(MSB)	LAST LOGICAL OBJECT LOCATION						
23								(LSB)
24	(MSB)	NUMBER OF BYTES IN OBJECT BUFFER						
31								(LSB)

The fields are defined the same as for the corresponding fields in the READ POSITION data format, short form (see table 62).

The ADDITIONAL LENGTH field shall contain 1Ch. If the information transferred to the Data-In Buffer is truncated because of an insufficient ALLOCATION LENGTH value, the ADDITIONAL LENGTH field shall not be altered to reflect the truncation.

Byte	Description

0 Position Information/Validity:

Bit	Description

7 BOP (beginning of partition):

Value	Description
0b	the current logical position is not at the beginning of partition.
1b	the device is at the beginning of the current partition.

6 EOP (end of partition)

Value	Description
0b	the device is not between early warning and end of partition.
1b	the device is positioned between early warning and end of the current partition.

5 LOCU (logical object count unknown)

Value	Description
0b	block count is exact
1b	block count is an estimate

4 BYCU (byte count unknown)

Value	Description
0b	byte count is exact
1b	byte count is an estimate

3 Reserved

2 LOLU (logical object location unknown)

Value	Description
0b	block position is exact
1b	block position is an estimate

1 PERR (position error):

Value	Description
0b	An overflow has not occurred in any of the returned position data fields.
1b	An overflow has occurred in at least one of the returned position data fields.

0 BPEW (beyond programmable early warning)

Value	Description
0b	The LOLU bit is set to one, the PEWS field in MP 10h[01h]: Device Configuration Extension (see 6.5.11 on page 323) is set to zero, or the logical object location is not in a PEWZ or on the EOP side of EW.
1b	The logical object location is in a PEWZ or on the EOP side of EW.

1 PARTITION NUMBER:

Reports the partition number for the current logical position. When the volume has only one partition, this field is set to 00h.

2-3 ADDITIONAL LENGTH: 1Ch

4 Reserved

5-7 NUMBER OF LOGICAL OBJECTS IN THE OBJECT BUFFER:

The number of data blocks and filemarks in the buffer that have not been written to the medium. (This value is zero if the device is reading rather than writing.)

8-15 FIRST LOGICAL OBJECT LOCATION:

Specifies the logical object address associated with the current logical position, in the range 0000 0000h to FFFF FFFFh. The value indicates the logical object address of the next data block or filemark to be transferred between the initiator and the target if a READ or WRITE command is issued.

16-23 LAST LOGICAL OBJECT LOCATION:

After a write command, this field specifies the logical object address associated with the next logical object to be transferred from the buffer to the medium, in the range 0000 0000h to FFFF FFFFh. After a read command, this field specifies the logical object address associated with the last (most recent) data

block or filemark to be transferred from the medium to the buffer. For any case where the buffer no longer contains a whole block of data or is empty, the value reported for the LAST LOGICAL OBJECT LOCATION is equal to the value reported for the FIRST LOGICAL OBJECT LOCATION.

24-31 NUMBER OF BYTES IN THE OBJECT BUFFER: The total number of write data bytes (before compaction) in the buffer that have not been written to the medium.

5.2.19 RECEIVE DIAGNOSTIC RESULTS - 1Ch

The Receive Diagnostic Results command is defined in SPC (see the latest version at http://www.t10.org/drafts.htm#SCSI3_CMNDSETS). This clause decribes the specific implementation.

After a Send Diagnostic command completes, use the Receive Diagnostic Results command to receive the results.

As allowed by the SCSI standards, devices may implement Send Diagnostic and handle status and return information for diagnostics in somewhat different manners. To work correctly with all common variations, the following sequence should be used by the host.

The SEND DIAGNOSTIC command is issued. If a CHECK CONDITION status occurs, and a non-deferred permanent error results, then the test failed (or was not started if sense key=ILLEGAL REQUEST). If GOOD status is returned, then a RECEIVE DIAGNOSTICS RESULTS command should be issued, and:

a) the “blocked” and “error” bit should be checked (byte 8, bits 2 and 0 respectively), and if either is set, the diagnostic was either not run or failed; and
r) if byte 8 bit 1 is set, the SIM/MIM data in the results is valid and contains additional information relating to the failure

NOTE 16 - This process is required by this device to determine diagnostics results for those diagnostics which indicate diagnostics results data is returned. GOOD status returned from the Send Diagnostic only indicates that the diagnostic was accepted but does not indicate the ultimate result of its execution.

NOTE 17 - For diagnostics that produce diagnostic results, the device should be reserved using the Reserve or Persistent Reserve Out command to protect the results from actions of other initiators.

Table 65 shows the command format.

Table 65 — RECEIVE DIAGNOSTIC RESULTS CDB

Byte	Bit							
	7 msb	**6**	**5**	**4**	**3**	**2**	**1**	**0 lsb**
0	OPERATION CODE (1Ch)							
1	Obsolete			Reserved				
2	Reserved							
3	MSB	ALLOCATION LENGTH						
4								LSB
5	Control Byte (see 5.1.2.3)							

The following parameters apply:

- ALLOCATION LENGTH: The maximum number of bytes to be returned in the page of data following the command (if any).

Diagnostic Parameters (Diag) (see 6.1 on page 161) has a listing of all diagnostic parameters.

5.2.20 RELEASE UNIT - 17h/57h

The Release Unit command is defined in SPC-2 (see http://www.t10.org/cgi-bin/ac.pl?t=f&f=spc2r20.pdf). This clause decribes the specific implementation.

Table 66 — 6-byte RELEASE UNIT CDB

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	OPERATION CODE (17h)							
1	Obsolete			Obsolete (00h)				
2	Obsolete							
3	Reserved							
4								
5	Control Byte (see 5.1.2.3)							

The following parameters apply:

- Obsolete: All obsolete fields shall be set to zero.

Table 67 — 10-Byte RELEASE UNIT CDB

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	OPERATION CODE (57h)							
1	Reserved			3RDPTY	Reserved		LONGID	Obsolete
2	Obsolete							
3	THIRD PARTY DEVICE ID							
4	Reserved							
5	Reserved							
6	Reserved							
7	PARAMETER LIST LENGTH							
8								
9	Control Byte (see 5.1.2.3)							

The following parameters apply:

- Obsolete: All obsolete fields shall be set to zero.
- LONGID: 0b
- 3RDPTY: 0b
- THIRD PARTY DEVICE ID: 00h

5.2.21 REPORT DENSITY SUPPORT - 44h

The Report Density Support command is defined in SSC (see the latest version at http://www.t10.org/drafts.htm#SCSI3_CMNDSETS). This clause decribes the specific implementation.

Table 68 — REPORT DENSITY SUPPORT CDB

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	OPERATION CODE (44h)							
1	Reserved							MEDIA
2	Reserved							
6								
7	MSB	ALLOCATION LENGTH						
8								LSB
9	Control Byte (see 5.1.2.3)							

The following parameters apply:

- MEDIA:

Value	Description
0b	report all supported densities for all supported medium types
1b	report all supported densities for the current medium in the drive. If the device is not ready, the drive will return 2/0400h (NOT READY, NOT READY CAUSE NOT REPORTABLE).

- ALLOCATION LENGTH: The maximum number of bytes to be transferred.

5.2.21.1 Report Density Support data format

5.2.21.1.1 Density descriptor overview

Density descriptors contain information that may be returned by the drive. While the information is reported in a manner useful to applications, SSC-4 specifies fields that have been found to not be useful by applications in selecting which density to use. Instead applications have been found to ignore the BITS PER MM field and the TRACKS field. This device does not change the values returned in these fields by the format type – media type combinations and instead returns the largest value for the set of supported format type media type combinations. The CAPACITY field is used by applications and does report values based on the format type – media type combinations. The DENSITY CODE fields, the ASSIGNING ORGANIZATION field, the DENSITY NAME field, and the DESCRIPTION field are constant per density and are correctly reported.

This device may return different combinations of the descriptors in the REPORT DENSITY SUPPORT data depending on drive generation, medium loaded, setting of the MEDIA bit, and settings of various mode parameters related to densities.

The Report Density Support data format is shown in table 69.

Table 69 — REPORT DENSITY SUPPORT data format

Byte	Bit							
	7	6	5	4	3	2	1	0
0	(MSB)			AVAILABLE DENSITY SUPPORT LENGTH				
1								(LSB)
2	Reserved							
3	Reserved							
	Density support data block descriptors							
4				Density support data block descriptor [first]				
	⋮							
				Density support data block descriptor [last]				
n								

The Density support data block descriptor format is shown in table 70.

Table 70 — Density support data block descriptor format

Byte	Bit							
	7	6	5	4	3	2	1	0
0	PRIMARY DENSITY CODE							
1	SECONDARY DENSITY CODE							
2	WRTOK	DUP	DEFLT	Reserved				DLV
3	(MSB)			DESCRIPTOR LENGTH				
4								(LSB)
5	(MSB)			BITS PER MM				
7								(LSB)
8	(MSB)			MEDIA WIDTH				
9								(LSB)
10	(MSB)			TRACKS				
11								(LSB)
12	(MSB)			CAPACITY				
15								(LSB)
16				ASSIGNING ORGANIZATION				
23								
24				DENSITY NAME				
31								
32				DESCRIPTION				
51								

5.2.21.1.2 Density information

The density information is shown in table 71.

Table 71 — Density information

Field	PRIMARY DENSITY CODE		
	44h	**46h**	**58h**
PRIMARY DENSITY CODE	44h	46h	58h
SECONDARY DENSITY CODE	44h	46h	58h
WRTOK	0b The device cannot write this format 1b The device can write this format		
DUP	0	0	0
DEFLT	0b This density is not currently selected for use on a write from BOP 1b This density is currently selected for use on a write from BOP		
DLV	0	0	0
DESCRIPTOR LENGTH	0000h	0000h	0000h
BITS PER MM	9,638	12,725	15,142
MEDIA WIDTH (mm)	127	127	127
TRACKS	704	896	1280
CAPACITY	381,469 (in 2^{20} bytes)	800,000 (in 10^6 bytes)	1,500,000 (in 10^6 bytes)
ASSIGNING ORGANIZATION (ASCII)	"LTO-CVE "	"LTO-CVE "	"LTO-CVE "
DENSITY NAME (ASCII)	"U-316 "	"U-416 "	"U-516 "
DESCRIPTION (ASCII)	"Ultrium 3/16T "	"Ultrium 4/16T "	"Ultrium 5/16T "

5.2.22 REPORT LUNS - A0h

The Report LUNs command is defined in SPC (see the latest version at http://www.t10.org/drafts.htm#SCSI3_CMNDSETS). This clause decribes the specific implementation.

Table 72 — REPORT LUNS CDB

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	OPERATION CODE (A0h)							
1	Reserved							
5								
6	MSB	ALLOCATION LENGTH						
9								LSB
10	Reserved							
11	Control Byte (see 5.1.2.3)							

The following parameters apply:

- ALLOCATION LENGTH: Tthe maximum number of bytes to be transferred.

5.2.22.1 Report LUNs data format

Table 73 shows the data that is returned:

Table 73 — Logical Unit Numbers Data

Byte	Bit							
	7	6	5	4	3	2	1	0
0	(MSB)	LUN LIST LENGTH						
3								(LSB)
4	Reserved							
7								
	LUN list							
8	(MSB)	FIRST LUN						
15								(LSB)
	⋮							
n-7	(MSB)	LAST LUN						
n								(LSB)

Byte Description

0-3 LUN LIST LENGTH (n-7): This field will be set to 8 times the number of LUNs configured in the device. There will always be a LUN 0. There may be a library LUN (i.e., LUN 1) and/or there may be an ADC LUN (i.e., LUN 2).

4-7 Reserved

8-15 FIRST LUN: 0000 0000 0000 0000h (i.e., LUN 0)

16-23 Second LUN, if any

LUN	Description
LUN 1	0001 0000 0000 0000h (returned only if LUN 1 exists)
LUN 2	0002 0000 0000 0000h (returned only if LUN 1 does not exist and the device is configured for ADI and the ENABLE bit of LOGICAL UNIT INDEX 02h in Mode Page 0Eh subpage 03h of the ADC LUN (i.e., LUN 2) is set to one.

24-31 LAST LUN, if any

LUN	Description
LUN 2	0002 0000 0000 0000h (returned only if LUN 1 exists and configured for ADI and the ENABLE bit of LOGICAL UNIT INDEX 02h in Mode Page 0Eh subpage 03h of the ADC LUN (i.e., LUN 2) is set to one.

NOTE 18 - If this command is received over the ADT port , then a LUN descriptor is returned with a value of 0002000000000000h, even if the ENABLE bit of LOGICAL UNIT INDEX 02h in Mode Page 0Eh subpage 03h is set to zero.

5.2.23 REPORT SUPPORTED OPERATION CODES - A3h[0Ch]

The Report LUNs command is defined in SPC (see the latest version at http://www.t10.org/drafts.htm#SCSI3_CMNDSETS). This clause decribes the specific implementation. Ultrium 5 and later devices support the REPORT SUPPORTED OPERATION CODES command. The REPORT SUPPORTED OPERATION CODES command (see table 74) requests information on commands the addressed logical unit supports. An application client may request a list of all operation codes and service actions supported by the logical unit or the command support data for a specific command.

The REPORT SUPPORTED OPERATION CODES command is a service action of the MAINTENANCE IN command.

Table 74 — REPORT SUPPORTED OPERATION CODES CDB

Byte	Bit							
	7	6	5	4	3	2	1	0
0	OPERATION CODE (A3h)							
1	Reserved			SERVICE ACTION (0Ch)				
2	RCTD	Reserved				REPORTING OPTIONS		
3	REQUESTED OPERATION CODE							
4	(MSB)	REQUESTED SERVICE ACTION						
5								(LSB)
6	(MSB)	ALLOCATION LENGTH						
9								(LSB)
10	Reserved							
11	Control Byte (see 5.1.2.3)							

A return command timeouts descriptor (RCTD) bit set to one specifies that the command timeouts descriptor (see 5.2.23.3) shall be included in each command descriptor (see 5.2.23.1) that is returned or in the one_command parameter data (see 5.2.23.2) that is returned. A RCTD bit set to zero specifies that the command timeouts descriptor shall not be included in any parameter data returned.

The REPORTING OPTIONS field (see table 75) specifies the information to be returned in the parameter data.

Table 75 — REPORT SUPPORTED OPERATION CODES REPORTING OPTIONS field

Code	Description	Parameter Data Reference
000b	A list of all operation codes and service actions supported by the logical unit shall be returned in the all_commands parameter data format. The REQUESTED OPERATION CODE CDB field and REQUESTED SERVICE ACTION CDB field shall be ignored.	5.2.23.1
001b	The command support data for the operation code specified in the REQUESTED OPERATION CODE field shall be returned in the one_command parameter data format. The REQUESTED SERVICE ACTION CDB field shall be ignored. If the REQUESTED OPERATION CODE field specifies an operation code that has service actions, then the command shall be terminated with CHECK CONDITION status, with the sense key set to ILLEGAL REQUEST, and the additional sense code set to INVALID FIELD IN CDB.	5.2.23.2
010b	The command support data for the operation code and service action specified in the REQUESTED OPERATION CODE CDB field and REQUESTED SERVICE ACTION CDB field shall be returned in the one_command parameter data format. If the REQUESTED OPERATION CODE CDB field specifies an operation code that does not have service actions, then the command shall be terminated with CHECK CONDITION status, with the sense key set to ILLEGAL REQUEST, and the additional sense code set to INVALID FIELD IN CDB.	5.2.23.2
011b to 111b	Reserved	

The REQUESTED OPERATION CODE field specifies the operation code of the command to be returned in the one_command parameter data format (see 5.2.23.2).

The REQUESTED SERVICE ACTION field specifies the service action of the command to be returned in the one_command parameter data format.

The ALLOCATION LENGTH field specifies the maximum number of bytes or blocks that an application client has allocated in the Data-In Buffer.

5.2.23.1 All_commands parameter data format

The REPORT SUPPORTED OPERATION CODES all_commands parameter data format (see table 76) begins with a four-byte header that contains the length in bytes of the parameter data followed by a list of supported commands. Each command descriptor contains information about a single supported command CDB (i.e., one operation code and service action combination, or one non-service-action operation code). The list of command descriptors shall contain all commands supported by the logical unit.

Table 76 — All_commands parameter data

Byte	Bit							
	7	6	5	4	3	2	1	0
0	(MSB)							
3	COMMAND DATA LENGTH (n-3)							(LSB)
	Command descriptors							
4	Command descriptor 0 (see table 77)							
	⋮							
n	Command descriptor x (see table 77)							

The COMMAND DATA LENGTH field indicates the length in bytes of the command descriptor list.

Each command descriptor (see table 77) contains information about a single supported command CDB.

Table 77 — Command descriptor format

Byte	Bit							
	7	6	5	4	3	2	1	0
0	OPERATION CODE							
1	Reserved							
2	(MSB)							
3	SERVICE ACTION							(LSB)
4	Reserved							
5	Reserved						CTDP	SERVACTV
6	(MSB)							
7	CDB LENGTH							(LSB)
8	Command timeouts descriptor, if any (see 5.2.23.3)							
19								

The OPERATION CODE field contains the operation code of a command supported by the logical unit.

The SERVICE ACTION field contains a supported service action of the supported operation code indicated by the OPERATION CODE field. If the operation code indicated in the OPERATION CODE field does not have a service actions, the SERVICE ACTION field shall be set to 00h.

A command timeouts descriptor present (CTDP) bit set to one indicates that the command timeouts descriptor (see 5.2.23.3) is included in this command descriptor. A CTDP bit set to zero indicates that the command timeouts descriptor is not included in this command descriptor.

A service action valid (SERVACTV) bit set to zero indicates the operation code indicated by the OPERATION CODE field does not have service actions and the SERVICE ACTION field contents are reserved. A SERVACTV bit set to one indicates the operation code indicated by the OPERATION CODE field has service actions and the contents of the SERVICE ACTION field are valid.

The CDB LENGTH field contains the length of the command CDB in bytes for the operation code indicated in the OPERATION CODE field, and if the SERVACTV bit is set to the service action indicated by the SERVICE ACTION field.

If the RCTD bit is set to one in the REPORT SUPPORTED OPERATION CODES CDB (see 5.2.23), the command timeouts descriptor (see table 80 in 5.2.23.3) shall be included. If the RCTD bit is set to zero, the command timeouts descriptor shall not be included.

5.2.23.2 One_command parameter data format

The REPORT SUPPORTED OPERATION CODES one_command parameter data format (see table 78) contains information about the CDB and a usage map for bits in the CDB for the command specified by the REPORTING OPTIONS, REQUESTED OPERATION CODE, and REQUESTED SERVICE ACTION fields in the REPORT SUPPORTED OPERATION CODES CDB.

Table 78 — One_command parameter data

Byte	Bit							
	7	6	5	4	3	2	1	0
0	Reserved							
1	CTDP	Reserved				SUPPORT		
2	(MSB)	CDB SIZE (n-3)						
3								(LSB)
4	CDB USAGE DATA							
n								
n+1	Command timeouts descriptor, if any (see 5.2.23.3)							
n+12								

A command timeouts descriptor present (CTDP) bit set to one indicates that the command timeouts descriptor (see 5.2.23.3) is included in the parameter data. A CTDP bit set to zero indicates that the command timeouts descriptor is not included in the parameter data.

The SUPPORT field is defined in table 79.

Table 79 — SUPPORT values

Support	Description
000b	Data about the requested SCSI command is not currently available. All data after byte 1 is not valid. A subsequent request for command support data may be successful.
001b	The device server does not support the requested command. All data after byte 1 is undefined.
010b	Reserved
011b	The device server supports the requested command in conformance with a SCSI standard. The parameter data format conforms to the definition in table 78.
100b	Reserved
101b	The device server supports the requested command in a vendor specific manner. The parameter data format conforms to the definition in table 78.
110b to 111b	Reserved

The CDB SIZE field contains the size of the CDB USAGE DATA field in the parameter data, and the number of bytes in the CDB for command being queried (i.e., the command specified by the REPORTING OPTIONS, REQUESTED OPERATION CODE, and REQUESTED SERVICE ACTION fields in the REPORT SUPPORTED OPERATION CODES CDB).

The CDB USAGE DATA field contains information about the CDB for the command being queried. The first byte of the CDB USAGE DATA field shall contain the operation code for the command being queried. If the command being queried contains a service action, then that service action code shall be placed in the CDB USAGE DATA field in the same location as the SERVICE ACTION field of the command CDB. All other bytes of the CDB USAGE DATA field shall contain a usage map for bits in the CDB for the command being queried.

The bits in the usage map shall have a one-for-one correspondence to the CDB for the command being queried. If the device server evaluates a bit in the CDB for the command being queried, the usage map shall contain a one in the corresponding bit position. If any bit representing part of a field is returned as one, all bits for the field shall be returned as one. If the device server ignores or treats as reserved a bit in the CDB for the command

being queried, the usage map shall contain a zero in the corresponding bit position. The usage map bits for a given CDB field all shall have the same value.

For example, the CDB usage bit map for the REPORT SUPPORTED OPERATION CODES command is: A3h, 0Ch, 87h, FFh, FFh, FFh, FFh, FFh, FFh, FFh, 00h, 07h. This example assumes that the logical unit only supports the low-order three bits of the CDB CONTROL byte. The first byte contains the operation code, and the second byte contains three reserved bits and the service action. The remaining bytes contain the usage map.

If the RCTD bit is set to one in the REPORT SUPPORTED OPERATION CODES CDB (see 5.2.23), the command timeouts descriptor (see table 80 in 5.2.23.3) shall be included. If the RCTD bit is set to zero, the command timeouts descriptor shall not be included.

5.2.23.3 Command timeouts descriptor

5.2.23.3.1 Overview

The command timeouts descriptor (see table 80) returns timeout information for commands supported by the logical unit based on the time from the start of processing for the command to its reported completion.

Values returned in the command timeouts descriptor do not include times that are outside the control of the device server (e.g., prior commands with the IMMED bit set to one in the CDB, concurrent commands from the same or different I_T nexuses, manual unloads, power-on self tests, prior aborted commands, commands that force cache synchronization, delays in the service delivery subsystem).

For commands that cause a change in power condition, values returned in the command timeouts descriptor do not include the power condition transition time (e.g., the time to thread the media).

Values returned in the command timeouts descriptor should not be used to compare products.

Table 80 — Command timeouts descriptor format

Byte	Bit							
	7	6	5	4	3	2	1	0
0	(MSB)							
1				DESCRIPTOR LENGTH (0Ah)				(LSB)
2	Reserved							
3	COMMAND SPECIFIC							
4	(MSB)							
7				NOMINAL COMMAND PROCESSING TIMEOUT				(LSB)
8	(MSB)							
11				RECOMMENDED COMMAND TIMEOUT				(LSB)

The DESCRIPTOR LENGTH field indicates the number of bytes that follow in the command timeouts descriptor.

The COMMAND SPECIFIC field contains timeout information that is specific to the commands listed in table 81.

Table 81 — Command timeouts descriptor COMMAND SPECIFIC field usage

Command	Reference
WRITE BUFFER	5.2.23.3.2

A non-zero value in the NOMINAL COMMAND PROCESSING TIMEOUT field indicates the minimum amount of time in seconds the application client should wait prior to querying for the progress of the command identified by the parameter data that contains this command timeouts descriptor. A value of zero in the NOMINAL COMMAND PROCESSING TIMEOUT field indicates that no timeout is indicated.

NOTE 19 - The value contained in the NOMINAL COMMAND PROCESSING TIMEOUT field may include time required for typical device error recovery procedures expected to occur on a regular basis.

A non-zero value in the RECOMMENDED COMMAND TIMEOUT field specifies the recommended time in seconds the application client should wait prior to timing out the command identified by the parameter data that contains this command timeouts descriptor. A value of zero in the RECOMMENDED COMMAND TIMEOUT field indicates that no time is indicated.

The device server should set the recommended command timeout to a value greater than or equal to the nominal command processing timeout.

Application clients should use the Report Supported Operation Codes command to discover command timoeut values. Table 82 lists the command timeout values at the time this document was published for the commands supported at the time the document was published. These values may have changed since publication.

Due to the sequential nature of tape devices, many host commands are serialized, and command timeouts consequently have an additive effect. Using reservations prevents this from causing application disruptions in a multi-initiator or SAN environment. Similar additive timeout effects may occur if the host is using command queuing (simple queuing).

NOTE 20 - The time-outs in the following table are based on the time from the start of processing of the command, to its reported completion. Since applications are generally concerned with the time from the command being issued, to its reported completion, it should be noted that this overall time may be affected by currently processing operations. Some of these conditions include:

a) A prior command was issued with the Immediate bit set in the CDB
b) Multiple concurrent commands with Simple queuing are processed
c) Multi-initiator configurations without reservations
d) Non-host operations, such as manual unloads, power-on self tests, etc.
e) Commands issued shortly after certain aborted commands
f) Commands which force flushes when unwritten write data is in the buffer

Table 82 — Command timeout values at time document was published (part 1 of 2)

Op Codes [Service Action]	Command	Full-Height		Half-Height	
		Nom	Rec	Nom	Rec
00h	TEST UNIT READY	60	60	60	60
01h	REWIND	240	600	300	780
03h	REQUEST SENSE	60	60	60	60
04h	FORMAT MEDIUM	180	1 560	180	1 980
05h	READ BLOCK LIMITS	60	60	60	60
08h	READ	120	1 500	120	1 920
0Ah	WRITE	120	1 500	120	1 920
0Bh	SET CAPACITY	120	780	120	960
10h	WRITE FILEMARK	300	1 620	300	1 740
11h	SPACE (6)	300	16 920	360	19 980
12h	INQUIRY	60	60	60	60
13h	VERIFY	120	1 500	120	1 860
15h	MODE SELECT (6)	60	60	60	60
16h	RESERVE UNIT (6)	60	60	60	60
17h	RELEASE UNIT (6)	60	60	60	60
19h	ERASE	13 680	16 380	13 740	19 200

Table 82 — Command timeout values at time document was published (part 2 of 2)

Op Codes [Service Action]	Command	Full-Height		Half-Height	
		Nom	Rec	Nom	Rec
1Ah	MODE SENSE (6)	60	60	60	60
1Bh	LOAD/UNLOAD	300	780	360	1 020
1Ch	RECEIVE DIAGNOSTIC RESULTS	60	60	60	60
1Dh	SEND DIAGNOSTIC	900	1 980	960	2 580
1Eh	PREVENT/ALLOW MEDIUM REMOVAL	60	60	60	60
2Bh	LOCATE (10)	300	16 920	360	19 980
34h	READ POSITION	60	60	60	60
3Bh	WRITE BUFFER	120	540	120	720
3Ch	READ BUFFER	120	480	120	660
44h	REPORT DENSITY SUPPORT	60	60	60	60
4Ch	LOG SELECT	60	60	60	60
4Dh	LOG SENSE	60	60	60	60
55h	MODE SELECT (10)	60	60	60	60
56h	RESERVE UNIT (10)	60	60	60	60
57h	RELEASE UNIT (10)	60	60	60	60
5Ah	MODE SENSE (10)	60	60	60	60
5Eh	PERSISTENT RESERVE IN	60	60	60	60
5Fh	PERSISTENT RESERVE OUT	60	60	60	60
82h	ALLOW DATA OVERWRITE	60	60	60	60
8Ch	READ ATTRIBUTE	60	60	60	60
8Dh	WRITE ATTRIBUTE	60	60	60	60
91h	SPACE (16)	300	16 920	360	19 980
92h	LOCATE (16)	300	16 920	360	19 980
A0h	REPORT LUNS	60	60	60	60
A2h	SECURITY PROTOCOL IN	60	60	60	60
A3h[0Ch]	REPORT SUPPORTED OPERATION CODE	60	60	60	60
A3h[0Dh]	REPORT SUPPORTED TASK MANAGEMENT FUNCTIONS	60	60	60	60
A3h[0Fh]	REPORT TIMESTAMP	60	60	60	60
A4h[0Fh]	SET TIMESTAMP	60	60	60	60
B5h	SECURITY PROTOCOL OUT	60	60	60	60

5.2.23.3.2 WRITE BUFFER command timeouts descriptor COMMAND SPECIFIC field usage

For the WRITE BUFFER command, the COMMAND SPECIFIC field usage is reserved for all modes except the following:

a) Download microcode mode (04h);
b) Download microcode and save mode (05h);
c) Download microcode with offsets mode (06h);
d) Download microcode with offsets and save mode (07h);
e) Download microcode with offsets and defer activation mode (0Eh) only if the microcode is activated by an event other than an activate deferred microcode mode; and

f) Activate deferred microcode mode (0Fh).

If the command timeouts descriptor describes one of the WRITE BUFFER modes listed in this subclause, then the COMMAND SPECIFIC field indicates the maximum time, in one second increments, that access to the SCSI device is limited or not possible through any SCSI ports associated with a logical unit that processes a WRITE BUFFER command that specifies one of the named modes. A value of zero in the COMMAND SPECIFIC field indicates that the no maximum time is indicated.

5.2.24 REPORT SUPPORTED TASK MANAGEMENT FUNCTIONS - A3h[0Dh]

The REPORT SUPPORTED TASK MANAGEMENT FUNCTIONS command is defined in SPC (see the latest version at http://www.t10.org/drafts.htm#SCSI3_CMNDSETS). The REPORT SUPPORTED TASK MANAGEMENT FUNCTIONS command (see table 83) requests information on task management functions supported by the drive.

Table 83 — REPORT SUPPORTED TASK MANAGEMENT FUNCTIONS CDB

Byte	Bit							
	7	6	5	4	3	2	1	0
0	OPERATION CODE (A3h)							
1	Reserved			SERVICE ACTION (0Dh)				
2	REPD	Reserved						
3	Reserved							
5								
6	(MSB)	ALLOCATED LENGTH (4h or larger)						
9								
10	Reserved							
11	Control Byte (see 5.1.2.3)							

The following parameters apply:

- SERVICE ACTION: 0Dh
- REPD (report extended parameter data): 0b
- ALLOCATION LENGTH: The number of bytes allowed to be returned. Shall be 4h or larger.

5.2.24.1 REPORT SUPPORTED TASK MANAGEMENT FUNCTIONS parameter data

The format of the parameter data returned by the REPORT TASK MANAGEMENT FUNCTIONS command is shown in table 84.

Table 84 — REPORT SUPPORTED TASK MANAGEMENT FUNCTIONS parameter data

Byte	Bit							
	7	6	5	4	3	2	1	0
0	ATS	ATSS	CACAS	CTSS	LURS	QTS	TRS	WAKE
1	Reserved					QAES	QTSS	ITNRS
2	Reserved							
3	REPORT SUPPORTED TASK MANAGEMENT FUNCTIONS ADDITIONAL DATA LENGTH							

The parameters are defined as follows:

Byte Description

0

Bit	Description
7	ATS (abort task): 1b
6	ATSS (abort task set): 1b
5	CACAS (clear aca): 0b
4	CTSS (clear task set):

Value	Description
0b	Set on SAS attached devices to indicate not supported.
1b	Set on FC attached devices to indicate supported.

Bit	Description
3	LURS (logical unit reset): 1b
2	QTS (query task):

Value	Description
0b	Set on FC attached devices to indicate not supported.
1b	Set on SAS attached devices to indicate supported.

Bit	Description
1	TRS (target reset):

Value	Description
0b	Set on SAS attached devices to indicate not supported.
1b	Set on FC attached devices to indicate supported.

Bit	Description
0	WAKE (wakeup): 0b

1

Bit	Description
7-3	Reserved
2	QAES (query asynchronous event): 0b
1	QTSS (query task set): 0b
0	ITNRS (I_T nexus reset): 0b

2 Reserved

3 REPORT SUPPORTED TASK MANAGEMENT FUNCTIONS ADDITIONAL DATA LENGTH: 00h

5.2.25 REPORT TIMESTAMP - A3h[0Fh]

The REPORT TIMESTAMP command (see table 85) is defined in SPC (see the latest version at http://www.t10.org/drafts.htm#SCSI3_CMNDSETS). This clause decribes the specific implementation.

Table 85 — REPORT TIMESTAMP CDB

Byte	Bit							
	7	6	5	4	3	2	1	0
0	OPERATION CODE (A3h)							
1	Reserved			SERVICE ACTION (0Fh)				
2	Reserved							
5								
6	(MSB)	ALLOCATION LENGTH						
9								(LSB)
10	Reserved							
11	Control Byte (see 5.1.2.3)							

The following parameters apply:

- SERVICE ACTION: 0Fh
- ALLOCATION LENGTH: The number of bytes that have been allocated for the returned parameter data.

5.2.25.1 REPORT TIMESTAMP parameter data

The format of the parameter data returned by the REPORT TIMESTAMP command is shown in table 86.

Table 86 — Timestamp Descriptor

Byte	Bit							
	7	6	5	4	3	2	1	0
0	(MSB)	TIMESTAMP PARAMETER DATA LENGTH (0Ah)						
1								(LSB)
2	Reserved					TIMESTAMP ORIGIN		
3	Reserved							
4	(MSB)	TIMESTAMP						
9								(LSB)
10	Reserved							
11								

The parameters are defined as follows:

Byte	Description
0-1	TIMESTAMP PARAMETER DATA LENGTH: 0Ah
2	

Bit	Description
7-3	Reserved
2-0	TIMESTAMP ORIGIN: Device Clocks (see 4.11 on page 54) defines the TIMESTAMP ORIGIN

3	Reserved
4-9	TIMESTAMP: Device Clocks (see 4.11 on page 54) defines the timestamp.
10-11	Reserved

5.2.26 REQUEST SENSE - 03h

The REQUEST SENSE command is defined in SPC (see the latest version at http://www.t10.org/drafts.htm#SCSI3_CMNDSETS). This clause decribes the specific implementation.

Table 87 — REQUEST SENSE CDB

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	OPERATION CODE (03h)							
1	Obsolete			Reserved				
2	Reserved							
3								
4	ALLOCATION LENGTH							
5	Control Byte (see 5.1.2.3)							

The following parameters apply:

- ALLOCATION LENGTH: The maximum number of bytes to be transferred.

  This device generates up to 96 bytes of sense data. If the ALLOCATION LENGTH specified is less than the generated sense data length, then the allocated amount is transferred, the remaining sense data is lost, and no error is reported. If the ALLOCATED LENGTH specified is greater, then the entire sense data is transferred and no error is reported.

  In read ILI conditions only 18 bytes of sense data may be generated. While processing sense data, the host should use the ADDITIONAL SENSE LENGTH field (i.e., byte 7) to determine the amount of sense data generated to insure that only valid transferred fields are examined.

  NOTE 21 - Since this device uses autosense, 96 bytes of unsolicited sense will always be generated using this command. Autosense may generate and return either 18 or 96 bytes.

5.2.26.1 Sense Data Format

Table 88 — Sense Data Format

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	VALID	RESPONSE CODE						
1	Obsolete (00h)							
2	FILEMARK	EOM	ILI	Reserved	SENSE KEY			
3	INFORMATION							
6								
7	ADDITIONAL SENSE LENGTH							
8	COMMAND SPECIFIC INFORMATION							
11								
12	ADDITIONAL SENSE CODE							
13	ADDITIONAL SENSE CODE QUALIFIER							
14	FIELD REPLACEABLE UNIT CODE							
15	SKSV	C/D	Reserved		BPV	BIT POINTER		
16	SKSV (1: FIELD POINTER)							
17	SKSV (0: REPORTING ERROR FAULT SYMPTOM CODE)							
18	REPORTING ERROR FLAG DATA							
19								
20	Reserved							
21	Reserved			DRVSRVC	CLN	Reserved	DUMP	VOLVALID
22	VOLUME LABEL							
28								
29	PHYSICAL WRAP							
30	(MSB) RELATIVE LPOS VALUE							
33								(LSB)
34	SCSI ADDRESS							
35	RS422 INFORMATION							
36	Reserved					ACTIVE PARTITION		
37	(MSB) PORT IDENTIFIER OF PORT REPORTING SENSE (This is the address of the port through which sense is reported.)							
39								(LSB)
40	TAPE DIRECTORY VALID	TAPE PARTITIONS EXIST	Reserved	Reserved	Reserved	RELATIVE TGT PORT REPORTING SENSE: 0: Reserved 1: Relative Tgt Port 1 (Port 0) 2: Relative Tgt Port 2 (Port 1) 3: Relative Tgt Port 3 (RS422 Port)		
41	HOST COMMAND (SCSI Opcode)							

Table 88 — Sense Data Format

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
42	CARTRIDGE GENERATION TYPE 0: No media present / Gen1 (384 track) 1: Gen2 (512 track) 2: Gen3 (704 track) 3: Gen 4 (896 track) 4: Gen 5 (1280 track)				MEDIA TYPE (Vendor Reserved)			
43	VOLUME LABEL CARTRIDGE TYPE							
44								
45	LOGICAL BLOCK NUMBER (Current LBA that would be reported in Read Position command)							
48								
49	(MSB) DATASET NUMBER							
52								(LSB)
53	1ST ERROR FSC							
54								
55	1ST ERROR FLAG DATA							
56								
57	2ND ERROR FSC							
58								
59	2ND ERROR FLAG DATA							
60								
61	NEXT-TO-LAST ERROR FSC							
62								
63	NEXT-TO-LAST ERROR FLAG DATA							
64								
65	LAST ERROR FSC							
66								
67	LAST ERROR FLAG DATA							
68								
69	LPOS REGION							
70	ERP SUMMARY INFORMATION							
85								
86	(MSB) CARTRIDGE SERIAL NUMBER (This is the value from the CM right justified, not the Barcode)							
95								(LSB)

Byte **Description**

0

Bit	Description
7	VALID

Value	Description
0b	information bytes 3-6 are not valid
1b	information bytes 3-6 are valid

Bit	Description
6-0	RESPONSE CODE

Value	Description
70h	current (non-deferred)
71h	deferred

1 Obsolete: 00h

2

Bit	Description
7	FILEMARK (see Request Sense Information, ILI, and Command Interactions (see 4.5 on page 32))

Value	Description
0b	the current command has not encountered a filemark
1b	the current command has encountered a filemark.

This device does not report Setmarks, per Mode Page 10h, byte 8, bit 5.

Bit	Description
6	EOM (End-Of-Medium):

Value	Description
0b	indicates that the device is not at the end of medium.
1b	indicates that the device is at the end of medium.

Bit	Description
5	ILI (Incorrect Length Indicator): see Request Sense Information, ILI, and Command Interactions (see 4.5 on page 32). ILI residual counts are in the Information field.
4	Reserved
3-0	SENSE KEY (see Annex B.)

3-6 INFORMATION: The content of this field varies depending on the failing command and error. This field is only valid when the Valid bit (byte 0, bit 7) is set to 1. This field is generally only valid for non-deferred errors. See Request Sense Information, ILI, and Command Interactions (see 4.5 on page 32)

7 ADDITIONAL SENSE LENGTH (n-7): 0Ah or 58h

This device returns 96 bytes of sense data (a value of 58h in the Additional Sense Length field). The first 18 bytes are standard.

Only the first 18 bytes of sense data may be returned (a value of 0Ah in the Additional Sense Length field) in association with ILI conditions for read-type commands.

8-11 COMMAND-SPECIFIC INFORMATION: 0000 0000h

This device does not support the commands associated with this field.

12 ADDITIONAL SENSE CODE (ASC) (see Annex B.)

13 ADDITIONAL SENSE CODE QUALIFIER (ASCQ) (see Annex B.)

14 FIELD REPLACEABLE UNIT CODE (FRU)

This field indicates a possible component or area which is related to the error or failure. Since this device is a single FRU product, this does not necessarily mean a replaceable component has been identified. Instead, this is used for extended fault isolation information.

15-17 SENSE KEY SPECIFIC

When the SKSV bit is 1b (often set when SENSE KEY is ILLEGAL REQUEST), bytes 15-17 are interpreted as follows:

Byte	Description
15	SENSE KEY SPECIFIC

Bit	Description
7	SKSV (Sense Key Specific Valid): 1b
6	C/D (Control/Data):

Value	Description
0b	specifies that the error is in a data field of the parameter list.
1b	specifies that the error is in a CDB field.

Bit	Description
5-4	Reserved
3	BPV (Bit Pointer Valid):

Value	Description
0b	specifies that the Bit Pointer Field is not valid.
1b	specifies that the Bit Pointer Field is valid.

Bit	Description
2-0	BIT POINTER

When BPV is set to 1b, this field points to the bit in error of the field specified by the FIELD POINTER.

Byte	Description
16-17	FIELD POINTER

Points to the CDB byte or parameter byte in error.

When the SKSV bit is 0b, bytes 15-17 are interpreted as follows:

Byte	Description
15	Vendor-Unique Indicators

Bit	Description
7	SKSV (Sense Key Specific Valid): 0b
6-0	Reserved

Byte	Description
16-17	REPORTING ERROR FAULT SYMPTOM CODE (FSC)
18-19	REPORTING ERROR FLAG DATA
20	Reserved
21	

Bit	Description
7-5	Reserved
4	DRVSRVC: This bit is set to one by code whenever the drive determines that it has a hardware fault causing the drive to be inoperative. This bit is mapped to the“"DEAD DRIVE" Flag {3Ch:000Dh}” (see page 290) of LP 3Ch: Drive usage information (see 6.3.27 on page 289). This bit: a) is maintained across all reset conditions, firmware downloads, and power cycles; b) is tested and reported by the SEND DIAGNOSTIC Command and any diagnostics run on the drive except the Power-On-Test if this drive is configured for attachment to eServer; c) does not affect drive operations; and d) is not affected by the Power-On-Test.
3	CLN:

Value	Description
0b	this device is not claimin the need for a clean.
1b	this device needs cleaned.

Bit	Description
2	Reserved
1	DUMP: This bit indicates if there is a drive dump (i.e., drive debug log) present in the drive. If this bit is set, the dump should be read prior to forcing a dump by using the Force Dump diagnostic of the SEND DIAGNOSTIC command.

WARNING WARNING

This bit should be examined before reading a drive dump and if it is set to zero, then no attempt should be made to read a dump prior to forcing the dump with the Force Dump diagnostic. If a dump is read when there is not one present, then interface information in a subsequent dump forced by the Force Dump diagnostic is washed out by the reading of the non-dump.

WARNING WARNING

Value	Description
0b	no dump is present.
1b	a dump is present.

0 VOLVALID: indicates if the VOLUME LABEL field and the VOLUME LABEL CARTRIDGE TYPE field contain valid information.

Value	Description
0b	the VOLUME LABEL field and the VOLUME LABEL CARTRIDGE TYPE field do not contain valid information.
1b	the VOLUME LABEL field and the VOLUME LABEL CARTRIDGE TYPE field contain valid information.

22-28 VOLUME LABEL: If a cartridge is loaded in the drive and the VOLVALID bit is set to 1b, then the VOLUME LABEL field reports a value in the following priority:

1) the seven characters from the left of the volume label from the CM Mechanism Related Data page (if one exists);
2) the seven characters from the left of the volume label from the host bar code field in the CM (if it exists); or
3) all spaces (ASCII 20h).

29 PHYSICAL WRAP: The physical wrap of the current location.

The least significant bit reflects the current physical direction.

Value	Description
0b	the current direction is away from physical beginning of tape.
1b	the current direction is towards physical beginning of tape.

30-33 RELATIVE LPOS VALUE: The current physical position on tape.

34 SCSI ADDRESS: Obsolete - See PORT IDENTIFIER OF PORT REPORTING SENSE (bytes 36-39) instead.

35 RS422 INFORMATION: This 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.

36

Bit	Description
7-3	Reserved
2-0	ACTIVE PARTITION: The partition number of the current logical position of the volume.

37-39 PORT IDENTIFIER OF PORT REPORTING SENSE: The address of the port through which sense is reported.

Byte	Description
36	Reserved
37-39	FIBRE CHANNEL FABRIC PORT ADDRESS (e.g., 011E13h or 000026h), if FC device; or HASHED SAS ADDRESS OF THE DRIVE PORT (e.g., F32A94h), if SAS device.

40

Bit	Description
7	TAPE DIRECTORY VALID:
6	TAPE PARTITIONS EXIST: This field is set to 0b when no volume is mounted

Value	Description
0b	The mounted volume contains only one partition (i.e., not partitioned)
1b	The mounted volume contains more than one partitions (i.e., is partitioned)

Bit	Description
5-3	Reserved
2-0	RELATIVE TGT PORT REPORTING SENSE: The relative target port through which sense data is being reported.

Value	Description
000b	Reserved
001b	Relative target port 1 (Port 0)
010b	Relative target port 2 (Port 1)
011b	Relative target port 3 (RS-422 Port)

41 HOST COMMAND: SCSI Opcode of the command to which sense data is being returned.

42

Bit	Description
7-4	CARTRIDGE GENERATION TYPE:

Value	Description
000b	No media present or Gen1 (384 track)
001b	Gen2 (512 track)
010b	Gen3 (704 track)
011b	Gen 4 (896 track)
100b	Gen 5 (1280 track)

Bit	Description
3-0	MEDIA TYPE (Vendor Reserved)

43-44 VOLUME LABEL CARTRIDGE TYPE: This field is only valid if the VOLVALID bit is set to 1b.

Value	Description
‘L3’	Ultrium 3 - Native capacity is 400 GB (2^{20})
‘LT’	Ultrium 3 WORM - Native capacity is 400 GB (2^{20})
‘L4’	Ultrium 4 - Native capacity is 800 GB (2^{20})
‘LU’	Ultrium 4 WORM - Native capacity is 800 GB (2^{20})
‘L5’	Ultrium 5 - Native capacity is 1500 GB (2^{20})
‘LV’	Ulrium 5 WORM- Native capacity is 1500 GB (2^{20})

45-48 LOGICAL BLOCK NUMBER: Current LBA that would be reported in Read Position command

49-52 DATASET NUMBER:

53-54 1ST ERROR FSC:

55-56 1ST ERROR FLAG DATA:

57-58 2ND ERROR FSC:

59-60 2ND ERROR FLAG DATA:

61-62 NEXT-TO-LAST ERROR FSC:

63-64 NEXT-TO-LAST ERROR FLAG DATA:

65-66 LAST ERROR FSC:

67-68 LAST ERROR FLAG DATA:

69 LPOS REGION:

70-85 ERP SUMMARY INFORMATION:

86-95 CARTRIDGE SERIAL NUMBER: This is the value from the CM right justified, not the Barcode

5.2.27 RESERVE - 16h/56h

The RESERVE command is defined in SPC-2 (see http://www.t10.org/cgi-bin/ac.pl?t=f&f=spc2r20.pdf). This clause decribes the specific implementation.

Table 89 — RESERVE(6) CDB

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	Operation code (16h)							
1	Obsolete			Obsolete				
2	Obsolete							
4								
5	Control Byte (see 5.1.2.3)							

Table 90 — RESERVE(10) CDB

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	OPERATION CODE (56h)							
1	Reserved			3RDPTY	Reserved		LONGID	Obsolete
2	Obsolete							
3	THIRD-PARTY DEVICE ID							
4	Reserved							
6								
7	(MSB)							
8	PARAMETER LIST LENGTH							(LSB)
9	Control Byte (see 5.1.2.3)							

The following parameters apply:

- 3RDPTY (Third Party): 0b
- LONGID: 0b
- Obsolete: All obsolete fields shall be set to zero.
- THIRD - PARTY DEVICE ID: 00h
- PARAMETER LIST LENGTH: 0000h

NOTE 22 - Reserves are honored across initiator as well as port boundaries. For additional information, see “Multiple Port Behavior” on page 263.

5.2.28 REWIND - 01h

The Rewind command is defined in SSC (see the latest version at http://www.t10.org/drafts.htm#SCSI3_CMNDSETS). This clause decribes the specific implementation.

Table 91 — REWIND CDB

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	OPERATION CODE (01h)							
1	Obsolete			Reserved				IMMED
2	Reserved							
4								
5	Control Byte (see 5.1.2.3)							

The following parameters apply:

- Immed (Immediate):

Value	Description
0b	present status when command is completed.
1b	present status when all buffered data is successfully written to the media.

NOTE 23 - On eServer enabled drives (i.e., The PRODUCT ID returned in Standard Inquiry is "HH LTO Gen x" where "x" is a number), a CHECK CONDITION status with SENSE KEY set to 1h and the additional sense code set to DEGRADED MEDIA (i.e., ASC/ASCQ 8252h) may be returned after completion of the REWIND command if certain conditions are met.

5.2.29 SECURITY PROTOCOL IN (SPIN) - A2h

The Security Protocol In command is defined in SPC-4 (see the latest version at http://www.t10.org/drafts.htm#SCSI3_CMNDSETS). This clause decribes the specific implementation.

The SECURITY PROTOCOL IN command (see table 92) is:

a) supported in encryption capable drives that are configured for AME-T10 mode (see 4.9); and
b) is used to retrieve security protocol information (see 6.7.1) or the results of one or more SECURITY PROTOCOL OUT commands (see 5.2.30).

Table 92 — SECURITY PROTOCOL IN - A2h CDB

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	OPERATION CODE (A2h)							
1	SECURITY PROTOCOL							
2	SECURITY PROTOCOL SPECIFIC							
3								
4	inc_512	Reserved						
5	Reserved							
6	(MSB)	Allocation Length						
9								(LSB)
10	Reserved							
11	Control Byte (see 5.1.2.3)							

The following parameters apply:

- SECURITY PROTOCOL: SPIN (00h[0000h]) - Supported Security Protocols List (see 6.7.1.1 on page 367) lists the supported security protocols.
- SECURITY PROTOCOL SPECIFIC - The contents depend on the protocol specified by the SECURITY PROTOCOL field. The following SPIN pages provide a list of supported SECURITY PROTOCOL SPECIFIC values:
  SPIN (00h[0000h]) - Supported Security Protocols List (see 6.7.1.1 on page 367)
  SPIN (20h[0000h]) - Tape Data Encryption In Support Pages page (see 6.7.2.1 on page 369)
  SPIN (20h[0001h]) - Tape Data Encryption Out Support Pages page (see 6.7.2.2 on page 370)
- INC_512: 0b
- ALLOCATION LENGTH:

Security Protocol Parameters (SPP) (see 6.7 on page 367) has a listing of all security protocol parameters.

5.2.30 SECURITY PROTOCOL OUT (SPOUT) - B5h

The Security Protocol Out command is defined in SPC-4 (see the latest version at http://www.t10.org/drafts.htm#SCSI3_CMNDSETS). This clause decribes the specific implementation.

The SECURITY PROTOCOL OUT command (see Table 93) is:

a) supported in encryption capable drives that are configured for AME-T10 mode Encryption Control - T10 Standards (see 4.9.2 on page 45); and
b) used to send data to the logical unit. The data sent specifies one or more operations to be performed by the logical unit. The format and function of the operations depends on the contents of the SECURITY PROTOCOL field (see table 93). Depending on the protocol specified by the SECURITY PROTOCOL field, the application client may use the SECURITY PROTOCOL IN command (see 5.2.29) to retrieve data derived from these operations.

NOTE 24 - The operation code, B5h has been recovered from a seldom used media changer (i.e. LUN 1) command (REQUEST VOLUME ELEMENT ADDRESS). If the device driver being used still uses the LUN field of the CDB from SCSI-2 days, this command will be routed to the incorrect LUN. Since the SPOUT command is a DATA OUT type command, whereas the REQUEST VOLUME ELEMENT ADDRESS command is a DATA IN type command this has the potential to cause strange system behaviors.

Table 93 — SECURITY PROTOCOL OUT B5h CDB

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	OPERATION CODE (B5h)							
1	SECURITY PROTOCOL							
2	SECURITY PROTOCOL SPECIFIC							
3								
4	inc_512	Reserved						
5	Reserved							
6	(MSB)							
9	ALLOCATION LENGTH							(LSB)
10	Reserved							
11	Control Byte (see 5.1.2.3)							

The following parameters apply:

- SECURITY PROTOCOL

Value	Description
20h	Tape Data Encryption security protocol (see 6.7.3).

- SECURITY PROTOCOL SPECIFIC: The contents depend on the protocol specified by the SECURITY PROTOCOL field.
- INC_512: 0b
- ALLOCATION LENGTH:

Security Protocol Parameters (SPP) (see 6.7 on page 367) has a listing of all security protocol parameters.

5.2.31 SEND DIAGNOSTIC - 1Dh

The SEND DIAGNOSTIC command is defined in SPC (see the latest version at http://www.t10.org/drafts.htm#SCSI3_CMNDSETS). This clause decribes the specific implementation.

After a Send Diagnostic command completes, use the Receive Diagnostic Results command to receive the results.

For diagnostics that produce diagnostic results, the LUN should be reserved to allow the I_T nexus that issued the Send Diagnostic command to issue the Receive Diagnostic Results command before a different I_T nexus clears the results by reading them.

Table 94 — SEND DIAGNOSTIC CDB

Byte	Bit							
	7 msb	**6**	**5**	**4**	**3**	**2**	**1**	**0 lsb**
0	OPERATION CODE (1Dh)							
1	Obsolete			PF	Reserved	SELFTEST	DEVOFL	UNITOFL
2	Reserved							
3	MSB	PARAMETER LIST LENGTH						
4								LSB
5	Control Byte (see 5.1.2.3)							

The following parameters apply:

- PF (Page Format): 1b
- SELFTEST:

Value	Description
0b	Perform the diagnostic operation specified in the parameter list.
1b	Perform self test. See 6.1.3 on page 170 for details of this diagnostic.

NOTE 25 - When Self Test is requested, no other diagnostic may be simultaneously requested.

- DEVOFL (Device Off Line):

Value	Description
0b	is supported and prohibits any diagnostic operations that may be detected by subsequent I/O processes.
1b	is supported and grants permission to the target to perform diagnostic operations that may affect all the logical units on a target; that is, alteration of reservations, log parameters, or sense data.
x	in the diagnostic description indicates that either 0b or 1b may be used with identical effects.

NOTE 26 - DEVOFL and UNITOFL are set by the system. These bits grant permission to the target to perform vendor-specific diagnostic operations on the target that may be visible to attached initiators. Thus, by preventing operations that are not enabled by these bits, the target assists the operating system in protecting its resources.

- UNITOFL (Unit Off Line):

Value	Description
0b	is supported and prohibits any diagnostic operations that may be detected by subsequent I/O processes.
1b	is supported and grants permission to the target to perform diagnostic operations that may affect the user medium on the logical unit; for example, write operations to the

user-accessible medium, or operations that reposition the medium on sequential access devices.

x in the diagnostic description indicates that either 0b or 1b may be used with identical effects.

- PARAMETER LIST LENGTH: This field specifies the length in bytes of the parameter list that is transferred from the initiator to the target. A parameter list length value of zero specifies that no data is transferred. This condition is not considered an error. If the specified parameter list length results in truncation of one or more pages (PF bit set to 1b), the target returns CHECK CONDITION status with associated sense data of 5/2400 (ILLEGAL REQUEST, INVALID FIELD IN CDB).

Diagnostic Parameters (Diag) (see 6.1 on page 161) has a listing of all diagnostic parameters.

5.2.32 SET CAPACITY - 0Bh

The SET CAPACITY command is defined in SSC-4 (see the latest version at http://www.t10.org/drafts.htm#SCSI3_CMNDSETS). This clause decribes the specific implementation.

The SET CAPACITY command sets the available medium for the currently mounted volume to a proportion of the total medium for use. Any excess space shall be unavailable on the medium after successful completion of this command until changed by a new SET CAPACITY command. This change shall persist through power cycles, logical unit resets, I_T nexus losses, and unloading or reloading of the volume.

Table 95 — SET CAPACITY Command

Byte	Bit							
	7	6	5	4	3	2	1	0
0	OPERATION CODE (0Bh)							
1	Reserved							IMMED
2	Reserved							
3	(MSB)	MEDIUM FOR USE PROPORTION VALUE						
4								(LSB)
5	Control Byte (see 5.1.2.3)							

If no volume is loaded, then the command is terminated with CHECK CONDITION status. The sense key is set to NOT READY, and the additional sense code is set to MEDIUM NOT PRESENT.

The SET CAPACITY command is accepted only when the medium is at beginning-of-partition 0 (BOP 0). If the medium is logically at any other position, the command is rejected with CHECK CONDITION status. The sense key is set to ILLEGAL REQUEST and the additional sense code is set to POSITION PAST BEGINNING OF MEDIUM.

A valid SET CAPACITY command causes all data and partitioning information on the entire physical volume to be lost. If the partitioning information changes, a unit attention condition is established for all initiators with the additional sense code set to MODE PARAMETERS CHANGED.

The following paramters apply:

- IMMED (immediate):

Value	Description
0b	present status when command is completed.
1b	present status when the command descriptor block has been validated all buffered data, if any, is successfully written to the medium.

- MEDIUM FOR USE PROPORTION VALUE (MFUPV): The portion of the total medium to be made available for use. This field is the numerator to a fraction that has a denominator of 65 535 (FFFFh). The resulting available capacity on the tape is equal to the total unscaled tape capacity multiplied by this fraction.

$$\frac{\text{MFUPV}}{65535} \times \text{TotalUnscaledTapeCapacity} = \text{ResultingAvailableCapacity}$$

This device may round up the capacity to the next highest supported value. This rounding is not considered an error and is not be reported. If the MEDIUM FOR USE PROPORTION VALUE does not meet the ranges specified in table 96 then CHECK CONDITION status is returned with ILLEGAL FIELD IN CDB (5/2400h).

WARNING WARNING

If the Capacity Proportion is increased it is possible that a debris dump may exist at the previous logical end of medium. This may cause a defect when attempting to write through that area.

WARNING WARNING

Table 96 — MEDIUM FOR USE PROPORTION VALUE and resultant capacity

Cartridge	Minimum MEDIUM FOR USE PROPORTION VALUE	Resultant Approximate MEDIUM FOR USE PROPORTION VALUE	Maximum Capacity
Ultrium 4	123Dh	52 GB	800 GB
Ultrium 5	0FD8h	92 GB	1500 GB
Note - Available and total tape capacities are approximate values that may be affected by defects which reduce the actual available capacity of the tape. Other factors, such as compression and block packing, may also affect available capacity.			

NOTE 27 - The MEDIUM FOR USE PROPORTION VALUE relates to the physical proportion of the medium that is available for use to record logical objects and is not limited by the maximum number of logical objects that the device server is capable of supporting. This maintains the orthogonality between the volume and the logical unit that exists due to volumes being transferred to logical units that may support a different number of logical objects.

5.2.33 SET TIMESTAMP - A4h[0Fh]

The SET TIMESTAMP command is defined in SPC-4 (see the latest version at http://www.t10.org/drafts.htm#SCSI3_CMNDSETS). This clause decribes the specific implementation.

The SET TIMESTAMP command (see table 97) requests the drive to initialize the timestamp (see 4.11), if the SCSIP bit is set to one or the TCMOS bit is set to one in MP 0Ah[01h]: Control Extension (see 6.5.8 on page 317). If the SCSIP bit is set to zero, the SET TIMESTAMP command is terminated with CHECK CONDITION status, with the sense key set to ILLEGAL REQUEST, and the additional sense code set to INVALID FIELD IN CDB.

Table 97 — SET TIMESTAMP CDB

Byte	Bit							
	7	6	5	4	3	2	1	0
0	OPERATION CODE (A4h)							
1	Reserved			SERVICE ACTION (0Fh)				
2	Reserved							
5								
6	(MSB)	PARAMETER LIST LENGTH						
9								(LSB)
10	Reserved							
11	Control Byte (see 5.1.2.3)							

The following paramters apply:

- PARAMETER LIST LENGTH: The length in bytes of the SET TIMESTAMP parameters that is transferred from the application client to the device server. A PARAMETER LIST LENGTH of zero indicates that no data is transferred, and that no change is made to the timestamp.

5.2.33.1 SET TIMESTAMP Parameter List

The format for the parameter data for the SET TIMESTAMP command is shown in table 98.

Table 98 — SET TIMESTAMP parameter list format

Byte	Bit							
	7	6	5	4	3	2	1	0
0	Reserved							
3								
4	(MSB)	TIMESTAMP						
9								(LSB)
10	Reserved							
11								

The definition of the parameters follows:

Byte	Description
0-3	Reserved
4-9	TIMESTAMP: The initial value of the timestamp in the format defined in Device Clocks (see 4.11 on page 54). The timestamp should be the number of milliseconds that have elapsed since midnight, 1

January 1970 UT. If the high order byte in the TIMESTAMP field is greater than F0h, the command is terminated with CHECK CONDITION status, with the sense key set to ILLEGAL REQUEST, and the additional sense code set to INVALID FIELD IN PARAMETER LIST.

10-11 Reserved

On successful completion of a SET TIMESTAMP command the drive generates a UNIT ATTENTION condition for the initiator port associated with every I_T nexus except the I_T nexus on which the SET TIMESTAMP command was received, with the additional sense code set to TIMESTAMP CHANGED.

5.2.34 SPACE (6/16) - 11h/91h

The Space commands are defined in SSC (see the latest version at http://www.t10.org/drafts.htm#SCSI3_CMNDSETS). This clause decribes the specific implementation.

The Space command is implemented similar to the Locate command, causing the tape to move at maximum speed when appropriate.

Table 99 — Space (6) CDB

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	Operation code (11h)							
1	Obsolete (LUN)			Reserved		Code		
2	MSB	Count						
3								
4								LSB
5	Control Byte (see 5.1.2.3)							

The Space(16) command (see table 100), operates identically to the Space(6) command, but allows specifying a Count field up to eight bytes in length.

This command is newly added to the standards. The only exceptions to SSC-3 for this command are that the explicit command set is not supported and the list of values supported in the Code field.

Table 100 — Space(16) command

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	Operation Code (91h)							
1	Reserved				Code			
2	Reserved							
3								
4	(MSB)	Count						
11								(LSB)
12	(MSB)	Parameter Length (0000h)						
13								
14	Reserved							
15	Control Byte (see 5.1.2.3)							

The following parameters apply:

- CODE: Specifies the type of logical objects to be spaced over or the termination point of the operation.

  Value **Description**

  0h Blocks:
  If a filemark is encountered while spacing over logical blocks, the command is terminated. CHECK CONDITION status is returned, and the FILEMARK and VALID bits are set to one in the sense data. The sense key is set to NO SENSE and the additional sense code is set to FILEMARK DETECTED. The INFORMATION field is set to the number of logical objects to be spaced over minus the actual number of logical objects spaced over not including the filemark. The logical position is on the end-of-partition side of the filemark if movement was

in the forward direction and on the beginning-of-partition side of the filemark if movement was in the reverse direction.

1h Filemarks
2h Sequential Filemarks
3h End of Data

- COUNT: A value in two's complement notation specifying the number of logical objects to be spaced over and the direction of movement. If the CODE field is set to 3h (i.e., End-of-data), then the COUNT field is ignored.

  When spacing over logical objects, the magnitude of the value in the COUNT field specifies the number of logical objects to be spaced over in the current partition and the sign of the value in the COUNT field specifies the direction of movement.

  If the COUNT field contains a positive value N and the CODE field does not contain 3h (i.e., end-of-data) then the device server positions in the forward direction (i.e., toward end-of-partition) over N logical objects ending on the end-of-partition side of the last logical object.

  If the COUNT field contains a negative value -N, in two's complement notation, and the CODE field does not contain 3h (i.e., end-of-data) then the device server positions in the reverse direction (i.e., toward beginning-of-partition) over N logical objects ending on the beginning-of-partition side of the last logical object.

  If the drive encounters End-of-Data (EOD) while processing this command, the command is terminated at the EOD position and CHECK CONDITION status is returned with associated sense data of 8/0005 (BLANK CHECK, END-OF-DATA DETECTED).

- PARAMETER LENGTH: 0000h

5.2.35 TEST UNIT READY - 00h

The TEST UNIT READY command is defined in SPC (see the latest version at http://www.t10.org/drafts.htm#SCSI3_CMNDSETS). This clause decribes the specific implementation.

The TEST UNIT READY command reports when there is a medium in the drive that is ready to accept medium access commands. If a medium is loaded and a problem is detected that does not force the automatic ejection of the medium, GOOD status will still be returned to the TEST UNIT READY command. Whatever error is detected will be returned in response to the next medium access command.

Table 101 — Table 355. TEST UNIT READY CDB

Byte	Bit							
	7	6	5	4	3	2	1	0
0	Operation Code (00h)							
1	Obsolete			Reserved				
2	Reserved							
3	Reserved							
4	Reserved							
5	Control Byte (see 5.1.2.3)							

5.2.36 VERIFY(6) - 13h

The VERIFY command is defined in SSC (see the latest version at http://www.t10.org/drafts.htm#SCSI3_CMNDSETS). This clause decribes the specific implementation. The VERIFY(6) command (see table 102) requests that the device server verify one or more logical block(s) beginning at the current logical position. Prior to performing the verify operation, the device server performs a synchronize operation (see 4.2.11).

Table 102 — VERIFY (6) CDB

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	OPERATION CODE (13h)							
1	Reserved					IMMED	BYTCMP	FIXED
2	(MSB)							
3	VERIFICATION LENGTH							
4								(LSB)
5	Control Byte (see 5.1.2.3)							

The following parameters apply:

- IMMED: 0b
- BYTCMP: 0b

  The verification is a verification of logical blocks on the medium (e.g., CRC, ECC). No data is transferred from the application client to the device server.

- FIXED (see 4.4)
- VERIFICATION LENGTH (see 4.4): The amount of data to verify in, logical blocks or bytes, as specified by the FIXED bit. If the VERIFICATION LENGTH field is zero, then no data is verified and the current logical position is not changed. This condition is not considered an error.

The VERIFY(6) command terminates as follows:

a) when conditions related to encryption are met;
b) when the verification length has been satisfied;
c) when an incorrect-length logical block is encountered;
d) when a filemark is encountered;
e) when end-of-data is encountered;
f) when the end-of-partition is encountered;
g) when early-warning is encountered (if the REW bit is one in the Device Configuration mode page); or
h) when an unrecoverable read error is encountered.

General Read-Type Handling (see 4.5.1 on page 33) provides additional information.

5.2.37 WRITE - 0Ah

The WRITE command is defined in SSC (see the latest version at http://www.t10.org/drafts.htm#SCSI3_CMNDSETS). This clause decribes the specific implementation.

Table 103 — WRITE CDB

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	OPERATION CODE (0Ah)							
1	Obsolete (LUN)			Reserved				FIXED
2	MSB							
3	TRANSFER LENGTH							
4								LSB
5	Control Byte (see 5.1.2.3)							

The following parameters apply:

- FIXED (see 4.4)
- TRANSFER LENGTH (see 4.4)

If the logical object identifier of the current position on medium is greater than FFFFFF00h and less than FFFFFFF0h, then rules for Logical EOM processing are applied. If the logical object identifier of the current position on medium is greater than or equal to FFFFFFF0h, rules for physical end of partition processing are applied.

5.2.38 WRITE ATTRIBUTE - 8Dh

The WRITE ATTRIBUTE command is defined in SPC-4 (see the latest version at http://www.t10.org/drafts.htm#SCSI3_CMNDSETS). This clause decribes the specific implementation.

The WRITE ATTRIBUTE command (see table 104) allows an application client to write attributes to medium auxiliary memory. The READ ATTRIBUTE command (see 5.2.13) is used to read these attribute. Application clients should issue READ ATTRIBUTE commands prior to using this command to discover device server support for medium auxiliary memory.

Table 104 — WRITE ATTRIBUTE CDB

Bit Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (8Dh)							
1	Reserved							WTC
2	Reserved							
4								
5	VOLUME NUMBER (00h)							
6	Reserved							
7	PARTITION NUMBER							
8	Reserved							
9								
10	(MSB)			PARAMETER LIST LENGTH				
13								(LSB)
14	Reserved							
15	Control Byte (see 5.1.2.3)							

The following parameters apply:

Byte **Description**

0 OPERATION CODE (8Dh)

1 Byte 1

Bit	Description
7-1	Reserved
0	WTC - Write-through cache

Value	Description
0b	The attributes in the parameter list may be cached.
1b	The attributes in the parameter list shall be synchronized with the medium auxiliary memory during the processing of the WRITE ATTRIBUTE command and GOOD status shall not be returned until the attributes have been synchronized with the medium auxiliary memory.

2-4 Reserved

5 VOLUME NUMBER (00h)

6 Reserved

7 PARTITION NUMBER - The number of the partition to which these attributes belong. This shall be zero if there is only one partition on the volume.

8-9 Reserved

10-13 PARAMETER LIST LENGTH - The length in bytes of the parameter list contained in the Data-Out Buffer. A parameter list length of zero specifies that no parameter data is present; this shall not be considered an error. If the parameter list length results in the truncation of an attribute, the WRITE ATTRIBUTE

command is terminated with CHECK CONDITION status, with the sense key set to ILLEGAL REQUEST, and the additional sense code set to PARAMETER LIST LENGTH ERROR.

14 Reserved

15 CONTROL (see 5.1.2.3)

The parameter list shall have the format shown in table 105. Attributes shall be sent in ascending numerical order. If the attributes are not in order, then no attributes are changed and the WRITE ATTRIBUTE command is terminated with CHECK CONDITION status, with the sense key set to ILLEGAL REQUEST, and the additional sense code set to INVALID FIELD IN PARAMETER LIST.

Table 105 — WRITE ATTRIBUTE parameter list format

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)							
3	PARAMETER DATA LENGTH (n-3)							(LSB)
	Attribute(s)							
4	Attribute 0 (see 6.4)							
	⋮							
n	Attribute x (see 6.4)							

The PARAMETER DATA LENGTH field should contain the number of bytes of attribute data and shall be ignored by the device server.

The format of the attributes is described in “READ ATTRIBUTE” on page 252.

If there is not enough space to write the attributes to the medium auxiliary memory, then no attributes shall be changed and the WRITE ATTRIBUTE command shall be terminated with CHECK CONDITION status, with the sense key set to ILLEGAL REQUEST, and the additional sense code set to AUXILIARY MEMORY OUT OF SPACE.

If the medium auxiliary memory is not accessible because there is no medium present, then no attributes shall be changed and the WRITE ATTRIBUTE command shall be terminated with CHECK CONDITION status, with the sense key set to NOT READY, and the additional sense code set to MEDIUM NOT PRESENT.

If the medium is present but the medium auxiliary memory is not accessible, then no attributes shall be changed and the WRITE ATTRIBUTE command shall be terminated with CHECK CONDITION status, with the sense key set to MEDIUM ERROR, and the additional sense code set to LOGICAL UNIT NOT READY, AUXILIARY MEMORY NOT ACCESSIBLE.

If the medium auxiliary memory is not operational (e.g., bad checksum), the WRITE ATTRIBUTE command shall be terminated with CHECK CONDITION status, with the sense key set to MEDIUM ERROR, and the additional sense code set to AUXILIARY MEMORY WRITE ERROR.

If the WRITE ATTRIBUTE command parameter data contains an attribute with an ATTRIBUTE LENGTH field set to zero, then one of the following actions shall occur:

a) if the attribute state is unsupported or read only (see 4.13), then no attributes shall be changed and the WRITE ATTRIBUTE command shall be terminated with CHECK CONDITION status, with the sense key set to ILLEGAL REQUEST, and the additional sense code set to INVALID FIELD IN PARAMETER LIST;
b) if the attribute state is read/write, the attribute shall be changed to the nonexistent state. This attribute shall not be returned in response to a READ ATTRIBUTE command and not be reported by the READ ATTRIBUTE command with ATTRIBUTE LIST service action; or
c) if the attribute state is nonexistent, the attribute in the WRITE ATTRIBUTE command parameter list shall be ignored; this shall not be considered an error.

No attributes shall be changed, the WRITE ATTRIBUTE command shall be terminated with CHECK CONDITION status, with the sense key set to ILLEGAL REQUEST, and the additional sense code set to INVALID FIELD IN PARAMETER LIST if the parameter data contains any of the following:

a) an attempt to change an attribute in the read only state;
b) an attribute with incorrect ATTRIBUTE LENGTH field contents; or
c) an attribute with unsupported ATTRIBUTE VALUE field contents.

5.2.39 WRITE BUFFER - 3Bh

The Write Buffer command is defined in SPC (see the latest version at http://www.t10.org/drafts.htm#SCSI3_CMNDSETS). This clause decribes the specific implementation.

The Write Buffer command is supported, but not all buffers are described in this document because most buffers are intended only to be written by the service representative or by manufacturing. OEM customers who intend to support host microcode download on a new platform should contact IBM for a complete description of the Write Buffer command for this purpose. Note that new microcode may also be loaded without requiring the use of the SCSI Write Buffer command, by using the Field Microcode Replacement (FMR) tape process described in the maintenance information manual for this product. See Supported Buffers (see 6.6.2 on page 360) for a list of the buffers supported by the drive. Table 106 shows the command format.

Table 106 — WRITE BUFFER CDB

Byte	Bit							
	7 msb	**6**	**5**	**4**	**3**	**2**	**1**	**0 lsb**
0	OPERATION CODE (3Bh)							
1	Obsolete			MODE				
2	BUFFER ID							
3	(MSB)							
4	BUFFER OFFSET							
5								(LSB)
6	(MSB)							
7	PARAMETER LIST LENGTH							
8								(LSB)
9	Control Byte (see 5.1.2.3)							

The following parameters apply:

- MODE:

Value	Description
00h	Combined header and data: the header is required to be all zeroes.
02h	Data.
04h	Download Microcode.
05h	Download Microcode and Save.
06h	Download Microcode With Offsets: use of strictly increasing offsets is required.
07h	Download Microcode With Offsets and Save: use of strictly increasing offsets is required.
0Ah	Echo buffer.

- BUFFER ID: This field is ignored if MODE field is set to 04h, 05h, 06h, or 07h. The supported buffers are described in Supported Buffers (see 6.6.2 on page 360).
- BUFFER OFFSET: The relative byte location within the buffer to write the data transferred by this command.

Supported Buffers (see 6.6.2 on page 360) describes the supported Buffer ID's.

5.2.40 WRITE FILEMARKS - 10h

The Write Filemarks command is defined in SSC (see the latest version at http://www.t10.org/drafts.htm#SCSI3_CMNDSETS). This clause decribes the specific implementation.

Table 107 — WRITE FILEMARKS CDB

Byte	Bit							
	7 msb	**6**	**5**	**4**	**3**	**2**	**1**	**0 lsb**
0	OPERATION CODE (10h)							
1	Obsolete			Reserved			Obsolete	IMMED
2	(MSB)							
3	FILEMARK COUNT							
4								(LSB)
5	Control Byte (see 5.1.2.3)							

The following parameters apply:

- IMMED (Immediate):

Value	Description
0b	present status when command is completed.
1b	present status when command is verified.

- FILEMARK COUNT: The number of filemarks to be written.

  The initiator may issue a WRITE FILEMARKS command with the IMMED bit set to 0b and the FILEMARK COUNT set to zero to ensure that all buffered data and filemarks are successfully written to the medium (synchronized).

If the logical object identifier of the current position on medium is:

a) greater than FFFFFF00h and less than FFFFFFF0h, then rules for Logical EOM processing are applied;
b) greater than or equal to FFFFFFF0h, then rules for physical end of partition processing are applied.

A WRITE FILEMARK with FILEMARK COUNT set to zero when there is no data in the buffer to be synchronized always returns GOOD Status even if the volume is a WORM volume and:

a) the media is not at a writable location; or
b) the WORM volume has been tampered with.

On eServer enabled drives, the msb of the vendor specific field in the control byte (i.e., bit 7) is ignored.

6. Parameters for SCSI Commands

This clause describes the parameters used in SCSI commands that are supported on LUN 0.

Parameters are described in a “term-definition” format. In this format, the bits or bytes to be described are highlighted and listed on the left. The definition for the bits or bytes is to the right (not highlighted).

The following is a list of abbreviations used to describe the various parameters referenced in this document as well as a reference to the parameter clause in which those specific parameters are defined:

Term	Description
Daig	Diagnostic Parameters (Diag) (see 6.1 on page 161)
IP	Inquiry Vital Product Data Parameters (IP) (see 6.2 on page 189)
LP	Log Parameters (LP) (see 6.3 on page 217)
MAM	Medium auxiliary memory attributes (MAM) (see 6.4 on page 295)
MP	Mode Parameters (MP) (see 6.5 on page 305)
RB	Read/Write Buffers (RB) (see 6.6 on page 357)
SPP	Security Protocol Parameters (SPP) (see 6.7 on page 367)

6.1 Diagnostic Parameters (Diag)

Diagnostic parameters are used with the SEND DIAGNOSTIC command(see SEND DIAGNOSTIC - 1Dh (see 5.2.31 on page 142) and RECEIVE DIAGNOSTIC RESULTS - 1Ch (see 5.2.19 on page 112) for additional information on the commands).

Terms used in this clause are:

Term	Description
CD	Cryptographic Diagnostic
Diag	Diagnostic
Page	Page Code
Parm	Parameter
RcvDiag	Receive Diagnostic Results
SendDaig	Send Diagnostic

6.1.1 Diag Page Formats

The drive supports two diagnostic pages for normal use: Page Code 00h and 80h. Page Code 81h is for engineering use only.

6.1.1.1 Page 00h

6.1.1.2 SendDiag Data - Page 00h

The format for the Send Diagnostic command follows:

Byte	Description
0	Page Code: 00h
1	Reserved (00h)
2-3	Page Length: 0000h

6.1.1.3 RcvDiag Data - Page 00h

The format for the Receive Diagnostic Results command follows:

Byte	Description
0	Page Code: 00h
1	Reserved
2-3	Page Length: 0002h
4	Page Code Supported: 00h
5	Page Code Supported: 80h

6.1.1.4 Page 80h

Page Code 80h is a general purpose page for sending flags and diagnostic parameters to the target.

6.1.1.4.1 SendDiag - Page 80h

The format for the Send Diagnostic command follows:

Byte	Description
0	Page Code: 80h

1 Reserved

2-3 Page Length (n-3)

4-5 Diagnostic ID

This field specifies the diagnostic that is to be run

6 Flags (Send Diagnostic command)

Bits	Description
7-1	Reserved
0	Cartridge Required Set to 1b when a cartridge is required for a diagnostic. When 1b, a cartridge must be loaded and ready for the Send Diagnostic command to be accepted. See specific diagnostic descriptions for cartridge use: some diagnostics require this bit to be set to 1b, some require it to be set to 0b, and some do not require a specific bit setting. • 0b: No cartridge required • 1b: Cartridge required

7 Reserved

8-n Diagnostic Parameters

The Diagnostic Parameters field contains the parameters required to run the diagnostic.

See 6.1.2 for a list of supported diagnostic page 80h routines.

6.1.1.5 RcvDiag - Page 80h

The format for the Receive Diagnostic Results command follows:

Byte Description

0 Page Code: 80h

1 Reserved

2-3 Page Length (n-3)

4-5 Diagnostic ID

This field contains the same value as that sent with the Send Diagnostic command for which this response is associated.

6 Flags

Set to 00h for the Receive Diagnostic Results command

7 Reserved

8-n Diagnostic Results

The Diagnostic Results field contains the results from the diagnostic.

See the individual Send Diagnostic parameter descriptions for the field contents. Refer to Supported Page 80h Diags (see 6.1.2) for a list of diagnostic parameters supported by the drive.

6.1.1.5.1 SIM/MIM Definition

SIMs (Service Information Messages), and MIMs (Medium Information Messages) provide the initiator and operator details on service problems encountered by the device. The first 9 bytes are common to both the SIMs and the MIMs.

6.1.1.5.1.1 SIM/MIM Header Data

Table 108 — SIM Data Structure

Byte	Bit							
	7	6	5	4	3	2	1	0
0	Page Code (31h)							
1	Reserved							
2	(MSB)			PAGE LENGTH (0044h)				
3								(LSB)
4	(MSB)			PARAMETER CODE (0000h)				
5								(LSB)
6	PARAMETER CONTROL (61h)							
7	PARAMETER LENGTH (40h)							
8	SIM/MIM INDICATOR							
9	SIM or MIM data							
71								

Byte Description

0 Page Code

Bit	Description
7-6	Reserved
5-0	Page Code: 31h

1 Reserved

2-3 Page Length: 0044h

4-5 Parameter Code: 0000h

6 Parameter control byte

Bit	Description
7	DU (Disable Update): 0b
6	DS (Disable Save): 1b
5	TSD (Target Save Disable): 1b
4	ETC (Enable Threshold Comparison): 0b
3-2	TMC (Threshold Met Comparison): 00b
1	Reserved
0	LP (List Parameter): 1b

7 Parameter length: 40h

8 SIM/MIM Indicator

Value	Description
00h	Bytes 9 through 71 are invalid.
01h	Bytes 9 through 71 are a SIM message. See “SIM Messages” on page 164.
02h	Bytes 9 through 71 are a MIM message. See “MIM Messages” on page 167.
03-FF	Bytes 9 through 71 are invalid.

6.1.1.5.1.2 SIM Messages

The following data are the parameters for the hardware SIM message

Table 109 — SIM Data Structure

Byte	Bit							
	7	6	5	4	3	2	1	0
9	Reserved							
15								
16	PRODUCT REVISION LEVEL							
19								
20	(MSB)	SIM MESSAGE CODE						
21								(LSB)
22	Reserved							
23								
24	EXCEPTION MESSAGE CODE							
25	SERVICE MESSAGE CODE							
26	SERVICE MESSAGE SEVERITY CODE							
27	Reserved							
28	(MSB)	EXCEPTION DATA						
29								(LSB)
30	(MSB)	SCD ERROR CODE						
33								(LSB)
34	(MSB)	FIRST FSC						
37								(LSB)
38	(MSB)	LAST FSC						
41								(LSB)
42	(MSB)	PRODUCT ID (8000h)						
45								(LSB)
46	Product Identifier							
	(MSB)	VENDOR ID "IBM"						
48								(LSB)
49	(MSB)	PLANT OF MANUFACTURE						
50								(LSB)
51	'-'							
52	(MSB)	SERIAL NUMBER						
63								(LSB)
64	(MSB)	DEVICE TYPE						
71								(LSB)

Byte Description

9-15 Reserved

16-19 PRODUCT REVISION LEVEL (microcode level): Same as bytes 32 - 35 in Standard Inquiry data

20-21 SIM MESSAGE CODE

Value (ASCII)	Description
'00'	No Message
'41'	Device Degraded. Call for Service
'42;	Device Hardware Failure. Call for Service
'43'	Service Circuits Failed, Operations Not Affected. Call for Service
'55'	Drive Needs Cleaning. Load Cleaning Cartridge
'57'	Drive Has Been Cleaned
All Others	Device Message message

22-23 Reserved

24 EXCEPTION MESSAGE CODE

Value (ASCII)	Description
'0'	Vendor-Reserved
'1'	Effect of Failure Is Unknown
'2'	Device Exception. No Performance Impact
'3;	Exception on Host Interface xx See bytes 28-29 (Exception Data xx) in this SIM record for the xx value.
'4'	Device Exception on ACF
'5'	Device Exception on Operator Panel
'6'	Device Exception on Tape Path
'7'	Device Exception in Drive
'8'	Cleaning Required
'9'	Cleaning Done
'A'-'F'	Vendor-Reserved

25 SERVICE MESSAGE CODE

Value (ASCII)	Description
'0'	Vendor-Reserved
'1'	Repair Impact is Unknown
'2'-'6'	Vendor-Reserved
'7'	Repair Will Disable Access to Device serno (serno refers to serial number in bytes 52-63 of this SIM record)
'9'	Clean Device
'A'	Device Cleaned
'B'	Device Cleaning For Performance Reasons is Required
'C'-'F'	Vendor-Reserved

26 SERVICE MESSAGE SEVERITY CODE

Value (ASCII)	Description
'0'	SIM severity code "Service"
'1'	SIM severity code "Moderate"
'2'	SIM severity code "Serious"
'3'	SIM severity code "Acute"
'4'-'9', 'A'-'F'	Vendor-Reserved

27 Reserved

28-29 EXCEPTION DATA

Interface Data is returned when byte 24 (Exception Message Code) in this SIM record contains the ASCII value '3'.

Value (ASCII)	Description
'00'	interface 0 is indicated
'01'	interface 1 is indicated

30-33 SCD ERROR CODE: Error code indicated on SCD (ASCII code). For example 0x00000035 for SCD '5'.

34-37 FIRST FSC

38-41 LAST FSC

42-45 PRODUCT ID: '8000' (these 4 bytes define "TAPE")

46-63 PRODUCT IDENTIFIER

Broken out into constituent bytes:

Byte	Description
46-48	MANUFACTURER: "IBM"
49-50	PLANT OF MANUFACTURE
51	'-' (Dash symbol)
52-63	SERIAL NUMBER

64-71 DEVICE TYPE (device type portion of PRODUCT IDENTIFICATION; Inquiry Standard Data bytes 16-23)

6.1.1.5.2 MIM Messages

Media Information Messages (MIMs) are supported by this device. The following data are the parameters for the MIM

Table 110 — MIM Data Structure

Byte	Bit							
	7	6	5	4	3	2	1	0
9	Reserved							
15								
16	PRODUCT REVISION LEVEL							
19								
20	(MSB)	MIM MESSAGE CODE						
21								(LSB)
22	Reserved							
23								
24	EXCEPTION MESSAGE CODE							
25	MEDIA MESSAGE CODE							
26	MEDIA MESSAGE SEVERITY CODE							
27	Reserved							
29								
30	(MSB)	FAULT SYMPTOM CODE (FSC)						
33								(LSB)
34	VOLID (Volume Serial Number)							
39								
38	VOLID VALID							
41	Reserved							
42	(MSB)	PRODUCT ID (8000h)						
45								(LSB)
46	Product Identifier							
	(MSB)	VENDOR ID "IBM"						
48								(LSB)
49	(MSB)	PLANT OF MANUFACTURE						
50								(LSB)
51	'-'							
52	(MSB)	SERIAL NUMBER						
63								(LSB)
64	(MSB)	DEVICE TYPE						
71								(LSB)

Byte Description

9-15 Vendor-Reserved

16-19 PRODUCT REVISION LEVEL (microcode level): Same as bytes 32 - 35 in Standard Inquiry data

20-21 MIM MESSAGE CODE

Value (ASCII)	Description
'00'	No Message
'60'	Bad Media, Read Only permitted
'61'	Rewrite Media if possible
'62'	Tape Directory Invalid. Re-read media if possible
'64'	Bad Media-Cannot Read or Write
'72'	Replace Cleaner Cartridge
Others	Vendor-Reserved

22-23 Reserved

24 EXCEPTION MESSAGE CODE

Value (ASCII)	Description
'2'	Data Degraded
'4'	Medium Degraded
'6'	CM Error
'7'	Medium Exception
Others	Vendor-Reserved

25 MEDIA MESSAGE CODE

26 MEDIA MESSAGE SEVERITY CODE

Value (ASCII)	Description
'0'	Service
'1'	Moderate-High Temp Read/Write Errors Detected
'2'	Serious-Permanent Read/Write Errors Detected
'3'	CM Error
Others	Vendor-Reserved

27-29 Reserved

30-33 FAULT SYMPTOM CODE (FSC)

34-39 VOLID (Volume Serial Number) (in ASCII). Only valid if indicated by VOLID Valid Flag (byte 40)

40 VOLID VALID

Value (ASCII)	Description
'0'	VOLID (bytes 34-39) not valid
'1'	VOLID valid, obtained from tape
'3'	VOLID valid, obtained from host (MAM Attribute ID 0806 in CM)
'5'	VOLID valid, obtained from library (volser in mechanism related page in CM)
Others	Vendor-Reserved for future use (odd number will always indicate VOLID valid)

41 Reserved

42-45 PRODUCT ID: '8000' (these 4 bytes define "TAPE")

46-63 PRODUCT IDENTIFIER

Broken out into constituent bytes:

Byte	Description
46-48	MANUFACTURER: "IBM"
49-50	PLANT OF MANUFACTURE
51	'-' (Dash symbol)
52-63	SERIAL NUMBER

64-71 DEVICE TYPE (device type portion of PRODUCT IDENTIFICATION; Inquiry Standard Data bytes 16-23)

6.1.2 Supported Page 80h Diags

Table 111 shows the supported diagnostic page 80h routines and indicates values required in the Send Diagnostic CDB. These diagnostics reside in the device (see SEND DIAGNOSTIC - 1Dh (see 5.2.31 on page 142) and RECEIVE DIAGNOSTIC RESULTS - 1Ch (see 5.2.19 on page 112) for additional information on the commands). Individual diagnostic descriptions follow table 111.

Table 111 — Supported Page 80 Diag Routines

ID	Name/Description	See Page	Parm Length	Result Length [b]	Self Test	Dev Ofl	Unit Ofl	Cart Req'd
None	Self Test	170	0000h	-	1	X	X	-
0090h	Primary Port Wrap Test	171	0008h	0051h	0	X	X	X
0100h	POST A Self Test Diagnostic	172	0008h	0051h	0	X	X	X
0101h	POST B Performance Diagnostic [a]	174	0008h	0051h	0	X	1	1
0102h	POST C Media Test Diagnostic	176	0008h	0051h	0	X	1	1
0103h	POST D Head Test Diagnostic	177	0008h	0051h	0	X	1	1
0160h	Force Dump	178	0008h	-	0	X	X	X
0161h	Write Dump to Cartridge [a]	179	0008h	0051h	0	X	1	1
0162h	Write Dump to FLASH (EEPROM)	-	0008h	-	0	X	X	X
016Fh	Clear FLASH Dump (EEPROM)	-	0008h	-	0	X	X	X
0190h	Set Traps	181	000Ah	-	0	X	X	X
0191h	Remove Traps	182	000Ah	-	0	X	X	X
1002h	Read Thermal Sensor	-	0008h	0051h	0	X	X	X
2002h	Reset Drive (Soft)	186	0008h	-	0	1	X	0
E000h	Encryption Diagnostics	187	????	????	0	X	X	X

Legend
- Not Applicable
???? Variable

[a] These diagnostics will destroy all data on the currently mounted cartridge.

[b] GOOD status is returned for diagnostics which expect result data based solely on validation of the diagnostic. The Receive Diagnostics Results command must be used to determine the success or failure of the actual execution of such diagnostics. Diagnostic procedures are recommended above.

6.1.3 Diag - SelfTest: Self Test

When the SelfTest bit is 1b in the Send Diagnostic command (see SEND DIAGNOSTIC - 1Dh (see 5.2.31 on page 142) and RECEIVE DIAGNOSTIC RESULTS - 1Ch (see 5.2.19 on page 112) for additional information on the commands), the target runs the normal power-on self test (POST A) diagnostics that occur at bring-up. No diagnostic results are returned.

6.1.3.1 SendDiag Command - Self Test

Table 112 shows the Send Diagnostic command format to specify Self Test (the SelfTest bit is set to 1b).

Table 112 — SendDiag CDB - Self Test

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	Operation code (1Dh)							
1	Obsolete (LUN)			PF (1b)	Reserved (0b)	SelfTest (1b)	DevOfl (0b)	UnitOfl (0b)
2	Reserved (00h)							
3	(MSB)	Parameter List Length (0000h)						
4								(LSB)
5	Control Byte (see 5.1.2.3)							

When the SelfTest bit is 1b in the Send Diagnostic command, the target will process its default power-on self test. If the self test successfully passes, the command is terminated with Good status. If the self test detects a failure, the command is terminated with CHECK CONDITION status and the sense key is set to Hardware Error.

6.1.3.2 RcvDiag Data - Self Test

There are no diagnostic results for the self test.

6.1.4 Diag - 0090h: Primary port wrap test

This test will perform a wrap test on the specified primary port. A wrap tool must be attached prior to running this command. See SEND DIAGNOSTIC - 1Dh (see 5.2.31 on page 142) and RECEIVE DIAGNOSTIC RESULTS - 1Ch (see 5.2.19 on page 112) for additional information on the commands.

6.1.4.1 SendDiag Parm Data - Primary port wrap test

Table 113 shows the parameter data for the Send Diagnostic command.

Table 113 — Primary Port Wrap Test SendDiag Parm Data

Byte	7	6	5	4	3	2	1	0
0	PAGE CODE (80h)							
1	Reserved							
2	(MSB)							
3	PAGE LENGTH (0004h)							(LSB)
4								
5	DIAGNOSTIC ID (0090h)							
6	FLAGS (0000000b)							CR (0b)
7	PORT IDENTIFIER							

The following parameters apply:

- CR (cartridge required): 0b
- PORT IDENTIFIER: This field is identicle to the PORT IDENTIFIER field described in the Device Identification Inquiry page <<XREF>>. If the value of the PORT IDENTIFIER is zero, then the wrap test will be performed on all primary ports. If the value is a valid port identifier, the wrap test is performed on the port indicated by the PORT IDENTIFIER field. If an invalid port identifier value is used, the drive will respond with a CHECK CONDITION for INVALID FIELD IN PARAMETER LIST.

6.1.4.2 RcvDiag Data - Primary port wrap test

Table 114 shows the diagnostic results data received from the attempted Primary port wrap test diagnostic.

Table 114 — Primary Port Wrap Test Receive Diag Parm Data

Byte	7	6	5	4	3	2	1	0
0	PAGE CODE (80h)							
1	Reserved							
2	(MSB)							
3	PAGE LENGTH (004Dh)							(LSB)
4								
5	DIAGNOSTIC ID (0090h)							
6	FLAGS							
7	Reserved							
8	FLAGS (00000b)					BLOCKED	SIM/MIM PRESENT	ERROR
9								
80	SIM/MIM Message or All Zeros							

6.1.5 Diag - 0100h: POST A

This diagnostic runs the POST A (power-on self test) diagnostics, as does running the Self Test diagnostic by setting the SelfTest bit to 1b in a Send Diagnostic command. However, unlike Self Test, the POST A diagnostic returns data through the Receive Diagnostic Results command. (see SEND DIAGNOSTIC - 1Dh (see 5.2.31 on page 142) and RECEIVE DIAGNOSTIC RESULTS - 1Ch (see 5.2.19 on page 112) for additional information on the commands)

6.1.5.1 SendDiag Parm Data - POST A

Table 115 shows the parameter data for the Send Diagnostic command.

Table 115 — SendDiag Parm Data - POST A

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	Page Code (80h)							
1	Reserved (00h)							
2	(MSB)			Page Length (0004h)				
3								(LSB)
4	(MSB)			Diagnostic ID (0100h)				
5								(LSB)
6	Flags (0000000b)							CR(x)
7	Reserved (00h)							
Note 1 - The CR (Cartridge Required) flag may be set to 0b or 1b. If a cartridge is in the drive when this diagnostic is received, some diagnostics will not run. If the diagnostic is blocked because a cartridge is loaded in the drive or for any other reason, the BLOCKED bit is set in the Receive Diagnostics Results data.								

6.1.5.2 RcvDiag Data - POST A

Table 116 shows the diagnostic results data received from the POST A diagnostic.

Table 116 — RcvDiag Data - POST A

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	Page Code (80h)							
1	Reserved (00h)							
2	(MSB)							
3	Page Length (004Dh)							(LSB)
4	(MSB)							
5	Diagnostic ID (0100h)							(LSB)
6	Flags (00h)							
7	Reserved (00h)							
8	Reserved (00000b)					Diagnostic Blocked	SIM/MIM Present	Error
9	SIM/MIM message or all zeros							
80								

Note 1 - The ERROR bit in byte 8 is set when the diagnostic detects an error.
Note 2 - The SIM/MIM Present bit in byte 8 is set when a SIM or MIM message is contained in the diagnostic results.
Note 3 - SIM/MIM messages are defined exactly as described in SIM/MIM Definition (see 6.1.1.5.1 on page 162); the SIM/MIM is not valid if the SIM/MIM Present bit is 0b.
Note 4 - The Diagnostic Blocked bit is set when the diagnostic cannot run all its tests. This occurs if a cartridge is in the drive.

6.1.6 Diag - 0101h: POST B Performance

The Performance Diagnostic performs a test to determine how well the tape drive writes data. If the percentage degradation exceeds the threshold, the SEND DIAGNOSTIC command will return a CHECK CONDITION. The SENSE KEY will be set to 1h and the ASC/ASCQ set to 0000h. The FSC field of sense data will be set to 52E5h, if the degradation is in the forward direction, or 52E6h, if the degradation was in the backward direction. The FSC FLAG field of the sense data will be set to the percentage. TapeAlert2 (Write Warning) will be set and the SCD will display the character 'A.' The RECEIVE DIAGNOSTIC command will return SIM data related to the failure.

See SEND DIAGNOSTIC - 1Dh (see 5.2.31 on page 142) and RECEIVE DIAGNOSTIC RESULTS - 1Ch (see 5.2.19 on page 112) for additional information on the commands.

6.1.6.1 SendDiag Parm Data - POST B Performance

Table 117 shows the parameter data for the Send Diagnostic command.

Table 117 — SendDiag Parm Data - POST B

Byte	Bit							
	7 msb	**6**	**5**	**4**	**3**	**2**	**1**	**0 lsb**
0	Page Code (80h)							
1	Reserved (00h)							
2	(MSB)	Page Length (0004h)						
3								(LSB)
4	(MSB)	Diagnostic ID (0101h)						
5								(LSB)
6	Flags (0000000b)							Cartridge Required (1b)
7	Reserved (00h)							
Note 1 - Cartridge Required=1b, a cartridge must be loaded and ready.								

6.1.6.2 RcvDiag Data - POST B Performance

Table 118 shows the diagnostic results data received from the POST B diagnostic.

Table 118 — RcvDiag Data - POST B

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	Page Code (80h)							
1	Reserved (00h)							
2	(MSB)	Page Length (004Dh)						
3								(LSB)
4	(MSB)	Diagnostic ID (0101h)						
5								(LSB)
6	Flags (00h)							
7	Reserved (00h)							
8	Reserved (00000b)					Diagnostic Blocked	SIM/MIM Present	Error
9	SIM/MIM message or all zeros							
80								

Note 1 - The Error bit in byte 8 is set when the diagnostic detects an error.
Note 2 - The SIM/MIM Present bit in byte 8 is set when a SIM or MIM message is contained in the diagnostic results.
Note 3 - SIM/MIM messages are defined exactly as described in SIM/MIM Definition (see 6.1.1.5.1 on page 162); the SIM/MIM is not valid if the SIM/MIM Present bit is 0.

6.1.7 Diag - 0102h: POST C Media Test

6.1.7.1 SendDiag Parm Data - POST C Media Test

Table 119 — SendDiag Parm Data - POST C Media Test

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

6.1.7.2 RcvDiag Data - POST C Media Test

Table 120 — Table 325. POST C Media Test Receive Diag Parm Data

Byte	Bit							
	7	6	5	4	3	2	1	0
0	Page Code (80h)							
1	Reserved							
2	(MSB)	Page Length (004Dh)						
3								(LSB)
4	(MSB)	Diagnostic ID (0102h)						
5								(LSB)
6	Flags							
7	Reserved							
8	Flags (00000b)					Diag. Blocked	SIM/MIM Present	ERROR
9	SIM/MIM message or all zeros							
80								

6.1.8 Diag - 0103h: POST D Head Test

6.1.8.1 SendDiag Parm Data - POST D Head Test

Table 121 — SendDiag Parm Data - POST D Head Test

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

6.1.8.2 RcvDiag Data - POST D Head Test

Table 122 — Receive Diag Parm Data - POST D Head Test

Byte	Bit							
	7	6	5	4	3	2	1	
0	Page Code (80h)							
1	Reserved							
2	(MSB)			Page Length (004Dh)				
3								(LSB)
4	(MSB)			Diagnostic ID (0103h)				
5								(LSB)
6	Flags							
7	Reserved							
8	Flags (00000b)					Diag. Blocked	SIM/MIM Present	ERROR
9	SIM/MIM message or all zeros							
80								

6.1.9 Diag - 0160h: Force Dump

This diagnostic forces a dump. The dump data is stored in device control storage and can be read by the Read Buffer command (Buffer ID of 00h) (see 5.2.17).

When a higher priority dump has been generated automatically by the drive but has not yet been read, the drive will ignore this Send Diagnostic command and return GOOD status.

Because forcing a drive dump will overwrite any previously stored dump, before forcing the dump the DUMP field of the sense data should be examined to determine if a drive dump exists.

See SEND DIAGNOSTIC - 1Dh (see 5.2.31 on page 142) and RECEIVE DIAGNOSTIC RESULTS - 1Ch (see 5.2.19 on page 112) for additional information on the commands.

6.1.9.1 SendDiag Parm Data - Force Dump

Table 123 shows the parameter data for the Send Diagnostic command.

Table 123 — SendDiag Parm Data - Force Dump

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	Page Code (80h)							
1	Reserved (00h)							
2	(MSB)							
3	Page Length (0004h)							(LSB)
4	(MSB)							
5	Diagnostic ID (0160h)							(LSB)
6	Flags (0000000b)							Cartridge Required (x)
7	Reserved (00h)							
Note 1 - The Cartridge Required flag may be set to 0b or 1b.								

6.1.9.2 RcvDiag Data - Force Dump

There are no diagnostic results for this function.

6.1.10 Diag -0161h: Write Dump to Cartridge

This diagnostic causes dump information residing in the device control storage to be written to a cartridge without the need to retrieve the dump data across the host interface. A cartridge is required to be loaded to run the diagnostic (see SEND DIAGNOSTIC - 1Dh (see 5.2.31 on page 142) and RECEIVE DIAGNOSTIC RESULTS - 1Ch (see 5.2.19 on page 112) for additional information on the commands).

6.1.10.1 SendDiag Parm Data - Write Dump to Cartridge

Table 124 shows the parameter data for the Send Diagnostic command.

Table 124 — SendDiag Parm Data - Write Dump to Cartridge

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	Page Code (80h)							
1	Reserved (00h)							
2	(MSB)			Page Length (0004h)				
3								(LSB)
4	(MSB)			Diagnostic ID (0161h)				
5								(LSB)
6	Flags (0000000b)							Cartridge Required (1b)
7	Reserved (00h)							
Note 1 - Cartridge Required=1b, a cartridge must be loaded and ready.								

6.1.10.2 RcvDiag Data - Write Dump to Cartridge

Table 125 shows the diagnostic results data received from the Write Dump to Cartridge diagnostic.

Table 125 — RcvDiag Data - Write Dump to Cartridge

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	Page Code (80h)							
1	Reserved (00h)							
2	(MSB)	Page Length (004Dh)						
3								(LSB)
4	(MSB)	Diagnostic ID (0161h)						
5								(LSB)
6	Flags (00h)							
7	Reserved (00h)							
8	Reserved (00000b)					Diagnostic Blocked	SIM/MIM Present	Error
9	SIM/MIM message or all zeros							
80								

Note 1 - The Error bit in byte 8 is set when the diagnostic detects an error.
Note 2 - The SIM/MIM Present bit in byte 8 is set when a SIM or MIM message is contained in the diagnostic results.
Note 3 - SIM/MIM messages are defined exactly as described in SIM/MIM Definition (see 6.1.1.5.1 on page 162); the SIM/MIM is not valid if the SIM/MIM Present bit is 0b.

6.1.11 Diag - 0190h: Set Traps

This diagnostic permits a SCSI interface user to set a microcode trap that causes a dump to occur when the trap is sprung. The drive continues to operate after the dump completes (see SEND DIAGNOSTIC - 1Dh (see 5.2.31 on page 142) and RECEIVE DIAGNOSTIC RESULTS - 1Ch (see 5.2.19 on page 112) for additional information on the commands).

6.1.11.1 SendDiag Parm Data - Set Traps

Table 126 shows the parameter data for the Send Diagnostic command.

Table 126 — SendDiag Parm Data - Set Traps

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	Page Code (80h)							
1	Reserved (00h)							
2	(MSB)			Page Length (0006h)				
3								(LSB)
4	(MSB)			Diagnostic ID (0190h)				
5								(LSB)
6	Flags (0000000b)							Cartridge Required (x)
7	Reserved (00h)							
8	(MSB)			Fault Symptom Code				
9								(LSB)
Note 1 - Cartridge Required=1, a cartridge must be loaded and ready before the diagnostic is run.								

6.1.11.2 RcvDiag Data - Set Traps

There are no diagnostic results for this function.

6.1.12 Diag - 0191h: Remove Traps

See SEND DIAGNOSTIC - 1Dh (see 5.2.31 on page 142) and RECEIVE DIAGNOSTIC RESULTS - 1Ch (see 5.2.19 on page 112) for additional information on the commands.

This diagnostic permits a SCSI interface user to remove a microcode trap that was set either via the CE service panel or the SCSI Set Traps Diagnostic.

Sending down the Remove Traps diagnostic with the FAULT SYMPTOM CODE set to 0000h will set up diagnostic results that show which traps are currently set without changing the state of any traps.

6.1.12.1 SendDiag Parm Data - Remove Traps

Table 127 shows the parameter data for the Send Diagnostic command.

Table 127 — SendDiag Parm Data - Remove Traps

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	Page Code (80h)							
1	Reserved (00h)							
2	(MSB)			Page Length (0006h)				
3								(LSB)
4	(MSB)			Diagnostic ID (0191h)				
5								(LSB)
6	Flags (0000000b)							Cartridge Required (x)
7	Reserved (00h)							
8	(MSB)			FAULT SYMPTOM CODE				
9								(LSB)

6.1.12.2 RcvDiag Data - Remove Traps

Table 128 shows the diagnostic results data received from the Remove Traps diagnostic.

Table 128 — RcvDiag Data - Remove Traps

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	Page Code (80h)							
1	Reserved (00h)							
2	(MSB)	Page Length (n-4)						
3								(LSB)
4	(MSB)	Diagnostic ID (0191h)						
5								(LSB)
6	Flags (00h)							
7	Reserved (00h)							
8	Reserved (00000b)					Diagnostic Blocked	Reserved	Error
	List of Fault Symptom Code's with Trap still set							
9	(MSB)	Fault Symptom Code [first]						
10								(LSB)
	⋮							
n-1	(MSB)	Fault Symptom Code [last]						
n								(LSB)

6.1.13 Diag - 1002h: Read Thermal Sensor

The Read Thermal Sensor diagnostic is used to read the digital thermal sensor on the drive (see SEND DIAGNOSTIC - 1Dh (see 5.2.31 on page 142) and RECEIVE DIAGNOSTIC RESULTS - 1Ch (see 5.2.19 on page 112) for additional information on the commands).

6.1.13.1 SendDiag Parm Data - Read Thermal Sensor

Table 129 shows the parameter data for the Read Thermal Sensor diagnostic.

Table 129 — Diag parameter data - Read Thermal Sensor

Byte	Bit							
	7	6	5	4	3	2	1	0
0	Page Code (80h)							
1	Reserved							
2	(MSB)			Page Length (0004h)				
3								(LSB)
4	(MSB)			Diagnostic ID (1002h)				
5								(LSB)
6	Flags (0000000b)							
7	Reserved							

6.1.13.2 RcvDiag Data - Read Thermal Sensor

Table 130 shows the diagnostic results data received from the Read Thermal Sensor diagnostic.

Table 130 — Receive Diag parameter data - Read Thermal Sensor

Byte	Bit							
	7	6	5	4	3	2	1	0
0	Page Code (80h)							
1	Reserved							
2	(MSB)	Page Length (000Eh)						
3								(LSB)
4	(MSB)	Diagnostic ID (1002h)						
5								(LSB)
6	Flags (0000000b)							
7	Reserved							
8	Flags (00000b)					Diag. Blocked	Reserved	Error
9	Reserved							
10	Thermal Reading (units of ^{o}C) [a] (Value read by sensor)							
11	Reserved							
12	Full-Height Drives: Warning Threshold (units of ^{o}C) [a] - drive raises on alert							
	Half-Height Drives: Fan Start Temperature (units of ^{o}C) [a]							
13	Reserved							
14	Fencing Threshold (units of ^{o}C) [a] - operations fenced							
15	Reserved							
16	Fencing Removal Threshold (units of ^{o}C) [a] - remove operation fence							
17	Reserved							

[a] A value of 00h indicates the value is not applicable
[b] How to determine if a drive is a Full-Height drive or Half-Height drive is shown in Table 26, “Product Identification Table,” on page 75.

6.1.14 Diag - 2002h: Reset Drive

This diagnostic aborts all current drive operations and restarts the functional microcode. This reset is equivalent to a power on reset (see SEND DIAGNOSTIC - 1Dh (see 5.2.31 on page 142) and RECEIVE DIAGNOSTIC RESULTS - 1Ch (see 5.2.19 on page 112) for additional information on the commands).

6.1.14.1 SendDiag Parm Data - Reset Drive

Table 131 shows the parameter data for the Send Diagnostic command.

Table 131 — SendDiag Parm Data - Reset Drive

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	Page Code (80h)							
1	Reserved (00h)							
2	(MSB)	Page Length (0004h)						
3								(LSB)
4	(MSB)	Diagnostic ID (2002h)						
5								(LSB)
6	Flags (0000000b)							Cartridge Required (0b)
7	Reserved (00h)							

6.1.14.2 RcvDiag Command - Reset Drive

There are no diagnostic results for this function.

6.1.15 Cryptographic Diagnostics

The cryptographic diagnostics are specified in the Encryption version of the SCSI Reference.

6.2 Inquiry Vital Product Data Parameters (IP)

Inquiry vital product data parameters are returned to the Inquiry command. INQUIRY - 12h (see 5.2.4 on page 72) describes how to request these pages.

6.2.1 IP 00h: Supported Vital Product Data Pages

INQUIRY - 12h (see 5.2.4 on page 72) describes how to request this pages. The following parameters apply to this request:

- EVPD (Enable Vital Product Data): 1b
- Page Code: 00h
- Allocation Length: 0Ah

6.2.1.1 Returned Data - Inquiry Page 00h: Supported Inquiry Pages

The Supported Vital Product Data Page contains pages that the device will return.:

Table 132 — Table 14. Supported Vital Product Data Inquiry Page

Byte	Bit							
	7	6	5	4	3	2	1	0
0	Peripheral Qualifier (000b)			Peripheral Device Type (01h)				
1	Page Code (00h)							
2	Reserved							
3	Page Length (n-3)							
	Supported VPD page list							
4	VPD Page Code [first]							
	⋮							
n	VPD Page Code [last]							

Byte Description

0 Peripheral Data

Bit	Description
7-5	Peripheral Qualifier: 000b
4-0	Peripheral Device Type: 01h

1 Page Code: 00h

2 Reserved

3 Page Length (n-3)

4-n Supported VPD pages: This field is a list of 1-byte long page codes and may include some or all of the following:

Code	Inquiry Page
00h	IP 00h: Supported Vital Product Data Pages (see 6.2.1 on page 190)
03h	IP 03h: Firmware Designation (see 6.2.2 on page 192)
80h	IP 80h: Unit Serial Number (see 6.2.3 on page 194)
83h	IP 83h: Device Identification (see 6.2.4 on page 195)
86h	IP 86h: Extended INQUIRY Data (see 6.2.5 on page 201)
87h	IP 87h: Mode Page Policy (see 6.2.6 on page 204)
88h	IP 88h: SCSI ports (see 6.2.7 on page 207)
90h	IP 90h: Protocol-Specific Logical Unit Information (see 6.2.8 on page 209)
B0h	IP B0h - Sequential-Access device capabilities (see 6.2.9 on page 211)
C0h	IP C0h: Drive Component Revision Levels (see 6.2.10 on page 212)
C1h	IP C1h: Drive Serial Numbers (see 6.2.11 on page 214)
C7h	IP C7h: Device Unique Configuration Data (see 6.2.12 on page 215)
C8h	IP C8h: Mode Parameter Default Settings (see 6.2.13 on page 216)
E0-EF	Vendor-Reserved (Attachment Specification Information)

NOTE 28 - Only those drives that have the AS/400® (iSeries®) attachment enabled will have valid data in pages E0h/E1h. The contents of pages E0h/E1h are not specified in this document.

NOTE 29 - OEM drives may add pages not specified in this document.

6.2.2 IP 03h: Firmware Designation

INQUIRY - 12h (see 5.2.4 on page 72) describes how to request this pages. The following parameters apply to this request:

- EVPD (Enable Vital Product Data): 1b
- Page Code: 03h
- Allocation Length: 25h (37) bytes available

6.2.2.1 Returned Data - IP 03h: Firmware Designation

The Firmware Designation Page is used to identify which code image may be downloaded to which drive. See Firmware Download for Firmware Download procedures.

Table 133 — Firmware Designation Page

Byte	Bit							
	7	6	5	4	3	2	1	0
0	PERIPHERAL QUALIFIER (000b)			PERIPHERAL DEVICE TYPE (01h)				
1	PAGE CODE (03h)							
2	Reserved							
3	PAGE LENGTH (21h)							
4	ASCII LENGTH (00h)							
5 to 7	Reserved							
8 to 11	LOAD ID (Identifies downloadable firmware with the drive level hardware)							
12 to 15	FIRMWARE REVISION LEVEL (Defined in Standard Inquiry Data, bytes 32-35)							
16 to 19	PTF NUMBER (00000000h)							
20 to 23	PATCH NUMBER (00000000h)							
24 to 31	RU NAME (8-byte EBCDIC representation of the RU name.)							
32 to 36	LIBRARY SEQUENCE NUMBER							

The Load ID and RU Name and which drive level hardware they designate are defined in Table 397.

Byte	Description
0	Peripheral Data **Bit** **Description** 7-5 PERIPHERAL QUALIFIER: 000b 4-0 PERIPHERAL DEVICE TYPE: 01h
1	PAGE CODE: 03h
2	Reserved
3	PAGE LENGTH: 21h
4	ASCII LENGTH: 00h

5-7 Reserved

8-11 LOAD ID

The Load ID of ROM microcode, represented by eight hex characters, is used to determine if the microcode to be downloaded is compatible with the device electronics. This value can be used to compare with bytes 8-11 in the firmware image file to insure that the microcode level is intended for this device type and model.

12-15 FIRMWARE REVISION LEVEL

The FIRMWARE REVISION LEVEL of the device microcode, represented with four ASCII characters, is used to determine if the latest level of microcode is downloaded. As each change is implemented, the firmware revision level chosen must be numerically larger than any previous firmware revision level used, as determined by converting the ASCII characters to numerical format and subtracting. For example, if the old FIRMWARE REVISION LEVEL is ASCII '032C', and the new FIRMWARE REVISION LEVEL is ASCII '03B1', that is equivalent to 3033323Ch and 30333B31h, respectively. When the two values are compared numerically, the new FIRMWARE REVISION LEVEL is greater than the old FIRMWARE REVISION LEVEL, which satisfies the requirement.

16-19 PTF NUMBER: (unsupported)

21-23 PATCH NUMBER: (unsupported)

24-31 RU NAME

Used by the attaching system. This is an 8-byte EBCDIC field that is incremented each time the LOAD ID is incremented. This value can be compared with bytes 24-31 in the microcode image file to insure that the microcode level is intended for this device type and model.

32-36 LIBRARY SEQUENCE NUMBER (in ASCII): If this field is emptry it is filled in with ASCII NULL.

6.2.3 IP 80h: Unit Serial Number

INQUIRY - 12h (see 5.2.4 on page 72) describes how to request this pages. The following parameters apply to this request:

- EVPD (Enable Vital Product Data): 1b
- Page Code: 80h
- Allocation Length: 10h (16) bytes available

6.2.3.1 Returned Data - IP 80h: Unit Serial Number

For a LUN that is associated with an installed device (see 5.1) the following data is returned:

Table 134 — Table 27. Unit Serial Number Inquiry Page

Byte	Bit						
	7	6	5	4	3	2	1
0	PERIPHERAL QUALIFIER (000b)			PERIPHERAL DEVICE TYPE (01h)			
1	PAGE CODE (80h)						
2	Reserved						
3	PAGE LENGTH (0Ah)						
4	UNIT SERIAL NUMBER						
13							

Byte Description

0 Peripheral Data

Bit	Description
7-5	PERIPHERAL QUALIFIER: 000b
4-0	PERIPHERAL DEVICE TYPE: 01h

1 PAGE CODE: 80h

2 Reserved

3 PAGE LENGTH: 0Ah

4-13 UNIT SERIAL NUMBER: Serial number of device, right-justified with leading zeroes, in ASCII.
Valid Serial Number values are 0 through 9, A through D, and F. On eServer enabled drives this is the last 10 characters of the 11S identifier

6.2.4 IP 83h: Device Identification

INQUIRY - 12h (see 5.2.4 on page 72) describes how to request this pages. The following parameters apply to this request:

- EVPD (Enable Vital Product Data): 1b
- Page Code: 83h
- Allocation Length: 60h (96) bytes available

6.2.4.1 Returned Data - Inquiry Page 83h: Device Identification

The Device Identification VPD page (see table 135) provides the means to retrieve designation descriptors applying to the logical unit. For a LUN that is associated with an installed device (see 5.1) the following data is returned:

Table 135 — Device Identification VPD page

Byte	Bit							
	7	6	5	4	3	2	1	0
0	PERIPHERAL QUALIFIER			PERIPHERAL DEVICE TYPE				
1	PAGE CODE (83h)							
2	(MSB)			PAGE LENGTH (n-3)				
3								(LSB)
	Designation descriptor list							
4	T10 vendor ID based designation descriptor							
41								
42	Logical Unit (NAA) - WWNN designation descriptor							
53								
54	Relative target port identifier designation descriptor							
61								
62	Port Name (NAA) - WWPN designation descriptor							
73								
74	Target Device Name (NAA) designation descriptor (SAS only)							
83								

Each designation descriptor contains information identifying the logical unit, SCSI target device containing the logical unit, or access path (i.e., target port) used by the command and returned parameter data

Byte **Description**

0 Peripheral Data

Bit	Description
7-5	Peripheral Qualifier: 000b
4-0	Peripheral Device Type: 01h

1 Page Code: 83h

2 Reserved

3 Page Length:

Value	Interface type
46h	Fibre Channel attached drives
50h	SAS attached drives

4-41 T10 vendor ID based designation descriptor (see 6.2.4.1.1)

42-53 Logical Unit (NAA) - WWNN designation descriptor (see 6.2.4.1.2)
54-61 Relative target port identifier designation descriptor (see 6.2.4.1.3)
62-73 Port Name (NAA) - WWPN designation descriptor (see 6.2.4.1.4)
74-83 Target Device Name (NAA) designation descriptor (SAS only) (see 6.2.4.1.5)

6.2.4.1.1 T10 vendor ID designation descriptor

Table 136 — T10 vendor ID based designation descriptor

Byte		Bit							
page	desc	7	6	5	4	3	2	1	0
4	0	PROTOCOL IDENTIFIER				CODE SET			
5	1	PIV	Reserved	ASSOCIATION		DESIGNATOR TYPE			
6	2	Reserved							
7	3	DESIGNATOR LENGTH (1Eh)							
8	4	VENDOR IDENTIFICATION							
15	11								
16	12	PRODUCT IDENTIFICATION							
31	27								
32	28	SERIAL NUMBER							
41	37								

Byte Description

4 Device ID (T10 vendor ID)

Bit	Description
7-4	PROTOCOL IDENTIFIER: 0h
3-0	CODE SET: 2h

Descriptor contains ASCII printable characters (i.e., code values 20h to 7Eh).

5

Bit	Description
7	PIV - Protocol Identifier Valid: 0h
6	Reserved
5-4	ASSOCIATION: 00b
3-0	DESIGNATOR TYPE: 1h

6 Reserved
7 DESIGNATOR LENGTH: 1Eh
8-15 VENDOR IDENTIFICATION (same as Inquiry Standard Data bytes 8-15)
16-31 PRODUCT IDENTIFICATION (same as Inquiry Standard Data bytes 16-31)
32-41 SERIAL NUMBER (same as the serial number reported in the Unit serial number page bytes 4-13)

6.2.4.1.2 Logical Unit (NAA) - WWNN designation descriptor

Table 137 — Logical Unit (NAA) - WWNN designation descriptor

Byte		Bit							
page	desc	7	6	5	4	3	2	1	0
42	0	PROTOCOL IDENTIFIER				CODE SET			
43	1	PIV	Reserved	ASSOCIATION		DESIGNATOR TYPE			
44	2	Reserved							
45	3	DESIGNATOR LENGTH (n-3)							
46	4	WORLD WIDE NODE NAME (WWNN)							
53	11								

Byte Description

42

Bit	Description
7-4	PROTOCOL IDENTIFIER: 0h
3-0	CODE SET: 1h

Descriptor contains binary values.

43

Bit	Description
7	PIV - Protocol Identifier Valid: 0h
6	Reserved
5-4	ASSOCIATION: 00b
3-0	DESIGNATOR TYPE: 3h

44 Reserved

45 Identifier Length: 8h

46-53 World Wide Node Name

6.2.4.1.3 Relative target port identifier designation descriptor

Table 138 — Relative target port identifier designation descriptor

Byte		Bit							
page	desc	7	6	5	4	3	2	1	0
54	0	PROTOCOL IDENTIFIER				CODE SET			
55	1	PIV	Reserved	ASSOCIATION		DESIGNATOR TYPE			
56	2	Reserved							
57	3	DESIGNATOR LENGTH (n-3)							
58	4	Reserved							
59	5								
60	6	RELATIVE TARGET PORT							
61	7								

Byte Description

54

Bit	Description
7-4	PROTOCOL IDENTIFIER
3-0	CODE SET: 1h

Descriptor contains binary values.

55

Bit	Description
7	PIV - Protocol Identifier Valid: 1h
6	Reserved
5-4	ASSOCIATION: 01b
3-0	DESIGNATOR TYPE: 4h

56 Reserved

57 Identifier Length: 4h

58-59 Reserved

60-61 Port Identifier

Value	Description
0001h	Fibre/SAS port 0
0002h	Fibre/SAS port 1
0003h	RS-422 (ADI)

NOTE 30 - This relates to the port on which the Inquiry command was received.

6.2.4.1.4 Port Name (NAA) - WWPN designation descriptor

Table 139 — Port Name (NAA) - WWPN designation descriptor

Byte		Bit							
page	desc	7	6	5	4	3	2	1	0
62	0	PROTOCOL IDENTIFIER				CODE SET			
63	1	PIV	Reserved	ASSOCIATION		DESIGNATOR TYPE			
64	2	Reserved							
65	3	DESIGNATOR LENGTH (n-3)							
66	4	WORLD WIDE PORT NAME (WWPN)							
73	11								

Byte Description

62

Bit	Description
7-4	PROTOCOL IDENTIFIER
3-0	CODE SET: 1h

Descriptor contains binary values.

63

Bit	Description
7	PIV - Protocol Identifier Valid: 1h
6	Reserved
5-4	ASSOCIATION: 01b
3-0	DESIGNATOR TYPE: 3h

64 Reserved

65 DESIGNATOR LENGTH: 8h

66-73 WORLD WIDE PORT NAME

6.2.4.1.5 Target Device Name (NAA) designation descriptor (SAS only)

Table 140 — Target Device Name (NAA) designation descriptor (SAS only)

Byte		Bit							
page	desc	7	6	5	4	3	2	1	0
74	0	PROTOCOL IDENTIFIER				CODE SET			
75	1	PIV	Reserved	ASSOCIATION		DESIGNATOR TYPE			
76	2	Reserved							
77	3	DESIGNATOR LENGTH (n-3)							
78	4	SAS ADDRESS OF DRIVE							
83	11								

Byte Description

74

Bit	Description
7-4	PROTOCOL IDENTIFIER
3-0	CODE SET: 1h

Descriptor contains binary values.

75

Bit	Description
7	PIV - Protocol Identifier Valid: 1h
6	Reserved
5-4	ASSOCIATION: 10b
3-0	DESIGNATOR TYPE: 3h

76 Reserved

77 DESIGNATOR LENGTH: 8h

78-83 SAS ADDRESS OF DRIVE - This is in NAA IEEE Registered format and is the same as the World Wide Node Name (WWNN) of LUN 0

6.2.5 IP 86h: Extended INQUIRY Data

The Extended INQUIRY Data VPD page (see table 141) provides the application client with a means to obtain information about the logical unit.

Table 141 — Extended INQUIRY Data VPD page

Byte	Bit							
	7	6	5	4	3	2	1	0
0	PERIPHERAL QUALIFIER (000b)			PERIPHERAL DEVICE TYPE (01h)				
1	PAGE CODE (86h)							
2	Reserved							
3	PAGE LENGTH (3Ch)							
4	ACTIVATE MICROCODE		SPT			GRD_CHK (0b)	APP_CHK (0b)	REF_CHK (0b)
5	Reserved		UASK_SUP (0b)	GROUP_SUP (0b)	PRIOR_SUP (0b)	HEADSUP (0b)	ORDSUP (0b)	SIMPSUP (1b)
6	Reserved				WU_SUP (0b)	CRD_SUP (0b)	NV_SUP (0b)	V_SUP (0b)
7	Reserved			P_I_I_SUP (0b)	Reserved			LUICLR (0b)
8	Reserved			R_SUP (0b)	Reserved			CBCS (0b)
9	Reserved				MULTI I_T NEXUS MICROCODE DOWNLOAD			
10	Reserved							
63								

The following data is returned.

Byte Description

0

Bit	Description
7-5	PERIPHERAL QUALIFIER: 000b
4-0	PERIPHERAL DEVICE TYPE: 01h (Sequential Access Device)

1 PAGE CODE (86h)

2 Reserved

3 PAGE LENGTH (3Ch)

4

Bit	Description
7-6	ACTIVATE MICROCODE (00b) The ACTIVATE MICROCODE field indicates how the device server activates microcode and establishes a unit attention condition when a WRITE BUFFER command (see 5.2.39) with the download microcode mode set to 05h or 07h is processed. **Value** **Description** 00b The actions of the device server may or may not be as defined for values 01b or 10b. 01b-10b Not supported 11b Reserved
5-3	SPT A supported protection type (SPT) field indicates the type of protection the logical unit supports. The SPT field is reserved if the PROTECT bit in Standard Inquiry Data (see 5.2.4.1 on page 72) is set to zero. **Value** **Protection type supported** 001b Logical block protection: others Reserved
2	GRD_CHK (0b)
1	APP_CHK (0b)
0	REF_CHK (0b)

5

Bit	Description
7-6	Reserved
5	UASK_SUP (0b)
4	GROUP_SUP (0b)
3	PRIOR_SUP (0b)
2	HEADSUP (0b)
1	ORDSUP (0b)
0	SIMPSUP (1b) - The device server supports simple queing.

6

Bit	Description
7-4	Reserved
3	WU_SUP (0b)
2	CRD_SUP (0b)
1	NV_SUP (0b)
0	V_SUP (0b)

7

Bit	Description
7-4	Reserved
3	P_I_I_SUP (0b)
2-1	Reserved
0	LUICLR (0b)

8

Bit	Description
7-4	Reserved
3	R_SUP (0b)
2-1	Reserved
0	CBCS (0b)

9

Bit	Description
7-4	Reserved
3-0	MULTI I_T NEXUS MICROCODE DOWNLOAD (0b)

The MULTI I_T NEXUS MICROCODE DOWNLOAD field indicates how the device server handles concurrent attempts to download microcode using the WRITE BUFFER command (see 5.2.38) from multiple I_T nexuses.

Value	Description
0h	The handling of concurrent WRITE BUFFER download microcode operations from multiple I_T nexus is vendor specific.
1h-3h	Not Supported
4h-Fh	Reserved.

10-63 Reserved

6.2.6 IP 87h: Mode Page Policy

The Mode Page Policy Page (see table 142) indicates which mode page policy is in effect for each mode page supported by the logical unit.

INQUIRY - 12h (see 5.2.4 on page 72) describes how to request this pages. The following parameters apply to this request:

- EVPD (Enable Vital Product Data): 1b
- Page Code: 87h
- Allocation Length:

6.2.6.1 Returned Data - IP 87h: Mode Page Policy

The data returned is shown in table 142.

Table 142 — Mode Page Policy page

Byte	Bit							
	7	6	5	4	3	2	1	0
0	Peripheral Qualifier (000b)			Peripheral Device Type (01h)				
1	Page Code (87h)							
2	(MSB)			Page Length (n-3)				
3								(LSB)
	Mode page policy descriptor list							
4				Mode page policy descriptor (first)				
7								
	⋮							
n-3				Mode page policy descriptor (last)				
n								

Each mode page policy descriptor (see table 143) contains information describing the mode page policy for one or more mode pages or subpages. The information in the mode page policy descriptors in this page describe the mode page policy for every mode page and subpage supported by the logical unit.

Table 143 — Mode page policy descriptor

Byte	Bit							
	7	6	5	4	3	2	1	0
0	Reserved		policy page code					
1	policy subpage code							
2	mlus	Reserved						mode page policy
3	Reserved							

The Policy Page Code field and Policy Subpage Code field indicate the mode page and subpage to which the descriptor applies.

The first mode page policy descriptor in the list contains a Policy Page Code field set to 3Fh and a Policy Subpage Code field set to FFh, indicating that the descriptor applies to all mode pages and subpages not described by other mode page policy descriptors. The Policy Page Code field is set to 3Fh and the policy Subpage Code field is set to FFh only in the first mode page policy descriptor in the list.

If the Policy Page Code field contains a value other than 3Fh or a policy Subpage Code field contains a value other than FFh, then the Policy Page Code field and the Policy Subpage Code field indicate a single mode page and a subpage to which the descriptor applies.

A Multiple Logical Units Share (MLUS) bit set to 1 indicates the mode page and subpage identified by the Policy Page Code field and policy Subpage Code field is shared by more than one logical unit. An MLUS bit set to zero indicates the logical unit maintains its own copy of the mode page and subpage identified by the Policy Page Code field and Policy Subpage Code field. The MLUS values are described in table 145.

The Mode Page policy field (see table 144) indicates the mode page policy for the mode page and subpage identified by the Policy Page Code field and policy Subpage Code field. The mode page policies are described in table 145

Table 144 — MODE PAGE POLICY field

Code	Description
00b	Shared
01b	Per target port
10b	Obsolete
11b	Per I_T nexus

Table 145 — Mode Page Policy for LUN 0 (SSC Device)

Page Name	Page Code	Subpage Code	MLUS	Mode Page Policy
Read-Write Error Recovery	01h	00h	0	Shared (00b)
Disconnect/Reconnect	02h	00h	1	Per I_T nexus (11b)
Control	0Ah	00h	0	Per I_T nexus (11b)
Control Extension	0Ah	01h	1	Shared (00b)
Data Compression	0Fh	00h	0	Shared (00b)
Sequential Access Device Configuration	10h	00h	0	Shared (00b)
Medium Partition	11h	00h	0	Shared (00b)
Protocol Specific Logical Unit Control	18h	00h	0	Per I_T nexus (11b)
Protocol Specific Port Control	19h	00h	1	Per target port (01b)
Power Condition	1Ah	00h	0	Shared (00b)
Information Exceptions	1Ch	00h	0	Shared (00b)
Medium Configuration	1Dh	00h	0	Shared (00b)
Vendor-Specific	24h	00h	0	Shared (00b)
Behavior Configuration	2Fh	00h	0	Shared (00b)
Directory Listing - Device Attribute Settings	30h	00h	0	Shared (00b)
Drive MAC address - Device attribute settings	30h	01h	0	Shared (00b)
Drive IP address and subnet mask - Device attribute settings	30h	02h	0	Shared (00b)
Key manager IP address information - Device attribute settings	30h	03h	0	Shared (00b)

Table 145 — Mode Page Policy for LUN 0 (SSC Device)

Page Name	Page Code	Subpage Code	MLUS	Mode Page Policy
Encryption mode - Device Attribute Settings	30h	20h	0	Shared (00b)
SkipSync - Device attribute settings	30h	40h		
End of partition behavior control - Device attribute settings	30h	42h	0	Shared (00b)
Engineering Support	3Eh	00h	0	Shared (00b)

For LUN 0, this would lead to returning a Mode Page Policy Descriptor of page 3Fh and subpage FFh stating MLUS (0) and Mode Page Policy (000b - Shared). This would be followed by descriptors for the Disconnect/Reconnect Page, the Control Extension Page, the Protocol Specific Logical Unit Control Page, and the Protocol Specific Port Control Page.

6.2.7 IP 88h: SCSI ports

The SCSI Ports Inquiry page (see table 146) provides a means to retrieve identification descriptors for all the SCSI ports in the drive.

INQUIRY - 12h (see 5.2.4 on page 72) describes how to request this pages. The following parameters apply to this request:

- EVPD (Enable Vital Product Data): 1b
- Page Code: 88h
- Allocation Length:

6.2.7.1 Returned Data - IP 88h: SCSI ports

The SCSI ports page is shown in table 146.

Table 146 — SCSI Ports VPD page

Byte	Bit							
	7	6	5	4	3	2	1	0
0	peripheral qualifier (000b)			peripheral device type (01h)				
1	PAGE CODE (88h)							
2	(MSB)			PAGE LENGTH (n-3)				
3								(LSB)
	Designation descriptor list							
4				SCSI port designation descriptor [first] (see table 147)				
	. . .							
				SCSI port designation descriptor [last] (see table 147)				
n								

Each SCSI Port designation descriptor (see table 147) identifies a SCSI port. The SCSI port designation descriptors may be returned in any order. There will be one SCSI port designation descriptor for each port in the drive.

Table 147 — SCSI port designation descriptor

Byte	Bit							
	7	6	5	4	3	2	1	0
0	Reserved							
1								
2	(MSB)							
3	RELATIVE PORT IDENTIFIER							(LSB)
4	Reserved							
5								
6	(MSB)							
7	INITIATOR PORT TRANSPORTID LENGTH (0)							(LSB)
8	Reserved							
9								
10	(MSB)							
11	TARGET PORT DESCRIPTORS LENGTH (n-11)							(LSB)
	Target port descriptor list							
12	Target port descriptor [first] (see table 148)							
	.							
	.							
	.							
	Target port descriptor [last] (see table 148)							
n								

Table 148 — Target port descriptor

Byte	Bit							
	7	6	5	4	3	2	1	0
0	PROTOCOL IDENTIFIER				CODE SET (1h)			
1	PIV (1b)	Reserved	ASSOCIATION (01b)		DESIGNATOR TYPE (3h)			
2	Reserved							
3	DESIGNATOR LENGTH (8)							
4	WORLD WIDE PORT NAME (WWPN)							
11								

The PROTOCOL IDENTIFIER value is 0h on Fibre Channel devices and 6h on SAS devices.

6.2.8 IP 90h: Protocol-Specific Logical Unit Information

The Protocol-Specific Logical Unit Information VPD page is returned on LUN 0 of SAS attached devices that support changing the TLR control field in the frame header and contains parameters for logical unit 0 that are protocol-specific based on the I_T nexus being used to access the logical unit.

INQUIRY - 12h (see 5.2.4 on page 72) describes how to request this pages. The following parameters apply to this request:

- EVPD (Enable Vital Product Data): 1b
- Page Code: 90h
- Allocation Length: 16 (10h)

6.2.8.1 Returned Data - IP 88h: SCSI ports

Table 149 defines the Protocol-Specific Logical Unit Information VPD page for logical units with SAS target ports.

Table 149 — Protocol-Specific Logical Unit Information VPD page for SAS SSP

Byte	Bit							
	7	6	5	4	3	2	1	0
0	PERIPHERAL QUALIFIER (000b)			PERIPHERAL DEVICE TYPE (01h)				
1	PAGE CODE (90h)							
2	(MSB)	PAGE LENGTH (0Ch)						
3								(LSB)
Logical unit information descriptor list								
4	Logical unit information descriptor (first)(see table 150)							
15								
16	Logical unit information descriptor (second)(see table 150)							
27								

The fields are defined as follows:

Byte **Description**

0 Peripheral Data

Bit	Description
7-5	PERIPHERAL QUALIFIER: 000b
4-0	PERIPHERAL DEVICE TYPE: 01h

1 PAGE CODE: 90h

2-3 Page Length: 0Ch

4-27 Logical unit information descriptor list: The logical unit information descriptor list contains a logical unit information descriptor for each SAS target port known to the device server Logical unit information descriptor (see 6.2.8.2 on page 210).

6.2.8.2 Logical unit information descriptor

Table 150 defines the logical unit information descriptor for logical units with SAS target ports.

Table 150 — Logical unit information descriptor for SAS SSP

Byte	Bit							
	7	6	5	4	3	2	1	0
0	(MSB)			RELATIVE PORT IDENTIFIER				
1								(LSB)
2	Reserved				PROTOCOL IDENTIFIER (6h)			
3				Reserved				
5								
6	(MSB)			DESCRIPTOR LENGTH (0004h)				
7								(LSB)
Per logical unit SCSI transport specific data								
8	Reserved							TLR CTL SUP
9				Reserved				
11								

The fields are defined as follows:

Byte **Description**

0-1 RELATIVE PORT IDENTIFIER: The Relative Target Port from the IP 83h: Device Identification (see 6.2.4 on page 195).

2

Bit	Description
7-4	Reserved
3-0	PROTOCOL IDENTIFIER: 06h (i.e. SAS SSP specific descriptor)

3-5 Reserved

6-7 DESCRIPTOR LENGTH: 0004h

8

Bit	Description
7-1	Reserved
0	TLR CTL SUP (TLR Control Supported):

Value	Description
0b	The combination of the SCSI target port and logical unit do not support the TLR CONTROL field in the SSP frame header.
1b	The combination of the SCSI target port and logical unit support the TLR CONTROL field in the SSP frame header.

9-11 Reserved

6.2.9 IP B0h - Sequential-Access device capabilities

INQUIRY - 12h (see 5.2.4 on page 72) describes how to request this pages. The following parameters apply to this request:

- EVPD (Enable Vital Product Data): 1b
- Page Code: B0h
- Allocation Length: 06h bytes available

6.2.9.1 Returned Data - IP B0h: Sequential-Access device capabilities

For LUN 0, the following data is returned:This page provides the application client with the means to determine if the features specified in this page are supported by the drive.

Table 151 — Table 23. Sequential-Access Device Capabilities Page

Byte	Bit							
	7	6	5	4	3	2	1	0
0	Peripheral Qualifier (000b)			Peripheral Device Type (01h)				
1	Page Code (B0h)							
2	Page Length (2)							
3								
4	Reserved							WORM
5	Reserved							

If the write once read many (WORM) bit is set to one, the device server supports WORM mode operation (see 4.2.24.3). If the WORM bit is set to zero, the device server does not support WORM mode operation.

6.2.10 IP C0h: Drive Component Revision Levels

INQUIRY - 12h (see 5.2.4 on page 72) describes how to request this pages. The following parameters apply to this request:

- EVPD (Enable Vital Product Data): 1b
- Page Code: C0h
- Allocation Length: 43(2Bh) bytes available

6.2.10.1 Returned Data - IP C0h: Drive Component Revision Levels

For LUN 0, the following data is returned:

Table 152 — IP C0h: Drive Component Revision Levels

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	PERIPHERAL QUALIFIER (000b)			PERIPHERAL DEVICE TYPE (01h)				
1	PAGE CODE (C0h)							
2	Reserved							
3	PAGE LENGTH (27h)							
4	CODE NAME							
15								
16	TIME(HHMMSS)							
22								
23	DATE (YYYYMMDD)							
30								
31	PLATFORM							
42								

Byte Description

0 Peripheral Data

Bit	Description
7-5	Peripheral Qualifier: 000b
4-0	Peripheral Device Type: 01h

1 Page Code: C0h

2 Reserved

3 Page Length: 27h

4-15 CODE NAME - The code name definition is not published.

16-22 TIME - Time the code was built in HHMMSS format with a trailing NULL (i.e., 00h). Prior to May 2010, this field was set to ASCII zeros (i.e., 30h)

23-30 DATE - The date the code was built.

31-42 PLATFORM - ASCII characters containing the <protocol>_<package>[_<variant>] for the drive. This is left-aligned with ASCII spaces padded at the end. This is set to ASCII zeros on Ultrium drive platforms released prior to May 2010.

Table 153 — PLATFORM definition

Symbol	Description	
<protocol>	**Value**	**Transport Protocol**
	sas	Serial Attached SCSI (SAS)
	fcp	Fibre Channel (FC)
<package>	**Value**	**Type**
	fh	Full height
	hh	Half height
	hl	Half height V2
<variant>	**Value**	**Type**
	f	FIPS

6.2.11 IP C1h: Drive Serial Numbers

INQUIRY - 12h (see 5.2.4 on page 72) describes how to request this pages. The following parameters apply to this request:

- EVPD (Enable Vital Product Data): 1b
- Page Code: C1h
- Allocation Length: 1Ch (28) bytes available

6.2.11.1 Returned Data - IP C1h: Drive Serial Numbers

For LUN 0, the following data is returned:

Table 154 — Inquiry Page C1h: Drive Serial Numbers

Byte	Bit							
	7	6	5	4	3	2	1	0
0	Peripheral Qualifier (000b)			Peripheral Device Type (01h)				
1	Page Code (C1h)							
2	Reserved							
3	Page Length (18h)							
4	Manufacturing Serial Number							
15								
16	Reported Serial Number							
27								

Byte Description

0 Peripheral Data

Bit	Description
7-5	Peripheral Qualifier: 000b
4-0	Peripheral Device Type: 01h

1 Page Code: C1h

2 Reserved

3 Page Length: 18h

4-15 Manufacturing Serial Number (set at time of manufacture), right-justified with leading zeroes, in ASCII

16-27 Reported Serial Number over the primary interface (e.g. Inquiry pages 80h and 83h), right-justified with leading zeroes, in ASCII

6.2.12 IP C7h: Device Unique Configuration Data

This page provides data required by IBM eServers for connection to the drive.

INQUIRY - 12h (see 5.2.4 on page 72) describes how to request this pages. The following parameters apply to this request:

- EVPD (Enable Vital Product Data): 1b
- Page Code: C7h
- Allocation Length: 117 (75h) bytes available

6.2.12.1 Returned Data - IP C7h: Device Unique Configuration Data

The Device Unique Configuration Data Page is supported on IBM eServer capable drives only. On drives that are not eServer capable this page will be returned with all zero data.

6.2.13 IP C8h: Mode Parameter Default Settings

This page provides data required by IBM eServers for connection to the drive.

INQUIRY - 12h (see 5.2.4 on page 72) describes how to request this pages. The following parameters apply to this request:

- EVPD (Enable Vital Product Data): 1b
- Page Code: C8h
- Allocation Length: 51 (33h) bytes available

6.2.13.1 Returned Data - IP C8h: Mode Parameter Default Settings

The Mode Parameter Default Settings page is supported on IBM eServer capable drives only. On drives that are not eServer capable this page will be returned with all zero data. For LUN 0, the following data is returned on eServer capable drives only.

6.3 Log Parameters (LP)

Log parameters are used in relation to LOG SELECT - 4Ch (see 5.2.7 on page 82) commands and LOG SENSE - 4Dh (see 5.2.8 on page 83) commands.

Index Of Counters (log parameters not in counter format are not included) (see on page 423) provides an alphabetized list of all counter type log parameters and may be useful in finding parameters that provide the information desired.

6.3.1 Log Page Format

Each log page begins with a four-byte page header followed by zero or more variable-length log parameters defined for that log page. The log page format is defined in table 155.

Table 155 — Log page format

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	DS	SPF	PAGE CODE					
1	SUBPAGE CODE							
2	(MSB)	PAGE LENGTH (n-3)						
3								(LSB)
	Log parameter(s) (see 6.3.2)							
4	Log parameter (First)							
	.							
	.							
	Log parameter (Last)							
n								

If the SPF bit is set to 0 then the Subpage Code field is reserved and is set to zero. If the SPF bit is set to one, then the subpage format is being used and the Subpage Code field is used to determine which log parameters are to be returned.

6.3.2 Log Parameter Format

Each log parameter begins with a 4-byte parameter header, followed by 1 or more bytes of parameter data. Table 156 shows the log parameter format. The fields of byte 2 are described under clause 6.3.2.1.

Table 156 — Log Parameter Format

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	MSB	PARAMETER CODE						
1								LSB
2	DU	DS	TSD	ETC	TMC		Rsvd	LP
3	PARAMETER LENGTH (n-3)							
4	MSB	Parameter Value						
n								LSB

6.3.2.1 Log Parameter Byte 2 — Control Byte

A Log Parameter Control Byte is returned for each parameter code described in the log pages. The Log Parameter Control Byte is described here one time only. Any parameters using a different Log Parameter Control Byte have that byte described within that parameter.

The contents of this byte are constant; the user cannot set these values. This byte is part of the returned data described in the SCSI standard; it is described in the following list:

Bit	Description
7	DU (Disable Update): 0b
6	DS (Disable Save): 1b
5	TSD (Target Save Disable): 1b
4	ETC (Enable Threshold Comparison): 0b
3-2	TMC (Threshold Met Comparison): 00b
1	Rsvd (Reserved)
0	LP (List Parameter): 0b (indicates this is a log counter)

6.3.3 General Log Parameter Reset Behavior

Unless otherwise specified, each log counter is reset when read by the Log Sense command. Specific exceptions include Pages 30h, 37h, and 3Dh. Several pages have values which are reset at load time, as specified.

WARNING WARNING

The parameters in log pages should be dynamically parsed as some parameters may not be present and new parameters may be insterted. The relative location of parameters have changed and are anticipated to continue to change.

WARNING WARNING

6.3.4 LP 00h: Supported Log Pages

See LOG SELECT - 4Ch (see 5.2.7 on page 82) and LOG SENSE - 4Dh (see 5.2.8 on page 83) for directions on how to use this page. This log page returns the list of log pages supported. There may be log pages which can be read or reset which are not included in this list. Such pages are for engineering or manufacturing use and are not intended for general use. This page does not contain any log parameters.

6.3.4.1 Parameter Reset Behavior (00h)

This data can be neither reset nor written.

6.3.4.2 Parameter Definitions (00h)

Byte	Description
0	**Bit** **Description** 7-6 Reserved 5-0 Page Code (000000b)
1	Reserved
2-3	Page Length (n-3)
4-n	Supported Log Pages: This field is a list of 1-byte log page codes and may include some or all of the following:

Code	Log Page
00h	LP 00h: Supported Log Pages (see 6.3.4 on page 220)
02h	LP 02h: Write Error Counters (see 6.3.5 on page 221)
03h	LP 03h: Read Error Counters (see 6.3.6 on page 222)
06h	LP 06h: Non-Medium Errors (see 6.3.7 on page 223)
0Ch	LP 0Ch: Sequential-Access Device (see 6.3.8 on page 224)
11h	LP 11h: DT Device Status (see 6.3.9 on page 226)
14h	LP 14h: Device Statistics (see 6.3.10 on page 237)
16h	LP 16h: Tape diagnostic data (see 6.3.11 on page 245)
17h	LP 17h: Volume Statistics (see 6.3.12 on page 248)
18h	LP 18h: Protocol-specific port (see 6.3.13 on page 255)
1Ah	LP 1A: Power Condition Transitions (see 6.3.15 on page 262)
1Bh	LP 1Bh: Data Compression (see 6.3.14 on page 259)
2Eh	LP 2Eh: TapeAlerts (see 6.3.16 on page 263)
30h	LP 30h: Tape Usage (see 6.3.17 on page 266)
31h	LP 31h: Tape capacity (see 6.3.18 on page 267)
32h	LP 32h: Data compression (see 6.3.19 on page 268)
33h	LP 33h: Write Errors (see 6.3.20 on page 269)
34h	LP 34h: Read Forward Errors (see 6.3.21 on page 271)
37h	LP 37h: Performance Characteristics (see 6.3.22 on page 273)
38h	LP 38h: Blocks/Bytes Transferred (see 6.3.23 on page 284)
39h	LP 39h: Host Port 0 Interface Errors (see 6.3.24 on page 286)
3Bh	LP 3Bh: Host Port 1 Interface Errors (see 6.3.26 on page 288)
3Ch	LP 3Ch: Drive usage information (see 6.3.27 on page 289)
3Dh	LP 3Dh: Subsystem Statistics (see 6.3.28 on page 291)

NOTE 31 - LP 3Ah: Drive control verification (see 6.3.25 on page 287), LP 3Eh: Engineering Use (see 6.3.29 on page 293) and LP 3Eh[3Ch]: Drive Control Statistics (see 6.3.30 on page 294) are for engineering use only and are not reported as a supported log page, but can be used with Log Sense and Log Select commands.

An Index Of Counters may be found at the end of this clause. Log parameters that are not in counter format are not included in this list.

6.3.5 LP 02h: Write Error Counters

See LOG SELECT - 4Ch (see 5.2.7 on page 82) and LOG SENSE - 4Dh (see 5.2.8 on page 83) for directions on how to use this page. This page is for Write Errors.

6.3.5.1 Parameter Reset Behavior (02h)

Parameters in this page are reset when a cartridge is loaded.

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

6.3.5.2 Parameter Definitions (02h)

Parameters 0000h through 0002h are not supported and are returned as 0000_0000h.

WARNING WARNING

The parameters in log pages should be dynamically parsed as some parameters may not be present and new parameters may be insterted. The relative location of parameters have changed and are anticipated to continue to change.

WARNING WARNING

Table 157 — LP 02h: Write Error Log Parameters

Parameter Code (in Hex)	Counter: Description	Size
0000h	Not supported	4
0001h	Not supported	4
0002h	Not supported	4
0003h	**Total Corrected Write Errors {02h:0003h}:** These errors are corrected by ECC and do not require error recovery procedures (ERPs). Each count represents one block in error that was corrected and written.	4
0004h	**Total Write Retries {02h:0004h}:**	4
0005h	**Total Write Kilobytes Processed {02h:0005h}:** Each count represents a kilobyte (1024 bytes) of data processed across the host interface during write-type commands. The count does not include ERP retries. This field is identical to the Host Write Kilobytes Processed field of Page Code 38h, parameter code 0001h.	4
0006h	**Total Uncorrected Write Errors {02h:0006h}:** The total number of write errors that could not be corrected by ECC, no servo error was reported, and the error was not a transient error. Each count represents one block in error that was not corrected, but was recovered by ERPs and successfully written.	4
8000h	Unspecified	8
8001h	Unspecified	4

6.3.6 LP 03h: Read Error Counters

See LOG SELECT - 4Ch (see 5.2.7 on page 82) and LOG SENSE - 4Dh (see 5.2.8 on page 83) for directions on how to use this page. This page is for Read Errors.

6.3.6.1 Parameter Reset Behavior (03h)

Parameters in this page are reset when a cartridge is loaded.

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

6.3.6.2 Parameter Definitions (03h)

Parameters 0000h through 0002h are not supported and are returned as 0000_0000h.

WARNING WARNING

The parameters in log pages should be dynamically parsed as some parameters may not be present and new parameters may be insterted. The relative location of parameters have changed and are anticipated to continue to change.

WARNING WARNING

Table 158 — LP 03h: Read Error Log Parameters

Parameter Code	Counter: Description	Size
0000h	Not supported	4
0001h	Not supported	4
0002h	Not supported	4
0003h	**Total Corrected Read Errors {03h:0003h}:** These are errors that are corrected by ECC and do not require error recovery procedures (ERPs). Each count represents one block in error that was corrected and read.	4
0004h	**Total Read Retries {03h:0004h}:**	4
0005h	**Total Read Kilobytes Processed {03h:0005h}:** Each count represents a kilobyte (1024 bytes) processed across the host interface during read-type commands. The count does not include ERP retries. This field is identical to the Host Read Kilobytes Processed field of Page Code 38h, parameter code 0003h.	4
0006h	**Total Uncorrected Read Errors {03h:0006h}:** The total number of read errors that could not be corrected by ECC, no servo error was reported, and the error was not a transient error. Each count represents one block in error that was not corrected, but was recovered by ERPs and successfully read.	4
8000h	Unspecified	8

6.3.7 LP 06h: Non-Medium Errors

See LOG SELECT - 4Ch (see 5.2.7 on page 82) and LOG SENSE - 4Dh (see 5.2.8 on page 83) for directions on how to use this page. This page sums the occurrences of error events other than write or read failures. Parameter codes do not discriminate among the various types of events.

6.3.7.1 Parameter Reset Behavior (06h)

Parameters in this page are never reset.

6.3.7.2 Parameter Definitions (06h)

WARNING WARNING

The parameters in log pages should be dynamically parsed as some parameters may not be present and new parameters may be insterted. The relative location of parameters have changed and are anticipated to continue to change..

WARNING WARNING

Table 159 — LP 06h: Non-Medium Errors log parameter codes

Code	Counter: Description	Size
0000h	**Total Non-Medium Error Count {06h:0000h}:**	4

6.3.8 LP 0Ch: Sequential-Access Device

See LOG SELECT - 4Ch (see 5.2.7 on page 82) and LOG SENSE - 4Dh (see 5.2.8 on page 83) for directions on how to use this page. This page is for counters specific to tape drives.

6.3.8.1 Parameter Reset Behavior (0Ch)

Parameters in this page are reset on load.

6.3.8.2 Parameter Definitions (0Ch)

WARNING WARNING

The parameters in log pages should be dynamically parsed as some parameters may not be present and new parameters may be insterted. The relative location of parameters have changed and are anticipated to continue to change.

WARNING WARNING

Table 160 — LP 0Ch: Sequential-Access Device log parameters (part 1 of 2)

Code	Counter: Description	Length
0000h	**Total Channel Write Bytes {0Ch:0000h}:** The total number of bytes of data written from the host on this mount.	8
0001h	**Total Device Write Bytes {0Ch:0001h}:** The total number of bytes of data written to tape on this mount, not counting ECC and formatting overhead. This is the number of data bytes after compression.	8
0002h	**Total Device Read Bytes {0Ch:0002h}:** The total number of bytes of data read from tape on this mount, not counting ECC and formatting overhead. This is the number of compressed data bytes read from media before decompression.	8
0003h	**Total Channel Read Bytes {0Ch:0003h}:** The total number of bytes of data read to the host on this mount.	8
0004h	**Approximate native capacity from BOP to EOD {0Ch:0004h}:** This is in megabytes (i.e., 10^6). This is not sensitive to the current position of the medium. The approximate native capacity between EOD and EW is the difference of parameter 0005h and this parameter. Conditions may occur that reduce the amount of data that is written before reaching EW. EOD may be beyond LEOP. A value of all bits set to one indicates that this information is invalid (e.g., no volume is mounted, EOD information needs to be rebuilt).	4
0005h	**Approximate native capacity between BOP and EW of the current partition {0Ch:0005h}:** This is in megabytes (i.e., 10^6). If no volume is mounted or this value is unknown the device server shall set all bits in this parameter to one.	4
0006h	**Minimum native capacity between EW and LEOP of the current partition {0Ch:0006h}:** This is in megabytes (i.e., 10^6). If no volume is mounted the device server shall set all bits in this parameter to one.	4
0007h	**Approximate native capacity from BOP to the current position of the medium {0Ch:0007h}:** This is in megabytes (i.e., 10^6). If no volume is mounted the device server shall set all bits in this parameter to one.	4
0008h	**Maximum native capacity that is currently allowed to be in the device object buffer {0Ch:0008h}:** This is in megabytes (i.e., 10^6). This value may change depending on the current position of the medium (e.g., available native capacity may decrease as the current position of the medium approaches LEOP).	4
0100h	**Cleaning Requested {0Ch:0100h}:** A non-zero value indicates a cleaning action is requested by the drive.	8

Table 160 — LP 0Ch: Sequential-Access Device log parameters (part 2 of 2)

Code	Counter: Description	Length
8000h	**Total Megabytes Processed Since Cleaning {0Ch:8000h}:** Number of megabytes (10^6) processed to tape since last cleaning (written after compression/read before decompression)	4
8001h	**Lifetime load cycles {0Ch:8001h}:** This is the number of times the drive has been loaded in its lifetime.	4
8002h	**Lifetime cleaning cycles {0Ch:8002h}:** This is the number of times over its lifetime the drive has been cleaned using a cleaner cartridge.	4
8003h	**Lifetime Power-on time {0Ch:8003h}:** This is the number of seconds the drive has been powered on over its lifetime.	4

6.3.9 LP 11h: DT Device Status

See LOG SELECT - 4Ch (see 5.2.7 on page 82) and LOG SENSE - 4Dh (see 5.2.8 on page 83) for directions on how to use this page.

The DT Device Status log page (see table 161) defines log information pertaining to the DT device (i.e. tape drive) and DT device primary ports.

Table 161 — LP 11h: DT Device Status log page

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	Reserved		PAGE CODE (11h)					
1	Reserved							
2	(MSB)	PAGE LENGTH (n-3)						
3								(LSB)
4	DT Device Status log parameters							
n								

Byte Description

0

Bit	Description
7-6	Reserved
5-0	Page Code (11h)

1 Reserved

2-3 Page Length (n-3)

4-n DT Device Status log parameters(see 6.3.9.2).

6.3.9.1 Parameter Reset Behavior (11h)

6.3.9.2 Parameter Definitions (11h)

WARNING WARNING

The parameters in log pages should be dynamically parsed as some parameters may not be present and new parameters may be insterted. The relative location of parameters have changed and are anticipated to continue to change.

WARNING WARNING

DT Device Status log parameters are shown in table 162.

Table 162 — DT Device Status log parameters

Parameter Code	Description
0000h	**Very high frequency data:** (see 6.3.9.2.1)
0001h	**Very high frequency polling delay:** (see 6.3.9.2.2)
0002h to 0003h	Reserved
0100h	Obsolete
0101h - 01FFh	**DT device primary port status:** (see 6.3.9.2.3)
8000h to FFFFh	Vendor-specific

6.3.9.2.1 Very high frequency data log parameter

The very high frequency data log parameter format is shown in Table 163.

Table 163 — Very high frequency data log parameter format

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	(MSB)	PARAMETER CODE (0000h)						
1								(LSB)
2	DU (0)	Obsolete	TSD (0)	ETC (0)	TMC (0)		LBIN (1)	LP (1)
3	PARAMETER LENGTH (04h)							
4	VHF data descriptor							
7								

Byte Description

0-1 PARAMETER CODE: (0000h)

2 Parameter list control byte - binary format list log parameter

Bit	Description
7	DU: 0b
6	Obsolete
5	TSD: 0b
4	ETC: 0b
3-2	TMC: 00b
1	LBIN: 1b
0	LP: 1b

3 PARAMETER LENGTH: (04h)

Transfer of the complete parameter is required.

4-7 VHF data descriptor

The VHF data descriptor is defined in table 164. Returned data shall reflect the last known values since the DT device initialized.

Table 164 — VHF data descriptor

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
4	PAMR	HIU	MACC	CMPR	WRTP	CQRST	CRQRD	DINIT
5	INXTN	Rsvd	RAA	MPRSNT	Rsvd	MSTD	MTHRD	MOUNTED
6	DT DEVICE ACTIVITY							
7	VS	Rsvd	TDDEC	EPP	ESR	RRQST	INTFC	TAFC

NOTE 32 - In addition to reliance on indication of initialization completion, reliance on returned values should also take into consideration conditions indicated by changes in Tape Alert flag status, and process those first as needed.

Byte Description

4

Bit Description

7 PAMR(prevent/allow medium removal):

Value	Description
0b	Medium removal is not prevented as the result of a PREVENT/ALLOW MEDIUM REMOVAL command on LUN 0.
1b	Medium removal is prevented as the result of a PREVENT/ALLOW MEDIUM REMOVAL command on LUN 0.

6 HIU(host initiated unload):

Value	Description
0b	Volume is not in an unload state due to a LOAD UNLOAD command.
1b	Volume is unloaded due to a LOAD UNLOAD command on LUN 0.

5 MACC (medium auxiliary memory accessible):

Value	Description
0b	Medium Auxiliary Memory (MAM) is not accessible.
1b	Medium Auxiliary Memory (MAM) is accessible.

4 CMPR (compress):

Value	Description
0b	Data compression is not enabled.
1b	Data compression is enabled.

3 WRTP (write protect): only valid if the MPRSNT bit is set to one.

Value	Description
0b	Volume is not physically write protected.
1b	Volume is physically write protected.

2 CQRST (cleaning requested):

Value	Description
0b	Cleaning not requested.
1b	Cleaning requested.

1 CRQRD (cleaning required):

Value	Description
0b	Cleaning not required; normal operation possible without cleaning.
1b	Cleaning required; normal operation may not be possible until drive is cleaned.

0 DINIT (DT device initialized):

Value	Description
0b	DT device initialization is required or incomplete. VHF data not valid.
1b	VHF data valid

5

Bit	Description
7	INXTN (in transition): Indicates the stability of the other bits in this byte (i.e., byte 5) and whether state transitions are taking place. **Value** **Description** 0b Device is in the state reflected by the remaining bits in this byte and is making no attempt to leave this state. 1b Device is transitioning to another state; other bits in this byte are in transition.
6	Rsvd (Reserved)
5	RAA (robotic access allowed): **Value** **Description** 0b Library or Medium Changer should not move a volume to or from the device. 1b Library or Medium Changer may move a volume to or from the device.
4	MPRSNT (medium present): **Value** **Description** 0b The device does not detect a volume present. 1b The device detects a volume present.
3	Rsvd (Reserved)
2	MSTD (medium seated): **Value** **Description** 0b Cartridge is not seated; further mechanical motion remains in order to complete the loading process, exclusive of tape threading. 1b Cartridge is mechanically seated within the loading mechanism (i.e., the physical loading process has completed).
1	MTHRD (medium threaded): The value of the MTHRD bit may or may not correspond to the device responding with a status of GOOD to a TEST UNIT READY command, as additional processing may be required by the device after threading before the logical unit becomes ready. **Value** **Description** 0b Medium is not threaded. 1b Medium has been threaded; tape motion operations are possible. The value of the MTHRD bit may or may not correspond to the DT device responding with a status of GOOD to a TEST UNIT READY command, as additional processing may be required by the DT device after threading before the logical unit becomes ready.
0	MOUNTED: **Value** **Description** 0b Volume is not mounted. 1b Volume is mounted. The drive may be able to respond to a TEST UNIT READY command with GOOD status, however when a cleaning cartridge or microcode update cartridge is loaded the drive may respond to a TEST UNIT READY command with a CHECK CONDITON with the sense key set to NOT READY.

6 DT DEVICE ACTIVITY: This field is used to describe the current activity of the device

Value	Description
00h	No DT device activity
01h	Cleaning operation in progress
02h	Medium is being loaded
03h	Medium is being unloaded
04h	Other medium activity
05h	Reading from medium
06h	Writing to medium
07h	Locating medium
08h	Rewinding medium
09h	Erasing medium
0Ah	Formatting medium
0Bh	Calibrating medium
0Ch	Other DT device activity
0Dh	Microcode update in progress

7

Bit	Description
7	VS: (0b)
6-3	Reserved
5	TDDEC (tape diagnostic data entry created):

Value	Description
0b	The device has not created a new Tape Diagnostic Data log page entry since the last retrieval of any of the parameters from the Tape Diagnostic Data log page by this I_T nexus.
1b	The device has created a new Tape Diagnostic Data log page entry since the last retrieval of any of the parameters from the Tape Diagnostic Data log page by this I_T nexus.

4 EPP (encryption parameters present):

Value	Description
0b	The device does not have a set of saved data encryption parameters with either the ENCRYPTION MODE field set to a value other than DISABLE or the DECRYPTION MODE field set to a value other than DISABLE
1b	The device has a set of saved data encryption parameters with either the ENCRYPTION MODE field set to a value other than DISABLE or the DECRYPTION MODE field set to a value other than DISABLE

3 ESR (encryption service request):

Value	Description
0b	At least one bit in the SERVICE REQUEST INDICATORS field in the DT device ADC data encryption control status log parameter has been set to one since the last retrieval of the DT device ADC data encryption control status log parameter by this I_T nexus and at least one bit in the SERVICE REQUEST INDICATORS field in the DT device ADC data encryption control status log parameter is set to one.
1b	No bits in the SERVICE REQUEST INDICATORS field in the DT device ADC data encryption control status log parameters have been set to one since the last retrieval of the DT device ADC data encryption control status log parameter by

this I_T nexus or all of the bits in the SERVICE REQUEST INDICATORS field in the DT device ADC data encryption control status log parameter are set to zero.

2 RRQST (recovery requested):

Value	Description
0b	No recovery procedure is requested.
1b	Device has detected an error and one or more requested recovery procedures are available via the ADC Requested Recovery log page.

1 INTFC (interface changed):

Value	Description
0b	No fields in the DT device primary port status log parameters have changed since the last retrieval of any of the DT device primary port status log parameters from the DT Device Status log page over this I_T nexus.
1b	One or more fields in the DT device primary port status log parameters have changed since the last retrieval of any of the DT device primary port status log parameters from the DT Device Status log page over this I_T nexus.

0 TAFC (TapeAlert state flag changed):

Value	Description
0b	No TapeAlert state flag has changed since the last retrieval of the TapeAlert Response log page over this I_T nexus.
1b	At least one TapeAlert state flag has changed since the last retrieval of the TapeAlert Response log page over this I_T nexus.

6.3.9.2.2 Very high frequency polling delay log parameter

The very high frequency polling delay log parameter format is shown in Table 165.

Table 165 — Very high frequency polling delay log parameter format

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	(MSB)	PARAMETER CODE (0001h)						
1								(LSB)
2	DU (0)	Obsolete	TSD (0)	ETC (0)	TMC (00)		LBIN (1)	LP (1)
3	PARAMETER LENGTH (02h)							
4	(MSB)	VHF POLLING DELAY						
5								(LSB)

Byte Description

0-1 PARAMETER CODE: (0001h)

2 Parameter list control byte - binary format list log parameter

Bit	Description
7	DU: 0b
6	Obsolete
5	TSD: 0b
4	ETC: 0b
3-2	TMC: 00b
1	LBIN: 1b
0	LP: 1b

3 PARAMETER LENGTH: (02h)

Transfer of the complete parameter is required.

4-7 VHF POLLING DELAY: The minimum delay in milliseconds before another DT Device Status log page should be requested.

6.3.9.2.3 Primary port status log parameter(s)

There is a primary port status log parameter for each primary port of the device. The format is shown in table 166.

Table 166 — Primary port status log parameter(s) format

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	(MSB)	PARAMETER CODE						
1								(LSB)
2	DU (0)	Obsolete	TSD (0)	ETC (0)	TMC (00)		LBIN (1)	LP (1)
3	PARAMETER LENGTH (n-3)							
4	(MSB)	Primary port status data						
n								(LSB)

Byte Description

0-1 PARAMETER CODE:

0100h plus the value of the Relative Target Port field associated with that port. The Relative Target Port is the same as the relative target port value defined in the VPD pages of inquiry

Value	Description
0101h	Primary port 1; traditionally known as port 0.
0102h	Primary port 2; traditionally known as port 1.

2 Parameter list control byte - binary format list log parameter

Bit	Description
7	DU: 0b
6	Obsolete
5	TSD: 0b
4	ETC: 0b
3-2	TMC: 00b
1	LBIN: 1b
0	LP: 1b

3 PARAMETER LENGTH:

4-7 Primary port status data: This is determined by the protocol of the port with which the parameter is associated. The protocol of the port is reported in the PROTOCOL IDENTIFIER field of the Relative target port identifier designation descriptor of the Device identification VPD page for the associated port.

Value	Description
0h	Fibre Channel port status data (see 6.3.9.2.4 on page 233)
6h	Serial Attached SCSI port status data (see 6.3.9.2.5 on page 235)

6.3.9.2.4 Fibre Channel port status data

The format of the primary port status data for a Fibre Channel port is shown in table 167. This descriptor reports the current operating points of the specified port.

Table 167 — Fibre Channel port status data format

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	CURRTOP	CURRENT SPEED			LC	CONFLICT	SIGNAL	PIC
1	CURRENT N_PORT_ID							
3								
4	ECSV	Reserved						
5	Reserved				EXTENDED CURRENT SPEED			
6	Reserved							
7	Rsvd	CURRENT FC-AL LOOP ID						
8	CURRENT PORT NAME							
15								
16	CURRENT NODE NAME							
23								

Byte Description

0

Bit	Description
7	CURRTOP (current topology): This field is undefined when the PIC field is set to zero

Value	Description
0b	Port is currently operating in arbitrated loop mode.
1b	Port is currently operating in point to point mode.

6-4 CURRENT SPEED: This field is undefined when the PIC field is set to zero

Value	Description
000b	1 Gb/sec.
001b	2 Gb/sec.
010b	4 Gb/sec.
011b	8 Gb/sec.
100b	10 Gb/sec

3 LC (login complete):

Value	Description
0b	No host is currently logged in to the drive through this port .
1b	At least one host is currently logged in to the drive through this port (i.e., has successfully completed PRLI and still has an active session).

2 CONFLICT:

Value	Description
0b	No AL_PA conflict exists on this port.
1b	The required Hard AL_PA is in use by another device or no AL_PA is available for this port.

1 SIGNAL:

Value	Description
0b	Signal (i.e., light) is not detected on this port.
1b	Signal (i.e., light) is detected on this port.

0 PIC (port initialization complete):

Value	Description

0b	The FC_Port state machine is not in the ACTIVE state (if port is operating in point-to-point topology), or has not successfully completed the most recent LIP.
1b	The FC_Port state machine is in the ACTIVE state (if port is operating in point-to-point topology), or the most recent LIP has completed successfully.

1-3 CURRENT N_PORT_ID: The 24-bit N_Port_ID that is currently assigned to this port. This field is undefined when the PIC field is set to zero.

4

Bit	Description
7	ECSV (extended current speed valid): 0b
6-0	Reserved

5

Bit	Description
7-4	Reserved
3-0	EXTENDED CURRENT SPEED: 0h

6 Reserved

7

Bit	Description
7	Reserved
6-0	CURRENT FC-AL LOOP ID: The loop identifier assigned to this port. This field is ignored ignored when the PIC bit is set to zero or when the CURRTOP bit is set to one.

8-15 CURRENT PORT NAME: The port's name identifier (i.e., WWPN).

16-23 CURRENT NODE NAME: The device's node name identifier (i.e., WWNN).

6.3.9.2.5 Serial Attached SCSI port status data

The format of the primary port status data for a SAS port is shown in table 168.

Table 168 — Serial Attached SCSI port status data format

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	NEGOTIATED PHYSICAL LINK RATE				Reserved		SIGNAL	PIC
1	(MSB)							
3				HASHED SAS ADDRESS				(LSB
4	(MSB)							
11				SAS ADDRESS				(LSB)

Byte Description

0

Bit Description

7-4 NEGOTIATED PHYSICAL LINK RATE: The negotiated physical link rate of the port.

Table 169 — NEGOTIATED PHYSICAL LINK RATE **values**

SP state machine ResetStatus state machine variable	Code	Description
UNKNOWN	0h	Phy is enabled; unknown physical link rate.
DISABLED	1h	Phy is disabled.
PHY_ RESET_ PROBLEM	2h	Phy is enabled; a phy reset problem occurred.
SPINUP_HOLD	3h	Not Supported
PORT_SELECTOR	4h	Not Supported
RESET_IN_PROGRESS	5h	Not Supported
UNSUPPORTED_ PHY_ATTACHED	6h	Phy is enabled; a phy is attached without any commonly supported settings.
Reserved	7h	Reserved
G1	8h	Phy is enabled; 1.5 Gbps physical link rate.
G2	9h	Phy is enabled; 3 Gbps physical link rate.
G3	Ah	Phy is enabled; 6 Gbps physical link rate.
Reserved	Bh to Fh	Phy is enabled; reserved for future logical or physical link rates.

3-2 Reserved

1 SIGNAL:

Value	Description
0b	Signal is not detected by the port.
1b	Signal is detected by the port.

0 PIC (port initialization complete):

Value	Description
0b	The port has not successfully completed the link reset sequence.
1b	The port has successfully completed the link reset sequence and is ready to accept connection requests.

1-3 HASHED SAS ADDRESS: The 24 bit hashed address that is assigned to the port. The Hashed SAS Address is based on the WWPN.

4-11 SAS ADDRESS: The SAS address of the port (i.e., WWPN).

6.3.10 LP 14h: Device Statistics

See LOG SELECT - 4Ch (see 5.2.7 on page 82) and LOG SENSE - 4Dh (see 5.2.8 on page 83) for directions on how to use this page. This page contains non-volatile information relating to volume usage.

The Device Statistics log page is included in Ultrium 5 and later drives. It is not included in earlier generation drives. The Device Statistics log page (see table 170) defines parameters associated with utilization of the tape device.

Table 170 — LP 14h: Device Statistics log page

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
	ds	SPF (0b)	PAGE CODE (14h)					
	SUBPAGE CODE (00h)							
	(MSB)	page length (n-3)						
								(LSB)
Device Statistics log parameter(s)								
	Device Statistics log parameter [first] (see table 171)							
	⋮							
n	Device Statistics log parameter]last] (see table 171)							

See SPC-4 for a description of the DS bit, SPF bit, PAGE CODE field, SUBPAGE CODE field and PAGE LENGTH field.

6.3.10.1 Parameter Reset Behavior (14h)

The reset behavior varies by parameter and is specified in the Persist and Clear columns of (see table 171).

6.3.10.2 Parameter Definitions (14h)

WARNING WARNING

The parameters in log pages should be dynamically parsed as some parameters may not be present and new parameters may be insterted. The relative location of parameters have changed and are anticipated to continue to change.

WARNING WARNING

Table 171 specifies the Device Statistics log page parameter codes.

Table 171 — LP14h: Device Statistics log parameter codes (part 1 of 4)

Parameter Code	Description	Type	Persist	Clear	Size
0000h	**Lifetime volume loads {14h:0000h}:** Total number of successful load operations.	C	P	N	4
0001h	**Lifetime cleaning operations {14h:0001h}:** Total number of successful and failed cleaning operations.	C	P	N	4
0002h	**Lifetime power on hours {14h:0002h}:** Total number of hours the device has been powered on. The value reported shall be rounded up to the next full hour.	C	P	N	4
0003h	**Lifetime medium motion (i.e., head) hours {14h:0003h}:** Total number of hours that the device has spent processing commands that require medium motion. The value reported shall be rounded up to the next full hour.	C	P	N	4
0004h	**Lifetime meters of tape processed {14h:0004h}:** Total number of meters of tape that have been processed by the drive mechanism in either direction.	C	P	N	4
0005h	**Lifetime medium motion (head) hours when incompatible medium was last loaded {14h:0005h}:** The value that would have been reported in a lifetime medium motion (head) hours parameter at the time when an incompatible volume was last loaded.	C	P	N	4
0006h	**Lifetime power on hours when the last temperature condition occurred (i.e., TapeAlert code 24h) {14h:0006h}:** The value that would have been reported in a lifetime power on hours parameter at the time when the TapeAlert code 24h flag was last set.	C	P	N	4
0007h	**Lifetime power on hours when the last power consumption condition occurred (i.e., TapeAlert code 1Ch) {14h:0007h}:** The value that would have been reported in a lifetime power on hours parameter at the time when the TapeAlert code 1Ch flag was last set.	C	P	N	4

Type	**Description**
C	Device statistics data counter log parameter (see 6.3.10.3.1)
M	Device statistics medium type log parameter (see 6.3.10.3.2)
S	Device statistics string data log parameter (see 6.3.10.3.3)
Persist	**Description**
P	Parameter shall be Persistent across I_T nexus loss, logical unit reset, and power-on
V	The persistence of this parameter varies and is inherited from the value being reported
D	The parameter is a duty cycle parameter and is cleared when parameter 0010h (i.e., Duty cycle sample time {14h:0010h}:) is cleared
Clear	**Description**
N	Parameter shall not be cleared by use of a LOG SELECT command
Y	Parameter may be cleared by use of a LOG SELECT command

[a] n = Number of Medium Types supported

Table 171 — LP14h: Device Statistics log parameter codes (part 2 of 4)

Parameter Code	Description	Type	Persist	Clear	Size
0008h	**Medium motion (i.e., head) hours since last successful cleaning operation {14h:0008h}:** Count of hours that medium has been in motion in either direction since the last successful cleaning operation. The value reported shall be rounded up to the next full hour.	C	P	N	4
0009h	**Medium motion (i.e., head) hours since second to last successful cleaning operation {14h:0009h}:** Count of hours that medium has been in motion in either direction since the second to last successful cleaning operation. The value reported shall be rounded up to the next full hour.	C	P	N	4
000Ah	**Medium motion (i.e., head) hours since third to last successful cleaning operation {14h:000Ah}:** Count of hours that medium has been in motion in either direction since the third to last successful cleaning operation. The value reported shall be rounded up to the next full hour.	C	P	N	4
000Bh	**Lifetime power on hours when the last operator initiated forced reset and/or emergency eject occurred {14h:000Bh}:** The value that would have been reported in a lifetime power on hours parameter at the time of the last forced reset and/or emergency eject.	C	P	N	4
000Ch	**Lifetime power cycles {14h:000Ch}:** Total number of times the drive has detected a power-on event.	C	P	N	4
000Dh	**Volume loads since last parameter reset {14h:000Dh}:** Count of successful volume loads since the last time this parameter was reset to zero by use of a LOG SELECT command. This parameter should be retained across a power cycle.	C	P	Y	4
000Eh	**Hard write errors {14h:000Eh}:** Number of times that a write type command has terminated with a CHECK CONDITION status having the sense key set to MEDIUM ERROR or HARDWARE ERROR since the last time this parameter was reset to zero by the use of a LOG SELECT command.	C	P	Y	4
000Fh	**Hard read errors {14h:000Fh}:** Number of times that a read type command has terminated with a CHECK CONDITION status having the sense key set to MEDIUM ERROR or HARDWARE ERROR since the last time this parameter was reset to zero by the use of a LOG SELECT command.	C	P	Y	4

Type	**Description**
C	Device statistics data counter log parameter (see 6.3.10.3.1)
M	Device statistics medium type log parameter (see 6.3.10.3.2)
S	Device statistics string data log parameter (see 6.3.10.3.3)
Persist	**Description**
P	Parameter shall be Persistent across I_T nexus loss, logical unit reset, and power-on
V	The persistence of this parameter varies and is inherited from the value being reported
D	The parameter is a duty cycle parameter and is cleared when parameter 0010h (i.e., Duty cycle sample time {14h:0010h}:) is cleared
Clear	**Description**
N	Parameter shall not be cleared by use of a LOG SELECT command
Y	Parameter may be cleared by use of a LOG SELECT command

[a] n = Number of Medium Types supported

Table 171 — LP14h: Device Statistics log parameter codes (part 3 of 4)

Parameter Code	Description	Type	Persist	Clear	Size
0010h	**Duty cycle sample time {14h:0010h}:** The time in milliseconds since the last time this parameter was reset to zero by: a) the use of a LOG SELECT command; b) a hard reset condition; or c) a vendor specific method	C	V	Y	6
0011h	**Read duty cycle {14h:0011h}:** Percentage (i.e., an integer between 0 and 100 representing a percentage) of duty cycle sample time (i.e., the value reported in parameter code 0010h) that the device was ready and was processing read type commands. This parameter shall be set to zero when the duty cycle sample time parameter is set to zero.	C	D	Y	1
0012h	**Write duty cycle {14h:0012h}:** Percentage of duty cycle sample time that the device was ready and was processing write type commands. This parameter shall be set to zero when the duty cycle sample time parameter is set to zero.	C	D	Y	1
0013h	**Activity duty cycle {14h:0013h}:** Percentage of duty cycle sample time that the device was ready and was processing write type commands, ready type commands, and other commands that cause the medium to be moved. This parameter shall be set to zero when the duty cycle sample time parameter is set to zero.	C	D	Y	1
0014h	**Volume not present duty cycle {14h:0014h}:** Percentage of the duty cycle sample time that the device server did not detect a volume present (e.g., the physical device attribute medium present was not set to true).	C	D	Y	1
0015h	**Ready duty cycle {14h:0015h}:** Percentage of duty cycle sample time that the device was in the ready state.	C	D	Y	1
0016h-003Fh	Reserved				
0040h	**Drive manufacturer's serial number {14h:0040h}:** Value that is reported in the MANUFACTURER-ASSIGNED SERIAL NUMBER field of the Manufacturer-assigned serial number VPD page (B1h)	S	P	N	12
0041h	**Drive serial number {14h:0041h}:** Value that is reported in the PRODUCT SERIAL NUMBER field of the Unit Serial Number VPD page (80h).	S	P	N	12
0042h-007Fh	Reserved				

Type	**Description**
C	Device statistics data counter log parameter (see 6.3.10.3.1)
M	Device statistics medium type log parameter (see 6.3.10.3.2)
S	Device statistics string data log parameter (see 6.3.10.3.3)
Persist	**Description**
P	Parameter shall be Persistent across I_T nexus loss, logical unit reset, and power-on
V	The persistence of this parameter varies and is inherited from the value being reported
D	The parameter is a duty cycle parameter and is cleared when parameter 0010h (i.e., Duty cycle sample time {14h:0010h}:) is cleared
Clear	**Description**
N	Parameter shall not be cleared by use of a LOG SELECT command
Y	Parameter may be cleared by use of a LOG SELECT command

[a] n = Number of Medium Types supported

Table 171 — LP14h: Device Statistics log parameter codes (part 4 of 4)

Parameter Code	Description	Type	Persist	Clear	Size
0080h	**Medium removal prevented {14h:0080h}:** A value of 01h indicates that medium removal has been prevented by: a) a prevention of medium removal condition in the device server, b) a configuration setting, or c) a vendor specific means. A value of 00h indicates that medium removal has not been prevented by one of the listed means. An error condition preventing removal of the medium does not cause this parameter to be set to a non-zero value.	C	V	N	1
0081h	**Maximum recommended mechanism temperature exceeded {14h:0081h}:** Indicates whether the device has detected at any point in the past that the maximum recommended mechanism temperature has been exceeded. a) a value of 00h indicates the temperature has not been exceeded; b) a value of 01h indicates the temperature has been exceeded; and c) a value of FFh indicates that it is unknown if the temperature has been exceeded.	C	P	N	1
0082h-0FFFh	Reserved				
1000h	**Medium motion (i.e., head) hours for each medium type {14h:1000h}:**	M	P	N	8*n [a]
1001h-EFFFh	Reserved				
F000h-FFFFh	Vendor-specifc				

Type	**Description**
C	Device statistics data counter log parameter (see 6.3.10.3.1)
M	Device statistics medium type log parameter (see 6.3.10.3.2)
S	Device statistics string data log parameter (see 6.3.10.3.3)
Persist	**Description**
P	Parameter shall be Persistent across I_T nexus loss, logical unit reset, and power-on
V	The persistence of this parameter varies and is inherited from the value being reported
D	The parameter is a duty cycle parameter and is cleared when parameter 0010h (i.e., Duty cycle sample time {14h:0010h}:) is cleared
Clear	**Description**
N	Parameter shall not be cleared by use of a LOG SELECT command
Y	Parameter may be cleared by use of a LOG SELECT command

[a] n = Number of Medium Types supported

6.3.10.3 Log parameter formats

6.3.10.3.1 Device statistics data counter log parameter format

The device statistics data counter log parameter is used for reporting parameters specified as device statistics data counter log parameters in (see table 171). The device statistics data counter log parameter format is specified in table 172.

Table 172 — Device statistics data counter log parameter format

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	(MSB)	PARAMETER CODE						
1								(LSB)
2	DU	Obsolete	TSD (0b)	ETC(0b)	TMC(00b)		FORMAT AND LINKING (11b)	
3	PARAMETER LENGTH (n-3)							
4	(MSB)	DEVICE STATISTICS DATA COUNTER						
n								(LSB)

Byte Description

0-1 PARAMETER CODE: defined in (see table 171).

2 Parameter control byte

Bit	Description
7	DU (Disable Update):
6	Obsolete:
5	TSD (Target Save Disable): 0b
4	ETC (Enable Threshold Comparison): 0b
3-2	TMC (Threshold Met Comparison): 00b
1-0	FORMAT AND LINKING: 11b

3 PARAMETER LENGTH: the number of bytes in the device statistics data counter field that follows.

4-n DEVICE STATISTICS DATA COUNTER: the value of the data counter associated with the parameter code.

6.3.10.3.2 Device statistics medium type log parameter format

The device statistics medium type log parameter is used for reporting parameters specified as device statistics medium type log parameters in (see table 171). The device statistics medium type log parameter format is specified in table 173.

Table 173 — Device statistics medium type log parameter format

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	(MSB)	PARAMETER CODE (1000h)						
1								(LSB)
2	DU (0b)	Obsolete	TSD (0b)	ETC (0b)	TMC (00b)		FORMAT AND LINKING (11b)	
3	PARAMETER LENGTH (n-3)							
Device statistics medium type descriptor(s)								
4	Device statistics medium type descriptor [first] (see table 174)							
	⋮							
n	Device statistics medium type descriptor [last] (see table 174)							

Byte Description

0-1 PARAMETER CODE: 1000h.

2 Parameter control byte

Bit	Description
7	DU (Disable Update): 0b
6	Obsolete:
5	TSD (Target Save Disable): 0b
4	ETC (Enable Threshold Comparison): 0b
3-2	TMC (Threshold Met Comparison): 00b
1-0	FORMAT AND LINKING: 11b

3 PARAMETER LENGTH: the number of bytes in the medium type descriptors that follow.

4-n Device statistics medium type descriptor(s) : the value of the data counter associated with the parameter code. The device statistics medium type descriptor is defined in 6.3.10.3.2.1.

6.3.10.3.2.1 Device statistics medium type descriptor

The device statistics medium type descriptor format is specified in table 174.

Table 174 — Device statistics medium type descriptor format

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	Reserved							
1	Reserved							
2	DENSITY CODE							
3	MEDIUM TYPE							
4	(MSB)	MEDIUM MOTION HOURS						
7								(LSB)

Byte Description

0-1 Reserved

2 DENSITY CODE: the value returned in the general mode parameter block descriptor.

3 MEDIUM TYPE: the value returned in the mode parameter header.

4-7 MEDIUM MOTION HOURS: the number of medium motion (i.e., head) hours for the type of medium specified by the combination of the MEDIUM TYPE field and DENSITY CODE field.

6.3.10.3.3 Device statistics string data log parameter format

The device statistics string data log parameter is used for reporting parameters specified as device statistics string data log parameters in (see table 171). The device statistics string data log parameter format is specified in table 175. The device statistics string data log parameter shall be a multiple of 4 bytes.

Table 175 — Device statistics string data log parameter format

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	(MSB)	PARAMETER CODE						
1								(LSB)
2	DU (0b)	Obsolete	TSD (0b)	ETC(0b)	TMC(00b)		FORMAT AND LINKING (01b)	
3	PARAMETER LENGTH (n-3)							
4	(MSB)	STRING DATA						
n								(LSB)

Byte Description

0-1 PARAMETER CODE: defined in (see table 171).

2 Parameter control byte

Bit	Description
7	DU (Disable Update): 0b
6	Obsolete:
5	TSD (Target Save Disable): 0b
4	ETC (Enable Threshold Comparison): 0b
3-2	TMC (Threshold Met Comparison): 00b
1-0	FORMAT AND LINKING: 01b

3 PARAMETER LENGTH: the number of bytes in the data that follows.

4-n STRING DATA: an ASCII string describing the device statistics parameter specified by the PARAMETER CODE value. The string data field is an ASCII data field.

6.3.11 LP 16h: Tape diagnostic data

See LOG SELECT - 4Ch (see 5.2.7 on page 82) and LOG SENSE - 4Dh (see 5.2.8 on page 83) for directions on how to use this page. This page is used to track significant errors or conditions.

The Tape Diagnostic Data log page (see table 176) provides for a number of error-event records using the list parameter format. Each error-event record contains diagnostic information for a single error type encountered by the device including data counters associated with the error event, sense data, operation code/service action and medium type with associated media motion hours, etc. The Tape Diagnostic Data log page may be used to aid in field analysis and repair.

The Tape Diagnostic Data log page only includes parameter entries for commands that terminated with a CHECK CONDITION status having the sense key set to MEDIUM ERROR, HARDWARE ERROR or ABORTED COMMAND.

The parameter code value associated with an error-event indicates the relative time at which a command terminated with a CHECK CONDITION status. A lower parameter code indicates that the command terminated with a CHECK CONDITION status at a more recent time. The parameter code values returned shall be numbered consecutively from 0000h (i.e., the most recent) up to n, where n is the number of current parameter entries.

Table 176 — LP 16h: Tape diagnostic data log page format

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	DS	SPF(0)	PAGE CODE (16h)					
1	SUBPAGE CODE (00h)							
2	(MSB)	PAGE LENGTH (n-3)						
3								(LSB)
Tape Diagnostic Data log parameter(s)								
4	Tape Diagnostic Data log parameter (first)							
	. . .							
n	Tape Diagnostic Data log parameter (last)							

6.3.11.1 Parameter Reset Behavior (16h)

All parameter codes are persistent across I_T nexus losses, logical unit resets, and power-on. The parameter entries are not set to zero or changed with the use of a LOG SELECT command.

6.3.11.2 Parameter Definitions (16h)

In each parameter (see table 177) if the REPEAT bit is set to zero, then the parameter represents only one event. If the REPEAT bit is set to one, then the parameter represents more than one consecutive events that had identical values for the MEDIUM ID NUMBER field, SENSE KEY field, ADDITIONAL SENSE CODE field and ADDITIONAL SENSE CODE QUALIFIER field in the parameter. If the REPEAT bit is set to one in the parameter, then other fields in the parameter shall be set to the values when the first of the consecutive events that had the identical values for the MEDIUM ID NUMBER field, SENSE KEY field, ADDITIONAL SENSE CODE field and ADDITIONAL SENSE CODE QUALIFIER field occurred.

The Tape Diagnostic Data log parameter format is specified in (see table 177)

WARNING WARNING

The parameters in log pages should be dynamically parsed as some parameters may not be present and new parameters may be insterted. The relative location of parameters have changed and are anticipated to continue to change.

WARNING WARNING

Table 177 — Tape diagnostic data log parameter format

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	(MSB)	Parameter Code (1000h)						
1								(LSB)
2	du(0)	Obsolete	tsd(0)	etc(0)	tmc (00b)		format and linking (11b)	
3	Parameter Length (n-3)							
4	Reserved							
5	Reserved							
6	Density Code							
7	Medium Type							
8	(MSB)	Lifetime Media Motion Hours						
11								(LSB)
12	Reserved							
13	Repeat	Reserved			Sense Key			
14	Additional Sense Code							
15	Additional Sense Code Qualifier							
16	(MSB)	Vendor-Specific Code Qualifier						
19								(LSB)
20	(MSB)	Product Revision Level						
23								(LSB)
24	(MSB)	Hours Since Last Clean						
27								(LSB)
28	Operation Code							
29	Reserved				Service Action			
30	Reserved							
31	Reserved							
32	(MSB)	Medium Id Number						
63								(LSB)
64	Reserved					Timestamp Origin		
65	Reserved							
66	(MSB)	Timestamp						
71								(LSB)

The PARAMETER LENGTH field indicates the number of bytes in the Tape Diagnostic Data log parameter data that follows.

The DENSITY CODE field contains the density code of the medium loaded at the time the command terminated with the CHECK CONDITION status. The DENSITY CODE field is the same value as returned in the general

mode parameter block descriptor. If no medium was loaded at the time the command terminated with the CHECK CONDITION status, then the DENSITY CODE field shall be set to 00h.

The MEDIUM TYPE field contains the type of medium loaded at the time the command terminated with the CHECK CONDITION status. The MEDIUM TYPE field is the same value as returned in the mode parameter header. If no medium was loaded at the time the command terminated with the CHECK CONDITION status, then the MEDIUM TYPE field shall be set to 00h.

The LIFETIME MEDIA MOTION HOURS field contains the number of media motion (head) hours at the time the command terminated with the CHECK CONDITION status. The LIFETIME MEDIA MOTION HOURS field is equivalent to the value contained in the Device Statistics log page with a parameter code value of 0003h at the time the command terminated with the CHECK CONDITION status.

The REPEAT bit set to one indicates this parameter represents more than one consecutive events that had identical values for the MEDIUM ID NUMBER field, SENSE KEY field, ADDITIONAL SENSE CODE field, and ADDITIONAL SENSE CODE QUALIFIER field. The REPEAT bit set to zero indicates this parameter represents a single event.

The SENSE KEY field, ADDITIONAL SENSE CODE field, and ADDITIONAL SENSE CODE QUALIFIER field contain the sense key and additional sense code values of the command that terminated with the CHECK CONDITION status.

The VENDOR-SPECIFIC CODE QUALIFIER field contains the Last Error FSC and Last Error Flag Data (i.e. bytes 65-68 of Sense Data) generated for the command that terminated with the CHECK CONDITION status.

The PRODUCT REVISION LEVEL field contains the product revision level at the time the command terminated with the CHECK CONDITION status.

The HOURS SINCE LAST CLEAN field contains the time in media motion (i.e., head) hours since the last successful cleaning at the time the command terminated with the CHECK CONDITION status. The HOURS SINCE LAST CLEAN field is equivalent to the value contained in the Device Statistics log page with a parameter code of 0008h at the time the command terminated with the CHECK CONDITION status.

The OPERATION CODE field and SERVICE ACTION field if applicable contain the operation code and service action of the command that terminated with the CHECK CONDITION status.

If medium was present at the time the command terminated with the CHECK CONDITION status, then the MEDIUM ID NUMBER field contains (in prioritized order):

1) the BARCODE field value contained in the medium auxiliary memory;

2) the MEDIUM SERIAL NUMBER field value contained in the medium auxiliary memory; or

3) the VOLUME IDENTIFIER field value contained in the medium auxiliary memory.

If no medium was present at the time the command terminated with the CHECK CONDITION status, the MEDIUM ID NUMBER field is filled with 20h (i.e., ASCII space).

The TIMESTAMP ORIGIN field and TIMESTAMP field contain the timestamp origin and timestamp maintained by the tape drive at the time the command terminated with the CHECK CONDITION status. If a timestamp is not supported by the device server, the TIMESTAMP ORIGIN and TIMESTAMP fields shall be set to zero.

6.3.12 LP 17h: Volume Statistics

See LOG SELECT - 4Ch (see 5.2.7 on page 82) and LOG SENSE - 4Dh (see 5.2.8 on page 83) for directions on how to use this page. This page contains non-volatile information relating to volume usage.

The Volume Statistics log page is included in Ultrium 5 and later drives. It is not included in earlier generation drives.

The Volume Statistics log page (see table 190) defines data parameters associated with utilization of the tape volume and the medium within the volume. Volume statistics for the most recent mounted volume are reported in the volume Statistics log page parameters. Volume statistics for previously mounted volumes may be reported in Volume Statistics log subpages (see table 179). A device server that implements the Volume Statistics log page shall implement support for the most recent mounted volume and the defined parameters as shown in table 191. The parameters shall not be set to zero or changed with the use of a LOG SELECT command.

If a supported log subpage is requested for a mount which has not occurred, then all bytes in the parameter data fields shall be set to 00h.

The device server resets all volume statistics log parameter data fields to 00h after a hard reset.

NOTE 33 - An application client may detect if parameter values in the page are valid by testing for parameter value 0000h, (i.e., page valid) set to zero.

Table 178 — Volume Statistics log page

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	DS	SPF	PAGE CODE (17h)					
1	SUBPAGE CODE							
2	(MSB)	PAGE LENGTH (n-3)						
3								(LSB)
	Volume Statistics log parameters							
4	Volume Statistics log parameters [first]							
	. . .							
n	Volume Statistics log parameters [last]							

See table 179 for the definition of the SUBPAGE CODE field.

Table 179 — Volume Statistics log subpage codes

Code	Description
00h	Reserved
01h-0Fh	Volume statistics for previously mounted volumes 1 through 15. Use subpage FFh (i.e., Supported subpages log page) to determine which log subpages are supported. This will also indicate how many previous mounts are supported by the drive.
10h-FEh	Reserved
FFh	Supported subpages log page (see SPC-4)

6.3.12.1 Parameter reset behavior

Parameters in this page are read-only.

6.3.12.2 Parameter Definitions

WARNING WARNING

The parameters in log pages should be dynamically parsed as some parameters may not be present and new parameters may be insterted. The relative location of parameters have changed and are anticipated to continue to change.

WARNING WARNING

Table 180 — LP 17h: Volume statistics log parameters

Parameter Code	Description	Type	Size
0000h	**Page valid {17h:000h}:** A value of 01h indicates that the values reported in the parameters to follow are valid. A value of 00h indicates the values reported in the parameters that follow are invalid	C	1
0001h	**Volume Mounts {17h:0001h}:** Number of mounts for the current volume (i.e., Thread Count)	C	4
0002h	**Volume Datasets Written {17h:0002h}:** The total number of data sets written to the medium in the volume over the lifetime of the volume. (i.e., Total Datasets Written)	C	8
0003h	**Volume Recovered Write Data Errors {17h:0003h}:** The total number of recovered write data correction errors (e.g., write temps) for the lifetime of the volume. (i.e., Total Write Retries)	C	4
0004h	**Volume Unrecovered Write Data Errors (i.e., Write Perms) {17h:0004h}:** The total number of times that a write type command was terminated with CHECK CONDITION status and a sense key of MEDIUM ERROR or HARDWARE ERROR over the lifetime of the volume. (i.e., Total Unrecovered Write Errors)	C	2
0005h	**Volume Write Servo Errors (updated on both temp and perm) {17h:0005h}:** The total number of times that the device suspended a write due to detection of a servo condition which could result in an incorrectly written track and attempted to write the data at a different location. If a logical block is interrupted more than once this parameter shall only be incremented once. (i.e., Total Number of Suspended Writes)	C	2
0006h	**Volume Unrecovered Write Servo Errors {17h:0006h}:** The total number of times that the device suspended a write due to detection of a servo condition which could result in an incorrectly written track and was unable to write the data at a different location. (i.e., Total Number of Fatal Suspended Writes)	C	2
0007h	**Volume Datasets Read {17h:0007h}:** The total number of data sets read from the medium in the volume over the lifetime of the volume. (i.e., Total Data Sets Read)	C	8
0008h	**Volume Recovered Read Errors {17h:0008h}:** The total number of recovered read errors (e.g., read temps) for the lifetime of the volume. (i.e., Total Read Retries)	C	4
0009h	**Volume Unrecovered Read Errors (i.e., Read Perms) {17h:0009h}:** The total number of times that a read type command was terminated with CHECK CONDITION status and a sense key of MEDIUM ERROR or HARDWARE ERROR over the lifetime of the volume. (i.e., Total Unrecovered Read Errors)	C	2
000Ah-000Bh	Not Supported		
000Ch	**Last mount unrecovered write errors {17h:000Ch}:** Count of the number times a write type command was terminated with status of CHECK CONDITION and a sense key of HARDWARE ERROR, or MEDIA ERROR during the last mount	C	2
000Dh	**Last mount unrecovered read errors {17h:000Dh}:** Count of the number times a read type command was terminated with status of CHECK CONDITION and a sense key of HARDWARE ERROR, or MEDIA ERROR during the last mount	C	2

Type Key:
C - Volume statistics counter log parameter (see 6.3.14.3)
S - Volume statistics string data log parameter (see 6.3.12.3.2)
P - Volume statistics partition record log parameter (see 6.3.12.3.3). The size field is the size of the PARTITION RECORD DATA COUNTER field of each Volume statistics partition record descriptor.

Table 180 — LP 17h: Volume statistics log parameters

Parameter Code	Description	Type	Size
000Eh	**Last mount megabytes written {17h:000Eh}:** Count of the number of megabytes (i.e., 10^6 bytes) of logical objects that were written to the medium after compression during the last mount. The value reported shall be rounded up to the next megabyte. The value reported contains bytes written as part of the process of writing a filemark	C	4
000Fh	**Last mount megabytes read {17h:000Fh}:** Count of the number of megabytes (i.e., 10^6 bytes) of logical objects that were read from the medium before decompression during the last mount. The value reported shall be rounded up to the next megabyte. The value reported contains bytes read as part of a filemark	C	4
0010h	**Lifetime megabytes written {17h:0010h}:** Count of the number of megabytes (i.e., 10^6 bytes) of logical objects that have been written to the medium after compression during the lifetime of the volume. The value reported shall be rounded up to the next megabyte. The value reported contains bytes written as part of the process of writing a filemark.	C	8
0011h	**Lifetime megabytes read {17h:0011h}:** Count of the number of megabytes (i.e., 10^6 bytes) that have been read from the medium before decompression during the lifetime of the volume. The value reported shall be rounded up to the next megabyte. The value reported contains bytes read as part of a filemark.	C	8
0012h	**Last load write compression ratio {17h:0012h}:** (number of bytes transferred out of the logical object buffer to an application client ÷ the number of bytes in logical objects read from the medium) x 100	C	2
0013h	**Last load read compression ratio {17h:0013h}:** (number of bytes transferred from an application client into the logical object buffer ÷ the number of bytes in logical objects written to the medium) x 100	C	2
0014h	**Medium mount time {17h:0014h}:** Time in milliseconds from the time when the device server would first report GOOD status to a TEST UNIT READY command upon successful completion of a load operation until the device server did not detect a volume present.	C	6
0015h	**Medium ready time {17h:0015h}:** Time in milliseconds from the time the device server was able to process medium access commands until the device server started the processing of an unload operation.	C	6
0016h	**Total native capacity {17h:0016h}:** The sum of the total native capacity of all partitions in megabytes (i.e., 10^6 bytes) from BOP to EOP. A data counter value with all bytes set to FFh in the partition record data counter field (see 6.3.12.3.3) indicates that the total native capacity is unknown.	C	4
0017h	**Total used native capacity {17h:0017h}:** The sum of the used native capacity of all partitions in megabytes (i.e., 10^6 bytes) from BOP to EOD. A data counter value with all bytes set to FFh in the partition record data counter field (see 6.3.12.3.3) indicates that the total used native capacity is unknown	C	4
0018h-003Fh	Reserved		
0040h	**Volume serial number {17h:0040h}:** The volume serial number parameter contains the value from the serial number field of the cartridge manufacturer's information page in the LTO CM.	S	32
0041h	**Tape lot identifier {17h:0041h}:** The tape lot identifier field may contain the tape pancake identifier value extracted from the servorwriter manufacturer field in the media manufacturer's page of the LTO CM or may be extracted from the manufacturer's word in the servo pattern.	S	8

Type Key:
C - Volume statistics counter log parameter (see 6.3.14.3)
S - Volume statistics string data log parameter (see 6.3.12.3.2)
P - Volume statistics partition record log parameter (see 6.3.12.3.3). The size field is the size of the PARTITION RECORD DATA COUNTER field of each Volume statistics partition record descriptor.

Table 180 — LP 17h: Volume statistics log parameters

Parameter Code	Description	Type	Size
0042h	**Volume barcode {17h:0042h}:** The value from MAM attribute 0806h (i.e., BARCODE, see SPC-4)	S	32
0043h	**Volume manufacturer {17h:0043h}:** The volume manufacturer parameter contains the value from the cartridge manufacturer field of the cartridge manufacturer's information page of the LTO CM.	S	8
0044h	**Volume license code {17h:0044h}:** ASCII code to represent the license under which this volume was manufactured. The volume license code parameter contains the value from the cartridge license code parameter of the cartridge manufacturer's information page of the LTO CM.	S	4
0045h	**Volume personality {17h:0045h}:** The volume personality parameter contains an ASCII string to identify the combination of physical volume type and density formatted on the medium. The intent is to provide a designator sufficient for successful volume interchange . The value is in the format "ULTRIUM-"+"<generation number>" (e.g., "ULTRIUM-5")	S	9
0046h-007Fh	Reserved		
0080h	**Write protect {17h:0080h}:** A value of 01h indicates that a write protection state that is persistent with this volume is set; A value of 00h indicates that no write protection state that is persistent with this volume is set; and A value of FFh indicates that it is unknown if there is a persistent write protection condition set.	C	1
0081h	**WORM {17h:0081h}:** A value of 01h indicates that the volume is a WORM volume; A value of 00h indicates that the volume is not a WORM volume; and A value of FFh indicates that it is unknown if the volume is a WORM volume.	C	1
0082h	**Maximum recommended tape path temperature exceeded {17h:0082h}:** A value of 01h indicates a drive has detected at some point in the past that the maximum recommended tape path temperature has been exceeded; A value of 00h indicates no drive has detected at any point in the past that the maximum recommended tape path temperature has been exceeded; and A value of FFh indicates that it is not known if at any point in the past that the maximum recommended tape path temperature has been exceeded (e.g., Ultrium 4 volume).	C	1
0083h-00FFh	Reserved		
0100h	Not Supported		
0101h	**Beginning of medium passes {17h:0101h}:** Count of the total number of times the beginning of medium position has passed over the head. The value from the LP3 passes field of the usage information page of the LTO CM.	C	4
0102h	**Middle of tape passes {17h:0102h}:** count of the total number of times that the physical middle of the user data region on the tape has passed over the head (e.g., (EOM – BOM) ÷ 2). The value from the (LP5 – LP3) ÷ 2 passes field of the usage information page of the LTO CM.	C	4
0103h-01FFh	Reserved		

Type Key:
C - Volume statistics counter log parameter (see 6.3.14.3)
S - Volume statistics string data log parameter (see 6.3.12.3.2)
P - Volume statistics partition record log parameter (see 6.3.12.3.3). The size field is the size of the PARTITION RECORD DATA COUNTER field of each Volume statistics partition record descriptor.

Table 180 — LP 17h: Volume statistics log parameters

Parameter Code	Description	Type	Size
0200h	**First encrypted logical object identifier(s) {17h:0200h}:** The logical object identifier(s) for the first logical object on the medium which has been encrypted for each partition on the medium. Each byte in the partition record data counter field(s) shall be set to FFh if there are no encrypted logical objects or if the partition does not exist. The least significant byte in the partition record data counter field (see 6.3.12.3.3) shall be set to FEh and all other bytes shall be set to FFh if it is not known if there are encrypted logical objects on the medium.	P	6
0201h	**First unencrypted logical object on the EOP side of the first encrypted logical object identifier(s) {17h:0201h}:** The logical object identifiers for the first logical object on the medium which is not encrypted and is on the EOP side of the first encrypted logical object for each partition on the medium. Each byte in the partition record data counter field (see 6.3.12.3.3) shall be set to FFh if there are no unencrypted logical objects on the EOP side of the first encrypted logical object identifier or if the partition does not exist. The least significant byte in the partition record data counter field shall be set to FEh and all other bytes shall be set to FFh if: it is not known if there are unencrypted logical objects on the EOP side of the first encrypted logical object; all bytes in the first encrypted logical object identifier are set to FFh; or the least significant byte in the first encrypted logical object identifier is set to FEh and all other bytes are set to FFh.	P	6
0202h	**Approximate native capacity of partition(s) {17h:0202h}:** The native capacity of the partition(s) in megabytes (i.e., 10^6 bytes) from BOP to EOP. A data counter value with all bytes set to FFh in the partition record data counter field (see 6.3.12.3.3) indicates that the native capacity of the partition is unknown.	P	4
0203h	**Approximate used native capacity of partition(s) {17h:0203h}:** The used native capacity of the partition in megabytes (i.e., 10^6 bytes) from BOP to EOD. A data counter value with all bytes set to FFh in the partition record data counter field (see 6.3.12.3.3) indicates that the used native capacity of the partition is unknown.	P	4
0204h-EFFFh	Reserved		
F000h-FFFFh	Vendor specific		

Type Key:
C - Volume statistics counter log parameter (see 6.3.14.3)
S - Volume statistics string data log parameter (see 6.3.12.3.2)
P - Volume statistics partition record log parameter (see 6.3.12.3.3). The size field is the size of the PARTITION RECORD DATA COUNTER field of each Volume statistics partition record descriptor.

6.3.12.3 Parameter formats

6.3.12.3.1 Data counter log parameter format

The volume statistics data counter log parameter is used for reporting parameters specified as volume statistics data counter log parameters in Table 191, LP 1Bh: Data compression log parameters. The volume statistics data counter log parameter format is specified in Table 192, Data compression counter log parameter format.

Table 181 — Volume statistics data counter log parameter format

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	(MSB)	PARAMETER CODE						
1								(LSB)
2	DU	Obsolete	TSD (0b)	ETC(0b)	TMC		FORMAT AND LINKING (11b)	
3	PARAMETER LENGTH (n-3)							
4	(MSB)	VOLUME STATISTICS DATA COUNTER						
n								(LSB)

The PARAMETER CODE field is defined in Table 191, LP 1Bh: Data compression log parameters.

See SPC-4 for descriptions of the DU bit, TSD bit, ETC bit, TMC field and FORMAT AND LINKING field. The TSD bit and FORMAT AND LINKING field shall be set to the values specified in Table 192, Data compression counter log parameter format.

The PARAMETER LENGTH field indicates the number of bytes in the VOLUME STATISTICS DATA COUNTER field that follows.

The VOLUME STATISTICS DATA COUNTER field is the value of the data counter associated with the parameter code.

6.3.12.3.2 Volume statistics string data log parameter format

The volume statistics string data log parameter is used for reporting parameters specified as volume statistics string data log parameters in Table 191, LP 1Bh: Data compression log parameters. The volume statistics string data log parameter format is specified in Table 182, Volume statistics string data log parameter format. The volume statistics string data log parameter shall be a multiple of 4 bytes.

Table 182 — Volume statistics string data log parameter format

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	(MSB)	PARAMETER CODE						
1								(LSB)
2	DU(0b)	Obsolete	TSD (0b)	ETC(0b)	TMC(00b)		FORMAT AND LINKING (01b)	
3	PARAMETER LENGTH (n-3)							
4		STRING DATA						
n								

The PARAMETER CODE field is defined in Table 191, LP 1Bh: Data compression log parameters.

See SPC-4 for descriptions of the DU bit, TSD bit, ETC bit, TMC field and FORMAT AND LINKING field. These fields shall be set to the values specified in Table 182, Volume statistics string data log parameter format.

The PARAMETER LENGTH field indicates the number of bytes of data that follows.

The STRING DATA field contains an ASCII string describing the volume statistics parameter specified by the PARAMETER CODE value. The STRING DATA field is an ASCII data field (see SPC-4).

6.3.12.3.3 Volume statistics partition record log parameter format

The volume statistics partition record log parameter is used for reporting parameters specified as volume statistics partition record log parameters in Table 191, LP 1Bh: Data compression log parameters. The volume statistics partition record log parameter format is specified in Table 183, Volume statistics partition log parameter format.

Table 183 — Volume statistics partition log parameter format

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	(MSB)			PARAMETER CODE				
1								(LSB)
2	DU	Obsolete	TSD (0b)	ETC(0b)	TMC(00b)		FORMAT AND LINKING (11b)	
3	PARAMETER LENGTH (n-3)							
	Volume statistics partition record descriptor(s)							
4	Volume statistics partition record descriptor [first]							
	⋮							
n	Volume statistics partition record descriptor [last]							

The PARAMETER CODE field is defined in Table 191, LP 1Bh: Data compression log parameters.

See SPC-4 for descriptions of the DU bit, TSD bit, ETC bit, TMC field and FORMAT AND LINKING field. The TSD bit and FORMAT AND LINKING field shall be set to the values specified in Table 183, Volume statistics partition log parameter format.

The PARAMETER LENGTH field indicates the number of bytes in the volume statistics partition record log descriptors.

The volume statistics partition record descriptor format is specified in Table 184, Volume statistics partition record descriptor format.

Table 184 — Volume statistics partition record descriptor format

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	PARTITION RECORD DESCRIPTOR LENGTH (n-1)							
1	Reserved							
2	(MSB)			PARTITION NUMBER				
3								(LSB)
4	(MSB)			PARTITION RECORD DATA COUNTER				
n								(LSB)

The PARTITION RECORD DESCRIPTOR LENGTH field specifies the number of bytes that follow.

The PARTITION NUMBER field indicates the number of the partition that the following counter is associated with.

The PARTITION RECORD DATA COUNTER field is the value of the data counter associated with the parameter code and associated with the specified partition.

6.3.13 LP 18h: Protocol-specific port

See LOG SELECT - 4Ch (see 5.2.7 on page 82) and LOG SENSE - 4Dh (see 5.2.8 on page 83) for directions on how to use this page. The Protocol-specific log page for SAS is used to report errors that have occurred on the phys of SAS drives.

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

The Protocol-specific log page for SAS is defined in table 185.

Table 185 — Protocol-Specific log page for SAS

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	DS	SPF	PAGE CODE (18h)					
1	Reserved							
2	(MSB)	PAGE LENGTH (78h)						
3								(LSB)
Protocol-specific log parameter list								
4	Protocol-specific log parameter (first) (see table 186)							
63								
64	Protocol-specific log parameter (last) (see table 186)							
123								

6.3.13.1 Parameter Reset Behavior (18h)

All log parameters are cleared when this log page is read. Specific flags may be cleared when corrective actions have removed the condition that caused the flag to be set. All flags are cleared on POR/Reset.

6.3.13.2 Parameter Definitions (18h)

Table 186 defines the format for the Protocol-Specific log parameter for SAS.

WARNING WARNING

The parameters in log pages should be dynamically parsed as some parameters may not be present and new parameters may be insterted. The relative location of parameters have changed and are anticipated to continue to change.

WARNING WARNING

Table 186 — Protocol-Specific Port log parameter for SAS (part 1 of 2)

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	(MSB)	PARAMETER CODE (relative target port identifier)						
1								(LSB)
2	Parameter control byte							
	DU	Obsolete	TSD	ETC	TMC		FORMAT AND LINKING	
3	PARAMETER LENGTH (38h)							
4	Reserved				PROTOCOL IDENTIFIER (6h)			
5	Reserved							

Table 186 — Protocol-Specific Port log parameter for SAS (part 2 of 2)

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
6	GENERATION CODE (00h)							
7	NUMBER OF PHYS (01h)							
SAS phy log descriptor								
8	Reserved							
9	PHY IDENTIFIER							
10	Reserved							
11	SAS PHY LOG DESCRIPTOR LENGTH (m - 3)							
12	Reserved	ATTACHED DEVICE TYPE			ATTACHED REASON			
13	REASON				NEGOTIATED LOGICAL LINK RATE			
14	Reserved				ATTACHED SSP INITIATOR PORT	ATTACHED STP INITIATOR PORT	ATTACHED SMP INITIATOR PORT	Reserved
15	Reserved				ATTACHED SSP TARGET PORT	ATTACHED STP TARGET PORT	ATTACHED SMP TARGET PORT	Reserved
16	SAS ADDRESS							
23								
24	ATTACHED SAS ADDRESS							
31								
32	ATTACHED PHY IDENTIFIER							
33	Reserved							
39								
40	(MSB)	INVALID DWORD COUNT						
43								(LSB)
44	(MSB)	RUNNING DISPARITY ERROR COUNT						
47								(LSB)
48	(MSB)	LOSS OF DWORD SYNCHRONIZATION						
51								(LSB)
52	(MSB)	PHY RESET PROBLEM						
55								(LSB)
56	Reserved							
57								
58	PHY EVENT DESCRIPTOR LENGTH							
59	NUMBER OF PHY EVENT DESCRIPTORS							

The PARAMETER CODE field contains the relative target port identifier of the SSP target port that the log parameter describes.

Table 187 defines the values of the fields in the parameter control byte for the log parameter.

Table 187 — Parameter control byte in the Protocol-Specific Port log parameter for SAS

Field	Value for LOG SENSE	Value for LOG SELECT	Description
DU	0	0 or 1	The DU bit is not defined for list parameters, so shall be set to zero when read with the LOG SENSE command and shall be ignored when written with the LOG SELECT command.
TSD	0	0 or 1	The device server shall support implicitly saving the log parameter at vendor specific intervals.
ETC	0	0 or 1	The ETC bit is not defined for list parameters, so shall be set to zero when read with the LOG SENSE command and shall be ignored when written with the LOG SELECT command.
TMC	00b	any	The TMC field is not defined for list parameters, so shall be set to 00b when read with the LOG SENSE command and shall be ignored when written with the LOG SELECT command.
FORMAT AND LINKING	11b	11b	The log parameter is a binary format list parameter.

The PARAMETER LENGTH field shall be set to the value defined in table 186.

The PROTOCOL IDENTIFIER field shall be set to the value defined in table 186.

The GENERATION CODE field is related to the Phy Control and Discover mode page which is not supported.

The NUMBER OF PHYS field contains the number of phys in the SAS target port (not in the entire SAS target device) and indicates the number of SAS phy log descriptors in the SAS phy log descriptor list.

The PHY IDENTIFIER field indicates the phy identifier of the phy for which information is being returned.

The SAS PHY LOG DESCRIPTOR LENGTH field indicates the number of bytes that follow in the SAS phy log descriptor. A SAS PHY LOG DESCRIPTOR LENGTH field set to 00h indicates that there are 44 additional bytes.

The ATTACHED DEVICE TYPE field indicates the device type attached to this phy and is defined in table 188.

Table 188 — ATTACHED DEVICE TYPE field

Code	Description
000b	No device attached
001b	SAS device
010b	Edge Expander device
011b	Fan-out expander device
All others	Reserved

The ATTACHED DEVICE TYPE field shall only be set to a value other than 000b if a SAS device or expander device is attached, after the identification sequence is complete.

If a SAS phy or expander phy is attached, then the ATTACHED REASON field indicates the value of the REASON field received in the IDENTIFY address frame during the identification sequence.

The NEGOTIATED LOGICAL LINK RATE field is defined in table 189 and indicates the logical link rate being used by the phy. This is negotiated during the link reset sequence. This field may be different from the negotiated physical link rate when multiplexing is enabled.

Table 189 — NEGOTIATED PHYSICAL LINK RATE

Code	Name	Description
0h	UNKNOWN	Phy is enabled; unknown physical link rate.
1h	DISABLED	Phy is disabled.
2h	PHY_ RESET_ PROBLEM	Phy is enabled; the phy obtained dword synchronization for at least one physical link rate during the SAS speed negotiation sequence, but the SAS speed negotiation sequence failed (i.e., the last speed negotiation window, using a physical link rate expected to succeed, failed). These failures may be logged in the Protocol-Specific log page (see the SCSI Reference).
3h	SPINUP_ HOLD	Not Supported
4h	PORT_ SELECTOR	Not Supported
8h	G1	Phy is enabled; 1,5 Gbps physical link rate. This field shall be updated to this value after the speed negotiation sequence completes.
9h	G2	Phy is enabled; 3,0 Gbps physical link rate. This field shall be updated to this value after the speed negotiation sequence completes.
Ah	G3	Phy is enabled; 6,0 Gbps physical link rate. This field shall be updated to this value after the speed negotiation sequence completes.
All others	Reserved	

The INVALID DWORD COUNT field indicates the number of invalid dwords that have been received outside of phy reset sequences (i.e., between when the SP state machine sends a Phy Layer Ready (SAS) confirmation or Phy Layer Ready (SATA) confirmation and when it sends a Phy Layer Not Ready confirmation to the link layer). The count shall stop at the maximum value. The INVALID DWORD COUNT field is set to a vendor-specific value after power on.

The RUNNING DISPARITY ERROR COUNT field indicates the number of dwords containing running disparity errors that have been received outside of phy reset sequences. The count shall stop at the maximum value. The RUNNING DISPARITY ERROR COUNT field is set to a vendor-specific value after power on.

The LOSS OF DWORD SYNCHRONIZATION COUNT field indicates the number of times the phy has restarted the link reset sequence because it lost dword synchronization (i.e., the SP state machine transitioned from SP15:SAS_PHY_Ready or SP22:SATA_PHY_Ready to SP0:OOB_COMINIT). The count shall stop at the maximum value. The LOSS OF DWORD SYNCHRONIZATION COUNT field is set to a vendor-specific value after power on.

The PHY RESET PROBLEM COUNT field indicates the number of times a phy reset problem occurred. The count shall stop at the maximum value. The PHY RESET PROBLEM COUNT field is set to a vendor-specific value after power on.

The PHY EVENT DESCRIPTOR LENGTH field indicates the number of bytes in the phy event descriptor.

The NUMBER OF PHY EVENT DESCRIPTORS field indicates the number of phy event descriptors in the phy event descriptor list.

6.3.14 LP 1Bh: Data Compression

See LOG SELECT - 4Ch (see 5.2.7 on page 82) and LOG SENSE - 4Dh (see 5.2.8 on page 83) for directions on how to use this page. This page contains non-volatile information relating to volume usage.

The Data Compression log page is included in Ultrium 5 and later drives. It is not included in earlier generation drives.

The Data Compression log page (see table 190) defines data counters associated with the data compression operation for the most recent volume mount.

Table 190 — Data Compression log page

Byte	Bit							
	7 msb	**6**	**5**	**4**	**3**	**2**	**1**	**0 lsb**
0	ds	spf(0)	page code (1Bh)					
1	subpage code							
2	(msb)	page length (n-3)						
3								(lsb)
	Data Compression log parameters							
4	Data Compression log parameters [first]							
	. . .							
n	Data Compression log parameters [last]							

6.3.14.1 Parameter reset behavior

Parameters may be reset to zero but shall not be changed with the use of a log select command. Parameters shall be set to zero at the start of a medium load and after a hard reset. Parameters shall not be set to zero during the processing of an unload operation.

6.3.14.2 Parameter Definitions

Parameters 0002h through 0009h are pairs that represent a large number of bytes transferred. The first parameter of the pair represents the number of whole megabytes (i.e., 10^6 bytes) transferred, rounded to the nearest megabyte. The second parameter of the pair represents the difference between this number of megabytes and the actual number of bytes. This is a signed number and may be negative.

Parameters associated with data transferred from an application client indicate values prior to compression processing. Parameters associated with data transferred to the medium indicate values after compression processing. Compression processing may or may not compress logical blocks.

WARNING WARNING

The parameters in log pages should be dynamically parsed as some parameters may not be present and new parameters may be insterted. The relative location of parameters have changed and are anticipated to continue to change.

WARNING WARNING

Table 191 — LP 1Bh: Data compression log parameters

Parameter Code	Description	Size
0000h	**Read Compression ratio {1Bh:0000h}:** The average data compression ratio multiplied by 100 for all user data read from the medium since the last time this parameter was reset to zero. This parameter may include user data that was read from the medium but not returned to the application client (e.g., data that was read as part of a read ahead operation). The calculation is (number of bytes transferred out of the logical object buffer to an application client ÷ the number of bytes in logical objects read from the medium) x 100	2
0001h	**Write Compression Ratio x 100 {1Bh:0001h}:** The average data compression ratio multiplied by 100 for all user data written by the device since the last time this parameter was reset to zero. The calculation is (number of bytes transferred from an application client into the logical object buffer ÷ the number of bytes in logical objects written to the medium) x 100	2
0002h	**Megabytes transferred to application client {1Bh:0002h}:** The count of the number of megabytes (i.e., 10^6 bytes) of logical blocks that have been transferred to an application client after compression processing at the time this parameter is requested. The value reported shall be rounded to the nearest megabyte.	4
0003h	**Bytes transferred to application client {1Bh:0003j}:** The difference in bytes between the actual number of bytes of logical blocks transferred to the application client and the value reported in parameter 0002h (i.e., megabytes transferred to application client). The value reported in this parameter is a signed number and may be negative.	4
0004h	**Megabytes read from medium {1Bh:0004h}:** The count of the number of megabytes (i.e., 10^6 bytes) of logical blocks that have been read from the medium before compression processing at the time this parameter is requested. The value reported shall be rounded to the nearest megabyte.	4
0005h	**Bytes read from medium {1Bh:0005h}:** The difference in bytes between the actual number of bytes of logical blocks read from the medium before decompression at the time this parameter is requested and the value reported in parameter 0004h (i.e., megabytes read from medium). The value reported in this parameter is a signed number and may be negative.	4
0006h	**Megabytes transferred from application client {1Bh:0006h}:** The count of the number of megabytes (i.e., 10^6 bytes) of logical blocks that have been transferred from an application client before compression processing at the time this parameter is requested. The value reported shall be rounded to the nearest megabyte.	4
0007h	**Bytes transferred from application client {1Bh:0007h}:** The difference in bytes between the actual number of bytes of logical blocks transferred from an application client before compression processing at the time this parameter is requested and the value reported in parameter 0006h (i.e., megabytes transferred from application client). The value reported in this parameter is a signed number and may be negative.	4
0008h	**Megabytes written to medium {1Bh:0008h}:** The count of the number of megabytes (i.e., 10^6 bytes) of logical blocks that have written to the medium after compression processing at the time this parameter is requested. The value reported shall be rounded to the nearest megabyte.	4

Table 191 — LP 1Bh: Data compression log parameters

Parameter Code	Description	Size
0009h	**Bytes written to medium {1Bh:0009h}:** The difference in bytes between the actual number of bytes of logical blocks written to the medium in logical blocks at the time this parameter is requested and the value reported in parameter 0008h (i.e., megabytes written to medium). The value reported in this parameter is a signed number and may be negative.	4
000Ah-00FFh	Reserved	
0100h	**Data compression enabled {1Bh:0100h}:** Indication of whether logical blocks will be compressed before they are written to the medium. The value reported indicates the current state of the device and does not indicate that logical blocks previously written to the medium were compressed. A data counter value set to 01h indicates that logical blocks will be compressed before being written to the medium during write type commands. A zero value indicates that logical blocks will not be compressed before being written to the medium during write type commands.	1
0101h-EFFFh	Reserved	
F000h-FFFFh	Vendor-specific	

6.3.14.3 Parameter format

The data compression counter log parameter format is specified in

Table 192 — Data compression counter log parameter format

Byte	Bit							
	7 msb	**6**	**5**	**4**	**3**	**2**	**1**	**0 lsb**
0	(msb)	parameter code						
1								(lsb)
2	du	Obsolete	tsd (0b)	etc(0b)	tmc(00b)		format and linking (11b)	
3	parameter length (n-3)							
4	(msb)	data compression counter						
n								(lsb)

The PARAMETER CODE field is defined in table 191.

See SPC-4 for descriptions of the DU bit, TSD bit, ETC bit, TMC field and FORMAT AND LINKING field. The TSD bit and FORMAT AND LINKING field shall be set to the values specified in table 192.

The PARAMETER LENGTH field indicates the number of bytes in the data compression counter field that follows.

The DATA COMPRESSION COUNTER field is the value of the data counter associated with the parameter code.

6.3.15 LP 1A: Power Condition Transitions

See LOG SELECT - 4Ch (see 5.2.7 on page 82) and LOG SENSE - 4Dh (see 5.2.8 on page 83) for directions on how to use this page. The Power Condition Transitions log page provides a count of the occurrences of power condition transition events.

6.3.15.1 Parameter Reset Behavior (1Ah)

Parameters in this page are lifetime counters and are never reset.

6.3.15.2 Parameter Definitions (1Ah)

WARNING WARNING

The parameters in log pages should be dynamically parsed as some parameters may not be present and new parameters may be insterted. The relative location of parameters have changed and are anticipated to continue to change.

WARNING WARNING

The FORMAT AND LINKING field for log parameters in the Power Condition Transitions log page shall be set to 11b, indicating that the parameter is a binary format list parameter.

All Power Condition Transitions log page counters are saturating counters. A count is incremented by one for each transition (see table 193).

Table 193 — Parameter codes for the Power Condition Transitions log page

Parameter code	Description	Size
0001h	**Accumulated transitions to active:** The number of times the device server has transitioned to the active power condition since the device was manufactured.	4
0004h	**Accumulated transitions to idle_c:** The number of times the device server has transitioned to the idle_c power condition since the device was manufactured. This includes all transitions (e.g., idle_c_condition_timer expiration)	4

6.3.16 LP 2Eh: TapeAlerts

See LOG SELECT - 4Ch (see 5.2.7 on page 82) and LOG SENSE - 4Dh (see 5.2.8 on page 83) for directions on how to use this page. This page is used to track significant errors or conditions.

Byte	Description
0	
	Bit **Description** 7-6 Reserved 5-0 Page Code: 2Eh
1	Reserved
2-3	Page length: 0140h

Page Code 2Eh is used to report conditions in the tape drive. The TapeAlert log page is unique in that the parameter value is required to be 0000h or 0001h in the Log Sense command. A result of this requirement is that all parameters are requested, so the page length field is always returned 0140h.

For a description of service actions associated with the supported parameters, refer to the *IBM System Storage TS2350 Tape Drive Setup, Operator, and Service Guide, GC27-2277-00*.

6.3.16.1 Parameter Reset Behavior (2Eh)

All log parameters are cleared when this log page is read. Specific flags may be cleared when corrective actions have removed the condition that caused the flag to be set (see table 194). All flags are cleared on POR/Reset.

6.3.16.2 Parameter Definitions (2Eh)

There are 64 parameters numbered from 0001h to 0040h. However, for this product only parameters listed in table 194 have meaning. The remaining parameters always return a value of 00h.

All parameters are one byte long. Each parameter is either 00h to indicate the corresponding condition has not occurred or 01h to indicate that the condition has occurred. See 6.3.16.1 Parameter Reset Behavior (2Eh) for parameter clearing behavior.

The following parameters are supported for each TapeAlert. Table 194 lists the supported TapeAlerts and additional fields as specified in SSC may be supported in the future.

Parameter description:

Byte	Description
0-1	Parameter Code
2	Parameter control byte
	Bit **Description** 7 DU (Disable Update): 0b 6 DS (Disable Save): 1b 5 TSD (Target Save Disable): 0b 4 ETC (Enable Threshold Comparison): 0b 3-2 TMC (Threshold Met Comparison): 00b 1 Reserved 0 LO (List Parameter): 0b
3	Parameter length: 01h

4 TapeAlert Flag

Value	Description
01h	condition occurred
00h	condition did not occur

Table 194 — Supported TapeAlerts (part 1 of 2)

Code	Description	Set	Clear[1]	Type
0001h	Read Warning		R	Warning
0002h	Write Warning		R	Warning
0003h	Hard Error		R	Warning
0004h	Media		R	Critical
0005h	Read Failure		R	Critical
0006h	Write Failure		R	Critical
0007h	Media Life		L	Warning
0008h	Not Data Grade		R	Warning
0009h	Write Protect		R	Critical
000Ah	No Removal		R	Informational
000Bh	Cleaning Media		R	Informational
000Ch	Unsupported Format		R	Informational
000Eh	Unrecoverable Snapped Tape		R	Critical
000Fh	Memory Chip in Cartridge Failure		R	Warning
0010h	Forced Eject		L	Critical
0011h	Read Only Format		R	Warning
0012h	Tape Directory Corrupted		R	Warning
0013h	Nearing Media Life		R	Informational
0014h	Clean Now		C	Critical
0015h	Clean Periodic		C	Warning
0016h	Expired Cleaning Media	C	C	Critical
0017h	Invalid cleaning tape	C	R	Critical
0019h	Host Channel Failure			Warning
001Ah	Cooling Fan Failure	S		Warning
001Bh	Power Supply Failure	S		Warning
001Eh	Hardware A			Critical
001Fh	Hardware B			Critical
0020h	Interface			Warning
0021h	Eject Media		U,R	Critical
0022h	Download Fault			Warning
0024h	Drive Temperature	S		Warning
0025h	Drive Voltage	S		Warning
0026h	Predictive Failure			Critical
0027h	Diagnostics Required			Warning
0029h	Loader Stray Tape			Critical
002Ah	Loader Hardware			Warning
002Dh	Loader Magazine			Critical

Table 194 — Supported TapeAlerts (part 2 of 2)

Code	Description	Set	Clear[1]	Type
0032h	Lost Statistics		R	Warning
0033h	Tape Directory Invalid at Unload		L,R	Warning
0034h	Tape System Area Write Failure		L,R	Critical
0035h	Tape System Area Read Failure		R	Critical
0036h	No Start of Data		R	Critical
0037h	Loading Failure		R	Critical
0038h	Unrecoverable Unload Failure		R	Critical
0039h	Automation Interface Failure			Critical
003Ah	Firmware Failure			Warning
003Bh	WORM Medium - Integrity Check Failed		R	Warning
003Ch	WORM Medium - Overwrite Attempted		R	Warning

Legend
- Not set/supported
L Load - medium is loaded
C Clean - cleaner tape is loaded
U Unload - medium is ejected
E Error - error code is posted
R Removal - medium is FULLY removed
S Sensor - sensor check

6.3.17 LP 30h: Tape Usage

See LOG SELECT - 4Ch (see 5.2.7 on page 82) and LOG SENSE - 4Dh (see 5.2.8 on page 83) for directions on how to use this page. This page contains non-volatile information relating to volume usage.

WARNING WARNING

This page has been replaced by the standard log page Volume Statistics log page (17h) (see 6.3.14). This page is included for legacy applications and may become obsolete in future generation drives.

WARNING WARNING

6.3.17.1 Parameter Reset Behavior (30h)

Parameters in this page are read-only.

6.3.17.2 Parameter Definitions (30h)

WARNING WARNING

The parameters in log pages should be dynamically parsed as some parameters may not be present and new parameters may be insterted. The relative location of parameters have changed and are anticipated to continue to change..

WARNING WARNING

Table 195 — LP 30h: Tape Usage log parameter codes

Code	Counter: Description	Size
0001h	**Volume Mounts {30h:0001h}:** Number of mounts for the current volume:	4
0002h	**Volume Datasets Written {30h:0002h}:** Total number of datasets written	8
0003h	**Volume Write Retries {30h:0003h}:** Total number of write temps	4
0004h	**Volume Write Perms {30h:0004h}:** Total write perms	2
0005h	**Volume Suspended Writes {30h:0005h}:**	2
0006h	**Volume Fatal Suspended Writes {30h:0006h}:**	2
0007h	**Volume Datasets Read {30h:0007h}:** Total number of datasets read	8
0008h	**Volume Read Retries {30h:0008h}:** Total number of read temps	4
0009h	**Volume Read Perms {30h:0009h}:** Total read perms	2
000Ah	**Volume Suspended Reads {30h:000Ah}:** Always set to 0000h	2
000Bh	**Volume Fatal Suspended Reads {30h:000Bh}:** Always set to 0000h	2

6.3.18 LP 31h: Tape capacity

See LOG SELECT - 4Ch (see 5.2.7 on page 82) and LOG SENSE - 4Dh (see 5.2.8 on page 83) for directions on how to use this page.

6.3.18.1 Parameter Reset Behavior (31h)

This page is reflects the currently loaded volume and as such changes when a volume is loaded. Values change after a successful format of the volume. This data cannot be reset or written.

6.3.18.2 Parameter Definitions(31h)

The Tape capacity log parameters are listed in table 196.

WARNING WARNING

The parameters in log pages should be dynamically parsed as some parameters may not be present and new parameters may be insterted. The relative location of parameters have changed and are anticipated to continue to change.

WARNING WARNING

Table 196 — LP 31h: Tape capacity log parameters

Parameter Code (in Hex)	Counter: Description	Size
0001h	**Partition 0 Remaining Capacity {31h:0001h}:** A representation of the location on medium of EOD expressed in Megabytes (106) Native Capacity between EOD and EOP 0. This is intended to be used as a gauge to display the percentage of partition 0 used. There is no guarantee that the amount of data expressed in this parameter will be available for writing.	4
0002h	**Partition 1 Remaining Capacity {31h:0002h}:** A representation of the location on medium of EOD expressed in Megabytes (106) Native Capacity between EOD and EOP 1. This is intended to be used as a gauge to display the percentage of partition 1 used. There is no guarantee that the amount of data expressed in this parameter will be available for writing.	4
0003h	**Partition 0 Maximum Capacity {31h:0003h}:** Value representing the Native Capacity of partition 0 in Megabytes (10^6) Note that the value changes depending on how the volume is partitioned. Less than or equal to 0015 D3EFh (i.e., 1 500 000 000 000 bytes)	4
0004h	**Partition 1 Maximum Capacity {31h:0004h}:** Value representing the Native Capacity of partition 1 in Megabytes (10^6) Note that the value changes depending on how the volume is partitioned. The maximum size of partition 1 is determined by the minimum size of partition 0 and the size of formatting overhead (i.e., guard band). Less than or equal to 0014 BC89h (i.e., 1 425 000 000 000 bytes)	4

6.3.19 LP 32h: Data compression

See LOG SELECT - 4Ch (see 5.2.7 on page 82) and LOG SENSE - 4Dh (see 5.2.8 on page 83) for directions on how to use this page. This page contains counters related to compression.

WARNING WARNING

This page has been replaced by the standard log page, LP 1Bh: Data Compression (see 6.3.14 on page 259). This page is included for legacy applications and may become obsolete in future generation drives.

WARNING WARNING

6.3.19.1 Parameter Reset Behavior (32h)

Parameters in this page may be reset, but may not be written.

6.3.19.2 Parameter Definitions (32h)

Parameters 0002h through 0009h occur as pairs that represent a large number of bytes transferred. The first parameter represents the number of whole megabytes (10^6) transferred, rounded to the nearest megabyte. The second parameter represents the signed difference between this number of megabytes and the actual number of bytes using signed values.

WARNING WARNING

The parameters in log pages should be dynamically parsed as some parameters may not be present and new parameters may be insterted. The relative location of parameters have changed and are anticipated to continue to change.

WARNING WARNING

Table 197 — LP 33h: Data Compression Log Parameters

Parameter Code	Counter: Description	Size
0000h	**Read Compression ratio x 100 {32h:0000h}:**	2
0001h	**Write Compression Ratio x 100 {32h:0001h}:**	2
0002h	**Megabytes transferred to server {32h:0002h}:** (10^6)	4
0003h	**Bytes transferred to server {32h:0003h}:**	4
0004h	**Megabytes read from tape {32h:0004h}:** (10^6)	4
0005h	**Bytes read from tape {32h:0005h}:**	4
0006h	**Megabytes transferred from server {32h:0006h}:** (10^6)	4
0007h	**Bytes transferred from server {32h:0007h}:**	4
0008h	**Megabytes written to tape {32h:0008h}:** (10^6)	4
0009h	**Bytes written to tape {32h:0009h}:**	4

6.3.20 LP 33h: Write Errors

See LOG SELECT - 4Ch (see 5.2.7 on page 82) and LOG SENSE - 4Dh (see 5.2.8 on page 83) for directions on how to use this page. This page contains detailed counters related to write operations.

6.3.20.1 Parameter Reset Behavior (33h)

Parameters in this page are reset when a cartridge is loaded.

6.3.20.2 Parameter Definitions (33h)

When multiple errors occur on a dataset, the counter that is updated is generally based on the first error detected.

WARNING WARNING

The parameters in log pages should be dynamically parsed as some parameters may not be present and new parameters may be insterted. The relative location of parameters have changed and are anticipated to continue to change..

WARNING WARNING

Table 198 — LP 33h: Write Errors log parameter codes (part 1 of 2)

Code	Counter: Description	Size
0000h	**Datasets Corrected {33h:0000h}:** ECC is done by hardware. This is driven by an excessive CQs rewritten condition. Each count represents one dataset in error that was successfully corrected and written.	2
0001h	**Servo Transients {33h:0001h}:** ERP action was required because of a servo detected error and the first retry was successfully in place (stop write without backhitch, i.e, servo write skip). Each count represents one dataset in error that was successfully recovered and written.	2
0002h	**Data Transients {33h:0002h}:** ERP action was required because of a readback check or ECC detected error and the first retry was successfully in place (no backhitch). Each count represents one dataset in error that was successfully recovered and written.	2
0003h	**Velocity Events {33h:0003h}:** A velocity control problem occurred. Each count represents one occurrence, not just the count of affected datasets. Counts may include occurrences from both temporary and permanent errors.	2
0004h	**Servo Acquisition Temps {33h:0004h}:** A servo error (servo dropout or off-track shutdown) was detected while trying to acquire a DSS or dataset at the beginning of a write append sequence (motion); ERP action was required, and servo transient condition criteria were not met. Each count represents one dataset in error that was successfully recovered and written.	2
0005h	**Data Acquisition Temps {33h:0005h}:** During read-back check, the read channel failed to acquire a DSS or dataset at the beginning of a write append sequence and no servo error was reported, ERP action was required, and read/ECC transient condition criteria were not met. Each count represents one dataset in error that was successfully recovered and written.	2
0006h	**Servo Temps {33h:0006h}:** A servo error (servo dropout or off-track shutdown) was detected while writing data, ERP action was required, and servo transient condition criteria were not met. Each count represents one dataset in error that was successfully recovered and written.	2
0007h	**Data Temps {33h:0007h}:** An uncorrectable error, CRC error, instantaneous speed variation (ISV) error, or no ending burst error occurred during readback check of a dataset, and no servo error was reported; ERP action was required, and readback/ECC transient condition criteria were not met. Each count represents one dataset in error that was successfully recovered and written.	2
0008h	**Total Retries {33h:0008h}:** The count of the total number of ERP actions. Each count represents one occurrence, not just one time per dataset. Counts may include occurrences from both temporary and permanent errors.	2

Table 198 — LP 33h: Write Errors log parameter codes (part 2 of 2)

Code	Counter: Description	Size
0009h	Vendor-Reserved	2
000Ah	**Match Filter ERP {33h:000Ah}:** (write mode use)	2
000Bh	**Servo Skip Events {33h:000Bh}:** The count of long servo write skips, extended DSS or long spaces between datasets written. This is generally servo write skips, but may also include other write scenarios. Each count represents one occurrence, not one count per block. Counts may include occurrences from both temporary and permanent errors.	2
000Ch	**Housekeeping Events {33h:000Ch}:** The count of write problems in the Housekeeping Dataset Region. Each count represents one occurrence, not just one time per dataset. Counts may include occurrences from both temporary and permanent errors.	2
000Dh	**FID Events {33h:000Dh}:** The count of write problems while processing the FID. Each count represents one occurrence, not just one time per dataset. Counts may include occurrences from both temporary and permanent errors.	2
000Eh	**Vendor-Reserved (Blocks Lifted) {33h:000Eh}:**	2
000Fh	**Dataset Underrun {33h:000Fh}:** The number of times that the drive overran the buffer processing capability and had to stop and restart during a write. Each count represents one occurrence, not just one time per write.	2
0010h	Vendor-Reserved	2
0011h	**Servo Position Events {33h:0011h}:** The number of servo detected positional compare discrepancies.	2

6.3.21 LP 34h: Read Forward Errors

See LOG SELECT - 4Ch (see 5.2.7 on page 82) and LOG SENSE - 4Dh (see 5.2.8 on page 83) for directions on how to use this page. This page contains detailed counters related to read operations.

6.3.21.1 Parameter Reset Behavior (34h)

Parameters in this page are reset when a cartridge is loaded.

6.3.21.2 Parameter Definitions (34h)

When multiple errors occur on a dataset, the counter that is updated is generally based on the first error detected. ERP counters indicate which specific ERP methods were successfully employed.

WARNING WARNING

The parameters in log pages should be dynamically parsed as some parameters may not be present and new parameters may be insterted. The relative location of parameters have changed and are anticipated to continue to change.

WARNING WARNING

Table 199 — LP 34h: Read Error Counters log parameter codes (part 1 of 2)

Code	Counter: Description	Size
0000h	**Datasets Corrected {34h:0000h}:** ECC is done by hardware. Each count represents one dataset in error that was successfully corrected and read.	2
0001h	**Servo Transients {34h:0001h}:** ERP action was required because of a servo detected error and the first retry was successfully in place. Each count represents one dataset in error that was successfully recovered and read.	2
0002h	**Data Transients {34h:0002h}:** ERP action was required because of a read channel or ECC detected error and the first retry was successfully in place. Each count represents one dataset in error that was successfully recovered and read.	2
0003h	**Velocity Events {34h:0003h}:** A velocity control problem occurred. Each count represents one occurrence, not just the count of affected datasets. Counts may include occurrences from both temporary and permanent errors.	2
0004h	**Servo Acquisition Temps {34h:0004h}:** A servo error (servo dropout or off track shutdown) was detected while trying to acquire an initial DSS or dataset, ERP action was required, and servo transient condition criteria were not met. Each count represents one dataset in error that was successfully recovered and read.	2
0005h	**Data Acquisition Temps {34h:0005h}:** The read channel failed to acquire an initial DSS or dataset, and no servo error was reported; ERP action was required, and read/ECC transient condition criteria were not met. Each count represents one dataset in error that was successfully recovered and read.	2
0006h	**Servo Temps {34h:0006h}:** A servo error (servo drop out) was detected while reading a dataset; ERP action was required, and servo transient condition criteria were not met. Each count represents one dataset in error that was successfully recovered and read.	2
0007h	**Data Temps {34h:0007h}:** An uncorrectable error, CRC error, or no ending burst error occurred while reading a dataset, and no servo error was reported; ERP action was required, and read/ECC transient condition criteria were not met. Each count represents one dataset in error that was successfully recovered and read.	2
0008h	**Sequence Errors {34h:0008h}:** A dataset number out of sequence was encountered, and no Servo or read/ECC error reported; ERP action was required, and no transient condition criteria were not met. Each count represents one dataset in error that was successfully recovered and read.	2
0009h	**Vendor-Reserved {34h:0009h}:**	2
000Ah	**Vendor-Reserved {34h:000Ah}:**	2

Table 199 — LP 34h: Read Error Counters log parameter codes (part 2 of 2)

Code	Counter: Description	Size
000Bh	**Vendor-Reserved {34h:000Bh}:**	2
000Ch	**ERP Servo Adjust Hi {34h:000Ch}:** The dataset was recovered by reading with servo off-track variations. Each count represents one dataset in error that was successfully recovered and read.	2
000Dh	**ERP Servo Adjust Lo {34h:000Dh}:** The dataset was recovered by reading with servo off-track variations. Each count represents one dataset in error that was successfully recovered and read.	2
000Eh	**Vendor-Reserved {34h:000Eh}:**	2
000Fh	**Vendor-Reserved {34h:000Fh}:**	2
0010h	**Servo AGA Gain ERP {34h:0010h}:** (read only mode)	2
0011h	**Vendor-Reserved: {34h:0011h}**	2
0012h	**Servo Opposite Gap ERP {34h:0012h}:** (read only mode)	2
0013h	**Vendor-Reserved {34h:0013h}:**	2
0014h	Vendor-Reserved	2
0015h	**Total Retries {34h:0015h}:** The count of the total number of ERP actions. Each count represents one occurrence, not just one time per dataset. Counts may include occurrences from both temporary and permanent errors.	2
0016h	**Match Filter ERP {34h:0016h}:** (read mode use)	2
0017h	**Housekeeping Events {34h:0017h}:** The count of read problems in the Housekeeping Dataset Region. Each count represents one occurrence, not just one time per dataset. Counts may include occurrences from both temporary and permanent errors.	2
0018h	**Vendor-Reserved {34h:0018h}:**	2
0019h	**Dataset Overrun {34h:0019h}:** The number of times that the drive overran the buffer processing capability and had to stop and restart during a read. Each count represents one occurrence, not just one time per read.	2
001Ah	Vendor-Reserved	2
001Bh	**Servo Skip Events {34h:001Bh}:** The count of extended DSS or long spaces between datasets read. This may include servo write skips, but may also include other write scenarios. Each count represents one occurrence, not one count per block. Counts may include occurrences from both temporary and permanent errors.	2
001Ch	Vendor-Reserved	2
001Dh	**FID Events {34h:001Dh}:** The count of read problems while processing the FID. Each count represents one occurrence, not just one time per dataset. Counts may include occurrences from both temporary and permanent errors.	2
001Eh	**Servo Position Events {34h:001Eh}:** The number of servo detected positional compare discrepancies.	2

6.3.22 LP 37h: Performance Characteristics

See LOG SELECT - 4Ch (see 5.2.7 on page 82) and LOG SENSE - 4Dh (see 5.2.8 on page 83) for directions on how to use this page. This page includes various performance and capacity measurements across the operation of the drive. Some fields are normalized qualitative measures while others are quantitative.

6.3.22.1 Parameter Reset Behavior (37h)

Each parameter has different reset characteristics which are described under the Subpage Code field description for bits 7-6 Scope.

6.3.22.2 Parameter Definitions (37h)

This page uses the Subpage Code mechanism (see 6.3.1) to select which groups of counters to return. This page has three scopes controlled by the Subpage Code field.

The subpage field in LOG SENSE - 4Dh (see 5.2.8 on page 83) and Log Parameter Format is used as follows:

Bit	Description	
7-6	Scope	
	Value	**Description**
	00b	Transient values: reset on Log Select [all Subpages are reset]
	01b	Mount values: reset on load
	10b	Lifetime values: reset on device power on or device reset (not target reset)
	11b	Vendor-Reserved
5-4	Level	
	Value	**Description**
	00b	Return summary counters
	01b	Return basic counters
	10b	Return advanced counters
3-0	Group	
	Value	**Description**
	0h	All groups
	1h	Host Interface
	2h	Buffer
	3h	Medium
	4h	Capacity
	5h	Load/Unload
	6h	Servo

The Subpage field in LOG SENSE - 4Dh (see 5.2.8 on page 83) may be set to 00h when the page code field is 37h. This operation will reset all group and local counters in the transient scope. Other scope cannot be explicitly reset.

The individual log subpage and parameter codes are described in the following table. Note that the counters which are returned depends on the Level and Group fields in the subpage. A group value of 0h will return all counters of a level less than or equal to that specified.

In the following tables, multiple counter codes may be represented by a single row. There will be an aspect symbol in the counter code such as 'p', 'q', 's', or '?'. The Aspect(s) column indicates which of the following values applies to the given code(s).

Aspect	Definition
p=0	primary interface (fibre) all ports (totals)
p=1	primary interface (fibre) port 0
p=2	primary interface (fibre) port 1
p=A	automation interface (RS-422)
q=1	Non-Ready: NOTE: These commands include ALL commands which are processed when the drive is in a Not Ready state.
q=2	Head-of-Queue: NOTE: These commands are commands which may be processed in any order. Such commands include: Inquiry, Report LUNs, Test Unit Ready and Request Sense. These counts are updated only when the drive is in a Ready state.
q=3	Read: NOTE: This aspect has more features detailed below.
q=4	Write: NOTE: This aspect has more features detailed below.
q=5	Sync: NOTE: This aspect has more features detailed below.
q=6	Seek: NOTE: This aspect has more features detailed below.
q=7	Non-Medium: NOTE: These commands are command issued to LUN 0 which are not in any other applicable category. These include many commands such as Log Sense, Log Select, Read Buffer, Reserve, etc. These counts are updated only when the drive is in a Ready state.
q=8	Non-LUN0, Non-Ready: NOTE: These commands include ALL commands which are processed by a LUN other than LUN 0 when the drive is in a Not Ready state.
q=9	Non-LUN0, Head-of-Queue: NOTE: These commands are commands which may be processed in any order. Such commands include: Inquiry, Report LUNs, Test Unit Ready and Request Sense. These counts are updated only when the drive is in a Ready state.
q=A	Non-LUN0: NOTE: These commands include any commands processed by a LUN other than LUN 0. These counts are updated only when the drive is in a Ready state.
s=1	Speed 1: Highest read/write speed
s=2	Speed 2: Second highest read/write speed
s=3	Speed 3: Third highest read/write speed
s=4	Speed 4: Fourth highest read/write speed
s=5	Speed 5: Fifth highest read/write speed
s=6	Speed 6: Sixth highest read/write speed
s=7	Speed 7: Seventh highest read/write speed
s=8	Speed 8: Eighth highest read/write speed
s=9	Speed 9: Ninth highest read/write speed
s=A	Speed 10: Tenth highest read/write speed
s=B	Speed 11: Eleventh highest read/write speed
s=C	Speed 12: Twelfth highest read/write speed
s=D	Speed 13: Thirteenth highest read/write speed
s=E	Speed 14: Fourteenth highest read/write speed
s=F	High speed locate (not read/write capable)
t=0	Partition 0
t=1	Partition 1
?=1	write - write phase without host holdoff. NOTE: if no (paused) data is supported for a particular counter, this aspect will include all write information
?=2	write (paused) - write phase while the host is being held off (buffer full)
?=3	read - read phase without host holdoff. NOTE: if no (paused) data is supported for a particular counter, this aspect will include all read information
?=4	read (paused) - read phase while the host is being held off (buffer empty)
?=5	position - during the processing of a seek operation
?=6	load - during the processing of an load operation
?=7	unload - during the processing of an unload operation
?=F	other - not in an above phase

WARNING WARNING

The parameters in log pages should be dynamically parsed as some parameters may not be present and new parameters may be insterted. The relative location of parameters have changed and are anticipated to continue to change..

WARNING WARNING

Table 200 — LP 37h: Performance Characteristics: Quality Summary

Code	Aspect(s)	Name: Description	Unit	Size	Level	Group
0000h		**Drive Efficiency {37h:0000h}:** Overall measure of the drive's condition. 00 is unknown, from 01 (best) to FF (worst)	rating	1	0	0
0001h		**Media Efficiency {37h:0001h}:** Overall measure of the currently mounted media's condition. X'00' is unknown, from X'01' (best) to X'FF' (worst)	rating	1	0	0
0010h		**Primary Interface Efficiency {37h:0010h}:** Overall measure of the interface (to the host) condition. 00 is unknown, from 01 (best) to FF(worst)	rating	1	0	0
0011h		**Primary Interface Port 0 Efficiency {37h:0011h}:** Overall measure of the per port interface (to the host) condition. X'00' is unknown, from X'01' (best) to X'FF' (worst)	rating	1	0	0
0012h		**Primary Interface Port 1 Efficiency {37h:0012j}:** Overall measure of the per port interface (to the host) condition. 00 is unknown, from 01(best) to FF (worst)	rating	1	0	0
001Ah		**Library Interface Efficiency {37h:001Ah}:** Overall measure of the interface (to the library) condition. 00 is unknown, from 01 (best) to FF (worst)	rating	1	0	0

Table 201 — LP 37h: Performance Characteristics: Device Usage (part 1 of 2)

Code	Aspect(s)	Name: Description	Unit	Size	Level	Group
0040h		**Time {37h:0040h}:** Amount of entire sample duration	msec	6	2	5
0041h		**Medium Empty Time {37h:0041h}:** Duration without a tape present	msec	6	2	5
0042h		**Medium Insert Time {37h:0042h}:** Duration from cartridge insert to load	msec	6	2	5
0043h		**Medium Mount Time {37h:0043h}:** Total time from start of cartridge load until cartridge ejected	msec	6	2	5
0044h		**Medium Load Time {37h:0044h}:** Total time from start of cartridge load to load complete (ready)	msec	6	2	5
0045h		**Medium Ready Time {37h:0045h}:** Total time from load complete (ready) to start of unload	msec	6	2	5
0046h		**Medium Eject Time {37h:0046h}:** Time from start of unload to unload complete	msec	6	2	5
0047h		**Medium Extract Time {37h:0047h}:** Time from cartridge unloaded to removed	msec	6	2	5

Table 201 — LP 37h: Performance Characteristics: Device Usage (part 2 of 2)

Code	Aspect(s)	Name: Description	Unit	Size	Level	Group
0048h		**Medium Dwell Time {37h:0048h}:** Time from cartridge unloaded to (re)loaded. Note - This may include time which cannot be determined as dwell or extract (when time is queried with a cartridge remaining in the unloaded position)	msec	6	2	5
0049h		**Medium Clean Time {37h:0049h}:** Time from cleaner recognized to eject complete	msec	6	2	5
0051h		**Medium Empty Count {37h:0051h}:** Number of times tape was fully removed	count	4	2	5
0052h		**Medium Insert Count {37h:0052h}:** Number of cartridge insertions to load position detected	count	4	2	5
0053h		**Medium Mount Count {37h:0053h}:** Number of mount operations	count	4	2	5
0054h		**Medium Load Count {37h:0054h}:** Number of load operations	count	4	2	5
0055h		**Medium Ready Count {37h:0055h}:** Number of ready transitions	count	4	2	5
0056h		**Medium Eject Count {37h:0056h}:** Number of unloads	count	4	2	5
0057h		**Medium Extract Count {37h:0057h}:** Number of times tape was extracted	count	4	2	5
0058h		**Medium Dwell Count {37h:0058h}:** Number of times tape was reloaded (from unload)	count	4	2	5
0059h		**Medium Clean Count {37h:0059h}:** Number of recognized cleaner loads (does not indicate successful cleans, tape may be expired)	count	4	2	5

Table 202 — LP 37h: Performance Characteristics: Host Commands (part 1 of 4)

Code	Aspect(s)	Name: Description	Unit	Size	Level	Group
0q00h	12(3456)789A	**Count {37h:0q00h}:**	count	4	2	1
0q01h	12(3456)789A	**Timing {37h:0q01h}:**	msec	6	2	1
0q02h	12(3456)789A	**Relative Time {37h:0q01h}:**	% * 65536	4	1	1
0q04h	12(3456)789A	**Transfer Count to Host (in) {37h:0q04h}:**	count	4	2	1
0q05h	12(3456)789A	**Transfer Byte Count to Host (in) {37h:0q05h}:**	bytes	8	2	1
0q06h	12(3456)789A	**Transfer Timing to Host (in) {37h:0q06h}:**	msec	6	2	1
0q08h	12(4)789A	**Transfer Count from Host (out) {37h:0q08h}:**	count	4	2	1
0q09h	12(4)789A	**Transfer Byte Count from Host (out) {37h:0q09h}:**	bytes	8	2	1
0q0Ah	12(4)789A	**Transfer Timing from Host (out) {37h:0q0Ah}:**	msec	6	2	1
Note - Read type host commands include Read, Verify and Read Reverse (not all of these may be supported). These counts are updated only when the drive is in a Ready state						
0300h		**Read Count {37h:0300h}:** Number of blocks processed to the host by read type commands	blocks	6	2	1

Table 202 — LP 37h: Performance Characteristics: Host Commands (part 2 of 4)

Code	Aspect(s)	Name: Description	Unit	Size	Level	Group
0301h		**Read Timing {37h:0301h}:** Amount of time processing read type commands. Note - Due to device specific performance path resources, this may not reflect the actual time spent processing commands, but may reflect the amount of time where read commands could be processed.	msec	6	2	1
0302h		**Read Relative Time {37h:0302h}:** Ratio of time spent reading with respect to Medium Ready Time	% * 65536	4	1	1
0304h		**Transfer Count to Host (in) {37h:0304h}:**	count	6	2	1
0305h		**Transfer Byte Count to Host (in) {37h:0305h}:**	bytes	8	2	1
0306h		**Transfer Timing to Host (in) {37h:0306h}:**	msec	6	2	1
03D0h		**Read Performance Efficiency {37h:03D0h}:** Ratio of performance read type commands with respect to all read type commands	% * 65536	4	1	1
03D4h		**Read Filemark (perf) Relative Time {37h:03D4h}:** Amount of time spent sending filemark encountered status to the host with respect to time Read Timing.	% * 65536	4	2	1
Note - Write type host commands include Write and Write Filemarks [not including any synchronization portion]. These counts are updated only when the drive is in a Ready state.						
0400h		**Write Count {37h:0400h}:** Number of blocks processed from the host by write type commands	blocks	6	2	1
0401h		**Write Timing {37h:0401h}:** Amount of time processing write type commands. Note - Due to device specific performance path resources, this may not reflect the actual time spent processing commands, but may reflect the amount of time where write commands could be processed.	msec	6	2	1
0402h		**Write Relative Time {37h:0402h}:** Ratio of time spent writing with respect to Medium Ready Time	% * 65536	4	1	1
0404h		**Transfer Count to Host (in) {37h:0404h}:**	count	6	2	1
0405h		**Transfer Byte Count to Host (in) {37h:0405h}:**	bytes	8	2	1
0406h		**Transfer Timing to Host (in) {37h:0406h}:**	msec	6	2	1
0408h		**Transfer Count from Host (out) {37h:0408h}:**	count	6	2	1
0409h		**Transfer Byte Count from Host (out) {37h:0409h}:**	bytes	8	2	1
040Ah		**Transfer Timing from Host (out) {37h:040Ah}:**	msec	6	2	1
04D0h		**Write Performance Efficiency {37h:04D0h}:** Ratio of performance write commands with respect to all write type commands	% * 65536	4	1	1
04D4h		**Write Filemark Relative Time {37h:04D4j}:** Amount of time spent writing filemarks.	% * 65536	4	2	1
Note - Sync type host commands include Write Filemarks [non-immediate]. Implicit sync type commands include mode changes while writing, non-buffered mode and idle time based syncs. These counts are updated only when the drive is in a Ready state.						
0500h		**Sync Count [Host] {37h:0500h}:** Number of host sync operations (non-immediate Write Filemarks, non-buffered writes)	count	4	2	1

Table 202 — LP 37h: Performance Characteristics: Host Commands (part 3 of 4)

Code	Aspect(s)	Name: Description	Unit	Size	Level	Group
0501h		**Sync Timing [Host] {37h:0501h}:** Amount of time processing host sync commands	msec	6	2	1
0502h		**Sync Relative Time [Host] {37h:0502h}:** Ratio of time spent processing host sync commands with respect to Medium Ready Time	% * 65536	4	1	1
0504h		**Transfer Count to Host (in) {37h:0504h}:**	count	4	2	1
0505h		**Transfer Byte Count to Host (in) {37h:0505h}:**	bytes	8	2	1
0506h		**Transfer Timing to Host (in) {37h:0506h}:**	msec	6	2	1
05D1h		**Sync Count [Implicit] {37h:05D1h}:** Number of implicit sync commands (time based flushes, mode change flushes)	count	4	2	1
05D2h		**Sync Timing [Implicit] {37h:05D2h}:** Amount of time processing implicit sync commands	msec	6	2	1
05D4h		**Sync Relative Time [Implicit] {37h:05D4h}:** Ratio of time spent processing implicit sync commands with respect to Medium Ready Time	% * 65536	4	1	1
Note - Seek type host commands include Space, Locate, and Rewind. These counts are updated only when the drive is in a Ready state.						
0600h		**Seek Count {37h:0600h}:** Number of positioning host commands	count	4	2	1
0601h		**Seek Timing {37h:0601h}:** Amount of time spent processing host positioning commands	msec	6	2	1
0602h		**Seek Relative Time {37h:0602h}:** Ratio of time spend processing host seek commands with respect to Medium Ready Time	% * 65536	4	1	1
0604h		**Transfer Count to Host (in) {37h:0604h}:**	count	4	2	1
0605h		**Transfer Byte Count to Host (in) {37h:0605h}:**	bytes	8	2	1
0606h		**Transfer Timing to Host (in) {37h:0606h}:**	msec	6	2	1
06D1h		**Seek Block Count {37h:06D1h}:** Number of blocks processed in host positioning commands	blocks	4	2	1
0Cp0h	012A	**Command Count {37h:0Cp0h}:**	count	6	2	1
0Cp1h	012A	**Command Timing {37h:0Cp1h}:**	msec	6	2	1
0Cp2h	012A	**Command Relative Time {37h:0Cp2h}:**	% * 65536	4	2	1
0Cp4h	012A	**Command Transfer Count to Host (in) {37h:0Cp4h}:**	count	6	2	1
0Cp5h	012A	**Command Transfer Byte Count to Host (in) {37h:0Cp5h}:**	bytes	8	2	1
0Cp6h	012A	**Command Transfer Timing to Host (in) {37h:0Cp6h}:**	msec	6	2	1
0Cp8h	012A	**Command Transfer Count from Host (out) {37h:0Cp8h}:**	count	6	2	1
0Cp9h	012A	**Command Transfer Byte Count from Host (out) {37h:0Cp9h}:**	bytes	8	2	1
0CpAh	012A	**Command Transfer Timing from Host (out) {37h:0CpAh}:**	msec	6	2	1
0CpCh	012A	**Command Queue Count {37h:0CpCh}:**	count	6	2	1

Table 202 — LP 37h: Performance Characteristics: Host Commands (part 4 of 4)

Code	Aspect(s)	Name: Description	Unit	Size	Level	Group
0CpDh	012A	**Command Queue Latency {37h:0CpDh}:**	msec	6	2	1
0CpEh	012A	**Command Queue Relative Time {37h:0CpEh}:**	% * 65536	4	2	1
0Dp1h	12A	**Port Throughput Rate Maximum Bursting {37h:0Dp1h}:**	bytes/sec	6	2	1
0Dp2h	12A	**Port Throughput Rate Maximum Sustained {37h:0Dp2h}:**	bytes/sec	6	2	1
0Dp3h	12A	**Port Throughput Rate {37h:0Dp3h}:**	bytes/sec	6	2	1
0Dp4h	12A	**Port Throughput Efficiency {37h:0Dp4h}:**	% * 65536	4	1	1
0Dp7h	12A	**Port Rate Changes {37h:0Dp7h}:**	count	4	2	1
0DF0h		**Average Command Latency {37h:0DF0h}:** Average amount of time commands were queued waiting for execution with respect to all commands (including unqueued commands which processed immediately).	usec	4	1	1
0DF1h		**Average Dequeue Latency {37h:0DF1h}:** Average amount of time commands were queued waiting for execution with respect to commands which where queued (not processed immediately).	usec	4	1	1
0DF8h		**Long Queue Latency Count [>1 sec] {37h:0DF8h}:**	count	4	2	1
0DF9h		**Long Queue Latency Count [>10 sec] {37h:0DF9h}:**	count	4	2	1
0DFAh		**Long Queue Latency Count [>100 sec] {37h:0DFAh}:**	count	4	2	1
0DFBh		**Long Queue Latency Count [>1000 sec] {37h:0DFBh}:**	count	4	2	1

Table 203 — LP 37h: Performance Characteristics: Host Initiators

Code	Aspect(s)	Name: Description	Unit	Size	Level	Group
Note - In dual port configurations it is possible for the same host to be identified as a different initiator when using a different logical or physical path. This can occur in failover or load balancing applications.						
0E00h		**Active Initiator Count {37h:0E00h}:** Number of initiators which processed one or more commands.	count	4	2	1
0E01h		**Primary Initiator {37h:0E01h}:** Ratio of commands issued by the initiator which is issuing the most commands with respect to all initiators.	% * 65536	4	2	1
0E02h		**Secondary Initiator {37h:0E02h}:** Ratio of commands issued by the initiator which is issuing the second most commands with respect to all initiators.	% * 65536	4	2	1
0E03h		**Current Initiator {37h:0E03h}:** Ratio of commands issued by this (the querying) initiator with respect to all initiators.	% * 65536	4	2	1

Table 204 — LP 37h: Performance Characteristics: Host Recovery (by port)

Code	Aspect(s)	Name: Description	Unit	Size	Level	Group
0Fp0h	12A	**Transfer Recoveries [by port] {37h:0Fp0h}:**	count	4	2	1
0Fp1h	12A	**Transfer Recover Time [by port] {37h:0Fp1h}:**	msec	6	2	1
0Fp2h	12A	**Resource Recoveries [by port] {37h:0Fp2h}:**	count	4	2	1
0Fp3h	12A	**Reset Count [by port] {37h:0Fp3h}:**	count	4	2	1
0Fp8h	12A	**Abort Count [by port] {37h:0Fp8h}:**	count	4	2	1
0Fp9h	12A	**Abort Time [by port] {37h:0Fp9h}:**	msec	6	2	1

Table 205 — LP 37h: Performance Characteristics: Mode Phase Timing Windows (part 1 of 3)

Code	Aspect(s)	Name: Description	Unit	Size	Level	Group
1000h		**Write Cycles {37h:1000h}:**	count	4	2	2
1001h		**Write Pauses {37h:1001h}:**	count	4	2	2
1010h		**Write Cycle Time {37h:1010h}:**	msec	6	2	2
1020h		**Write Cycle Relative Time {37h:1020h}:** Ratio of time in write mode with respect to Medium Ready Time.	% * 65536	4	1	2
1021h		**Write Setup Relative Time {37h:1021h}:**	% * 65536	4	2	2
1022h		**Write Ready Relative Time {37h:1022h}:**	% * 65536	4	1	2
1023h		**Write Pause Relative Time {37h:1023h}:**	% * 65536	4	1	2
1024h		**Write Exit Relative Time {37h:1024h}:**	% * 65536	4	2	2
1200h		**Read Cycles {37h:1200h}:**	count	4	2	2
1201h		**Read Pauses {37h:1201h}:**	count	4	2	2
1210h		**Read Cycle Time {37h:1210h}:**	msec	6	2	2
1220h		**Read Cycle Relative Time {37h:1220h}:** Ratio of time in write mode with respect to Medium Ready Time.	% * 65536	4	1	2
1221h		**Read Setup Relative Time {37h:1221h}:**	% * 65536	4	2	2
1222h		**Read Ready Relative Time {37h:1222h}:**	% * 65536	4	1	2
1223h		**Read Pause Relative Time {37h:1223h}:**	% * 65536	4	1	2
1224h		**Read Exit Relative Time {37h:1224h}:**	% * 65536	4	2	2
1225h		**Read Traverse EM Relative Time {37h:1225h}:**	% * 65536	4	2	2
1400h		**Position Count {37h:1400h}:**	count	4	2	2
1410h		**Position Time {37h:1410h}:**	msec	6	2	2
1420h		**Position Relative Time {37h:1420h}:** Ratio of time spent physically and logically positioning with respect to Medium Ready Time.	% * 65536	4	1	2
1430h		**Position Relative Rate {37h:1430h}:**	bytes/sec	4	1	2
1480h		**Position Count (Media) {37h:1480h}:**	count	4	2	2
1490h		**Position Time (Media) {37h:1490h}:**	msec	6	2	2
14A0h		**Position Relative Time (Media) {37h:14A0h}:** Ratio of time spent physically positioning media with respect to Medium Ready Time.	% * 65536	4	1	2
14B0h		**Position Relative Rate (Media) {37h:14B0h}:**	bytes/sec	4	1	2

Table 205 — LP 37h: Performance Characteristics: Mode Phase Timing Windows (part 2 of 3)

Code	Aspect(s)	Name: Description	Unit	Size	Level	Group
14F0h		**Position Buffer Hits {37h:14F0h}:** Ratio of positioning operations where targets were already present in the buffer.	% * 65536	4	1	2
1500h		**Flush Count {37h:1500h}:** Number of low level buffer write flush operations. These may include operations which only affect the buffer and do not involve media motion.	count	4	1	2
1510h		**Flush Time {37h:1510h}:** Time spend executing operations counted by Flush Count.	msec	6	2	2
1520h		**Flush Relative Time {37h:1520h}:** Ratio of time spent flushing with respect to Medium Ready Time.	% * 65536	4	1	2
1580h		**Flush Count (Media) {37h:1580h}:** Number of low level buffer write flush operations which involve [or continue] media motion.	count	4	1	2
1590h		**Flush Time (Media) {37h:1590h}:** Time spent executing operations counted by Flush Count (Media).	msec	6	2	2
15A0h		**Flush Relative Time (Media) {37h:15A0h}:** Ratio of time spent flushing to media with respect to Write Cycle Time.	% * 65536	4	1	2
15F0h		**Flush Buffer Hits {37h:15F0h}:** Ratio of flush operations which required media motion.	% * 65536	4	1	2
2000h		**Media Idle {37h:2000h}:**	msec	6	2	3
2001h		**Media Write {37h:2001h}:**	msec	6	2	3
2002h		**Media Read {37h:2002h}:**	msec	6	2	3
2003h		**Media Erase {37h:2003h}:**	msec	6	2	3
2004h		**Media Position {37h:2004h}:**	msec	6	2	3
20?0h	1234567F	**Media Phase Timing {37h:20?0h}:**	msec	6	2	3
20?1h	1234567F	**Media Phase Cycles {37h:20?1h}:**	count	4	2	3
2?10h	1234567F	**Wrap Change Count {37h:2?10h}:** Total number of wrap changes.	count	4	2	3
2?11h	1234567F	**Band Change Count {37h:2?11h}:** Total number of changes to different servo bands.	count	4	2	3
2?50h	13	**Datarate Performance Impacting ERPs {37h:2?50h}:**	% * 65536	4	1	3
2?51h	13567F	**Performance Impacting ERPs {37h:2?51h}:**	% * 65536	4	1	3
2?52h	1234567F	**Performance Impact by ERPs {37h:2?52h}:**	% * 65536	4	1	3
2?60h	135	**Uncompressed Data {37h:2?60h}:**	bytes	8	2	2
2?61h	135	**Compressed Data {37h:2?61h}:**	bytes	8	2	2
2?62h	135	**Padded Data {37h:2?62h}:**	bytes	8	2	2
2?63h	135	**Degate Data {37h:2?63h}:**	bytes	8	2	2
2?68h	135	**Datasets Processed {37h:2?68h}:**	datasets	4	2	2
2?6Ch	13	**Compression Ratio {37h:2?6Ch}:**	% * 65536	4	1	2
2?71h	13F	**Compressed Data (Medium) {37h:2?71h}:**	bytes	8	2	3
2?72h	13F	**Padded Data (Medium) {37h:2?72h}:**	bytes	8	2	3
2?80h	13	**Maximum Host Transfer Rate {37h:2?80h}:**	bytes/sec	4	1	2

Table 205 — LP 37h: Performance Characteristics: Mode Phase Timing Windows (part 3 of 3)

Code	Aspect(s)	Name: Description	Unit	Size	Level	Group
2?81h	13	**Average Host Transfer Rate {37h:2?81h}:**	bytes/sec	4	1	2
2?82h	13	**Average Host Buffer Rate {37h:2?82h}:**	bytes/sec	4	1	2
2?83h	13	**Window Host Buffer Rate {37h:2?83h}:**	bytes/sec	4	1	2
2?84h	13	**Host Buffer Efficiency {37h:2?84h}:**	% * 65536	4	1	2
2?85h	13	**Window Buffer Efficiency {37h:2?85h}:**	% * 65536	4	1	2
2?88h	13	**Average Host Transfer Length {37h:2?88h}:**	bytes	4	2	2
2?8Ch	1	**Average Host Sync Length {37h:2?8Ch}:**	bytes	6	2	2
2?90h	13	**Maximum Comp Transfer Rate {37h:2?90h}:**	bytes/sec	4	1	2
2?91h	13	**Average Comp Transfer Rate {37h:2?91h}:**	bytes/sec	4	1	2
2?92h	13	**Average Comp Buffer Rate {37h:2?92h}:**	bytes/sec	4	1	2
2?93h	13	**Window Comp Buffer Rate {37h:2?93h}:**	bytes/sec	4	1	2
2?94h	13	**Comp Buffer Efficiency {37h:2?94h}:**	% * 65536	4	1	2
2?95h	13	**Window Comp Buffer Efficiency {37h:2?95h}:**	% * 65536	4	1	2
2?98h	13	**Average Comp Transfer Length {37h:2?98h}:**	bytes	4	2	2
2?9Ch	1	**Average Comp Sync Length {37h:2?9Ch}:**	bytes	6	2	2
2?A0h	13	**Maximum Tape Transfer Rate {37h:2?A0h}:**	bytes/sec	4	1	2
2?A1h	13	**Average Tape Buffer Rate {37h:2?A1h}:**	bytes/sec	4	2	2
2?A2h	13	**Window Tape Buffer Rate {37h:2?A2h}:**	bytes/sec	4	2	2
2?A3h	13	**Moving Tape Buffer Rate {37h:2?A3h}:**	bytes/sec	4	2	2
2?A4h	13	**Window Tape Buffer Efficiency {37h:2?A4h}:**	% * 65536	4	2	2
2?A5h	13	**Moving Tape Buffer Efficiency {37h:2?A5h}:**	% * 65536	4	2	2
2?A6h	13	**Tape Buffer Efficiency {37h:2?A6h}:** Ratio of amount of time we are usefully moving and ready with respect to amount of time the buffer is able to process data. A ratio larger than 1 indicates the compressed host data is arriving faster than the native device rate. Lower values indicate the device has under utilized host bandwidth.	% * 65536	4	2	2
2?A7h	13F	**Tape Thrashing {37h:2?A7h}:** Ratio of amount of time we are accelerating, decelerating or backhitching with respect to the time in mode.	% * 65536	4	2	2
2?A8h	13F	**Tape Efficiency {37h:2?A8h}:** Ratio of amount of time we are usefully moving and ready with respect to the time in mode.	% * 65536	4	1	2
2?F0h	13	**Speed Changes {37h:2?F0h}:**	count	4	2	2
2?F1h	13	**Speed Forced {37h:2?F1h}:**	count	4	2	2

Table 206 — LP 37h: Performance Characteristics: Servo Speed Characteristics

Code	Aspect(s)	Name: Description	Unit	Size	Level	Group
5Fs0h	123456789ABCDEF	**Servo Speed Relative Time {37h:5Fs0h}:**	% * 65536	4	2	6

Table 207 — LP 37h: Performance Characteristics: Static Capacity

Code	Aspect(s)	Name: Description	Unit	Size	Level	Group
7000h		**Static Capacity Efficiency {37h:7000h}:**	% * 65536	4	1	4
7010h		**Static Datasets Media {37h:7010h}:**	datasets	4	2	4
7011h		**Static Datasets Used {37h:7011h}:**	datasets	4	2	4
7020h		**Static Distance Media {37h:7020h}:**	mm	8	2	4
7021h		**Static Distance Used {37h:7021h}:**	mm	8	2	4
7030h		**Static Remaining Capacity in SkipSync Buffer {37h:7030h}:**	% * 65536	4	2	4

Table 208 — LP 37h: Performance Characteristics: Active Capacity

Code	Aspect(s)	Name: Description	Unit	Size	Level	Group
7?00h	13F	**Active Capacity Efficiency {37h:7?00h}:**	% * 65536	4	1	4
7?10h	13F	**Active Sync Loss {37h:7?10h}:**	% * 65536	4	2	4
7?11h	13F	**Active Skip Loss {37h:7?11h}:**	% * 65536	4	2	4
7?12h	13F	**Active DSS Loss {37h:7?12h}:**	% * 65536	4	2	4
7?13h	13F	**Active CQs Loss (on-the-fly) {37h:7?13h}:**	% * 65536	4	2	4
7?21h	13F	**Active Distance Skip {37h:7?21h}:**	mm	8	2	4
7?22h	13F	**Active Distance DSS {37h:7?22h}:**	mm	8	2	4
7?23h	13F	**Active Distance CQs (on-the-fly) {37h:7?23h}:**	mm	8	2	4
7?2Fh	13F	**Active Distance Total {37h:7?2Fh}:**	mm	8	2	4

Table 209 — Log Page 37h: Performance Characteristics: Static Capacity per Partition

Code	Aspect(s)	Name: Description	Unit	Size	Level	Group
8t00h	01	**Static Capacity Efficiency (Partition t) {37h:8t00h}:**	% * 65536	4	1	4
8t10h	01	**Static Datasets Media (Partition t) {37h:8t10h}:**	datasets	4	2	4
8t11h	01	**Static Datasets Used (Partition t) {37h:8t11h}:**	datasets	4	2	4
8t20h	01	**Static Distance Media (Partition t) {37h:8t20h}:**	mm	8	2	4
8t21h	01	**Static Distance Used (Partition t) {37h:8t21h}:**	mm	8	2	4

6.3.23 LP 38h: Blocks/Bytes Transferred

See LOG SELECT - 4Ch (see 5.2.7 on page 82) and LOG SENSE - 4Dh (see 5.2.8 on page 83) for directions on how to use this page.

6.3.23.1 Parameter Reset Behavior (38h)

Parameters in this page are reset when a cartridge is loaded.

6.3.23.2 Parameter Definitions (38h)

WARNING WARNING

The parameters in log pages should be dynamically parsed as some parameters may not be present and new parameters may be insterted. The relative location of parameters have changed and are anticipated to continue to change..

WARNING WARNING

Table 210 — LP 38h: Blocks/Bytes Transferred log parameter codes (part 1 of 2)

Code	Counter: Description	Size
0000h	**Host Write Blocks Processed {38h:0000h}:** Each count represents a block processed across the host interface during a Write. The count does not include ERP retries.	4
0001h	**Host Write Kilobytes Processed {38h:0001h}:** Each count represents a kilobyte (1024 bytes) processed across the host interface during a Write. The count does not include ERP retries. This count may be divided by Device Write Kilobytes Processed, 0005, to calculate an approximate write compression ratio.	4
0002h	**Host Read Blocks Processed {38h:0002h}:** Each count represents a block processed across the host interface during a Read. The count does not include ERP retries.	4
0003h	**Host Read Kilobytes Processed {38h:0003h}:** Each count represents a kilobyte (1024 bytes) processed across the host interface during a Read. The count does not include ERP retries. This count may be divided by Device Read Kilobytes Processed, 0007, to calculate an approximate read compression ratio.	4
0004h	**Device Write Datasets Processed {38h:0004h}:** Each count represents a dataset processed on the medium. The count does not include ERP retries.	4
0005h	**Device Write Kilobytes Processed {38h:0005h}:** Each count represents a kilobyte (1024 bytes) processed on the medium. The count does not include ERP retries or any tape formatting overhead bytes.	4
0006h	**Device Read Datasets Processed {38h:0006h}:** Each count represents a dataset processed from the medium. The count does not include ERP retries.	4
0007h	**Device Read Kilobytes Processed {38h:0007h}:** Each count represents a kilobyte (1024 bytes) processed from the medium. The count does not include ERP retries or any tape formatting overhead bytes.	4
0008h	**Device Write Datasets Transferred {38h:0008h}:** Each count represents a dataset processed on the medium. The count includes ERP retries.	4
0009h	**Device Write Kilobytes Transferred {38h:0009h}:** Each count represents a kilobyte (1024 bytes) processed on the medium. The count includes ERP retries and any tape formatting overhead bytes.	4
000Ah	**Device Read Datasets Transferred {38h:000Ah}:** Each count represents a dataset processed from the medium. The count includes ERP retries.	4
000Bh	**Device Read Kilobytes Transferred {38h:000Bh}:** Each count represents a kilobyte (1024 bytes) processed from the medium. The count includes ERP retries and any tape formatting overhead bytes.	4
000Ch	**Nominal Capacity of Partition {38h:000Ch}:** The nominal capacity of the current partition (in kilobytes).	4

Table 210 — LP 38h: Blocks/Bytes Transferred log parameter codes (part 2 of 2)

Code	Counter: Description	Size
000Dh	**Fraction of Partition Traversed {38h:000Dh}:** The fractional part of the current partition traversed (N/255).	1
000Eh	**Nominal Capacity of Volume {38h:000Eh}:** The nominal capacity of the mounted volume (in kilobytes). This is determined by the sum of the Nominal Capacity of Partition parameter for each partition.	4
000Fh	**Fraction of Volume Traversed {38h:000Fh}:** The fractional part of the mounted volume traversed (N/255). This reports the value that would be reported by the Fraction of Partition Traversed if the volume were a single partition.	1
0010h	**Remaining Capacity of Volume {38h:0010h}:** The nominal unwritten remaining capacity of the mounted volume (in kilobytes). This is not sensitive to current position. This is determined by the sum of the Remaining Capacity of Partition for each partition. If the tape does not have a valid EOD in at least one existing partition, or if a tape is not loaded, then a value of 'all ones' (-1) is returned.	4
0011h	**Remaining Capacity of Partition {38h:0011h}:** The nominal unwritten remaining capacity of the current partition (in kilobytes). This is not sensitive to current position. If the tape does not have a valid EOD in the current partition, or if a tape is not loaded, then a value of 'all ones' (-1) is returned.	

6.3.24 LP 39h: Host Port 0 Interface Errors

See LOG SELECT - 4Ch (see 5.2.7 on page 82) and LOG SENSE - 4Dh (see 5.2.8 on page 83) for directions on how to use this page. The count of errors occurring on host interface port 0 (while the device is active on the interface).

6.3.24.1 Parameter Reset Behavior (39h)

Parameters in this page are reset when a cartridge is loaded.

6.3.24.2 Parameter Definitions (39h)

WARNING WARNING

The parameters in log pages should be dynamically parsed as some parameters may not be present and new parameters may be insterted. The relative location of parameters have changed and are anticipated to continue to change..

WARNING WARNING

Table 211 — LP 39h: Host Port Interface Errors log parameter codes

Code	Counter: Description	Size
0000h	**Host Protocol Errors {39h:000h}:** Each count represents one occurrence. Counts may include occurrences from both temporary and permanent errors. (On SAS attached devices, this parameter is always set to zero. See LP 18h: Protocol-specific port (see 6.3.13 on page 255) for SAS protocol error counts).	2
0007h	**Host Aborts {39h:0007h}:** Each count represents one occurrence. Counts may include occurrences from both temporary and permanent errors.	2
0008h	**Host Resets {39h:0008h}:** Each count represents one occurrence. Counts may include occurrences from both temporary and permanent errors.	2
0009h	Vendor-Reserved	2
000Ah	Vendor-Reserved	2
0010h	**Host Recoveries {39h:0010h}:** Each count represents one occurrence. Counts may include occurrences from both temporary and permanent errors. An example of a host recoveries is a Fibre Channel Sequence Retransmission Request (SRR). On SAS attached devices, this parameter is the count of TLR's.	4

6.3.25 LP 3Ah: Drive control verification

See LOG SELECT - 4Ch (see 5.2.7 on page 82) and LOG SENSE - 4Dh (see 5.2.8 on page 83) for directions on how to use this page. This page is for special drive control mode verification. This page is not included in the list of supported pages (page code 00h) and is not intended for general use. This page is not shown in this document.

6.3.26 LP 3Bh: Host Port 1 Interface Errors

See LOG SELECT - 4Ch (see 5.2.7 on page 82) and LOG SENSE - 4Dh (see 5.2.8 on page 83) for directions on how to use this page. The count of errors occurring on host port 1 (while the device is active on the interface).

6.3.26.1 Parameter Reset Behavior (3Bh)

Parameters in this page are reset when a cartridge is loaded.

6.3.26.2 Parameter Definitions (3Bh)

NOTE 34 - The parameters are identical to those found in LP 39h: Host Port 0 Interface Errors (see 6.3.24 on page 286), except this data is recorded for incidents which occur on host interface port 1.

WARNING WARNING

The parameters in log pages should be dynamically parsed as some parameters may not be present and new parameters may be insterted. The relative location of parameters have changed and are anticipated to continue to change.

WARNING WARNING

6.3.27 LP 3Ch: Drive usage information

See LOG SELECT - 4Ch (see 5.2.7 on page 82) and LOG SENSE - 4Dh (see 5.2.8 on page 83) for directions on how to use this page. The Drive usage information log page only has valid data returned when the drive is configured for use in an eServer® system (i.e., The Product ID returned in Standard Inquiry is "HH LTO Gen x" where "x" is a number).

This page allows users to obtain the information last stored regarding the counts accumulated over the life of the drive.

6.3.27.1 Parameter Reset Behavior (3Ch)

This page is updated as events and tape pulling occurs. The nonvolatile memory is updated upon error events, the tape being unthreaded, or when the cartridge unloads. The counters are not cleared by any reset and cannot be changed with the LOG SELECT command. If power is lost before the updated data is written to the nonvolatile memory, the counts are not updated.

6.3.27.2 Parameter Definitions (3Ch)

Each parameter is a positive value. The counts do not overflow. Once a count reaches its maximum value, that maximum value is always returned. The counts do not roll over at the maximum value.

WARNING WARNING

The parameters in log pages should be dynamically parsed as some parameters may not be present and new parameters may be insterted. The relative location of parameters have changed and are anticipated to continue to change.

WARNING WARNING

Table 212 — LP 3Ch: Drive usage information log parameters (part 1 of 2)

Parameter Code	Counter: Description	Size
0001h	**Write Media Blocks Counter {3Ch:0001h}:** This counter is a lifetime statistic representing the number of physical groups (i.e. Datasets) written during a write operation. Upon reaching the maximum value, the counter does not wrap back to zero, but retains its maximum value (FFFF FFFF FFFF FFFFh).	8
0002h	**Rewrite Media Blocks Counter {3Ch:0002h}:** This counter is a lifetime statistic representing the number of physical groups (i.e. Datasets) rewritten during a write operation. Upon reaching the maximum value, the counter does not wrap back to zero, but retains its maximum value (FFFF FFFF FFFF FFFFh).	8
0003h	**Read Media Blocks Counter {3Ch:0003h}:** This counter is a lifetime statistic representing the number of physical groups (i.e. Datasets) read during a read or space operation. The counter will not increment/decrement during space reverse, space LEOP, or space fast operations. Upon reaching the maximum value, the counter does not wrap back to zero, but retains its maximum value (FFFF FFFF FFFF FFFFh).	8
0004h	**ECC Corrections Counter {3Ch:0004h}:** This counter is a lifetime statistic representing the number of physical groups (i.e. Datasets) corrected during a read operation. Upon reaching the maximum value, the counter does not wrap back to zero, but retains its maximum value (FFFF FFFF FFFF FFFFh).	8
0005h	**Reread Media Blocks Counter {3Ch:0005h}:** This counter is a lifetime statistic representing the number of physical groups (i.e. Datasets) reread during a read operation. Upon reaching the maximum value, the counter does not wrap back to zero, but retains its maximum value (FFFF FFFF FFFF FFFFh).	8
0006h	**Cumulative Cartridge Loads Counter {3Ch:0006h}:** This counter increments each time a new cartridge is loaded. All media types and lengths increments this counter. Cleaning cartridges do not increment the counter. Upon reaching the maximum value, the counter does not wrap back to zero, but retains its maximum value (FF FFFFh).	3

Table 212 — LP 3Ch: Drive usage information log parameters (part 2 of 2)

Parameter Code	Counter: Description	Size
0007h	**Time Since Last Cleaning Counter {3Ch:0007h}:** This counter tracks the tape pulling time since the last cleaning. The count is expressed in minutes. Upon reaching the maximum value, the counter does not wrap back to zero, but retains its maximum value (FF FFFFh). The counter is reset when the drive is cleaned.	3
0008h	**Cumulative Power On Time Counter {3Ch:0008h}:** This is a cumulative count of the time the drive has been powered on. The count is expressed in minutes. Upon reaching the maximum value, the counter does not wrap back to zero, but retains its maximum value (FF FFFFh).	3
0009h	**Cumulative Time Tape is Loaded and Tensioned {3Ch:0009h}:** This is the number of minutes a tape has been threaded with tension on the tape.	3
000Ah	**Cumulative Cleaning Counter {3Ch:000Ah}:** This is the count of the number of times that a cleaning cartridge was inserted into the drive. Upon reaching the maximum value, the counter does not wrap back to zero, but retains its maximum value (FFFFh).	2
000Bh	**"WORN MEDIA" Flag {3Ch:000Bh}:** This flag is used by the drive to recommend retirement of the current cartridge. This flag is set when the condition is detected (e.g. on rewind, processing of Log Sense). This flag is cleared on next cartridge load. This corresponds to TapeAlert Flag 07h. 0001h: Media should be retired. 0000h: Media is still good enough to use or media condition cannot be determined (e.g. No media loaded).	2
000Ch	**"DEAD MEDIA" Flag {3Ch:000Ch}:** This flag is used by the drive to indicate the media is no longer usable. This flag is set when the condition is detected and an error is reported. This flag is cleared on next cartridge load. This corresponds to TapeAlert flag 04h, and the posting of a "DEGRADED MEDIA" message (k/c/q '01/82/52'). 0001h: Media is no longer usable. 0000h: Media is still usable or media condition cannot be determined (e.g. No media loaded).	2
000Dh	**"DEAD DRIVE" Flag {3Ch:000Dh}:** This flag is used by the drive to recommend its own replacement. This flag is set when the condition is detected and an error is reported. This flag is never cleared once set. 0001h: Drive hardware failure has occurred or is imminent. Replace drive. 0000h: Drive hardware failure has not been detected. No drive replacement required.	2
000Eh	Undefined Parameter (0000h)	2
000Fh	Undefined Parameter (0000h)	2
0010h	Undefined Parameter (0000h)	2
0011h	**Clean Requested Flag {3Ch:0011h}:** This flag indicates the drive should be cleaned. 02h: Drive is not requesting clean 03h: Drive is requesting clean	1
0012h	Undefined Parameter (00h)	1
0013h	Undefined Parameter (00 0000h)	3
0014h	Undefined Parameter (00 0000h)	3
0015h	**Cartridge Serial Number {3Ch:0015h}:** This is right justified with leading spaces (20h). This value is update on cartridge load and retained until the next cartridge load. If no cartridge has been loaded since last power-on this value will be set to all spaces (20h).	12

6.3.28 LP 3Dh: Subsystem Statistics

See LOG SELECT - 4Ch (see 5.2.7 on page 82) and LOG SENSE - 4Dh (see 5.2.8 on page 83) for directions on how to use this page. The following counters all deal with subsystem statistics and errors.

6.3.28.1 Parameter Reset Behavior (3Dh)

Most of the counters on this page are never reset. Most counters are maintained in VPD and persist across Log Select, Log Sense, Power On Resets, and even microcode download. Lifetime values are written to VPD every eight operating hours when the drive is in a not ready state. The counters lock at maximum values.

6.3.28.2 Parameter Definitions (3Dh)

WARNING WARNING

The parameters in log pages should be dynamically parsed as some parameters may not be present and new parameters may be insterted. The relative location of parameters have changed and are anticipated to continue to change..

WARNING WARNING

Table 213 — LP 3Dh: Subsystem Statistics log parameter codes (part 1 of 2)

Code	Counter: Description	Size
0020h	**Volume Lifetime Mounts {3Dh:0020h}:** The total number of successful cartridge unloads performed during the lifetime of a cartridge. This field may not be updated for mounts that occur with the volume physically write-protected.	4
0021h	**Volume Lifetime Megabytes Written {3Dh:0021h}:** The total amount of data in Megabytes written during the lifetime of the cartridge. On each unload, an approximate value is calculated and stored by rounding up to the nearest Megabyte. These bytes are counted as they are processed to the medium (compressed bytes), not at the host interface. This field may not be updated during mounts that occur with the volume physically write-protected.	4
0022h	**Volume Lifetime Megabytes Read {3Dh:0022h}:** The total amount of data in Megabytes read during the lifetime of the cartridge. On each unload, an approximate value is calculated and stored by rounding up to the nearest Megabyte. These bytes are counted as they are processed from the medium (compressed bytes), not at the host interface. This field may not be updated during mounts that occur with the volume physically write-protected.	4
0040h	**Drive Lifetime Mounts {3Dh:0040h}:** The total number of successful cartridge unloads performed during the lifetime of the drive.	4
0041h	**Drive Lifetime Megabytes Written {3Dh:0041h}:** The total amount of data in Megabytes written during the lifetime of the drive. On each unload, an approximate value is calculated and stored by rounding up to the nearest Megabyte. These bytes are counted as they are processed to the medium (compressed bytes), not at the host interface.	4
0042h	**Drive Lifetime Megabytes Read {3Dh:0042h}:** The total amount of data in Megabytes read during the lifetime of the drive. On each unload, an approximate value is calculated and stored by rounding up to the nearest Megabyte. These bytes are counted as they are processed from the medium (compressed bytes), not at the host interface.	4
0060h	**Clean Lifetime Mounts {3Dh:0060h}:** The total number of successful cleaner cartridge operations performed during the lifetime of the drive.	4
0061h	**Megabytes Written since Clean {3Dh:0061h}:** The total amount of data in Megabytes written since the last successful clean operation. On each unload, an approximate value is calculated and stored by rounding up to the nearest Megabyte. These bytes are counted as they are processed to the medium (compressed bytes), not at the host interface.	4
0062h	**Megabytes Read since Clean {3Dh:0062h}:** The total amount of data in Megabytes read since the last successful clean operation. On each unload, an approximate value is calculated and stored by rounding up to the nearest Megabyte. These bytes are counted as they are processed from the medium (compressed bytes), not at the host interface.	4

Table 213 — LP 3Dh: Subsystem Statistics log parameter codes (part 2 of 2)

Code	Counter: Description	Size
0063h	**Mounts since Clean {3Dh:0063h}:** The total number of mounts performed since the last successful clean operation.	4
0080h	**Library Interface Messages Received {3Dh:0080h}:** This counter is not stored in VPD and reflects messages since reset.	4
0081h	**Library Interface Messages Transmitted {3Dh:0081h}:** This counter is not stored in VPD and reflects message since reset.	4
0082h	**Library Interface Resets {3Dh:0082h}:** Count of hardware reset or logical reinitializations during normal operation.	4
0083h	**Library Interface Buffer Errors {3Dh:0083h}:** This includes buffer overrun or underrun conditions.	4
0084h	**Library Interface Sync Errors {3Dh:0084h}:**	4
0085h	**Library Interface Framing Errors {3Dh:0085h}:**	4
0086h	**Library Interface Protocol Errors {3Dh:0086h}:**	4
0087h	**Library Interface Logical Errors {3Dh:0087h}:**	4
0088h	**Library Interface Loader Failures {3Dh:0088h}:** This counter reflects load attempts when the drive is in an incorrect state or was otherwise unable to attempt requested loader action.	4
0090h	**Drive Lifetime Write Perms {3Dh:0090h}:** Total number of write permanent errors which occurred on this drive.	4
0091h	**Drive Lifetime Read Perms {3Dh:0091h}:** Total number of read permanent errors which occurred on this drive.	4
0092h	**Drive Lifetime Load Perms {3Dh:0092h}:** Total number of load permanent errors which occurred on this drive.	4
0093h	**Drive Lifetime Unload Perms {3Dh:0093h}:** Total number of unload permanent errors which occurred on this drive.	4
00A0h	**Drive Lifetime Write Temps {3Dh:00A0h}:** Total number of write temporary errors which occurred on this drive. Note - This is not a count of ERP actions taken, and certain transient errors may not be included in this count.	4
00A1h	**Drive Lifetime Read Temps {3Dh:00A1h}:** Total number of read temporary errors which occurred on this drive. Note - This is not a count of ERP actions taken, and certain transient errors may not be included in this count.	4
00A2h	**Drive Lifetime Load Temps {3Dh:00A2h}:** Total number of load temporary errors which occurred on this drive. Note - This is not a count of ERP actions taken, and certain transient errors may not be included in this count.	4
00A3h	**Drive Lifetime Unload Temps {3Dh:00A3h}:** Total number of unload temporary errors which occurred on this drive. Note - This is not a count of ERP actions taken, and certain transient errors may not be included in this count.	4
0100h	**Lifetime Power On Seconds {3Dh:0100h}:** Cumulative number of seconds which the drive has been powered on. Note - Since this time is only periodically updated in non-volatile storage, it is possible that this time may not be entirely accurate to the full resolution of the counter.	4
0101h	**Power On Seconds {3Dh:0101h}:** Number of seconds since the drive was powered on or has undergone a hard reset condition.	4
0102h	**Reset Seconds {3Dh:0102h}:** Number of seconds since the drive has undergone a soft reset condition.	4

6.3.29 LP 3Eh: Engineering Use

See LOG SELECT - 4Ch (see 5.2.7 on page 82) and LOG SENSE - 4Dh (see 5.2.8 on page 83) for directions on how to use this page. This page is for engineering use only and is not included in the list of supported pages (i.e., page code 00h). As such, the counters on this page are not intended for general use and are not shown in this document.

6.3.30 LP 3Eh[3Ch]: Drive Control Statistics

See LOG SELECT - 4Ch (see 5.2.7 on page 82) and LOG SENSE - 4Dh (see 5.2.8 on page 83) for directions on how to use this page. This page is for special drive control mode statistics. It is not included in the list of supported pages (page code 00h) and is not intended for general use. This page is not shown in this document.

NOTE 35 - This page was log page 3Ch in Ultrium 2, but was moved to log page 3E[3C] for Ultrium 2 HH and newer generations (eServer support with it's log page 3C was added).

6.4 Medium auxiliary memory attributes (MAM)

6.4.1 Attribute format

Each medium auxiliary memory attribute shall be communicated between the application client and device server in the format shown in table 214. This format shall be used in the parameter data for the WRITE ATTRIBUTE command (see 5.2.38) and the READ ATTRIBUTE command (see 5.2.13). The attribute format in this standard implies nothing about the physical representation of an attribute in the medium auxiliary memory.

Table 214 — MAM ATTRIBUTE format

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	(MSB)	attribute identifier						
1								(LSB)
2	READ ONLY	Reserved					FORMAT	
3	(MSB)	ATTRIBUTE LENGTH (n-4)						
4								(LSB)
5	attribute value							
n								

The ATTRIBUTE IDENTIFIER field contains a code value identifying the attribute (see 6.4.2).

The READ ONLY bit indicates whether the attribute is in the read only state (see 4.13). If the READ ONLY bit is set to one, the attribute is in the read only state. If the READ ONLY bit is set to zero, the attribute is in the read/write state.

The FORMAT field (see table 215) specifies the format of the data in the ATTRIBUTE VALUE field.

Table 215 — MAM attribute FORMAT field

Format	Name	Description
00b	BINARY	The ATTRIBUTE VALUE field contains binary data.
01b	ASCII	The ATTRIBUTE VALUE field contains left-aligned ASCII data.
10b	TEXT	The attribute contains textual data. The character set is as described in the TEXT LOCALIZATION IDENTIFIER attribute (see 6.4.2.4.6).
11b		Reserved

The ATTRIBUTE LENGTH field specifies the length in bytes of the ATTRIBUTE VALUE field.

The ATTRIBUTE VALUE field contains the current value, for the READ ATTRIBUTE - 8Ch (see 5.2.15 on page 99) command, or intended value, for the WRITE ATTRIBUTE - 8Dh (see 5.2.38 on page 153) command, of the attribute.

6.4.2 Attribute identifier values

6.4.2.1 Attribute identifier values overview

The values in the ATTRIBUTE IDENTIFIER field (see 6.4.1) are assigned according to the attribute type (see 4.13) and whether the attribute is standard or vendor specific (see table 216).

Table 216 — MAM attribute identifier range assignments

Attribute Identifiers	Attribute Type	Standardized	Subclause
0000h to 03FFh	Device	Yes	6.4.2.2
0400h to 07FFh	Medium	Yes	6.4.2.3
0800h to 0BFFh	Host	Yes	6.4.2.4
0C00h to 0FFFh	Device	Vendor specific	
1000h to 13FFh	Medium	Vendor specific	
1400h to 17FFh	Host	Vendor specific	
1800h to FFFFh	Reserved		

Device servers may accept and process a WRITE ATTRIBUTE command containing standardized host type attribute identifier values (i.e., 0800h-0BFFh) or vendor specific host type attribute identifier values (i.e., 1400h-17FFh). Standardized host type attribute identifier values may be checked as described in 6.4.2.4.

6.4.2.2 Device type attributes

Device type attributes (see table 217) shall be maintained and updated by the device server when the medium and associated medium auxiliary memory are present. All supported medium type attributes shall have a status of read only (see 4.13).

Table 217 — Device type attributes

Attribute Identifier	Name	Attribute Length (in bytes)	Format	Subclause
0000h	REMAINING CAPACITY IN PARTITION	8	BINARY	6.4.2.2.1
0001h	MAXIMUM CAPACITY IN PARTITION	8	BINARY	6.4.2.2.1
0002h	TAPEALERT FLAGS	8	Binary	
0003h	LOAD COUNT	8	BINARY	6.4.2.2.2
0004h	MAM SPACE REMAINING	8	BINARY	6.4.2.2.3
0005h	ASSIGNING ORGANIZATION	8	ASCII	
0006h	FORMATTED DENSITY CODE	1	Binary	
0007h	INITIALIZATION COUNT	2	BINARY	6.4.2.2.4
0008h	Not Supported (VOLUME IDENTIFIER)	32	ASCII	
0009h	VOLUME CHANGE REFERENCE	4	BINARY	6.4.2.2.5
000Ah to 0209h	Reserved			
020Ah	DEVICE VENDOR/SERIAL NUMBER AT LAST LOAD	40	ASCII	6.4.2.2.6
020Bh	DEVICE VENDOR/SERIAL NUMBER AT LOAD-1	40	ASCII	6.4.2.2.6
020Ch	DEVICE VENDOR/SERIAL NUMBER AT LOAD-2	40	ASCII	6.4.2.2.6
020Dh	DEVICE VENDOR/SERIAL NUMBER AT LOAD-3	40	ASCII	6.4.2.2.6
020Eh to 021Fh	Reserved			
0220h	TOTAL MBYTES WRITTEN IN MEDIUM LIFE	8	BINARY	6.4.2.2.7
0221h	TOTAL MBYTES READ IN MEDIUM LIFE	8	BINARY	6.4.2.2.7
0222h	TOTAL MBYTES WRITTEN IN CURRENT/LAST LOAD	8	BINARY	6.4.2.2.8
0223h	TOTAL MBYTES READ IN CURRENT/LAST LOAD	8	BINARY	6.4.2.2.8
0224h	LOGICAL POSITION OF FIRST ENCRYPTED BLOCK	8	BINARY	6.4.2.2.9
0225h	LOGICAL POSITION OF FIRST UNENCRYPTED BLOCK AFTER THE FIRST ENCRYPTED BLOCK	8	BINARY	6.4.2.2.10
0226h to 033Fh	Reserved			
0340h	Not Supported (MEDIUM USAGE HISTORY)	90	BINARY	
0341h	Not Supported (PARTITION USAGE HISTORY)	60	BINARY	
0342h to 03FFh	Reserved			

6.4.2.2.1 REMAINING CAPACITY IN PARTITION and MAXIMUM CAPACITY IN PARTITION: Are native capacities (i.e., assuming no data compression for the specified medium partition). These values are expressed in increments of 1 048 576 bytes (e.g., a value of one means 1 048 576 bytes and a value of two means 2 097 152 bytes).

6.4.2.2.2 LOAD COUNT: Indicates how many times this medium has been fully loaded. This attribute should not be reset to zero by any action of the device server. The load counter is a saturating counter.

6.4.2.2.3 MAM SPACE REMAINING: Indicates the space currently available in the medium auxiliary memory. The total medium auxiliary memory capacity is reported in the MAM CAPACITY attribute (see 6.4.2.3.7).

NOTE 36 - It may not always be possible to utilize all of the available space in a given medium auxiliary memory implementation.

6.4.2.2.4 INITIALIZATION COUNT: Indicates the number of times that a device server has logically formatted the medium. This value is cumulative over the life of the medium and is not reset to zero. The initialization counter is a saturating counter.

6.4.2.2.5 VOLUME CHANGE REFERENCE: IThe VOLUME CHANGE REFERENCE attribute indicates changes in the state of the medium related to logical objects or format specific symbols of the currently mounted volume. There is one value for the volume change reference and the VOLUME CHANGE REFERENCE attribute for each partition shall use the same value. The VOLUME CHANGE REFERENCE attribute value shall:

a) be written to non-volatile medium auxiliary memory before the change on medium is valid for reading; and
b) change in a non-repeating fashion (i.e., never repeat for the life of the volume) and defined to be in a consistent manner per volume format.

The VOLUME CHANGE REFERENCE attribute value shall change when:

a) the first logical object for each mount is written on the medium in any partition;
b) the first logical object is written after GOOD status has been returned for a READ ATTRIBUTE command with the service action field set to ATTRIBUTE VALUES (i.e., 00h) and the first attribute identifier field set to VOLUME CHANGE REFERENCE (i.e, 0009h);
c) any logical object on the medium (i.e., in any partition) is overwritten; or
d) the medium is formatted.

The VOLUME CHANGE REFERENCE attribute may change at other times when the contents on the medium change.

The VOLUME CHANGE REFERENCE attribute should not change if the logical objects on the medium do not change.

A value of zero in the VOLUME CHANGE REFERENCE attribute indicates that the medium has not had any logical objects written to it (i.e., the volume is blank and has never been written to) or the value is unknown.

A value of all ones (e.g., 0xFFFFh) in the VOLUME CHANGE REFERENCE attribute indicates that all values have been used. This value indicates the VOLUME CHANGE REFERENCE value is no longer able to indicate changes to the volume. The device server does not allow further modifications of the medium.

When adding or modifying logical objects the VOLUME CHANGE REFERENCE attribute should only be read after all writing to the volume has completed and been synchronized.

6.4.2.2.6 DEVICE VENDOR/SERIAL NUMBER AT LAST LOAD, DEVICE VENDOR/SERIAL NUMBER AT LOAD –1, DEVICE VENDOR/SERIAL NUMBER AT LOAD –2 and DEVICE VENDOR/SERIAL NUMBER AT LOAD –3: Give a history of the last four device servers in which the medium has been loaded. The format of the attributes is shown in table 218.

Table 218 — DEVICE VENDOR/SERIAL NUMBER attribute format

Bit Byte	7	6	5	4	3	2	1	0
0	(MSB)							
7				T10 VENDOR IDENTIFICATION				(LSB)
8	(MSB)							
39				PRODUCT SERIAL NUMBER				(LSB)

The T10 VENDOR IDENTIFICATION field shall be the same value returned in the Standard INQUIRY data.

The PRODUCT SERIAL NUMBER field contains ASCII data that is a vendor specific serial number. If the product serial number is not available, the PRODUCT SERIAL NUMBER field shall contain ASCII spaces (20h).

6.4.2.2.7 TOTAL MBYTES WRITTEN IN MEDIUM LIFE and TOTAL MBYTES READ IN MEDIUM LIFE:

Indicate the total number of data bytes that are transferred to or from the medium, after any data compression has been applied, over the entire medium life. These values are cumulative and shall not be reset to zero. These values are expressed in increments of 1 048 576 bytes (e.g., a value of one means 1 048 576 bytes and a value of two means 2 097 152 bytes).

6.4.2.2.8 TOTAL MBYTES WRITTEN IN CURRENT/LAST LOAD and TOTAL MBYTES READ IN CURRENT/LAST LOAD: Indicate the total number of data bytes that are transferred to or from the medium, after any data compression has been applied, during the current load if the medium is currently loaded, or the last load if the medium is currently unloaded. The device server should reset these attributes to zero when the medium is loaded. These values are expressed in increments of 1 048 576 bytes (e.g., a value of one means 1 048 576 bytes and a value of two means 2 097 152 bytes).

6.4.2.2.9 LOGICAL POSITION OF FIRST ENCRYPTED BLOCK: Indicates the address of the first logical block on the medium that contains encrypted data.

6.4.2.2.10 LOGICAL POSITION OF FIRST UNENCRYPTED BLOCK AFTER THE FIRST ENCRYPTED BLOCK: Indicates the address of the first logical block in the partition that contains unencrypted data and follows the first logical block in the partition that contains encrypted data. If this attribute is supported, then the LOGICAL POSITION OF FIRST ENCRYPTED BLOCK (see 7.3.2.2.9) attribute shall be supported. The attribute value shall be set to FFFF FFFF FFFF FFFFh if the attribute value for the LOGICAL POSITION OF FIRST ENCRYPTED BLOCK is set to:

a) FFFF FFFF FFFF FFFFh; or
b) any value other than FFFF FFFF FFFF FFFFh or FFFF FFFF FFFF FFFEh and no logical block in the partition after the first encrypted logical block contains unencrypted data.

The attribute value shall be set to FFFF FFFF FFFF FFFEh if the attribute value for the LOGICAL POSITION OF FIRST ENCRYPTED BLOCK is set to:

a) FFFF FFFF FFFF FFFEh; or
b) any value other than FFFF FFFF FFFF FFFFh or FFFF FFFF FFFF FFFEh and it is unknown whether any logical block in the partition after the first encrypted logical block contains unencrypted data.

6.4.2.3 Medium type attributes

Medium type attributes (see table 219) are stored in the medium auxiliary memory by the manufacturer. The device server shall not alter medium type attributes. All supported medium type attributes shall have a status of read only (see 4.13).

Table 219 — Medium type attributes

Attribute Identifier	Name	Attribute Length (in bytes)	Format	Subclause
0400h	MEDIUM MANUFACTURER	8	ASCII	6.4.2.3.1
0401h	MEDIUM SERIAL NUMBER	32	ASCII	6.4.2.3.2

Table 219 — Medium type attributes

Attribute Identifier	Name	Attribute Length (in bytes)	Format	Subclause
0402h	MEDIUM LENGTH	4	Binary	6.4.2.3.3
0403h	MEDIUM WIDTH	4	Binary	6.4.2.3.4
0404h	ASSIGNING ORGANIZATION	8	ASCII	6.4.2.3.5
0405h	MEDIUM DENSITY CODE	1	Binary	
0406h	MEDIUM MANUFACTURE DATE	8	ASCII	6.4.2.3.6
0407h	MAM CAPACITY	8	BINARY	6.4.2.3.7
0408h	MEDIUM TYPE	1	BINARY	6.4.2.3.8
0409h	MEDIUM TYPE INFORMATION	2	BINARY	6.4.2.3.8
040Ah	Not Supported (NUMERIC MEDIUM SERIAL NUMBER)			
040Bh to 07FFh	Reserved			

6.4.2.3.1 MEDIUM MANUFACTURER: Contains eight bytes of left-aligned ASCII data identifying the vendor of the media.

6.4.2.3.2 MEDIUM SERIAL NUMBER: Contains the manufacturer's serial number for the medium.

6.4.2.3.3 MEDIUM LENGTH: Specifies the length of the medium in meters. A value of 0h specifies that the length of the medium is undefined.

6.4.2.3.4 MEDIUM WIDTH: Specifies the width of the medium supported by this density. This attribute has units of tenths of millimeters. The value in this attribute shall be rounded up if the fractional value of the actual value is greater than or equal to 0,5. The MEDIUM WIDTH attribute may vary for a given density depending on the mounted volume. A value of 0h specifies the width of the medium is undefined.

6.4.2.3.5 ASSIGNING ORGANIZATION: Identifies the organization responsible for the specifications defining the values in the MEDIUM DENSITY CODE attribute. The ASSIGNING ORGANIZATION attribute contains "LTO-CVE".

6.4.2.3.6 MEDIUM MANUFACTURE DATE: Contains the date of manufacture of the medium. The format is YYYYMMDD (i.e., four numeric ASCII characters for the year followed by two numeric ASCII characters for the month followed by two numeric ASCII characters for the day with no intervening spaces).

6.4.2.3.7 MAM CAPACITY: Is the total capacity of the medium auxiliary memory, in bytes, at manufacture time. It does not indicate the available space of an unused medium auxiliary memory because some of the medium auxiliary memory space may be reserved for device-specific use making it inaccessible to the application client.

6.4.2.3.8 MEDIUM TYPE and MEDIUM TYPE INFORMATION: Give information about non-data media and other types of media. The MEDIUM TYPE INFORMATION attribute is interpreted according to the type of medium indicated by the MEDIUM TYPE (see table 220).

Table 220 — MEDIUM TYPE and MEDIUM TYPE INFORMATION attributes

MEDIUM TYPE	Description	MEDIUM TYPE INFORMATION
00h	Data medium	Reserved
01h	Cleaning medium	Maximum number of cleaning cycles permitted
02h to 7Fh	Reserved	Reserved
80h	Write-once medium	Reserved
81h to FFh	Reserved	Reserved

6.4.2.4 Host type attributes

Application clients may use the WRITE ATTRIBUTE and READ ATTRIBUTE commands to maintain the attributes shown in table 221. All existent host type attributes shall have a status of read/write (see 4.13).

Table 221 — Host type attributes

Attribute Identifier	Name	Attribute Length (in bytes)	Format	Subclause
0800h	APPLICATION VENDOR	8	ASCII	6.4.2.4.1
0801h	APPLICATION NAME	32	ASCII	6.4.2.4.2
0802h	APPLICATION VERSION	8	ASCII	6.4.2.4.3
0803h	USER MEDIUM TEXT LABEL	160	TEXT	6.4.2.4.4
0804h	DATE AND TIME LAST WRITTEN	12	ASCII	6.4.2.4.5
0805h	TEXT LOCALIZATION IDENTIFIER	1	BINARY	6.4.2.4.6
0806h	BARCODE	32	ASCII	6.4.2.4.7
0807h	OWNING HOST TEXTUAL NAME	80	TEXT	6.4.2.4.8
0808h	MEDIA POOL	160	TEXT	6.4.2.4.9
0809h	Not Supported (PARTITION USER TEXT LABEL)			
080Ah	Not Supported (LOAD/UNLOAD AT PARTITION)			
080Bh	APPLICATION FORMAT VERSION	16	ASCII	6.4.2.4.10
080Ch	VOLUME COHERENCY INFORMATION		BINARY	6.4.2.4.11
080Bh to BFFh	Reserved			

6.4.2.4.1 APPLICATION VENDOR: Contains eight bytes of left-aligned ASCII data identifying the manufacturer of the application client (e.g., class driver or backup program) that last sent a WRITE ATTRIBUTE command to the device server while this medium auxiliary memory was accessible. The application vendor shall be a T10 vendor identification assigned by INCITS. A list of assigned T10 vendor identifications is on the T10 web site (http://www.T10.org).

6.4.2.4.2 APPLICATION NAME: Contains the name of the application client.

6.4.2.4.3 APPLICATION VERSION: Contains the version of the application client.

6.4.2.4.4 USER MEDIUM TEXT LABEL: Is the user level identifier for the medium.

6.4.2.4.5 DATE & TIME LAST WRITTEN: Contains when the application client last wrote to the medium auxiliary memory. The format is YYYYMMDDHHMM (i.e., four numeric ASCII characters for the year followed by two numeric ASCII characters for the month followed by two numeric ASCII characters for the day followed by two numeric ASCII characters between 00 and 24 for the hour followed by two numeric ASCII characters for the minute with no intervening spaces).

6.4.2.4.6 TEXT LOCALIZATION IDENTIFIER: Defines the character set (see table 222) used for attributes with a TEXT format (see 6.4.1).

Table 222 — TEXT LOCALIZATION IDENTIFIER attribute values

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

6.4.2.4.7 BARCODE: Is contents of a barcode associated with the medium in the medium auxiliary memory.

6.4.2.4.8 OWNING HOST TEXTUAL NAME: Indicates the host from which that USER MEDIUM TEXT LABEL (see 6.4.2.4.4) originates.

6.4.2.4.9 MEDIA POOL: Indicates the media pool to which this medium belongs.

6.4.2.4.10 APPLICATION FORMAT VERSION: Indicates the version of the format being used by the application that set this attribute.

6.4.2.4.11 VOLUME COHERENCY INFORMATION: Contains information used to maintain coherency of information on a volume (see 4.14). The VOLUME COHERENCY INFORMATION attribute ATTRIBUTE VALUE field is defined in table 223

Table 223: VOLUME COHERENCY INFORMATION attribute format

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	VOLUME CHANGE REFERENCE VALUE LENGTH (n)							
1	VOLUME CHANGE REFERENCE VALUE							
n								
n+1	VOLUME COHERENCY COUNT							
n+8								
n+9	VOLUME COHERENCY SET IDENTIFIER							
n+16								
n+17	APPLICATION CLIENT SPECIFIC INFORMATION LENGTH (y-(n+18))							
n+18								
n+19	APPLICATION CLIENT SPECIFIC INFORMATION							
y								

The contents of the VOLUME CHANGE REFERENCE VALUE field, the VOLUME COHERENCY SET IDENTIFIER field, the VOLUME COHERENCY COUNT field, and the APPLICATION CLIENT SPECIFIC INFORMATION field are described in 4.14.

The VOLUME CHANGE REFERENCE VALUE LENGTH field contains the length of the VOLUME CHANGE REFERENCE VALUE field.

6.4.2.5 Vendor-Specific Medium Type Attributes

Table 224 describes the vendor-specific medium type attributes. Application clients may use the READ ATTRIBUTE command to read the contents of the attributes shown in the table.

.

Table 224 — Vendor-Specific Medium Type Attributes

Attribute Identifier	Name	Attribute Length (in bytes)	Format	Subclause
1000h	UNIQUE CARTRIDGE IDENTITY (UCI)	28	Binary	6.4.2.5.1
1001h to 13FFh	Reserved			

6.4.2.5.1 UNIQUE CARTRIDGE IDENTITY (UCI): The UNIQUE CARTRIDGE IDENTITY (ICU) attribute is read only. Any attempt to access it using the WRITE ATTRIBUTE command will be rejected by the drive with a CHECK CONDITION status with the Sense Key set to ILLEGAL REQUEST and the additional sense code set to INVALID FIELD IN PARAMETER LIST (i.e., 5/2600h). If the cartridge has inconsistency between the various sources from which the components of the UCI are derived, then any command to read the UCI will be rejected with a CHECK CONDITION status with the Sense Key set to MEDIUM ERROR and additional sense code set to AUXILIARY MEMORY READ ERROR (i.e., 3/1112h). This error is also reported if the cartridge has not been initialized.

6.5 Mode Parameters (MP)

Mode parameters are used with the MODE SELECT (6/10) - 15h/55h (see 5.2.9) commands and the MODE SENSE (6/10) - 1Ah/5Ah (see 5.2.10) commands.

6.5.1 Mode Parameter List for Mode Select (6/10)

For Mode Select (6) the mode pages are preceded by a 4-byte mode parameter header below, and an optional 8-byte block descriptor (see 6.5.2.2). Table 225 shows the format of the mode parameter list for Mode Select (6).

Table 225 — Mode Parameter List for Mode Select (6)

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	Mode Parameter Header							
3								
4	Block Descriptor (n = 0 or n = 8; if n=0 Block Descriptor does not exist)							
4+n-1								
4+n	Mode Pages							
n								

For Mode Select (10) the mode pages are preceded by a 8-byte mode parameter header (see "Mode Parameter Header for Mode Select (6/10)" on page 305) and an optional 8-byte block descriptor (see "Block Descriptor for Mode Select (6/10)" on page 307). Mode page descriptions begin at "MP 01h: Read-Write Error Recovery" on page 313.

Table 226 shows the format of the mode parameter list for Mode Select (10).

Table 226 — Mode Parameter List for Mode Select (10)

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	Mode Parameter Header							
7								
8	Block Descriptor (n = 0 or n = 8; if n=0 Block Descriptor does not exist)							
8+n-1								
8+n	Mode Pages							
n								

6.5.1.1 Mode Parameter Header for Mode Select (6/10)

There is one copy of the mode parameter header for each initiator. Table 227 shows the format of the mode parameter header for Mode Select (6).

Table 227 — Mode Parameter Header for Mode Select (6)

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	Reserved (Mode Data Length)							
1	Medium Type							
2	WP	Buffer Mode			Read/Write Speed			
3	Block Descriptor Length							

Table 228 shows the format of the mode parameter header for Mode Select (10).

Table 228 — Mode Parameter Header for Mode Select (10)

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	MSB	Reserved (Mode Data Length)						
1								LSB
2	Medium Type							
3	WP	BUFFERED MODE			SPEED			
4		Reserved						
5								
6	MSB	BLOCK DESCRIPTOR LENGTH						
7								LSB

Mode parameter header field descriptions follow:

Byte Description

0-1 Reserved (Mode Data Length): must be zero.

2 MEDIUM TYPE: (changeable)

Value	Description
00h	No volume is loaded
18h	Ultrium 1 Data volume is loaded
28h	Ultrium 2 Data volume is loaded
38h	Ultrium 3 Data volume is loaded
3Ch	Ultrium 3 WORM volume is loaded
48h	Ultrium 4 Data volume is loaded
4Ch	Ultrium 4 WORM volume is loaded
58h	Ultrium 5 Data volume is loaded
5Ch	Ultrium 5 WORM volume is loaded

3 Device-Specific Parameter - Sequential Access Devices

Bit	Description
7	WP: (changeable-ignored)
6-4	BUFFERED MODE: 001b (changeable)

Value	Description
000b	Good status is reported when data on medium
001b	Good status is reported when data is in buffer
010b	Good status is reported when data in buffer and data from other initiators is written on medium
011b - 111b	Reserved

3-0 SPEED: 0b (use default read/write speed) (changeable)

WARNING WARNING

Setting the SPEED field to a value other than 0h (i.e., selecting a specific speed) is not recommended. The drive is designed to dynamically select the optimal speed to achieve maximum systemic performance. This is based on complex criteria including interface bandwidth, host throughput, data compressibility, etc.

WARNING WARNING

4-5 Reserved

6-7 BLOCK DESCRIPTOR LENGTH: (changeable)

Value	Description
0000h	No block descriptor follows
0008h	A single block descriptor follows

6.5.1.2 Block Descriptor for Mode Select (6/10)

The presence of the block descriptor in the Mode Select command depends on the value of the Block Descriptor Length in the mode parameter header. There is one copy of the block descriptor for each initiator. Table 229 shows the format of the block descriptor. The format of the block descriptor is the same for Mode Select (6) and Mode Select (10).

Table 229 — Block Descriptor for Mode Select

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	DENSITY CODE							
1	MSB	NUMBER OF BLOCKS						
3								LSB
4	Reserved							
5	MSB	BLOCK LENGTH						
7								LSB

The block descriptor field definitions follow:

Byte Description

0 DENSITY CODE: REPORT DENSITY SUPPORT - 44h (see 5.2.21 on page 114) provides additional information

Value	Description
00h	Volume present is unidentified for one of the following reasons: • No medium present • Unknown/Unsupported medium present
40h	Volume present is Ultrium 1 volume
42h	Volume present is Ultrium 2 volume
44h	Volume present is Ultrium 3 volume
46h	Volume present is Ultrium 4 volume
58h	Volume present is Ultrium 5 volume
7Fh	Do not change density (set only - NOOP)
FFh	Use current medium density (set only)

1-3 NUMBER OF BLOCKS: 000000h

4 Reserved

5-7 BLOCK LENGTH: 000000h (changeable)

Any value of block length can be specified between the minimum and the maximum block lengths, inclusive, specified in the Read Block Limits command.

A Block Length value of 000000h indicates that the logical block size to be written to or read from the medium must be explicitly specified by the Transfer Length field in the CDB and the fixed bit must be 0b (see READ - 08h (see 5.2.14 on page 98), VERIFY(6) - 13h (see 5.2.36 on page 151), and WRITE - 0Ah (see 5.2.37 on page 152)). Additionally the read-type overlength ILI reporting will be suppressed as described in General Read-Type Handling (see 4.5.1 on page 33).

6.5.2 Mode Parameter List for Mode Sense (6/10)

For Mode Sense (6) the mode pages are preceded by a 4-byte mode parameter header below and an optional block descriptor. If the DBD field is 0b, an 8-byte block descriptor follows the mode parameter header (see "Block Descriptor for Mode Sense (6/10)" on page 310). If the DBD field is 1b, the block descriptor is not present and the first mode page follows the mode parameter header. Table 230 shows the format of the mode parameter list.

Table 230 — Mode Parameter List for Mode Sense (6)

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	Mode Parameter Header							
3								
4	Block Descriptor (if DBD = 0b, then n = 8 an m=12 else DBD = 1b, n = 0,and m=4)							
4+n-1								
m	Mode Pages							
p								

For Mode Sense (10) the mode pages are preceded by an 8-byte mode parameter header (see "Mode Parameter Header for Mode Sense (6/10)" on page 308) and an optional block descriptor. If the DBD field is 0b, an 8-byte block descriptor follows the mode parameter header (see "Block Descriptor for Mode Select (6/10)" on page 307). If the DBD field is 1b, the block descriptor is not present and the first mode page follows the mode parameter header. Mode page descriptions begin at "MP 01h: Read-Write Error Recovery" on page 313. Table 231 shows the format of the mode parameter list.

Table 231 — Mode Parameter List for Mode Sense (10)

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	Mode Parameter Header							
7								
8	Block Descriptor (if DBD = 0b, then n = 8 an m=16 else DBD = 1b, n = 0,and m=8)							
8+n-1								
m	Mode Pages							
p								

6.5.2.1 Mode Parameter Header for Mode Sense (6/10)

There is one copy of the mode parameter header for each initiator. Table 232 shows the format of the mode parameter header for Mode Sense (6).

Table 232 — Mode Parameter Header for Mode Sense (6)

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	MODE DATA LENGTH							
1	MEDIUM TYPE							
2	WP	BUFFERED MODE			SPEED			
3	BLOCK DESCRIPTOR LENGTH							

Table 233 shows the format of the mode parameter header for Mode Sense (10).

Table 233 — Mode Parameter Header for Mode Sense (10)

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	MSB	MODE DATA LENGTH						
1								LSB
2	MEDIUM TYPE							
3	WP	BUFFERED MODE			SPEED			
4	MSB	Reserved						
5								LSB
6	MSB	BLOCK DESCRIPTOR LENGTH						
7								LSB

Mode parameter header field descriptions follow:

Byte Description

0-1 MODE DATA LENGTH

The length in bytes of the following data that is available to be transferred. The mode data length does not include itself; that is, the length value is total length of the data available minus the size of this field (1 or 2, depending on Mode Sense (6) or (10), respectively).

2 MEDIUM TYPE:

Value	Description
00h	No volume is loaded
18h	Ultrium 1 Data volume is loaded
28h	Ultrium 2 Data volume is loaded
38h	Ultrium 3 Data volume is loaded
3Ch	Ultrium 3 WORM volume is loaded
48h	Ultrium 4 Data volume is loaded
4Ch	Ultrium 4 WORM volume is loaded
58h	Ultrium 5 Data volume is loaded
5Ch	Ultrium 5 WORM volume is loaded

3 Device-Specific Parameter - Sequential Access Devices

Bit Description

7 WP (Write Protect): (changeable-ignored)

Value	Description
0b	medium is not write protected
1b	medium is write protected

6-4 BUFFERED MODE: 001b (changeable)

Value	Description
000b	Good status is reported after data is on the medium
001b	Good status is reported after data is in the buffer
010b	Good status is reported after data is in the buffer and data from other initiators is written on the medium
011b - 111b	Reserved

3-0 SPEED (Read/Write speed): 0h (use default speed) (changeable)

4-5 Reserved

6-7 BLOCK DESCRIPTOR LENGTH:

If DBD = 0, the BLOCK DESCRIPTOR LENGTH field is set to 0008h and a block descriptor follows. If DBD = 1, the BLOCK DESCRIPTOR LENGTH field is set to 0000h and no block descriptor follows.

6.5.2.2 Block Descriptor for Mode Sense (6/10)

The presence of the block descriptor in the MODE SENSE command depends on the value of the DBD bit in the CDB. There is one copy of the block descriptor for each initiator. Table 234 shows the format of the block descriptor.

Table 234 — Block Descriptor for Mode Sense (10) or Mode Sense (6)

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	DENSITY CODE							
1	MSB	NUMBER OF BLOCKS						
3								LSB
4	Reserved							
5	MSB	BLOCK LENGTH						
7								LSB

The block descriptor definition follows:

Byte Description

0 DENSITY CODE: Additional infomation found in REPORT DENSITY SUPPORT - 44h (see 5.2.21 on page 114)

- 00h Volume present is unidentified for one of the following reasons:
  - No medium present
  - Unknown/Unsupported medium present
- 40h Volume present is Ultrium 1 volume
- 42h Volume present is Ultrium 2 volume
- 44h Volume present is Ultrium 3 volume
- 46h Volume present is Ultrium 4 volume
- 58h Volume present is Ultrium 5 volume
- 7Fh Do not change density (set only - NOOP)
- FFh Use current medium density (set only)

1-3 NUMBER OF BLOCKS: 000000h

4 Reserved

5-7 BLOCK LENGTH: 000000h (changeable)

Any value of block length can be specified between the minimum and the maximum block lengths, inclusive, specified in the READ BLOCK LIMITS command.

A Block Length value of 000000h indicates that the logical block size to be written to or read from the medium must be explicitly specified by the TRANSFER LENGTH field in the CDB and the FIXED bit must be 0b (see READ - 08h (see 5.2.14 on page 98), VERIFY(6) - 13h (see 5.2.36 on page 151), and WRITE - 0Ah (see 5.2.37 on page 152)). Additionally the read-type overlength ILI reporting will be suppressed as described in General Read-Type Handling (see 4.5.1 on page 33).

6.5.3 Mode Page Format

Table 235 shows the format of mode pages that do not use subpages.

Table 235 — Mode Page Format

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	PS	SPF(0b)	PAGE CODE					
1	PAGE LENGTH (n-1)							
2	Mode Parameters							
n								

Table 236 shows the format of mode pages that use subpages.

Table 236 — Mode Page Subpage Format

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	PS	SPF(1b)	PAGE CODE					
1	SUBPAGE CODE							
2	(MSB)	PAGE LENGTH (n-3)						
3								(LSB)
4	Mode Parameters							
n								

The individual mode page descriptions that follow include the field descriptions. Each field is non-changeable unless specifically identified otherwise.

6.5.4 Supported Mode Pages

The following standards-based mode pages are supported

MP 01h: Read-Write Error Recovery (see 6.5.5 on page 313)
MP 02h: Disconnect-Reconnect (see 6.5.6 on page 315)
MP 0Ah: Control (see 6.5.7 on page 316)
MP 0Ah[01h]: Control Extension (see 6.5.8 on page 317)
MP 0Fh: Data Compression (see 6.5.9 on page 318)
MP 10h: Device Configuration (see 6.5.10 on page 320)
MP 10h[01h]: Device Configuration Extension (see 6.5.11 on page 323)
MP 11h: Medium Partition Page (see 6.5.12 on page 326)
MP 18h: Protocol-Specific Logical Unit (see 6.5.13 on page 331)
MP 19h: Protocol specific port (see 6.5.14 on page 333)
MP 1Ah: Power Condition (see 6.5.15 on page 336)
MP 1Ch: Informational Exceptions Control (see 6.5.16 on page 338)
MP 1Dh: Medium Configuration (see 6.5.17 on page 340)

The following vendor-specific mode pages are also supported

MP 24h: Vendor-Specific (see 6.5.18 on page 341)
(see on page 342)
MP 2Fh: Behavior Configuration (see 6.5.19 on page 343)
MP 30h: Device Attribute Settings (see 6.5.20 on page 347)
MP 30h[01h]: Drive MAC address - Device attribute settings (see 6.5.20.3.2 on page 351)
MP 30h[02h]: Drive IP address and subnet mask - Device attribute settings (see 6.5.20.3.3 on page 352)
MP 30h[40h]: SkipSync - Device attribute settings (see 6.5.20.4.1 on page 354)
MP 30h[41h]: Tape map control - Device attribute settings (see 6.5.20.4.2 on page 355)
MP 30h[42h]: End of partition behavior control - Device attribute settings (see 6.5.20.4.3 on page 355)
MP 3Eh: Engineering Support (see 6.5.21 on page 356)
Mode Page 3Fh: All Pages

NOTE 37 - Mode page 3Eh is for engineering use only and is not included in page 3Fh

6.5.5 MP 01h: Read-Write Error Recovery

See MODE SELECT (6/10) - 15h/55h (see 5.2.9 on page 84) for how to set these parameters and MODE SENSE (6/10) - 1Ah/5Ah (see 5.2.10 on page 86) for how to read these parameters.

This page is defined as common to all initiators.

The Read-Write Error Recovery mode page (see table 237) specifies the error recovery and reporting parameters that the device server shall use when transferring data between the device and the medium. These parameters do not affect protocol-level recovery procedures or positioning error recovery procedures.

NOTE 38 - The parameters in the Read-Write Error Recovery mode page also apply to verify operations.

Table 237 — Read-Write Error Recovery mode page

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	PS	SPF(0)	PAGE CODE (01h)					
1	PAGE LENGTH (0Ah)							
2	Reserved		TB	Rsvd	EER	PER	DTE	DCR
3	READ RETRY COUNT							
4	Reserved							
5	Reserved							
6	Reserved							
7	Reserved							
8	WRITE RETRY COUNT							
9	Reserved							
10	Reserved							
11	Reserved							

Byte Description

0

Bit	Description
7	PS (Parameter Saveable): 0b
6	Reserved
5-0	PAGE CODE: 01h

1 PAGE LENGTH: 0Ah

2

Bit	Description
7-6	Reserved
5	TB (Transfer Block): 1b
4	Reserved
3	EER (Enable Early Recovery): 1b
2	PER (Post Error): 0b

Value	Description
0b	The device does not create CHECK CONDITION status for Recovered Errors except for non-deferred sense data of: — 1/0017 (Recovered Error, DRIVE NEEDS CLEANING) for a LOAD UNLOAD command — 1/3700 (Recovered Error, ROUNDED PARAMETER) for a MODE SELECT command, and — 1/8383 (Recovered Error, DRIVE HAS BEEN CLEANED) for a LOAD UNLOAD command.
1b	The device will report a CHECK CONDITION status for all recovered data and non-data errors with a sense key of 1 in non-deferred sense data as well as deferred sense data.

1	DTE (Disable Transfer on Error): 0b (changeable-ignored)
0	DCR (Disable Correction): 0b

3 READ RETRY LIMIT: FFh (approximate maximum read recovery limit in seconds) (changeable)

Value	Description
05h	Limited error recovery; < 5 seconds.
FFh	Full Recovery Routines allowed (no time limit).
XXh	All other values may be rounded (to non-FFh).

4-7 Reserved

8 WRITE RETRY LIMIT: FFh (approximate maximum write recovery limit in seconds) (changeable)

Value	Description
02h	Limited error recovery; < 2 seconds.
05h	Limited error recovery; < 5 seconds.
FFh	Full Recovery Routines allowed (no time limit).
XXh	All other values may be rounded (to non-FFh).

9-11 Reserved

6.5.6 MP 02h: Disconnect-Reconnect

See MODE SELECT (6/10) - 15h/55h (see 5.2.9 on page 84) for how to set these parameters and MODE SENSE (6/10) - 1Ah/5Ah (see 5.2.10 on page 86) for how to read these parameters.

There is one copy of this page for each target port.

Table 238 — Disconnect-Reconnect mode page

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	PS	SPF (0b)	PAGE CODE (02h)					
1	PAGE LENGTH (0Eh)							
2	BUFFER FULL RATIO							
3	BUFFER EMPTY RATIO							
4	(MSB)	BUS INACTIVITY LIMIT						
5								(LSB)
6	(MSB)	DISCONNECT TIME LIMIT						
7								(LSB)
8	(MSB)	CONNECT TIME LIMIT						
9								(LSB)
10	(MSB)	MAXIMUM BURST SIZE						
11								(LSB)
12	EMDP	FAIR ARBITRATION			DIMM	DTDC		
13	Reserved							
14	(MSB)	FIRST BURST SIZE						
15								(LSB)

Byte Description

0

Bit	Description
7	PS: 0b
6	Reserved
5-0	PAGE CODE: 02h

1 PAGE LENGTH: 0Eh

2 BUFFER FULL RATIO: 00h

3 BUFFER EMPTY RATIO: 00h

4-5 BUS INACTIVITY LIMIT: 0000h (no limit)

6-7 DISCONNECT TIME LIMIT: 0000h (no limit)

8-9 CONNECT TIME LIMIT: 0000h (no limit)

10-11 MAXIMUM BURST SIZE: 0000h (no limit)

12

Bit	Description
7	EMDP (Enable Modify Data Pointers): 0b
6-4	FAIR ARBITRATION: 000b
3	DIMM (Disconnect Immediate): 0b
2-0	DTDC (Data Transfer Disconnect Word): 000b

13 Reserved

14-15 First Burst Size: 0000h

6.5.7 MP 0Ah: Control

See MODE SELECT (6/10) - 15h/55h (see 5.2.9 on page 84) for how to set these parameters and MODE SENSE (6/10) - 1Ah/5Ah (see 5.2.10 on page 86) for how to read these parameters.

There is one copy of this page for each initiator.

Byte	Description
0	
	Bit **Description** 7 PS: 0b 6 Reserved 5-0 Page Code: 0Ah
1	Page Length: 0Ah
2	
	Bit **Description** 7-5 TST (Task Set Type): 000b 4-2 Reserved 1 GLTSD (Global Logging Target Save Disable): 0b 0 RLEC (Report Log Exception Condition): 0b
3	
	Bit **Description** 7-4 Queue Algorithm Modifier: 0000b 3-2 Reserved 1 QErr (Queue Error): 0b 0 DQue (Disable Queuing): 1b
4	
	Bit **Description** 7 Reserved 6 RAC (Report A Check): 0b 5-3 Reserved 2 RAERP (Ready Asynchronous Event Reporting): 0b 1 UAAERP (Unit Attention Asynchronous Event Reporting): 0b 0 EAERP (Error Asynchronous Event Reporting): 0b
5	Reserved
6-7	Ready AEN Holdoff Period: 0000h If AEN is disabled (Byte 4 bit 2 = 0b), this field is not meaningful.
8-9	Busy time-out period: FFFFh
10	Reserved
11	Reserved

6.5.8 MP 0Ah[01h]: Control Extension

See MODE SELECT (6/10) - 15h/55h (see 5.2.9 on page 84) for how to set these parameters and MODE SENSE (6/10) - 1Ah/5Ah (see 5.2.10 on page 86) for how to read these parameters.

The mode page policy is shared.

Table 239 — Control Extension mode page

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	PS	SPF (1b)	PAGE CODE (0Ah)					
1	SUBPAGE CODE (01h)							
2	(MSB)	PAGE LENGTH (1Ch)						
3								(LSB)
4	Reserved					TCMOS	SCSIP	IALUAE
5	Reserved				INITIAL COMMAND PRIORITY			
6	Reserved							
31								

Byte Description

0

Bit	Description
7	PS: 0b
6	SPF: 1b
5-0	PAGE CODE: 0Ah

1 SUBPAGE CODE: 01h

2-3 PAGE LENGTH: 1Ch

4

Bit	Description
7-3	Reserved
2	TCMOS (Timestamp Changeable by Methods Outside this Standard) A TCMOS bit set to one specifies that the timestamp may be initialized by methods outside the scope of this standard (for example The LDI Set Timestamp command). A TCMOS bit set to zero specifies that the timestamp shall not be changed by any method except those defined by this standard.
1	SCSIP (SCSI precedence) A SCSIP bit set to one specifies that the timestamp changed using a SET TIMESTAMP command takes precedence over methods outside the scope of this standard (for example the LDI Set Timestamp command). A SCSIP bit set to zero specifies that methods outside this standard (for example the LDI Set Timestamp command) may change the timestamp and that the SET TIMESTAMP command is illegal.
0	IALUAE (implicit asymmetric logical unit access enabled): 0b

5

Bit	Description
7-4	Reserved
3-0	INITIAL COMMAND PRIORITY: 0h

6-31 Reserved

6.5.9 MP 0Fh: Data Compression

See MODE SELECT (6/10) - 15h/55h (see 5.2.9 on page 84) for how to set these parameters and MODE SENSE (6/10) - 1Ah/5Ah (see 5.2.10 on page 86) for how to read these parameters.

The Data Compression mode page (see table 240) specifies the parameters for the control of data compression in the device.

This page is defined as common to all initiators.

Table 240 — Data Compression mode page

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	PS	SPF(0)	PAGE CODE (0Fh)					
1	PAGE LENGTH (0Eh)							
2	DCE	DCC	Reserved					
3	DDE	RED		Reserved				
4	(MSB)	COMPRESSION ALGORITHM						
7								(LSB)
8	(MSB)	DECOMPRESSION ALGORITHM						
11								(LSB)
12		Reserved						
15								

Byte Description

0

Bit	Description
7	PS: 0b
6	Reserved
5-0	PAGE CODE: 0Fh

1 PAGE LENGTH: 0Eh

2

Bit	Description
7	DCE (Data Compression Enabled): 1b

Value	Description
0	Data compression is not enabled
1	Data compression is enabled

NOTE 39 - The only advantage to disabling data compression is predictable full tape capacity (see 2.1.39)

NOTE 40 - When the SELECT DATA COMPRESSION ALGORITHM field of MP 10h: Device Configuration (see 6.5.10) is set to one the DCE bit is forced to one, even if both pages are received in the same MODE SELECT command.

6	DCC (Data Compression Capable): 1b
5-0	Reserved

3

Bit	Description
7	DDE: 1b
6-5	RED (Report Exception on Decompression): 00b
4-0	Reserved

4-7 COMPRESSION ALGORITHM: 000000FFh (Unregistered algorithm)

8-11 DECOMPRESSION ALGORITHM: 000000FFh (Unregistered algorithm)

12-15 Reserved

6.5.10 MP 10h: Device Configuration

See MODE SELECT (6/10) - 15h/55h (see 5.2.9 on page 84) for how to set these parameters and MODE SENSE (6/10) - 1Ah/5Ah (see 5.2.10 on page 86) for how to read these parameters.

The Device Configuration mode page (see table 241) is used to specify the configuration of items specific to tape drives.

This page is defined as common to all initiators.

Table 241 — Device Configuration mode page

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	PS	SPF(0)	PAGE CODE (10h)					
1	PAGE LENGTH (0Eh)							
2	Rsvd	Obsolete	CAF	ACTIVE FORMAT				
3	ACTIVE PARTITION							
4	WRITE OBJECT BUFFER FULL RATIO							
5	READ OBJECT BUFFER EMPTY RATIO							
6	(MSB)	WRITE DELAY TIME						
7								(LSB)
8	OBR	LOIS	Obsolete	AVC	SOCF		ROBO	REW
9	Obsolete							
10	EOD DEFINED			EEG	SEW	SWP	BAML	BAM
11	(MSB)	OBJECT BUFFER SIZE AT EARLY WARNING						
13								(LSB)
14	SELECT DATA COMPRESSION ALGORITHM							
15	WTRE		OIR	REWIND ON RESET		ASOCWP	PERSWP	PRMWP

Byte Description

0

Bit	Description
7	PS: 0b
6	SPF: 0b
5-0	PAGE CODE: 10h

1 PAGE LENGTH: 0Eh

2

Bit	Description
7	Reserved
6	CAP (Change Active Partition): 0b (Obsolete - Refer to the LOCATE command to change partition)
5	CAF (Change Active Format): 0b (non-changeable)
4-0	ACTIVE FORMAT: 00000b (non-changeable)

3 ACTIVE PARTITION (non-changeable)

4 WRITE BUFFER FULL RATIO: 00h (value not specified) (non-changeable)

5 READ BUFFER EMPTY RATIO: 00h (value not specified) (non-changeable)

6-7 WRITE DELAY TIME: 0014h (about 2 sec) (changeable)

The maximum time, in 100 ms increments, that the device server waits before any buffered data that is to be written, is forced to the medium after the last buffered WRITE command that did not cause the object buffer to exceed the write object buffer full ratio.

WARNING WARNING

Changing the WRITE DELAY TIME may result in adverse performance.

WARNING WARNING

8

Bit	Description
7	OBR (Object Buffer Recovery): 0b (non-changeable)
6	LOIS (Logical Object Identifier Supported): 1b (non-changeable)
5	Obsolete
4	AVC (Automatic Velocity Control): 0b (non-changeable) The speed chosen is defined by the SPEED field in the mode parameter header.
3-2	SOCF (Stop on Consecutive Filemarks): 00b (non-changeable) Read ahead to fill buffer, without regard for filemarks
1	RBO (Recover Buffer Order): 0b (non-changeable)
0	REW (Report Early Warning): 0b (non-changeable)

9 GAP SIZE: 00h (non-changeable)

10

Bit	Description
7-5	EOD DEFINED (End Of Data Defined): 000b (non-changeable)
4	EEG (Enable EOD Generation): 1b (non-changeable)
3	SEW (Synchronize at Early-Warning): 0b (non-changeable) The device may retain unwritten buffered logical objects in the object buffer when positioned between early-warning and EOP.
2	SWP (Soft Write Protect): 0b (non-changeable)
1	BAML (Block Address Mode Lock): 0b (non-changeable)
0	BAM (Block Address Mode): 0b (non-changeable)

11-13 OBJECT BUFFER SIZE AT EARLY WARNING: 000000h (non-changeable)

14 SELECT DATA COMPRESSION ALGORITHM: 01h (changeable)

Value	Description
00h	No compression used NOTE 41 - The only advantage to disabling data compression is predictable full tape capacity (see 2.1.39)
01	Use default compression algorithm NOTE 42 - On a MODE SENSE, the value of byte 14 is consistent with what is found in Mode Page 0F, Byte 2, Bit 7. If this byte alone is updated on a MODE SELECT, and Mode Page 0F is not sent, then Mode Page 0F, Byte 2, Bit 7 is updated according to this field. If both Page 10 and Page 0F are sent, then if either setting is enabled, then compression will be enabled and both fields updated to reflect enablement.

15

Bit	Description
7-6	WTRE (WORM Tamper Read Enable): 00b (changeable)

Value	Description
00b	The device treats a value of 00b the same as if the value were 10b.
01b	Detection of compromised integrity on a WORM medium shall not affect processing of a task.

NOTE 43 - An application client should not set the WTRE bit to 01b except for the recovery of data from a WORM medium where the integrity of the stored data has been compromised.

10b If the drive detects compromised integrity on a WORM medium it returns CHECK CONDITION status with the sense key set to MEDIUM ERROR and the additional sense code set to WORM MEDIUM - INTEGRITY CHECK. (3/300Dh).

The position of the medium may have changed.

11b Reserved

5 OIR (Only If Reserved) 0b (changeable)

Value	Description
0b	Commands processed per RVC column of <<XREF-Table 1. Drive Commands>>
1b	Commands processed only if a reservation exists that allow access via the I_T nexus from which the command was received.

4-3 REWIND ON RESET: 10b (non-changeable)

The position on medium is not changed due to a logical unit reset.

2 ASOCWP (Associated Write Protect): 0b (non-changeable)

1 PERSWP (Persistent Write Protect) 0b (non-changeable)

0 PRMWP (Permanent Write Protect): 0b (non-changeable)

6.5.11 MP 10h[01h]: Device Configuration Extension

See MODE SELECT (6/10) - 15h/55h (see 5.2.9 on page 84) for how to set these parameters and MODE SENSE (6/10) - 1Ah/5Ah (see 5.2.10 on page 86) for how to read these parameters.

The Device Configuration Extension mode page (see table 242), a subpage of the Device Configuration mode page, provides control of the SCSI features specific to sequential-access devices. The Device Configuration Extension mode page uses the shared mode page policy (see SPC-4).

Table 242 — Device Configuration Extension mode page

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	PS	SPF(1b)	PAGE CODE (10h)					
1	SUBPAGE CODE (01h)							
2	(MSB)	PAGE LENGTH (1Ch)						
3								(LSB)
4	Reserved				TARPF	TASER	TARPC	TAPLSD
5	WRITE MODE				SHORT ERASE MODE			
6	(MSB)	PEWS						
7								(LSB)
8	Reserved							VCELBRE
9	Reserved							
31								

See SPC-4 for a description of the PS bit, SPF bit, PAGE CODE field, and PAGE LENGTH field.

The parameter saveable (PS) bit shall be set to one in the MODE SENSE command indicating that the changeable parameters in the mode page shall be saveable by issuing a MODE SELECT command with the SP bit set to one.

A TapeAlert prevent LOG SENSE deactivation (TAPLSD) bit set to one specifies that the device server shall not alter the value of implemented TapeAlert FLAG parameters due to processing of a LOG SENSE command with the PAGE CODE field set to 2Eh. A TAPLSD bit set to zero specifies that, as part of the processing of a LOG SENSE command with the PAGE CODE field set to 2Eh, the device server shall deactivate every supported TapeAlert flag.

A TapeAlert respect page control (TARPC) bit set to one specifies that the device server shall select the type of parameter values for the TapeAlert log page using the value of the PC field in a LOG SELECT or LOG SENSE command (see SPC-4). A TARPC bit set to zero specifies that the device server shall select cumulative parameter values for the TapeAlert log page regardless of the value of the PC field in a LOG SELECT or LOG SENSE command.

NOTE 44 - An application client using the TapeAlert threshold usage model should set the TARPC bit to one.

A TapeAlert Select exception reporting (TASER) bit set to one specifies that:

a) activation of a TapeAlert flag shall not result in an informational exception condition; and
b) activation or deactivation of a TapeAlert flag may result in the generation of a unit attention condition with the additional sense code set to THRESHOLD CONDITION MET depending on the value of the ETC bit in each parameter in the TapeAlert log page.

A TASER bit set to zero specifies that:

a) activation of a TapeAlert flag shall result in an informational exception condition;
b) activation or deactivation of a TapeAlert flag shall not result in the generation of a unit attention condition with the additional sense code set to THRESHOLD CONDITION MET; and

c) the device server shall set the ETC bit in each parameter of the TapeAlert log page to zero.

The device server may provide independent sets of TapeAlert log parameters for each I_T nexus (see SPC-4). If the device server does not support independent sets of TapeAlert log parameters and the processing of a MODE SELECT command with the TASER bit set to zero results in a change in the value of the ETC bit in a TapeAlert log parameter, then the device server shall establish a unit attention condition (see SAM-4) for the initiator port associated with every I_T nexus, except the I_T nexus on which the MODE SELECT command was received, with the additional sense code set to LOG PARAMETERS CHANGED.

A TapeAlert respect parameter fields (TARPF) bit set to one specifies that the device server shall select the parameters of the TapeAlert log page to report in response to a LOG SENSE command using the values of the PPC bit and the PARAMETER POINTER field (see SPC-4). A TARPF bit set to zero specifies that the device server shall report all TapeAlert log page parameters regardless of the values of the PPC bit and the PARAMETER POINTER field.

The SHORT ERASE MODE field specifies the action to be taken by the device server when an ERASE (16) or ERASE (6) command with the LONG bit set to zero is processed. The values for the SHORT ERASE MODE field are specified in table 243. The Ultrium 5 drive sets this field to 02h.

Table 243 — SHORT ERASE MODE field

Value	Description
00h	Not Supported
01h	Not Supported
02h	The device server shall record an EOD indication at the specified location on the medium.
03h - FFh	Reserved

The WRITE MODE field specifies the write mode (see 4.1) in which to place the device server. The values for the WRITE MODE field are specified in table 244. Ultrium 5 devices support a value of 00h or 01h. If a volume is loaded and an attempt is made to change the WRITE MODE from 01h (i.e., append-only) to 00h (i.e., write-anywhere), then the command shall be rejected with ILLEGAL REQUEST, INVALID FIELD IN PARAMETER LIST

Table 244 — WRITE MODE field

Value	Description
00h	write-anywhere mode (see 4.1.2).
01h	append-only mode (see 4.1.3).
02h - EFh	Reserved
F0h - FFh	Vendor-specific

The programmable early warning size (PEWS) field specifies the number of megabytes (i.e., 10^6) native capacity to use in establishing a PEWZ. See (see 4.2) for a description of programmable early warning. Ultrium 4 and earlier drives do not support the PEWS field and require that it be set to 0000h. The Ultrium 5 and later drives support the PEWS field set to any value and does not round the value (e.g., due to volume capacity). The default value is 0000h indicating that there is no PEWZ.

NOTE 45 - It is possible that a partition is set to a capacity less than the size that can be represented by the PEWS field. In this case the first write will get the programmable early warning indication.

NOTE 46 - PEWZ will be created using the amount of medium required to fit PEWS megabytes assuming one-to-one compression (e.g., compression disabled) and the medium is in good condition.

NOTE 47 - The drive employs a design to protect against the number of blocks on medium exceeding a value that can be represented in a 4-byte field. To ensure the programmable early warning indication is reported to an application during this scenario, the drive also uses the number of blocks on medium as a determination of entering PEWZ. The drive calculates how many blocks it will take to fill PEWZ assuming a modest block size of

64k (i.e., PEWS/10000h = number_of_blocks_to_make_PEWZ) and reports programmable early warning when the number of blocks on medium reaches PEWZ (i.e., FFFF FF00h - number_of_blocks_to_make_PEWZ).

If the volume containing encrypted logical blocks requires encryption (VCELBRE) bit is set to one and the VCELB bit in the Data Encryption Status page is set to one, then the device server shall require that any logical blocks written to the medium are encrypted (see SSC-4). If the VCELBRE bit is set to zero, then the device server does not use the VCELB bit in the Data Encryption Status page to determine if encryption is required for writing logical blocks. The encryption mode (see 4.10) setting determines the behavior of the VCELBRE bit. This interaction is described in table 245.

Table 245 — VCELBRE behavior related to encryption modes

Encryption mode	VCELBRE is	
	Set to	Changeable on LUN 0
AME	0b	Yes
Transparent Encryption - IBM (e.g., LME)	1b	No
ADC Controlled	1b	Yes

ADC Controlled — ADC tape data encryption (see ADC-3) using External data encryption control (see SSC-3).
AME — Application Managed Encryption using in-band methods of controlling encryption (e.g., Logical block encryption described in SSC-3 or the method used by TSM).
Transparent Encryption - IBM — Application transparent encryption using a proxy to the IBM EKM or TKLM (e.g., LME; SME).

6.5.12 MP 11h: Medium Partition Page

See MODE SELECT (6/10) - 15h/55h (see 5.2.9 on page 84) for how to set these parameters and MODE SENSE (6/10) - 1Ah/5Ah (see 5.2.10 on page 86) for how to read these parameters.

This page is defined as common to all initiators.

The Medium Partition mode page (see table 246) is used to specify the group of medium partitions. Fields in the Medium Partition mode page indicating the current state of the partitions for the medium are changed by the device server to the current medium state on a not ready to ready transition when the medium state changes from demounted to mounted.

The partitioning of the mounted volume is not changed until a subsequent FORMAT MEDIUM command is issued while the volume is mounted.

There is an overhead associated with each additional partition, regardless of the size of the partition, that subtracts from the customer data space on the volume. The larger the number of possible partitions, the more overhead is consumed when the volume is partitioned.

Table 246 — Medium Partition mode page

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	PS(0b)	SPF(0b)	PAGE CODE (11h)					
1	PAGE LENGTH (n-1)							
2	MAXIMUM ADDITIONAL PARTITIONS							
3	ADDITIONAL PARTITIONS DEFINED							
4	FDP	SDP	IDP	PSUM (11b)		POFM (1b))	CLEAR (0b)	ADDP(0b)
5	MEDIUM FORMAT RECOGNITION (03h)							
6	PARTITIONING TYPE				PARTITION UNITS			
7	Reserved							
Partition size descriptor(s)								
8	(MSB)	PARTITION SIZE (first)						
9								(LSB)
n-1	(MSB)	PARTITION SIZE (last)						
n								(LSB)

Byte Description

0

Bit	Description
7	PS (Page Save): 0b
6	SPF (SubPage Format): 0b
5-0	PAGE CODE: 11h

1 PAGE LENGTH:

The page length depends on the number of partitions on the volume (i.e., 08h + 2*ADDITIONAL PARTITIONS DEFINED).

2 MAXIMUM ADDITIONAL PARTITIONS: (non-changeable)

This field specifies the maximum number of additional partitions supported on the loaded volume. It can be thought of as the value N-1 where N is the maximum number of partitions allowed. In a MODE SENSE command the MAXIMUM ADDITIONAL PARTITIONS field is set to the value indicated by the loaded

volume, or the value reported for the previously loaded volume if there is no volume loaded. If there has been no volume loaded since power-on, then the MAXIMUM ADDITIONAL PARTITIONS field is set to 00h.

This value may be changed by the device if:

A) a volume is loaded; or
B) other unspecified events occur.

3 ADDITIONAL PARTITIONS DEFINED:

This field specifies the number of additional partitions on the mounted volume (in addition to partition 0). It can be thought of as the value N-1 where N is the total number of partitions.

If SDP or IDP is set to one, then this field may be set to 00h, or 01h.

If FDP is set to one, then this field is ignored.

This field may not be changed when the drive is not ready.

The partitioning of the mounted volume is not changed until a subsequent Format Medium command is issued while the volume is mounted. If the logical unit is not ready, the ADDITIONAL PARTITIONS DEFINED field is undefined.

NOTE 48 - If a MODE SENSE command is received after a MODE SELECT command but before a FORMAT MEDIUM command, then the ADDITIONAL PARTITIONS DEFINED value returned may not match the value sent in the MODE SELECT command but the device server retains the value sent in the MODE SELECT command until the FORMAT MEDIUM command is performed.

4

Bit	Description

7 FDP (Fixed Data Partitions):

A FDP bit of one in a MODE SELECT command specifies the logical unit shall partition the medium based on its fixed definition of partitions. Setting this bit to one is mutually exclusive with the SDP and IDP bits. The partition size descriptors are ignored by the MODE SELECT command when the FDP bit is set to one. The drive creates two partitions on the volume and assigns one partition as the minimum sized partition and one partition as the remaining available size.

When a MODE SENSE command is received after a MODE SELECT command but before a FORMAT MEDIUM command the FDP bit returned is the value that was set in the MODE SELECT command. When a MODE SENSE command is received and there is no pending change related to a MODE SELECT command for this page the FDP bit is set to zero.

NOTE 49 - The partition size descriptors are present in MODE SENSE data regardless of the settings of the FDP, SDP or IDP fields to give an estimate of the size of each partition.

6 SDP (Select Data Partitions):

For Mode Select, either value is allowed

Value	Description
0b	The SDP functionality is not used.
1b	The volume is partitioned into the number of partitions as specified by the ADDITIONAL PARTITIONS DEFINED field (n) using partitions as close to equal size as possible. If rounding is required to meet format requirements, partitions will be rounded up from the equal size and the last partition (i.e., n + 1) will use the remaining capacity. The drive partitions the volume into n+1 partitions numbered 0 through n. Setting this bit to one is mutually exclusive with the FDP and IDP fields. The partition size descriptors are ignored by the MODE SELECT command when the SDP bit is set to one.

When a MODE SENSE command is received after a MODE SELECT command but before a FORMAT command the SDP bit returned is the value that was set in the MODE SELECT

command. When a MODE SENSE command is received and there is no pending change related to a MODE SELECT command for this page the SDP bit is set to zero.

5 IDP (Initiator Defined Partitions):

For Mode Select, either value is allowed

Value	Description
0b	The IDP functionality is not used.
1b	The volume is partitioned as specified by the ADDITIONAL PARTITIONS DEFINED field and the partition size descriptors. Setting this bit to one is mutually exclusive with the FDP and SDP fields. The number of non-zero partition size descriptors received in the Medium Partition mode page shall be at least one more than the ADDITIONAL PARTITIONS DEFINED value. The size of partition 0 shall be non-zero.

When a MODE SENSE command is received after a MODE SELECT command but before a FORMAT MEDIUM command the IDP bit returned is the value that was set in the MODE SELECT command. When a MODE SENSE command is received and there is no pending change related to a MODE SELECT command for this page the IDP bit is set to one.

4-3 PSUM (Partition Size Unit of Measure): 11b ($10^{(\text{PARTITION UNITS})}$ bytes)

2 POFM (Partition on Format Medium): 1b

This bit indicates that the Mode Select command will not cause changes to the partition sizes or user data, either recorded or buffered. Actual media partitioning occurs with a subsequent Format Medium command using the mode data for this page. Field values specified by a Mode Select command for this page will not be changed by the drive before the volume is unloaded or the drive is reset. Some field checking may be performed by the MODE SELECT command. However, there is no guarantee that any subsequent partitioning during a FORMAT MEDIUM command will complete with no errors.

1 CLEAR (Partition clearing): 0b

0 ADDP (Adding Partitions): 0b

The drive does not retain the method used to partition the volume. The device server sets the IDP field to one in the MODE SENSE data. If a volume was previously partitioned through a MODE SELECT command with FDP or SDP set to one, the device server sets IDP to one in subsequent MODE SENSE data since the volume has been initiator partitioned.

Table 247 shows the partition sizes that result from a MODE SELECT with the indicated field settings if the SET CAPACITY command has not shortened the tape..

Table 247 — Partition sizes defined by FDP, SDP, and IDP bits

FDP	SDP	IDP	ADDITIONAL PARTITIONS DEFINED	PARTITION SIZE (first)	PARTITION SIZE (last)	Partition 0	Partition 1
1	0	0	X	X	X	1425 GB	37.5 GB
0	1	0	00h	X	X	1.5 TB	Does not exist
0	1	0	01h	X	X	750 GB	712.5 GB
0	0	1	00h	FFFFh	0	1.5 TB	Does not exist
				u	0	u=1500	Does not exist
			01h	s	FFFFh	37.5*n [1<=n<=38] [37.5*(n-1)< s <=37.5*n]	1.5 TB - (size of partition 0) - overhead
				FFFFh	s	1.5 TB - (size of partition 1) - overhead	37.5*n [1<=n<=38] [37.5*(n-1)< s <=37.5*n]
				u	v	u=37.5*n [1<=n<=38]	v=37.5*m [m=39-n]
All other combinations						CHECK CONDITION, ILLEGAL REQUEST, INVALID FIELD IN PARAMETER DATA	

Note - Sizes are approximate.
Note - The sum of capacity available for multiple partitions is 39 * 37.5 GB
Note - When more than one partition is defined there is overhead that results in a loss of capacity. This overhead comes from rounding partitions to increments of 37.5 GB and reserving a guard band between partitions.
Note - All values in PARTITION SIZE fields assume a PSUM field value of 11b and a PARTITION UNITS field value of 9h.

5 MEDIUM FORMAT RECOGNITION: 03h (Capable of format and partition recognition)

6

Bit **Description**

7-4 PARTITIONING TYPE:

The PARTITIONING TYPE field specifies the criteria used to create the partitions.

Value	Description
0h	The type of partitioning is vendor-specific or unknown The drive sets the PARTITIONING TYPE field to a value of 1h when a 0h is received in a MODE SELECT command. If the volume is not partitioned this value is returned in a MODE SENSE command unless there is a pending action from a MODE SELECT
1h	The type of partitioning is optimized for streaming performance (i.e., wrap-wise partitioning).
2h	Not Supported
3h-Eh	Reserved
Fh	For a MODE SELECT command this value is reserved.

When a MODE SENSE command is received after a MODE SELECT command but before a FORMAT MEDIUM command the PARTITIONING TYPE field returned is the value that was set in the MODE SELECT command. When a MODE SENSE command is received and there is no

pending change related to a MODE SELECT command for this page the PARTITIONING TYPE field is set depending on how the volume is currently partitioned.

3-0 PARTITION UNITS:

If the PSUM field is set to 11b, then each PARTITION SIZE descriptor specifies the size of a partition in $10^{\text{PARTITION UNITS}}$ bytes. The PARTITION UNITS used to partition the volume are not retained.

7 Reserved

8-n PARTITION SIZE descriptors: (n=9, or 11)

Each PARTITION SIZE descriptor specifies the size of a partition in $10^{\text{PARTITION UNITS}}$ bytes. The device rounds any value received in a PARTITION SIZE descriptor to the nearest valid partition size.

Byte	Description
8-9	PARTITION SIZE descriptor for partition 00h This shall exist and shall be non-zero.
10-11	PARTITION SIZE descriptor for partition 01h, if sent This descriptor shall be present and non-zero if the ADDITIONAL PARTITIONS DEFINED field is 01h or greater. This descriptor may be present and set to zero if the ADDITIONAL PARTITIONS DEFINED field is 00h.

NOTE 50 - Summing the partition sizes provides a standardized mechanism for an initiator to calculate the volume capacity with MODE SENSE.

In a MODE SELECT command:

a) a value of FFFFh received in a PARTITION SIZE descriptor, requests that the logical unit allocate all remaining partition space to that partition;
b) if the FDP bit is set to one any values are allowed in the PARTITION SIZE descriptors and ignored. The PARTITION SIZE descriptors are updated by the drive when an initiator specifies a new number of partitions;
c) if the SDP bit is set to one any values are allowed in the PARTITION SIZE descriptors and ignored. The PARTITION SIZE descriptors are updated by the drive when an initiator specifies a new number of partitions; and
d) the device server returns CHECK CONDITION status with the Sense Key set to ILLEGAL REQUEST and the additional sense code set to INVALID FIELD IN PARAMETER LIST if:
   A) insufficient space exists on the volume for the requested partition sizes; or
   B) multiple partition size descriptors are set to FFFFh.

In a MODE SENSE command:

a) a value of FFFFh returned in a PARTITION SIZE descriptor, indicates the partition size, in units indicated by PSUM and PARTITION UNITS, is greater than or equal to FFFFh;
b) if the logical unit is not ready, then thePARTITION SIZE descriptors are undefined;
c) if a MODE SELECT command has modified values in this page but a FORMAT MEDIUM command has not yet been processed, then the values in the PARTITION SIZE fields are the values set by the MODE SELECT command rounded to a valid partition size as described in table 247; and
d) if the logical unit is ready and there is no pending change related to a MODE SELECT command for this page, then the PARTITION SIZE fields reflect the size on the volume of the related partition.

NOTE 51 - When more than one partition is defined, the sum of the partition sizes may be less than when only a single partition is defined. Each partition requires a certain amount of overhead space on a volume, which reduces the usable customer data space.

6.5.13 MP 18h: Protocol-Specific Logical Unit

See MODE SELECT (6/10) - 15h/55h (see 5.2.9 on page 84) for how to set these parameters and MODE SENSE (6/10) - 1Ah/5Ah (see 5.2.10 on page 86) for how to read these parameters.

There is one copy of this page for each target port.

The Protocol-specific logical unit mode page for FCP attached devices is defined in 6.5.13.1.

The Protocol-specific logical unit mode page for SAS attached devices is defined in 6.5.13.2.

6.5.13.1 Fibre Channel Logical Unit (18h)

.

Table 248 — Fibre Channel Logical Unit mode page

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	PS	SPF (0b)	PAGE CODE (18h)					
1	PAGE LENGTH (n-1)							
2	Reserved				PROTOCOL IDENTIFIER			
3	Reserved							EPDC
4	Reserved							
n								

Byte Description

0

Bit	Description
7	PS (Page Save): 0b
6	Reserved
5-0	PAGE CODE: 18h

1 PAGE LENGTH: 06h

2

Bit	Description
7-1	Reserved
3-0	PROTOCOL IDENTIFIER: 0h (FCP)

3

Bit	Description
7-1	Reserved
0	EPDC (Enable Precise Delivery Control): 1b (changeable)

Value	Description
0b	Do not use the FCP precise delivery function and ignore the contents of the COMMAND REFERENCE NUMBER field in the FCP_CMND IU.
1b	Use the FCP precise delivery function (checking the contents of the COMMAND REFERENCE NUMBER field in the FCP_CMND IU) to ensure that command packets are delivered in order.

4-7 Reserved

6.5.13.2 SAS Logical Unit (18h)

.

Table 249 — SAS Logical Unit mode page

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	PS	SPF (0b)	PAGE CODE (18h)					
1	PAGE LENGTH (n-1)							
2	Reserved			TLR	PROTOCOL IDENTIFIER			
3	Reserved							
n								

Byte Description

0

Bit	Description
7	PS (Page Save): 0b
6	Reserved
5-0	PAGE CODE: 18h

1 PAGE LENGTH: 06h

2

Bit	Description
7-5	Reserved
4	TLR (Transport Layer Retries): 1b (changeable)
3-0	PROTOCOL IDENTIFIER: 6h (Serial Attached SCSI)

3-7 Reserved

6.5.14 MP 19h: Protocol specific port

See MODE SELECT (6/10) - 15h/55h (see 5.2.9 on page 84) for how to set these parameters and MODE SENSE (6/10) - 1Ah/5Ah (see 5.2.10 on page 86) for how to read these parameters.

There is one copy of this page per primary port.

The Protocol specific port mode page for FCP attached devices is defined in 6.5.14.1.

The Protocol specific port mode page for SAS attached devices is defined in 6.5.14.2.

6.5.14.1 FCP port (19h)

Table 250 — Fibre Channel Port mode page

Byte	Bit							
	7	6	5	4	3	2	1	0
0	PS (0)	SPF (0)	PAGE CODE (19h)					
1	PAGE LENGTH							
2	Reserved				PROTOCOL IDENTIFIER			
3	DTFD (0)	PLPB (0)	DDIS (0)	DLM (0)	RHA (0)	ALWI (0)	DTIPE (0)	DTOLI (0)
4	Reserved							
5								
6	Reserved					RR_TOV UNITS		
7	Resource Recovery Time Out Value (RR_TOV)							

Byte Description

0

Bit	Description
7	PS (Page Save): 0b
6	SPF (SubPage Format): 0b
5-0	PAGE CODE: 19h

1 PAGE LENGTH: 06h

NOTE 52 - A PAGE LENGTH of 0Eh is allowed on Mode Select for backwards compatibility with older devices and levels of the standard. Any fields beyond byte 7 below are ignored.

2

Bit	Description
7-1	Reserved
3-0	PROTOCOL IDENTIFIER: 0h (FCP)

3

Bit	Description
7	DTFD (Disable Target Fabric Discovery): 0b
6	PLPB (Prevent Loop Port Bypass): 0b
5	DDIS (Disable Discovery): 0b
4	DLM (Disable Loop Master): 0b
3	RHA (Require Hard Address): 0b
2	ALWI (Allow Login without Loop Initialization): 0b
1	DTIPE (Disable Target Initiated Port Enable): 0b
0	DTOLI (Disable Target Originated Loop Initialization): 0b

4-5 Reserved

6

Bit	Description
7-3	Reserved
2-0	RR_TOV UNITS (changeable)

Value	Description
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

7 RR_TOV (Resource Recovery Time Out Value): (changeable)

NOTE 53 - The default RR_TOV value is 25 seconds.

6.5.14.2 SAS port (19h)

Table 251 — SAS Port mode page

Byte	Bit							
	7	6	5	4	3	2	1	0
0	PS	SPF (0)	PAGE CODE (19h)					
1	PAGE LENGTH							
2	Reserved	CONTINUE AWT	BRDCST ASYNCH EVENT	RLM	PROTOCOL IDENTIFIER			
3	Reserved							
4	(MSB)	I_T NEXUS LOSS TIME (07D0h)						
5								(LSB)
6	(MSB)	INITIATOR RESPONSE TIMEOUT (07D0h)						
7								(LSB)
8	(MSB)	REJECT TO OPEN LIMIT (0000h)						
9								(LSB)
10	Reserved							
15								

Byte Description

0

Bit	Description
7	PS (Page Save): 0b (non-changeble)
6	SPF (SubPage Format): 0b (non-changeable)
5-0	PAGE CODE: 19h

1 PAGE LENGTH: 0Eh

2

Bit	Description
7-5	Reserved
6	CONTINUE AWT (continue arbitration wait timer): 1b (non-changeble)
5	BRDCST ASYNCH EVENT: 0b (non-changeble)
4	RLM (Ready LED Meaning): 0b (non-changeble)
3-0	PROTOCOL IDENTIFIER: 6h (SAS)

3 Reserved

4-5 I_T NEXUS LOSS TIME: 07D0h (non-changeable)

6-7 INITIATOR RESPONSE TIMEOUT: 07D0h (non-changeable)

8-9 REJECT TO OPEN LIMIT: 0000h (non-changeable)
10-15 Reserved

6.5.15 MP 1Ah: Power Condition

See MODE SELECT (6/10) - 15h/55h (see 5.2.9 on page 84) for how to set these parameters and MODE SENSE (6/10) - 1Ah/5Ah (see 5.2.10 on page 86) for how to read these parameters.

The power condition mode page controls the timers that the drive uses to go into a low-power mode. If any idle condition timer is enabled, then the low power condition is entered as the result of the expiration of one of the power condition timers in this mode page even if a volume is loaded.

This page is defined as common to all initiators.

Table 252 defines the Power Condition mode page.

Table 252 — MP 1Ah: Power Condition mode page format

Byte	Bit							
	7	6	5	4	3	2	1	0
0	PS	SPF (0b)	PAGE CODE (1Ah)					
1	PAGE LENGTH (26h)							
2	Reserved							STANDBY_Y(0)
3	Reserved				IDLE_C	IDLE_B(0)	IDLE_A(0)	STANDBY_Z(0)
4	(MSB)	IDLE_A CONDITION TIMER (00000000h)						
7								(LSB)
8	(MSB)	STANDBY_Z CONDITION TIMER (00000000h)						
11								(LSB)
12	(MSB)	IDLE_B CONDITION TIMER (00000000h)						
15								(LSB)
16	(MSB)	IDLE_C CONDITION TIMER						
19								(LSB)
20	(MSB)	STANDBY_Y CONDITION TIMER (00000000h)						
23								(LSB)
24	Reserved							
39								

Byte Description

0

Bit	Description
7	PS (Page Save): 0b
6	SPF (SubPage Format): 0b
5-0	PAGE CODE: 19h

1 PAGE LENGTH: 26h

2

Bit	Description
7-1	Reserved
0	STANDBY_Y: 0b (non-changeable)

3

Bit	Description
7-4	Reserved
3	IDLE_C: 1b (changeable)

Value	Description
0b	The idle_c condition timer is disabled and the power condition is disabled.
1b	The idle_c condition timer is enabled.

2	IDLE_B: 0b (non-changeable)
1	IDLE_A: 0b (non-changeable)
0	STANDBY_Z: 0b (non-changeable)

4-7 IDLE_A CONDITION TIMER: 00000000h (non-changeable)

8-11 STANDBY_Z CONDITION TIMER: 00000000h (non-changeable)

12-15 IDLE_B CONDITION TIMER: 00000000h (non-changeable)

16-19 IDLE_C CONDITION TIMER: 00002EE0h (i.e., 20 minutes)(changeable)

Initial value, in 100 millisecond increments, for the idle_c condition timer. This value may be rounded up or down to the nearest implemented time. When in the IDLE_C mode, a REQUEST SENSE command returns NO SENSE/IDLE_C CONDITION ACTIVATED BY TIMER (0/5E07).

20-23 STANDBY_Y CONDITION TIMER:00000000h (non-changeable)

24-39 Reserved

6.5.16 MP 1Ch: Informational Exceptions Control

See MODE SELECT (6/10) - 15h/55h (see 5.2.9 on page 84) for how to set these parameters and MODE SENSE (6/10) - 1Ah/5Ah (see 5.2.10 on page 86) for how to read these parameters.

There is one copy of this page for each initiator.

Table 253 — Informational Exceptions Control mode page

Byte	Bit							
	7	6	5	4	3	2	1	0
0	PS	SPF (0b)	PAGE CODE (1Ch)					
1	PAGE LENGTH (0Ah)							
2	PERF	Reserved	EBF	EWASC	DEXCPT	TEST	EBACKERR	LOGERR
3	Reserved				MRIE			
4	(MSB)	INTERVAL TIMER						
7								(LSB)
8	(MSB)	REPORT COUNT						
11								(LSB)

Byte Description

0

Bit	Description
7	PS (Page Save): 0b
6	SPF (Subpage Format): 0b
5-0	PAGE CODE: 1Ch

1 PAGE LENGTH: 0Ah

2

Bit	Description
7	PERF(performance): 0b (non-changeable)
6	Reserved
5	EBF (enable background function): 0b (non-changeable)
4	EWASC (enable warning): 0b (non-changeable)
3	DEXCPT (disable exception control): 1b (changeable)

Value	Description
0b	Exception Reporting is enabled
1b	Exception Reporting is disabled

2 TEST: 0b (changeable)

Value	Description
0b	The next command is processed normally (always on Mode Sense)
1b	The next command will fail with a 1/5DFF (Recovered Error, FAILURE PREDICTION THRESHOLD EXCEEDED-FALSE).

1 EBACKERR (enable background error): 0b (non-changeable)

0 LOGERR (log errors): 0b (non-changeable)

3

Bit	Description
7-4	Reserved
3-0	MRIE: 3h (non-changeable)

If an exception occurs, the next command will return 1/5D00 (Recovered Error, FAILURE PREDICTION THRESHOLD EXCEEDED).

4-7 INTERVAL TIMER: 00000000h (non-changeable)

8-11 REPORT COUNT: 00000000h (non-changeable)

6.5.17 MP 1Dh: Medium Configuration

See MODE SELECT (6/10) - 15h/55h (see 5.2.9 on page 84) for how to set these parameters and MODE SENSE (6/10) - 1Ah/5Ah (see 5.2.10 on page 86) for how to read these parameters.

The Medium Configuration mode page (see table 254) specifies any special considerations the device server shall use when processing commands that access the medium.

Table 254 — Medium Configuration mode page

Byte	Bit							
	7	6	5	4	3	2	1	0
0	PS	SPF(0)	PAGE CODE (1Dh)					
1	PAGE LENGTH (1Eh)							
2	Reserved							WORMM
3	Reserved							
4	WORM MODE LABEL RESTRICTIONS							
5	WORM MODE FILEMARK RESTRICTIONS							
6	Reserved							
31								

Byte Description

0

Bit	Description
7	PS (Page Save): 0b
6	SPF (Subpage Format): 0b
5-0	PAGE CODE: 1Dh

1 PAGE LENGTH: 1Eh

2

Bit	Description
7-1	Reserved
0	WORMM(WORM mode): (non-changeable)

Value	Description
0	The device server is not operating in WORM mode
1	The device server is operating in WORM mode

This field is changed by the device and is not allowed to be changed in a MODE SELECT command.

3 Reserved

4 WORM MODE LABEL RESTRICTIONS: 01h (non-changeable)

The device allows a tape label to be overwritten. The tape label is defined as 0, 1, or 2 logical blocks followed by nothing except 0 to n Filemarks and EOD. This must be overwritten from BOP.

5 WORM MODE FILEMARKS RESTRICTIONS: 02h (non-changeable)

The device server shall allow any number of filemarks immediately preceding EOD to be overwritten except the filemark closest to BOP.

6-31 Reserved

6.5.18 MP 24h: Vendor-Specific

See MODE SELECT (6/10) - 15h/55h (see 5.2.9 on page 84) for how to set these parameters and MODE SENSE (6/10) - 1Ah/5Ah (see 5.2.10 on page 86) for how to read these parameters.

The Vendor-Specific Speed Matching Control mode page provides control over undocumented test options. Modifying these values could have adverse effects on the drives operation. As such, this page should never be used in a MODE SELECT operation. A MODE SENSE of this page may be used to determine if the drive supports encryption. The Vendor-Specific mode page is defined in table 255.

Table 255 — Vendor-Specific mode page

Byte	Bit							
	7	6	5	4	3	2	1	0
0	PS (0)	SPF(0)	PAGE CODE (24h)					
1	PAGE LENGTH (06h)							
2	Vendor-Specific							
3	Vendor-Specific							
4	Reserved							
6								
7	Reserved				ENCR_E	Reserved	FIPS	ENCR_C

Byte Description

0

Bit	Description
7	PS (Page Save): 0b
6	SPF (SubPage Format): 0b
5-0	PAGE CODE: 24h

1 PAGE LENGTH: 06h

2 Vendor-Specific:

3 Vendor-Specific:

4-6 Reserved

7

Bit	Description
7-4	Reserved
3	ENCR_E (Device Supports Encryption - Enabled) (Changeable-Ignored)

Value	Description
0b	Device does not support encryption
1b	Device supports encryption (encryption interface(s) are enabled)

NOTE 54 - There are multiple encryption methods, Application Managed Encryption (AME), System Managed Encryption (SME), and Library Managed Encryption (LME). When the drive is configured for SME or LME, encryption is transparent to the application and the SECURITY PROTOCOL IN command reports no encryption support.

2	Vendor-Reserved
1	FIPS:

Value	Description
0b	Code is not FIPS level of code
1b	Code is FIPS level of code

0	ENCR_C (Device Supports Encryption- Capable) (Changeable-Ignored)

Value	Description
0b	Device does not support encryption (does not have encryption hardware)
1b	Device supports encryption (encryption interface(s) are not necessarily enabled)

6.5.19 MP 2Fh: Behavior Configuration

There is one copy of this page for the drive.

Device support for the fields in this page vary by generation and/or code level. To discover if a field can be modified, issue a MODE SENSE with the PC field set to 01b to see if the field is changeable. This will also return the PAGE LENGTH, which must be examined to determined the length of this page, because it is expected to increase as additional Behavior configurations are added to subsequent code levels.

WARNING WARNING

This page changes the normal behavior of the drive. Some settings effect error reporting and may even cause the drive to violate SCSI standards. Care should be taken to ensure that the behavior change and its effects on the system are understood.

WARNING WARNING

Table 256 — Behavior Configuration Mode Page

Byte	Bit							
	7	6	5	4	3	2	1	0
0	PS	SPF (0b)	PAGE CODE (2Fh)					
1	PAGE LENGTH (*n*-1)							
2	FENCE BEHAVIOR							
3	CLEAN BEHAVIOR							
4	WORM BEHAVIOR							
5	SENSE DATA BEHAVIOR							
6	Reporting Behavior							
	Reserved					CCDM	DDEOR	CLNCHK
7	Firmware Update Behavior							
	Reserved							DFMRDL
8	Unload On Error Behavior							
	Reserved		UOE-C		UOE-F		UOE-D	
9	TapeAlert Behavior							
	Reserved							TA10
⋮								
n	Reserved for Future Use							

Byte Description

0

Bit	Description
7	PS (Page Save):
6	SPF (SubPage Format): 0b
5-0	PAGE CODE: 2Fh

1 PAGE LENGTH:

2 FENCE BEHAVIOR: 00h (changeable)

This field defines drive behavior in situations deemed dangerous for either media or data on the media.

Value	Description
00h	Normal operation (i.e., MTR Fence) (see 4.12.4.1.4.1 on page 59)
01h	Panic Fence operation (see 4.12.4.1.4.2 on page 59)
02h-FFh	Reserved

3 CLEAN BEHAVIOR: 00h (changeable)

Value	Description
00h	Normal Operation
01h	Periodic Clean Notification The device monitors criteria since last cleaning. When that criteria is exceeded, the drive puts itself in a clean needed notification state. The criteria used is subject to change. The criteria used at the publication of this document is listed in table 257.

Table 257 — Periodic Clean Notification Criteria

Generation Drive	Data Sets Processed	Approximate Equivalent Full File Passes	Meters of tape pulled across head
Ultrium 5 HH	5,000,000	8	2,500,000
Ultrium 5 FH	7,500,000	12	3,750,000

When entering this state the device shall set the Drive Status Flags 1, Byte 7, Bit 6: Drive Clean Required as defined in the LDI and the device shall set TapeAlert flag 21.
This device remains in this state until a successful cleaning cycle or a Power On Reset occurs (e.g. If there is another data cartridge inserted without the drive having been cleaned, the drive functions as normal. Once the TapeAlert is reported the first time it will be cleared following normal TapeAlert rules. The Drive Status Flags will function as defined in the LDI.)

02h-FFh	Reserved

NOTE 55 - Note: On eServer enabled drives (i.e., The PRODUCT ID returned in Standard Inquiry is "HH LTO Gen x" where "x" is a number) that are attached to AIX, the CLEAN BEHAVIOR gets modified by the SCDD to use Periodic Clean Notification (01h).

4 WORM BEHAVIOR: 00h (changeable)

Value	Description
00h	Normal Operation (reset to this value on Medium Removal)
01h	Data Cartridge Emulates WORM Treat data cartridge like a WORM cartridge. When a data cartridge is inserted into the drive the drive reports that it is WORM media and the drive behaves like the media is WORM. It follows all overwrite rules. This Emulate mode is cleared when the cartridge is unloaded. There is no emulation of the WORM tampering responses. Sense code of 300Dh is never reported in WORM Emulation mode. WTRE of the Sequential Access Device Configuration Mode page (10h) may be modified but does not affect device behavior in emulation mode.
02h-FFh	Reserved

5 SENSE DATA BEHAVIOR: 01h (non-changeable)

When the sense data is associated with an Illegal Length read, an 18-byte Request Sense data may be used regardless of the value in this field.

Value	Description
00h	Obsolete (Earlier generation devices used this to indicate Sense data was 35-bytes in length)
01h	Sense data is 96-bytes in length
02h-FFh	Reserved

6 Reporting Behavior

Configures behaviors related to reporting conditions across the primary interface.

Bit	Description
7-3	Reserved
2	CCDM(Check Condition for Dead Media): 0b (changeable) On eServer enabled drives (i.e., The PRODUCT ID returned in Standard Inquiry is "HH LTO Gen x" where "x" is a number) the default of this field is one. **Value** **Description** 0b Does not specify CHECK CONDITION behavior when cleaning is required. 1b Return a CHECK CONDITION with Sense Key set to 1h and the additional sense code set to DEGRADED MEDIA (8252h) after a Rewind command when the criteria are met to set the DEAD MEDIA flag in Log Page 3Ch.
1	DDEOR (Disable Deferred Error On Rewind): 0b (changeable) On eServer enabled drives (i.e., The PRODUCT ID returned in Standard Inquiry is "HH LTO Gen x" where "x" is a number) that are attached to AIX, the DDEOR bit gets set to one by the SCDD. **Value** **Description** 0b Deferred error may be reported to a rewind command. 1b Deferred error shall not be reported to a rewind command.
0	CLNCHK(Clean Check): 0b (changeable) **Value** **Description** 0b Does not specify CHECK CONDITION behavior when cleaning is required. 1b Return a CHECK CONDITION with Sense Key set to 0h and the additional sense code set to DRIVE REQUIRES CLEANING (8282h) after a REWIND, SPACE, LOCATE, or UNLOAD when cleaning is required.

7 Firmware Update Behavior

Configures behaviors related to updating device firmware.

Bit	Description
7-1	Reserved
0	DFMRDL (Disable Field Microcode Replacement Down Level): 0b (changeable) This configures the ability to use an FMR tape to update to a lower level of firmware. This bit does not effect code downloads by means other than an FMR tape (e.g. WRITE BUFFER over SCSI interface). On eServer enabled drives (i.e., The PRODUCT ID returned in Standard Inquiry is "HH LTO Gen x" where "x" is a number) that are attached to AIX, the DFMRDL bit is set to one by the SCDD. **Value** **Description** 0b Device may accept down level firmware by FMR tape. 1b Device shall not accept down level firmware by FMR tape.

8 Unload On Error Behavior

Configures auto unload behaviors of different types of cartridges when the following errors occur:

a) Bad Media causes a mount failure;
b) FMR cartridge is loaded when it has not been requested;
c) Expired cleaner cartridge is loaded; or

d) An invalid or unsupported cleaner cartridge is loaded.

Settings specified over a library interface (i.e. LDI or ADI) take precedence over these settings, but do not modify these values.

Currently the only values allowed are 00h (no exceptional behavior for any cartridge type) or 15h (do not auto-eject on error for any cartridge type). That is, all fields shall have the same value.

Bit	Description
7-6	Reserved
5-4	UOE-C (Unload On Error - Cleaner): 00b (changeable)

Value	Description
00b	No exceptional behavior specified
01b	Do not auto-eject on error
10b-11b	Reserved

Bit	Description
3-2	UOE-F (Unload on Error - FMR): 00b (changeable)

Value	Description
00b	No exceptional behavior specified
01b	Do not auto-eject on error
10b-11b	Reserved

Bit	Description
1-0	UOE-D (Unload On Error - Data): 00b (changeable)

Value	Description
00b	No exceptional behavior specified
01b	Do not auto-eject on error
10b-11b	Reserved

9 TapeAlert Behavior

This field defines unique behaviors for specific TapeAlert flags.

Bit	Description
7-1	Reserved
0	TA10: 1b (changeable)

Value	Description
0b	TapeAlert 10h is asserted when a Write, Read, or Verify command is aborted because the unload button on the panel is pressed
1b	TapeAlert 10h is asserted when the unload button on the panel is pressed and the tape is away from BOP (channel LBA != 0); TapeAlert 10h will not be asserted if the tape is at BOP 0 or BOP 1 or if the tape is not threaded.

10-n Future behaviors that may have been defined after publication of this document.

6.5.20 MP 30h: Device Attribute Settings

The device attribute settings page and the related subpages are used to query and configure settings used by the drive to control its behavior and configuration in a specified environment. The page_0 mode page 30h is the directory listing of supported subpages. Each subpage is for the query and/or setting of device attributes for a specific function. The persistence of parameters and statement of which parameters are settable or only readable is stated in the section describing each subpage.

See MODE SELECT (6/10) - 15h/55h (see 5.2.9 on page 84) for how to set these parameters and MODE SENSE (6/10) - 1Ah/5Ah (see 5.2.10 on page 86) for how to read these parameters.

6.5.20.1 MP 30h: Directory Listing - Device Attribute Settings

The directory listing - device attribute settings mode page is used to report the list of supported subpages in the device attribute settings mode page and subpages. The page is valid only for a Mode Sense command.

This page is defined as common to all initiators.

Table 258 — MP 30h: Directory Listing - Device Attribute Settings mode page format

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	PS	SPF(0)	PAGE CODE (30h)					
1	PAGE LENGTH (n-1)							
Supported subpage list								
2	Supported subpage [first]							
⋮								
n	Supported subpage [last]							

The supported subpage list is a list of supported subpages listed in ascending order. Since the list of supported subpages is anticipated to differ between code levels (i.e., newer code levels may add subpages) the complete list is not described here. A user should read this page to determine which subpages may be used.

The following parameters apply:

Byte **Description**

0

Bit	Description
7	PS (Page Save):
6	SPF (SubPage Format): 0b
5-0	PAGE CODE: 30h

1 PAGE LENGTH:

2-n Supported subpage list: Supported subpage list - Device Attribute Settings (see 6.5.20.2 on page 348) describes the subpages that were implemented or planned at the time this document was published.

6.5.20.2 Supported subpage list - Device Attribute Settings

The supported subpage list returns the list of supported subpages. These subpages are organized in logical groupings by function.

Range	Description
01h-03h	MP 30h[01h-03h]: Ethernet attributes - Device attribute settings (see 6.5.20.3 on page 348).
04h-1Fh	Reserved
21h-3Fh	Reserved
40h-42h	MP 30h[40h-42h]: Data processing attributes - Device attribute settings (see 6.5.20.4 on page 354)
43h-FEh	Reserved

The list of subpages that were implemented or planned at the time this document was published follows:

MP 30h[01h]: Drive MAC address - Device attribute settings (see 6.5.20.3.2 on page 351)
MP 30h[02h]: Drive IP address and subnet mask - Device attribute settings (see 6.5.20.3.3 on page 352)
MP 30h[40h]: SkipSync - Device attribute settings (see 6.5.20.4.1 on page 354)
MP 30h[42h]: End of partition behavior control - Device attribute settings (see 6.5.20.4.3 on page 355)

Byte	Description
2	First subpage: 01h
3	Second subpage: 02h
4	Third subpage: 03h
5	Fourth subpage: 20h
6	Fifth subpage: 40h
7	Sixth subpage: 41h
8	Seventh subpage: 42h

6.5.20.3 MP 30h[01h-03h]: Ethernet attributes - Device attribute settings

6.5.20.3.1 Ethernet attributes overview

The Ethernet attributes subpages of the device attribute mode page describe information related to the drives Ethernet interface. The subclauses to this subclause list structures used by the Ethernet attribute subpages that are described in the subclauses that are at a peer level to this subclause.

6.5.20.3.1.1 Ethernet socket address descriptor

The IP address and subnet mask is defined in table 259..

Table 259 — Ethernet socket address descriptor

Byte	Bit							
	7	6	5	4	3	2	1	0
0	MSB							
1				ethernet socket address descriptor length (22h)				LSB
2	MSB							
3				relative socket address identifier				LSB
4								
31				sockaddr				
32	subnet mask length							
33								
35				Reserved				

The following parameters apply:

Byte Description

0-1 ETHERNET SOCKET ADDRESS DESCRIPTOR LENGTH - The number of bytes to follow in the Ethernet socket address descriptor.

2-3 RELATIVE SOCKET ADDRESS IDENTIFIER - A unique identifier for this Ethernet socket address.

4-31 SOCKADDR - defined by type of IP address

Type	Description
IPv4	6.5.20.3.1.1.1
IPv6	6.5.20.3.1.1.2

32 SUBNET MASK LENGTH - The number of bits set to one in the subnet mask.

33-35 Reserved

6.5.20.3.1.1.1 Sockaddr for an IPv4 IP address

The sockaddr for an IPv4 IP address is defined in table 260.

Table 260 — Sockaddr format for IPv4

Byte	Bit							
	7	6	5	4	3	2	1	0
0	address length							
1	address family							
2	MSB							
3				port				LSB
4	MSB							
7				internet address				LSB
8								
27				Pad bytes				

The following parameters apply:

Byte	Description
0	ADDRESS LENGTH (10h)
1	ADDRESS FAMILY (02h)
2-3	PORT - The TCP port number, if any. Zero if there is no TCP port number.
4-7	INTERNET ADDRESS - The IP Address.
8-27	Pad bytes - All bytes set to zero.

6.5.20.3.1.1.2 Sockaddr for an IPv6 address

The sockaddr for an IPv6 IP address is defined in table 261.

Table 261 — Sockaddr format for IPv6

Byte	Bit							
	7	6	5	4	3	2	1	0
0	address length							
1	address family							
2	MSB	port						
3								LSB
4		flow info						
7								
8	MSB	internet address						
23								LSB
24		scope id						
27								

The following parameters apply:

Byte	Description
0	ADDRESS LENGTH (1Ch)
1	ADDRESS FAMILY (0Ah)
2-3	PORT - The TCP port number, if any. Zero if there is no TCP port number.
4-7	FLOW INFO - (0000 0000h)
8-23	INTERNET ADDRESS - The IP Address.
24-27	SCOPE ID - (0000 0000h)

6.5.20.3.2 MP 30h[01h]: Drive MAC address - Device attribute settings

The drive MAC address is read only and is defined in table 262.

Table 262 — Drive MAC address

Byte	Bit							
	7	6	5	4	3	2	1	0
0	ps (0b)	spf(1b)	PAGE CODE (30h)					
1	SUBPAGE CODE (01h)							
2	(MSB)	PAGE LENGTH (n-3)						
3								(LSB)
4	Reserved							
5	Reserved							
6	Reserved							
7	number of drive port mac address descriptors							
8	Drive port MAC address descriptor [first]							
15								
	⋮							
n-7	Drive port MAC address descriptor [last]							
n								

The following parameters apply:

Byte Description

0

Bit	Description
7	PS (0b)
6	SPF (1b)
5-0	PAGE CODE (30h)

1 SUBPAGE CODE (01h)

2-3 PAGE LENGTH

4-6 Reserved

7 NUMBER OF DRIVE PORT MAC ADDRESS DESCRIPTORS - The number of descriptors to follow

8-n Drive port MAC address descriptors.
The Drive port MAC address descriptors are listed in ascending order by RELATIVE TARGET PORT IDENTIFIER. The Drive port MAC address descriptor is defined in table 263.

Table 263 — Drive port MAC address descriptor

Byte	Bit							
	7	6	5	4	3	2	1	0
0	MSB	relative target port identifier						
1								LSB
2		mac address						
7								

Byte Description

0-1 RELATIVE TARGET PORT IDENTIFIER - The relative port value for the Ethernet port.
2-7 MAC ADDRESS - The binary representation of the MAC address for that port.

6.5.20.3.3 MP 30h[02h]: Drive IP address and subnet mask - Device attribute settings

The drive IP address and subnet mask subpage is defined in table 264. When sending the drive IP address and subnet mask subpage in a Mode Select command the SP bit shall be set to one. If the SP bit is set to zero, then the drive rejects the command with a CHECK CONDITION and sets the sense key to ILLEGAL REQUEST and the additional sense code to INVALID FIELD IN CDB.

Table 264 — Drive IP address and subnet mask subpage

Byte	Bit							
	7	6	5	4	3	2	1	0
0	ps	spf(1b)	PAGE CODE (30h)					
1	SUBPAGE CODE (02h)							
2	(MSB)	PAGE LENGTH (n-3)						
3								(LSB)
4	Reserved							
5	Reserved							
6	Reserved							
7	number of drive ethernet port descriptors							
8	Drive Ethernet port descriptor [first]							
m								
	⋮							
n-k	Drive Ethernet port descriptor [last]							
n								

The following parameters apply:

Byte	Description
0	

Bit	Description
7	PS - The PS bit is set to one on Mode Sense and reserved on Mode Select.
6	SPF (1b)
5-0	PAGE CODE (30h)

1	SUBPAGE CODE (02h)
2-3	PAGE LENGTH
4-6	Reserved
7	NUMBER OF DRIVE PORT DESCRIPTORS - May be set to any number between one and the number of drive Ethernet ports inclusive. Changes will only affect the ports for which a drive Ethernet port descriptor is sent.
8-n	Drive Ethernet port descriptors. The drive Ethernet port descriptors shall be sent in ascending order by RELATIVE TARGET PORT IDENTIFIER (see table 265). The drive Ethernet port descriptor is defined in table 265.

Table 265 — Drive Ethernet port descriptor

Byte	Bit							
	7	6	5	4	3	2	1	0
0	MSB	drive ethernet port descriptor length (n-1)						
1								LSB
2	MSB	relative target port identifier						
3								LSB
4	Reserved							
5								
6	Reserved							dhcp_v4
7	number of ethernet socket address descriptors							
8	Ethernet socket address descriptor [first]							
x								
	⋮							
y	Ethernet socket address descriptor [last]							
n								

Byte	Description
0-1	DRIVE ETHERNET PORT DESCRIPTOR LENGTH - The number of bytes to follow in the drive Ethernet port descriptor.
2-3	RELATIVE TARGET PORT IDENTIFIER - The relative port identifier of the Ethernet port.
4-5	Reserved
6	

Bit	Description
7-1	Reserved
0	DHCP_V4

Value	Description
1b	DHCP shall be used to obtain an additional IPv4 address.
0b	DHCP shall not be used to obtain an additional IPv4 address.

7	NUMBER OF ETHERNET SOCKET ADDRESS DESCRIPTORS - Shall be set to 01h or 02h.

8-n Ethernet socket address descriptors. The Ethernet socket address descriptor is defined in 6.5.20.3.1.1 on page 349.

In each Ethernet socket address descriptor the PORT field of the SOCKADDR (see table 260 and table 261) is reserved and shall be set to zero.

In each Ethernet socket address descriptor the FLOW INFO field of the SOCKADDR (see table 261), if any, is reserved and shall be set to zero.

In each Ethernet socket address descriptor the SCOPE ID field of the SOCKADDR (see table 261), if any, is reserved and shall be set to zero.

6.5.20.4 MP 30h[40h-42h]: Data processing attributes - Device attribute settings

6.5.20.4.1 MP 30h[40h]: SkipSync - Device attribute settings

The SkipSync mode page is defined in table 262. SkipSync is a feature that performs a trade-off between how much data can be written to a volume and how fast that data can be written when the data is a small file size. This mode page allows the feature to be enabled and disabled. It also provides information that describes certain aspects of this trade-off, such as the Target Minumum Capacity. This feature is only available for use on volumes that are not scaled and that are not partitioned. Also, the volume must be an Ultrium 5 or newer cartridge.

Table 266 — SkipSync - Device attribute settings mode page format

Byte	Bit							
	7	6	5	4	3	2	1	0
0	ps	spf(1b)	Page Code (30h)					
1	Subpage Code (40h)							
2	(MSB)	Page Length (n-3)						
3								(LSB)
4	Reserved						mvsc	enable
5	Reserved							
6	Reserved							
7	Vendor-restricted							
8	(MSB)	Target Minimum Capacity						
11								(LSB)
12	(MSB)	Vendor-restricted						
15								(LSB)
16	(MSB)	Vendor-restricted						
19								(LSB)

The PS bit set to one indicates that the settings in this page are to be saved in nonvolatile storage and used during subsequent device power cycles. The PS bit set to zero indicates the settings in this page are not to be saved in nonvolatile storage and will revert to values saved in nonvolatile storage at the next logical unit reset event. It is recommended that users set the PS bit to one.

The mounted volume is skipsync capable (MVSC) bit set to one indicates that the volume last mounted in the drive is capable of having skipsync performed on it. A MVSC bit set to zero indicates that the volume last mounted in the drive is not capable of havinf skipsync performed on it.

The ENABLE bit set to one indicates that the SkipSync function is enabled and the drive operates in a manner to increase performance and reduce backhitches while still performing synchronizations on small file writes. The ENABLE bit set to zero indicates the SkipSync function is disabled.

The Target Minimum Capacity field indicates the target capacity in megabytes (2^{20}) to which the capacity of the medium when full may be decreased in order to perform SkipSync operations. The total capacity may be smaller

than Target Minimum Capacity if the average of transaction sizes is very small. If the mounted volume is not capable of supporting skipsync this field is set to zero. This field is not changeable.

NOTE 56 - For this command, a megabyte is equal to 1 048 576 bytes. As an example, a value of E 8D4Ah in the Target Minimum Capacity field is equal to 953 674 megabytes, which is equal to 976 562 176 bytes. This is actually in mebibytes (MiB).

6.5.20.4.2 MP 30h[41h]: Tape map control - Device attribute settings

The Tape map control - Device attribute settings mode page is not intended for general use.

6.5.20.4.3 MP 30h[42h]: End of partition behavior control - Device attribute settings

The End of partition behavior control - Device attribute settings mode page is defined in table 262.

Table 267 — End of partition behavior control - Device attribute settings mode page format

Byte	Bit							
	7	6	5	4	3	2	1	0
0	ps	spf(1b)	PAGE CODE (30h)					
1	SUBPAGE CODE (42h)							
2	(MSB)	PAGE LENGTH (n-3)						
3								(LSB)
4	leop method							

The following parameters apply:

Byte Description

0 Byte zero

Bit Description

7 PS - parameters saveable

When using the MODE SENSE command the parameters saveable (PS) bit is set to one indicating that the mode page may be saved.

When using the MODE SELECT command, the PS bit is reserved.

6 SPF (1b)

5-0 PAGE CODE: 30h

1 SUBPAGE CODE (42h)

2-3 PAGE LENGTH

4 LEOP METHOD - Logical end of partition (LEOP) method: 00h (changeable)

Value Description

00h LEOP is determined by density code

Value	Description
58h	Constant medium capacity
others	Maximize medium capacity

01h Maximize medium capacity - LEOP is based on the amount of physical medium available. Early warning is based on the drive's buffer size, the nominal physical dataset length, and some margin (i.e., the drive will accept write request before LEOP if there is tape available).

02h Constant medium capacity - LEOP is determined to provide constant medium capacity. Early warning is based on the user's logical data capacity already written to the tape (i.e constant capacity). If the medium condition or drive condition is degraded enough to reach a predetermined LPOS tape region, then LEOP may be reached prior to the constant capacity.

others Reserved

6.5.21 MP 3Eh: Engineering Support

See MODE SELECT (6/10) - 15h/55h (see 5.2.9 on page 84) for how to set these parameters and MODE SENSE (6/10) - 1Ah/5Ah (see 5.2.10 on page 86) for how to read these parameters.

The initiator behavior for this page is not defined, and may contain elements which are common to all initiators, as well as elements which are initiator unique.

NOTE 57 - As this page is not for normal application use, it is not returned in mode page 3Fh (all pages). Consequently, this page must be specifically queried and set.

NOTE 58 - For more information on special needs and the usage of this page contact IBM.

Table 268 — MP 3Eh: Engineering Support mode page

Byte	Bit							
	7	6	5	4	3	2	1	0
0	PS	SPF (0b)	PAGE CODE (3Eh)					
1	PAGE LENGTH (*n*-1)							
2	Vendor-reserved							
127								

Byte Description

0

Bit	Description
7	PS (Page Save): 0b
6	SPF (SubPage Format): 0b
5-0	PAGE CODE: 3Eh

1 PAGE LENGTH: 7Eh

2-127 Vendor-Reserved

6.6 Read/Write Buffers (RB)

Read/Write Buffers are used with the READ BUFFER command (see 5.2.17) and/or the WRITE BUFFER command (see 5.2.39).

6.6.1 Buffer modes for READ BUFFER

6.6.1.1 00h – Combined header and data mode

In this mode, a four-byte header followed by data bytes is returned to the application client in the Data-In Buffer. The allocation length should be set to four or greater. The BUFFER ID and the BUFFER OFFSET fields are reserved.

The four-byte READ BUFFER header (see table 269) is followed by data bytes from the buffer.

Table 269 — READ BUFFER header

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	Reserved							
1	(MSB)			BUFFER CAPACITY				
3								(LSB)
4	Data							
n								

The following parameters apply:

Byte Description

0 Reserved

1-3 BUFFER CAPACITY: The total number of data bytes available in the buffer.

4-n Data: Data from the buffer specified by the BUFFER ID field.

6.6.1.2 02h – Data mode

In this mode, the Data-In Buffer is filled only with logical unit buffer data. The BUFFER ID field specifies a buffer within the logical unit from which data shall be transferred.

The BUFFER OFFSET field contains the byte offset within the specified buffer from which data shall be transferred. The application client should conform to the offset boundary requirements returned in the READ BUFFER descriptor (see 6.6.1.3). If the device server is unable to accept the specified buffer offset, the command shall be terminated with CHECK CONDITION status, with the sense key set to ILLEGAL REQUEST, and the additional sense code set to INVALID FIELD IN CDB.

6.6.1.3 03h – Descriptor mode

In this mode, a maximum of four bytes of READ BUFFER descriptor information is returned. The BUFFER OFFSET field is reserved in this mode. The allocation length should be set to four or greater. The READ BUFFER descriptor is defined as shown in table 270.

Table 270 — READ BUFFER descriptor

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	OFFSET BOUNDARY							
1	(MSB)	BUFFER CAPACITY						
3								(LSB)

The following parameters apply:

Byte Description

0 OFFSET BOUNDARY:

For READ BUFFER commands, the OFFSET BOUNDARY field 03h – Descriptor mode (see 6.6.1.3 on page 358) applies to the following modes:

e) data (i.e., 02h) (see 6.6.1.2); and
f) error history (i.e., 1Ch) which is not supported.

For WRITE BUFFER commands, the OFFSET BOUNDARY field 03h – Descriptor mode (see 6.6.1.3 on page 358) applies to the following modes:

a) data (i.e., 02h) (see 5.2.39);
b) download microcode with offsets and activate (i.e., 06h) (see 5.2.39); and
c) download microcode with offsets, save, and activate (i.e., 07h) (see 5.2.39).

For data mode (i.e., 02h), the boundary alignment indicated by the OFFSET BOUNDARY field applies only to the buffer specified by the BUFFER ID field. For modes other than data to which the OFFSET BOUNDARY field applies, the boundary alignment applies regardless of the buffer specified by the BUFFER ID field.

Value	Description
others	Multiples of 2^{code} (e.g., 00h means multiples of 1 byte or no offset restrictions, 01h means multiples of 2 bytes or even offsets, 02h means multiples of 4 bytes)
FFh	000000h is the only supported buffer offset

1-3 BUFFER CAPACITY: The maximum size in bytes of the buffer specified by the BUFFER ID field for the:

a) READ BUFFER command with data mode (i.e., 02h); and
b) WRITE BUFFER command with data mode (i.e., 02h).

6.6.1.4 07h – Descriptor with algorithmic offset boundary

For buffers where the size does not fit into the BUFFER OFFSET field and the BUFFER CAPACITY fields (see table 272) the BUFFER OFFSET field and the BUFFER CAPACITY fields are interpreted for buffer modes 00h, 01h, 02h, 03h, and 07h as follows:

Value	Description
00h to 7Fh	Multiples of 64 bytes (i.e., the value is left shifted by 6 bits)
80h to FEh	Left shifted by n where n is the value returned in the Offset Boundary field using the equation 80h | n (e.g., 86h indicates shift value left by 6 bits)
FFh	000000h is the only supported buffer offset

6.6.1.5 0Ah – Read data from echo buffer mode

In this mode the device server transfers data to the application client from the echo buffer that was written by the most recent WRITE BUFFER command with the MODE field set to write data to echo buffer (see 5.2.39) received on the same I_T nexus.

The BUFFER ID and BUFFER OFFSET fields are ignored in this mode.

If no WRITE BUFFER command with the mode set to write data to echo buffer received on this I_T nexus has completed without an error, then the READ BUFFER command terminates with CHECK CONDITION status, with the sense key set to ILLEGAL REQUEST, and the additional sense code set to COMMAND SEQUENCE ERROR. If the data in the echo buffer has been overwritten by another I_T nexus, then the READ BUFFER command is terminated with CHECK CONDITION status, with the sense key set to ABORTED COMMAND, and the additional sense code set to ECHO BUFFER OVERWRITTEN.

6.6.1.6 0Bh – Echo buffer descriptor mode

In this mode, a maximum of four bytes of READ BUFFER descriptor information is returned. The device server returns the descriptor information for the echo buffer. The BUFFER ID field and BUFFER OFFSET field are reserved in this mode. The allocation length should be set to four or greater. The READ BUFFER descriptor is defined as shown in table 271.

Table 271 — Echo buffer descriptor

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	Reserved							EBOS
1	Reserved							
2	Reserved			(MSB)				
3	BUFFER CAPACITY							(LSB)

The following parameters apply:

Byte Description

0

Bit	Description
7-1	Reserved
0	EBOS (echo buffer overwritten supported): 1b

1 Reserved

2-3

Bit	Description
7-5;B2	Reserved
4-0;B2+	
7-0;B3	BUFFER CAPACITY: The size of the echo buffer in bytes aligned to a four-byte boundary. The maximum echo buffer size is 4 096 bytes.

6.6.2 Supported Buffers

Table 272 lists the supported buffers and their IDs.

Table 272 — Supported Buffer IDs

ID[a]	R/W	Buffer Description	Offset Boundary
00h	R	Format Buffer[b] (Main Data)	4
01h	R	Dump Data[c][d]	4
02h	R/W	Test	4
03h	R/W	VPD	4
04h	R/W	Firmware	4
05h	R	Cartridge Memory	4
06h	R	Error Log	4
07h	R	SCSI Log	4
08h	R	WWN	4
50h	R	Active IP addresses	TBD
20h	R	Cartridge Memory (same as Buffer ID 05h)	4
21h[e]	R	Cartridge Memory from EOD dataset	4

Legend

R	Read Only
W	Write Only
R/W	Read/Write
-	Not Applicable
NS	Not Supported

Notes

a. In a WRITE BUFFER command, if the MODE field is 04h, 05h, 06h or 07h, then the BUFFER ID is ignored and the command is treated as a Firmware buffer (i.e., BUFFER ID 04h).

b. 07h – Descriptor with algorithmic offset boundary (see 6.6.1.4 on page 358) describes how to interpret the OFFSET BOUNDARY and BUFFER OFFSET fields for buffers that are too large to use the OFFSET BOUNDARY and BUFFER OFFSET fields such as the Format buffer (i.e., BUFFER ID 00h). This interpretation for the Format buffer is only valid for buffer modes 00h, 01h, 02h, 03h, and 07h.

c. When reading dump data, take care to ensure that the amount of data in each transfer does not exceed the DMA settings of the HBA. The dump data currently exceeds 1 MB in size. The default DMA setting for some HBAs is 1 MB. For this reason, it is recommended that the dump data is read in a series of smaller blocks with appropriate offsets (for example, 256 KB).

d. When reading dump data the data should be read with strictly increasing offsets.

e. The volume must be positioned at the EOD from which the CM contents will be read (e.g., issue LOCATE to desired partition then issue SPACE EOD then issue the READ BUFFER command). If the medium is not positioned at EOP, then the Read Buffer command is rejected with CHECK CONDITION status and Sense Key set to ILLEAGAL REQUEST with the additional sense code set to SEQUENTIAL POSITIONING ERROR. If the medium is positioned at EOP and the EOD cannot be found the READ BUFFER command is rejected with CHECK CONDITION status and Sense Key set to MEDIUM ERROR with the additional sense code set to END-OF-DATA NOT FOUND.

6.6.3 RB 06h: Error Log

The error log buffer (also known as Engineering Log) contains zero or more entries described in table 273. Entries are returned in order by the most recent entry first.

Table 273 — Error Log Buffer (06h)

Byte	Bit							
	7	6	5	4	3	2	1	0
0	(MSB)							
3				TIME STAMP				(LSB)
4	ENTRY NUMBER							
5	ERROR CODE							
6				FSC 1ST TEXT				
7								
8				FSC 1ST DATA				
9								
10				FSC 2ND TEXT				
11								
12				FSC 2ND DATA				
13								
14				CARTRIDGE SERIAL NUMBER				
21								
22				LINK LEVEL				
27								
28				HARDWARE LEVEL				
31								

The following parameters apply to the Error Log Buffer:

Byte Description

0-3 TIME STAMP: The value of the drive's timestamp at the time of the error. This timestamp may be the power-on seconds or it may be the value of the timestamp as set by the library or the host. It is generally not sufficient on its own to provide relative ordering of the entries.

4 ENTRY NUMBER: This is a value used internally to the drive.

5 ERROR CODE: The error code used for the Single Character Display.

6-7 FSC 1ST TEXT: Fault Symptom Code text

8-9 FSC 1ST DATA: Fault Symptom Code data

10-11 FSC 2ND TEXT: Fault Symptom Code text

12-13 FSC 2ND DATA: Fault Symptom Code data

14-21 CARTRIDGE SERIAL NUMBER: This is the cartridge serial number of the volume that was mounted in the drive when the error occurred. The cartridge serial number is set using this priority:

1) Volume Serial Number set by library;
2) Volume Serial Number set by host; then
3) Cartridge Serial Number from Cartridge Memory.

22-27 LINK LEVEL: The link level of the code that was loaded in the drive when the error occurred.

28-31 HARDWARE LEVEL: Not used.

6.6.4 RB 08h: World Wide Name

This buffer contains the World Wide Name values that are used by the drive.

Table 274 — World Wide Name Buffer (08h)

Byte	Bit							
	7	6	5	4	3	2	1	0
0	(MSB)							
7				WORLD WIDE NODE NAME				(LSB)
8	(MSB)							
15				WORLD WIDE PORT NAME				(LSB)

The following parameters apply:

Byte Description

0-7 WORLD WIDE NODE NAME: The world wide identifier used by the drive to identify LUN 0.

8-15 WORLD WODE PORT NAME: The world wide identifier used by the drive port through which the READ BUFFER command was recevied.

6.6.5 RB 07h: SCSI Log (aka Error log)

The SCSI Log Buffer contains 10 entries, each of which has the format described in table 275. An entry is created each time sense data with a Sense Key 3h or 4h is returned with a CHECK CONDITION Status to a command that is received on LUN 0.

Table 275 — SCSI Log Buffer (07h)

Byte	Bit							
	7	6	5	4	3	2	1	0
0	(MSB)			TIME STAMP (seconds)				
3								(LSB)
4	ENTRY NUMBER							
5	INITIATOR SCSI ID							
6	SCSI STATUS							
7	Reserved							
8	CDB							
23								
24	SENSE DATA							
59								

The following parameters apply:

Byte	Description
0-3	TIME STAMP: The time stamp in seconds when the entry was created.
4	ENTRY NUMBER: A value of 0 indicates that the entry is not valid. The scheme used for setting the Entry Number is not described in this manual.
5	INITIATOR SCSI ID: The least significant byte of the address used to identify the initiator (e.g., on Fibre Channel drives the ALPA)
6	SCSI STATUS: The value that would be returned as SCSI Status.
7	Reserved
8-23	CDB: The contents of the CDB that was presented the CHECK CONDITION Status even if that CHECK CONDITION is for a DEFERRED ERROR.
24-59	SENSE DATA: The sense data that was created as a result of this error.

6.6.6 RB 50h: Active IP addresses

The Active IP addresses buffer returns a list of IP addresses that have successfully completed negotiation on the Ethernet link and are active. This list does not contain IP addresses that the drive attempts but cannot use due to conflicts or other errors. The format of the Data field of the active IP addresses buffer depends on the value in byte 0. If byte 0 contains a non-zero value, then the format is defined in Active IP addresses fixed buffer (see 6.6.6.1). If byte 0 contains a zero value, then the format is defined in the Active IP addresses variable buffer (see 6.6.6.2).

6.6.6.1 Active IP addresses fixed buffer

The format of the Data field of the active IP addresses fixed buffer is described in table 276

.

Table 276 — Active IP addresses fixed buffer format

Byte	Bit							
	7	6	5	4	3	2	1	0
0	NUMBER OF ETHERNET PORTS							
List of Ethernet port descriptors								
1	Ethernet port fixed descriptor [first]							
x								
	…							
y	Ethernet port fixed descriptor [last]							
n								

The following parameters apply:

Byte Description

0 NUMBER OF ETHERNET PORTS - The number of physical Ethernet ports functioning in the drive.

1-n List of Ethernet port descriptors. There will be one Ethernet port descriptor (see table 277) for each physical Ethernet port functioning in the drive. The size of each descriptor may vary from Ethernet port to Ethernet port.

The Ethernet port descriptor format is defined in table 277

Table 277 — Ethernet port fixed descriptor format

Byte	Bit							
	7	6	5	4	3	2	1	0
0	SIZE OF SOCKADDR (m-1)							
1	NUMBER OF SOCKADDR STRUCTURES							
List of sockaddr structures (see 6.5.20.3.1.1.1 or 6.5.20.3.1.1.2)								
2	sockaddr [first]							
m								
	⋮							
n-m	sockaddr [last]							
n								

The following parameters apply:

Byte	Description
0	SIZE OF SACKADDR - The size of each sockaddr. All sockaddr's are the same size
1	NUMBER OF SOCKADDR - The number of sockaddr structures returned.
2-n	List of sockaddr structures. Each sockaddr structure describes one active IP address. The sockaddr structure is defined in clauses Sockaddr for an IPv4 IP address (see 6.5.20.3.1.1.1 on page 349) and Sockaddr for an IPv6 address (see 6.5.20.3.1.1.2 on page 350).

6.6.6.2 Active IP addresses variable buffer

The format of the Data field of the active IP addresses buffer is described in table 276

.

Table 278 — Active IP addresses variable buffer format

Byte	Bit							
	7	6	5	4	3	2	1	0
0 1	Reserved							
2 3	ACTIVE IP ADDRESSES BUFFER LENGTH (n-3)							
4 6	Reserved							
7	NUMBER OF ETHERNET PORTS							
List of Ethernet port descriptors								
8	Ethernet port variable descriptor [first]							
	⋮							
n	Ethernet port variable descriptor [last]							

The following parameters apply:

Byte	Description
0	NUMBER OF ETHERNET PORTS - The number of physical Ethernet ports functioning in the drive.
1-n	List of Ethernet port descriptors. There will be one Ethernet port descriptor (see table 279) for each physical Ethernet port functioning in the drive. The size of each descriptor may vary from Ethernet port to Ethernet port.

The Ethernet port variable descriptor format is defined in table 279

Table 279 — Ethernet port variable descriptor format

Byte	Bit							
	7	6	5	4	3	2	1	0
0	DESCRIPTOR LENGTH (m-1)							
1								
2	PORT IDENTIFIER							
3								
4	Reserved							
6								
7	NUMBER OF SOCKADDR STRUCTURES							
List of Ethernet socket address descriptors (see 6.5.20.3.1.1)								
8	Ethernet socket address descriptor [first]							
	⋮							
	Ethernet socket address descriptor [last]							
m								

The following parameters apply:

Byte **Description**

0 SIZE OF SACKADDR - The size of each sockaddr. All sockaddr's are the same size

1 number of sockaddr - The number of sockaddr structures returned.

2-n List of Ethernet socket address descriptors. Each Ethernet socket address descriptor describes one active IP address and has the RELATIVE SOCKET ADDRESS IDENTIFIER field set to zero. The Ethernet socket address descriptor is defined in Ethernet socket address descriptor (see 6.5.20.3.1.1 on page 349).

6.7 Security Protocol Parameters (SPP)

Security Protocol parameters are used by the SECURITY PROTOCOL IN (SPIN) - A2h (see 5.2.29 on page 140)command and by the SECURITY PROTOCOL OUT (SPOUT) - B5h (see 5.2.30 on page 141) command.

The following terms are used in this clause:

Term	Description
SPIN	Security Protocol In
SPOUT	Security Protocol Out

6.7.1 SPIN Pages (00h - Security Protocol Information)

See SECURITY PROTOCOL IN (SPIN) - A2h (see 5.2.29 on page 140) for a description of how to request this page. The Security Protocol Specific field of the SPIN CDB is defined by Table 280

Table 280 — Security Protocol Specific Definitions for Security Protocol 00h

Code	Description	Reference
0000h	Supported security protocol list	see page 367
0001h	Certificate data	see page 367
0002h - FFFFh	Reserved	

6.7.1.1 SPIN (00h[0000h]) - Supported Security Protocols List

See SECURITY PROTOCOL IN (SPIN) - A2h (see 5.2.29 on page 140) for a description of how to request this page. If the SECURITY PROTOCOL field is set to 00h and the SECURITY PROTOCOL SPECIFIC field is set to 0000h in a SECURITY PROTOCOL IN command, the parameter data shall have the format shown in Table 281.

Table 281 — Supported Security Protocols List Structure

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	Reserved							
5								
6	(MSB)	SUPPORTED SECURITY PROTOCOL LIST LENGTH (m-7)						
7								(LSB)
8	Supported Security Protocol (first)							
	⋮							
m	Supported Security Protocol (last)							

The Supported Security Protocol list contains the following supported security protocols:

Value	Description
00h	Security protocol information (see 6.7.1).
20h	Tape Data Encryption (see 6.7.2).

6.7.1.2 SPIN (00h[0001h]) - Certificate Data

See SECURITY PROTOCOL IN (SPIN) - A2h (see 5.2.29 on page 140) for a description of how to request this page. The drive certificate (if present) is provided in X.509 format via this interface (see SPC-4).

If the Security Protocol field is set to 00h and the Security Protocol Specific field is set to 0001h in a Security Protocol In command, the parameter data shall have the format shown in Table 282.

Table 282 — 0001h - Certificate Data Structure

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	Reserved							
1								
2	(MSB)	CERTIFICATE LENGTH (m-3)						
3								(LSB)
4	CERTIFICATE							
m								

The following parameters apply:

- Certificate Length - The total length, in bytes, of the certificate that follows.
- Certificate - The drive certificate set during manufacturing is returned.

6.7.2 SPIN Pages (20h - Tape Data Encryption)

See SECURITY PROTOCOL IN (SPIN) - A2h (see 5.2.29 on page 140) for a description of how to request this page. The SECURITY PROTOCOL SPECIFIC field specifies the type of report that the application client is requesting. Table 283 shows supported SECURITY PROTOCOL SPECIFIC field values.

Table 283 — Security Protocol Specific Definitions for Security Protocol 20h

Page Code	Description	Reference
0000h	Tape Data Encryption In Support Pages	see page 369
0001h	Tape Data Encryption Out Support Pages	see page 370
0010h	Data Encryption Capabilities	see page 370
0011h	Supported Key Formats	see page 375
0012h	Data Encryption Management Capabilities	see page 376
0020h	Data Encryption Status	see page 377
0021h	Next Block Encryption Status	see page 380
0030h	Random Number page	see page 383

6.7.2.1 SPIN (20h[0000h]) - Tape Data Encryption In Support Pages page

See SECURITY PROTOCOL IN (SPIN) - A2h (see 5.2.29 on page 140) for a description of how to request this page. Supported protocol specific in pages for protocol 20h are indicated above (see SSC-3).

Table 284 — 0000h - Tape Data Encryption In Support Pages Structure

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	(MSB)	PAGE CODE (0000h)						
1								(LSB)
2	(MSB)	PAGE LENGTH (n-3)						
3								(LSB)
Tape Data Encryption In Support page code list								
4	(MSB)	Tape Data Encryption In Support page code (first)						
5								(LSB)
	⋮							
n-1	(MSB)	Tape Data Encryption In Support page code (last)						
n								(LSB)

Table 285 on page 369 show which Tape Data Encryption In page codes are supported:

Table 285 — Tape Data Encryption In page codes

Page Code	Description	Reference
0000h	Tape Data Encryption In Support Pages	see page 369
0001h	Tape Data Encryption Out Support Pages	see page 370
0010h	Data Encryption Capabilities	see page 370
0011h	Supported Key Formats	see page 375
0012h	Data Encryption Management Capabilities	see page 376
0020h	Data Encryption Status	see page 377
0021h	Next Block Encryption Status	see page 380

6.7.2.2 SPIN (20h[0001h]) - Tape Data Encryption Out Support Pages page

See SECURITY PROTOCOL IN (SPIN) - A2h (see 5.2.29 on page 140) for a description of how to request this page. Supported protocol specific out pages for protocol 20h are indicated above (see SSC-3).

Table 286 — 0001h - Tape Data Encryption Out Support Pages Structure

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	(MSB)			Page Code (0001h)				
1								(LSB)
2	(MSB)			Page Length (n-3)				
3								(LSB)
Tape Data Encryption Out Support page code list								
4	(MSB)			Tape Data Encryption Out Support page code (first)				
5								(LSB)
	⋮							
n-1	(MSB)			Tape Data Encryption Out Support page code (last)				
n								(LSB)

Table 287 on page 370 show which Tape Data Encryption Out page codes are supported:

Table 287 — Tape Data Encryption Out page codes

Page Code	Description	Reference
0010h	Set Data Encryption	6.7.3.1 on page 385

6.7.2.3 SPIN (20h[0010h]) - Data Encryption Capabilities page

See SECURITY PROTOCOL IN (SPIN) - A2h (see 5.2.29 on page 140) for a description of how to request this page. Table 97 specifies the format of the Data Encryption Capabilities page.

Table 288 — 0010h - Data Encryption Capabilities page

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	(MSB)			PAGE CODE (0010h)				
1								(LSB)
2	(MSB)			PAGE LENGTH (n-3)				
3								(LSB)
4	Reserved				EXTDECC		CFG_P	
5				Reserved				
19								
Data Encryption Algorithm descriptor list								
20				Data Encryption Algorithm descriptor (first)				
	⋮							
				Data Encryption Algorithm descriptor (last)				
n								

The external data encryption control capable (EXTDECC) field specifies the external data encryption control capability of the device entity. The EXTDECC field values are specified in table 289.

Table 289 — EXTDECC field

Code	Description
00b	The external data encryption control capability is not reported.
01b	The device entity is not external data encryption control capable.
10b	The device entity is external data encryption control capable.
11b	Reserved

The configuration prevented (CFG_P) field specifies the logical block encryption parameters configuration capabilities for the algorithms reported in the logical block encryption algorithm descriptors. The CFG_P field values are specified in table 290.

Table 290 — CFG_P field

Code	Description
00b	The logical block encryption configuration capabilities are not reported.
01b	The device entity is configured to allow this device server to establish or change logical block encryption parameters.
10b	The device entity is configured to not allow this device server to establish or change logical block encryption parameters. In code levels that set this field, this value is reported when in LME mode.
11b	Reserved

6.7.2.3.1 Data Encryption Algorithm Descriptor - Standard Encryption

The Standard Encryption Algorithm Descriptor is shown in Table 291 on page 372

Table 291 — Data Encryption Algorithm Descriptor - Standard Encryption Structure

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	ALGORITHM INDEX (01h)							
1	Reserved							
2	(MSB)	DESCRIPTOR LENGTH (0014h)						
3								(LSB)
4	AVFMV	SDK_C (0b)	MAC_C (1b)	DELB_C (1b)	DECRYPT_C (2h)		ENCRYPT_C (2h)	
5	AVFCLP		NONCE_C (3h)		KADF_C	VCELB_C (1b)	UKADF	AKADF
6	(MSB)	MAXIMUM UNAUTHENTICATED KEY-ASSOCIATED DATA (U-KAD) BYTES (0000h)						
7								(LSB)
8	(MSB)	MAXIMUM AUTHENTICATED KEY-ASSOCIATED DATA (A-KAD) BYTES (000Ch)						
9								(LSB)
10	(MSB)	LOGICAL BLOCK ENCRYPTION KEY SIZE (0020h)						
11								(LSB)
12	DKAD_C		EEMC_C (2h)		RDMC_C (5h)			EARM (1b)
13	Reserved							
14	MSDK_COUNT (00000000h)							
15								
16	Reserved							
19								
20	(MSB)	SECURITY ALGROTIHM CODE (00010014h)						
23								(LSB)

The ALGORITHM INDEX field is used by the SECURITY PROTOCOL OUT command Set Data Encryption page to select this algorithm.

The algorithm valid for mounted volume (AVFMV) bit is set to one if there is a volume currently mounted and the encryption algorithm being described is valid for that volume. The AVFMV bit is set to zero if there is no volume mounted or the algorithm is not valid for the currently mounted volume.

The supplemental decryption key capable (SDK_C) bit is set to zero because the device entity is not capable of supporting supplemental decryption keys.

The message authentication code capable (MAC_C) bit is set to one to indicate the algorithm includes a message authentication code added to encrypted logical blocks.

The distinguish encrypted logical block capable (DELB_C) bit is set to one to indicate the device entity is capable of distinguishing encrypted logical blocks from unencrypted logical blocks when reading it from the medium.

The DECRYPT_C field (see table 292) specifies the decryption capabilities of the device entity.

Table 292 — DECRYPT_C field

Code	Name	Description
00b	No capability	The device entity has no logical block decryption capability using this algorithm. This value shall be returned if the specified algorithm is disabled.
01b	Software capable	Not Supported.
10b	Hardware capable	The device entity has the ability to decrypt logical blocks using this algorithm in hardware.
11b	Capable with external control	The device entity has the capability to decrypt logical blocks using this algorithm, but control of the logical block encryption parameters by this device server is prevented.

The ENCRYPT_C field (see table 293) specifies the encryption capabilities of the device entity.

Table 293 — ENCRYPT_C field

Code	Name	Description
00b	No capability	The device entity has no logical block encryption capability using this algorithm. This value shall be returned if the specified algorithm is disabled.
01b	Software capable	Not Supported.
10b	Hardware capable	The device entity has the ability to encrypt logical blocks using this algorithm in hardware.
11b	Capable with external control	The device entity has the capability to encrypt logical blocks using this algorithm, but control of the logical block encryption parameters by this device server is prevented.

The algorithm valid for current logical position (AVFCLP) field specifies if the encryption algorithm being specified is valid for writing to the mounted volume at the current logical position. Table 294 specifies the values for the AVFCLP field.

Table 294 — AVFCLP field values

Code	Description
00b	Current logical position is not applicable to the encryption algorithm validity or no volume is loaded.
01b	The encryption algorithm being specified is not valid for writing to the mounted volume at the current logical position.
10b	The encryption algorithm being specified is valid for writing to the mounted volume at the current logical position.
11b	Reserved

Table 295 specifies the values for the NONCE_C field.

Table 295 — NONCE_C field

Code	Description
00b	Not Supported.
01b	Not Supported.
10b	Not Supported.
11b	The device entity supports all or part of the nonce value provided by the application client. If the Set Data Encryption page that enables encryption does not include a nonce value descriptor, the device entity generates the nonce value.

A KAD format capable (KADF_C) bit set to one indicates that the device server supports:

a) the ENCRYPTION PARAMETERS KAD FORMAT field in the Data Encryption Status page (see 6.7.2.6);
b) the NEXT BLOCK KAD FORMAT field in the Next Block Encryption Status page (see 6.7.2.7); and
c) the KAD FORMAT field in the Set Data Encryption page (see 6.7.3.1).

A KADF_C bit set to zero indicates that the device server does not support:

a) the ENCRYPTION PARAMETERS KAD FORMAT field in the Data Encryption Status page (see 6.7.2.6);
b) the NEXT BLOCK KAD FORMAT field in the Next Block Encryption Status page (see 6.7.2.7); or
c) the KAD FORMAT field in the Set Data Encryption page (see 6.7.3.1).

The volume contains encrypted logical blocks capable (VCELB_C) bit is set to one to indicate that the device server is capable of determining that a volume contains logical blocks encrypted using this algorithm when the volume is mounted.

The U-KAD fixed (UKADF) bit shall be set to one if the device server requires the length of U-KAD in the parameter data for a SECURITY PROTOCOL OUT command to equal the value in the MAXIMUM UNAUTHENTICATED KEY-ASSOCIATED BYTES field. If the UKADF bit is set to one, then the MAXIMUM UNAUTHENTICATED KEY-ASSOCIATED BYTES field shall contain a non-zero value. If the UKADF bit is set to zero and the value in the MAXIMUM UNAUTHENTICATED KEY-ASSOCIATED BYTES field is non-zero, then the length of the U-KAD, if present in the parameter data for a SECURITY PROTOCOL OUT command, shall be a value between one and the value in the MAXIMUM UNAUTHENTICATED KEY-ASSOCIATED BYTES field.

The A-KAD fixed (AKADF) bit shall be set to one if the device server requires the length of A-KAD in the parameter data for a SECURITY PROTOCOL OUT command to equal the value in the MAXIMUM AUTHENTICATED KEY-ASSOCIATED BYTES field. If the AKADF bit is set to one, then the MAXIMUM AUTHENTICATED KEY-ASSOCIATED BYTES field shall contain a non-zero value. If the AKADF bit is set to zero and the value in the MAXIMUM AUTHENTICATED KEY-ASSOCIATED BYTES field is non-zero, then the length of the A-KAD, if present in the parameter data for a SECURITY PROTOCOL OUT command, shall be a value between one and the value in the MAXIMUM AUTHENTICATED KEY-ASSOCIATED BYTES field.

The MAXIMUM UNAUTHENTICATED KEY-ASSOCIATED DATA BYTES field indicates the maximum size of the unauthenticated key-associated data supported by the device server for this algorithm.

The MAXIMUM AUTHENTICATED KEY-ASSOCIATED DATA BYTES field indicates the maximum size of the authenticated key-associated data supported by the device server for this algorithm.

The LOGICAL BLOCK ENCRYPTION KEY SIZE field indicates the size in bytes of the logical block encryption key required by the algorithm.

Table 296 specifies the values for the decryption KAD capabilties (DKAD_C) field. The DKAD_C field indicates the decryption capabilities when the DECRYPTION MODE field of the Set Data Encryption page (see 6.7.3.1) is set to DECRYPT or MIXED.

Table 296 — DKAD_C field

Code	Name	Description
00b	not specified	No capabilities are specified.
01b	KAD Required	Not Supported.
10b	KAD Not Allowed	Not Supported.
11b	KAD Capable	The device entity has the capability to accept a U-KAD or A-KAD to be provided by the application client with the Set Data Encryption page, but one is not required.

The external encryption mode control capabilities (EEMC_C) field indicates the capabilities the encryption algorithm provides to the application client to control write operations that transfer encrypted logical blocks while the encryption mode is set to EXTERNAL. Table 297 defines the values for the EEMC_C field.

Table 297 — EEMC_C field

Code	Description
0h	No capabilities are specified.
1h	Not Supported.
2h	The encryption algorithm allows write operations in EXTERNAL encryption mode. The device server does act as a KCDLU (see 4.2.22.5) for this encryption algorithm.
3h	Reserved

The raw decryption mode control capabilities (RDMC_C) field indicates the capabilities the encryption algorithm provides to the application client to control read operations that access encrypted logical blocks while the decryption mode is set to RAW. Table 298 defines the values for the RDMC_C field.

Table 298 — RDMC_C field

Code	Description
0h	No capabilities are specified.
1h	Not Supported.
2h-3h	Reserved
4h	Not Supported.
5h	The encryption algorithm enables read operations in RAW mode by default and allows the application client to control RAW reads via the RDMC field in the Set Data Encryption page (see 6.7.3.1). The device server acts as a KCSLU (see 4.2.22.5) for this encryption algorithm.
6h	Not Supported.
7h	Not Supported.

The encryption algorithm records encryption mode (EAREM) bit shall be set to one if the encryption mode is recorded with each encrypted logical block. The EAREM bit shall be set to zero if the encryption mode is not recorded with each encrypted logical block.

The maximum supplemental decryption key count (MSDK_COUNT) field contains the maximum number of supplemental decryption keys that the device server supports with this algorithm. If the SDK_C bit is set to one, then the MSDK_COUNT field shall be set to non-zero. If the SDK_C bit is set to zero, then the MSDK_COUNT field shall be set to zero.

The SECURITY ALGORITHM CODE field contains a security algorithm code (see SPC-4).

6.7.2.4 SPIN (20h[0011h]) - Supported Key Formats page

See SECURITY PROTOCOL IN (SPIN) - A2h (see 5.2.29 on page 140) for a description of how to request this page.

The structure of the Supported Key Formats page is shown in Table 299 on page 376

Table 299 — 0011h - Supported Key Formats page Structure

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	(MSB)			PAGE CODE (0011h)				
1								(LSB)
2	(MSB)			PAGE LENGTH (n-3)				
3								(LSB)
Supported Key Format list								
4	Supported Key Format [first]							
	⋮							
n	Supported Key Format [last]							

Table 300 — Supported Key Formats

Key Format	Description	Reference
00h	Plaintext Key Format	See page 376

6.7.2.4.1 Plaintext Key Format (00h)

The Plaintext Key Format structure is shown in Table 301 on page 376

Table 301 — 00h - Plaintext Key Format Structure

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0				KEY				
n								

6.7.2.5 SPIN (20h[0012h]) - Data Encryption Management Capabilities

See SECURITY PROTOCOL IN (SPIN) - A2h (see 5.2.29 on page 140) for a description of how to request this page.

Table 302 on page 377 specifies the format of the Data Encryption Management Capabilities page.

Table 302 — 0012h - Data Encryption Management Capabilities page

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	(MSB)			PAGE CODE (0012h)				
1								(LSB)
2	(MSB)			PAGE LENGTH (000ch)				
3								(LSB)
4	Reserved							LOCK_C (1b)
5	Reserved					CKOD_C (1b)	CKORP_C (1b)	CKORL_C (1b)
6	Reserved							
7	Reserved					AITN_C (1b)	LOCAL_C (1b)	PUBLIC_C (1b)
8	Reserved							
15								

6.7.2.6 SPIN (20h[0020h]) - Data Encryption Status page

Table 303 specifies the format of the Data Encryption Status page

This is a query of information which was set with Security Protocol Out 0010h - Set Data Encryption and does not reflect the actual state of the medium itself or of any data on medium..

Table 303 — 0020h - Data Encryption Status page

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	(MSB)	PAGE CODE (0020h)						
1								(LSB)
2	(MSB)	PAGE LENGTH (n-3)						
3								(LSB)
4	I_T NEXUS SCOPE			Reserved		LOGICAL BLOCK ENCRYPTION SCOPE		
5	ENCRYPTION MODE							
6	DECRYPTION MODE							
7	ALGORITHM INDEX							
8	(MSB)	KEY INSTANCE COUNTER						
11								(LSB)
12	Reserved	parameters control			VCELB	CEEMS		RDMD
13	ENCRYPTION PARAMETERS KAD FORMAT							
14	(MSB)	ASDK_COUNT (0000h)						
15								(LSB)
16	Reserved							
23								
Key-associated data descriptor list								
24	Key-associated data descriptor (first)							
n	Key-associated data descriptor (last)							

The I_T NEXUS SCOPE field shall contain the value from the logical block encryption scope saved for the I_T_L nexus through which this command was received.

The LOGICAL BLOCK ENCRYPTION SCOPE field shall contain the value from the logical block encryption scope in the saved logical block encryption parameters currently associated with the I_T_L nexus on which this command was received.

The ENCRYPTION MODE field shall contain the value from the encryption mode in the saved logical block encryption parameters currently associated with the I_T_L nexus on which this command was received.

The DECRYPTION MODE field shall contain the value from the decryption mode in the saved logical block encryption parameters currently associated with the I_T_L nexus on which this command was received.

The ALGORITHM INDEX field shall contain the value from the algorithm index in the saved logical block encryption parameters currently associated with the I_T_L nexus on which this command was received. If the ENCRYPTION MODE field and the DECRYPTION MODE field are both set to DISABLE, the value in the ALGORITHM INDEX field is undefined.

The KEY INSTANCE COUNTER field contains the value of the logical block encryption parameters key instance counter assigned to the logical block encryption key indicated by the LOGICAL BLOCK ENCRYPTION SCOPE field value.

The PARAMETERS CONTROL field specifies information on how the logical block encryption parameters are controlled. The PARAMETERS CONTROL field values are specified in table 304.

Table 304 — PARAMETERS CONTROL field

Code	Description
000b	Logical block encryption parameters control is not reported. This value is returned on Ultrium 4 devices
001b	Logical block encryption parameters are not exclusively controlled by external data encryption control. This value is returned when in AME encryption mode.
010b	Logical block encryption parameters are exclusively controlled by the sequential-access device server.
011b	Logical block encryption parameters are exclusively controlled by the automation/drive interface device server. This value is returned when in LME or ADC Controlled encryption mode.
100b	Not supported.
101b-111b	Reserved

A volume contains encrypted logical blocks (VCELB) bit set to one indicates that the mounted volume contains an encrypted logical block. A VCELB bit set to zero indicates that either:

a) the mounted volume does not contain any encrypted logical blocks;
b) there is no volume mounted; or
c) the VCELB_C bit in the Data Encryption Capabilities page is set to zero.

The raw decryption mode disabled (RDMD) bit shall be set to one if the device entity is configured to mark each encrypted record as disabled for raw read operations based on the RDMC_C value and the raw decryption mode disable parameter in the saved logical block encryption parameters currently associated with the I_T_L nexus on which the command was received.

The check external encryption mode status (CEEMS) field shall contain the value from the check external encryption mode parameter in the saved logical block encryption parameters currently associated with the I_T_L nexus on which the command was received.

The ENCRYPTION PARAMETERS KAD FORMAT field shall contain the value from the KAD_FORMAT in the saved logical block encryption parameters currently associated with the I_T_L nexus on which this command was received. If the encryption algorithm specified in the ALGORITHM INDEX field reports a KADF_C bit set to zero, then the ENCRYPTION PARAMETERS KAD FORMAT field shall be set to zero.

The available supplemental decryption key count (ASDK_COUNT) field shall bet set to zero because the device server is not capable of supporting supplemental decryption keys.

If the ENCRYPTION MODE field and the DECRYPTION MODE field are both set to DISABLE, the key-associated data descriptors list shall not be included in the page.

If either the ENCRYPTION MODE field or the DECRYPTION MODE field is set to a value other than DISABLE, the key-associated data descriptors list shall include Tape Data Encryption descriptors describing attributes assigned to the logical block encryption key defined by the I_T NEXUS SCOPE and LOGICAL BLOCK ENCRYPTION SCOPE fields at the time the logical block encryption key was established in the device entity (see “Key-Associated Data (KAD) Descriptors” on page 388). If more than one key-associated data descriptor is included, they shall be in increasing numeric order of the value in the KEY DESCRIPTOR TYPE field. Descriptors shall be included as defined by the following paragraphs.

An unauthenticated key-associated data descriptor shall be included if an unauthenticated key-associated data descriptor was included when the logical block encryption key was established in the device entity. The AUTHENTICATED field is reserved. The KEY DESCRIPTOR field shall contain the U-KAD value associated with the logical block encryption key.

An authenticated key-associated data descriptor shall be included if an authenticated key-associated data descriptor was included when the logical block encryption key was established in the device entity. The

AUTHENTICATED field is reserved. The KEY DESCRIPTOR field shall contain the A-KAD value associated with the logical block encryption key.

A nonce value descriptor shall be included if a nonce value descriptor was included when the logical block encryption key was established in the device entity. The AUTHENTICATED field is reserved. The KEY DESCRIPTOR field shall contain the nonce value associated with the logical block encryption key. A nonce value descriptor may be included if no nonce value descriptor was included when the logical block encryption key was established in the device entity. In this case, the KEY DESCRIPTOR field shall be set to the nonce value established by the device entity for use with the selected logical block encryption key.

A metadata key-associated data descriptor shall be included if the metadata key-associated data descriptor was included when the logical block encryption parameters were established. The KEY DESCRIPTOR field shall contain the M-KAD value associated with the logical block encryption key.

6.7.2.7 SPIN (20h[0021h]) - Next Block Encryption Status page

See SECURITY PROTOCOL IN (SPIN) - A2h (see 5.2.29 on page 140) for a description of how to request this page.

NOTE 59 - Next block encryption status may not be available in all situations. When it is not known appropriate values are returned as per the standard. In most situations next block information is available during read operations when read ahead is being performed. This is automatically managed by the device.

Table 305 specifies the format of the Next Block Encryption Status page

Table 305 — 0021h - Next Block Encryption Status page

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	(MSB)			PAGE CODE (0021h)				
1								(LSB)
2	(MSB)			PAGE LENGTH (n-3)				
3								(LSB)
4	(MSB)			LOGICAL OBJECT NUMBER				
11								(LSB)
12	COMPRESSION STATUS (0h)				ENCRYPTION STATUS			
13	ALGORITHM INDEX							
14	Reserved						EMES	RDMDS
15	NEXT BLOCK KAD FORMAT							
	Key-associated data descriptor list							
16	Key-associated data descriptor [first]							
n	Key-associated data descriptor [last]							

The LOGICAL OBJECT NUMBER field contains the logical object identifier of the next logical object (see 4.2.8.2).

The COMPRESSION STATUS field values are specified in table 306.

Table 306 — COMPRESSION STATUS field

Code	Description
0h	The device entity is incapable of determining if the logical object referenced by the LOGICAL OBJECT NUMBER field has been compressed.
1h	Not Supported.
2h	Not Supported.
3h	Not Supported.
4h	Not Supported.
5h-Fh	Reserved

The ENCRYPTION STATUS field values are specified in table 307.

Table 307 — ENCRYPTION STATUS field

Code	Description
0h	The device entity is incapable of determining if the logical object referenced by the LOGICAL OBJECT NUMBER field has been encrypted.
1h	The device entity is capable of determining if the logical object referenced by the LOGICAL OBJECT NUMBER field has been encrypted, but is not able to at this time. Possible reasons are: the next logical block has not yet been read into the buffer; there was an error reading the next logical block; or there are no more logical blocks (i.e., end-of-data).
2h	The device entity has determined that the logical object referenced by the LOGICAL OBJECT NUMBER field is not a logical block.
3h	The device entity has determined that the logical object referenced by the LOGICAL OBJECT NUMBER field is not encrypted.
4h	The device entity has determined that the logical object referenced by the LOGICAL OBJECT NUMBER field is encrypted by an algorithm that is not supported by this device server. The values in the key-associated data descriptors list contain information pertaining to the encrypted logical block.
5h	The device entity has determined that the logical object referenced by the LOGICAL OBJECT NUMBER field is encrypted by an algorithm that is supported by this device server. The values in the ALGORITHM INDEX field and key-associated data descriptors list contain information pertaining to the encrypted logical block.
6h	The device entity has determined that the logical object referenced by the LOGICAL OBJECT NUMBER field is encrypted by an algorithm that is supported by this device server, but the device entity is either not enabled to decrypt or does not have the correct logical block encryption key or nonce value to decrypt the encrypted logical block.
7h-Fh	Reserved

The ALGORITHM INDEX field indicates which of the encryption algorithms reported by the SECURITY PROTOCOL IN command Data Encryption Capabilities page was used to encrypt the logical block. For values in the ENCRYPTION STATUS field (see table 307) that do not indicate the ALGORITHM INDEX field is valid, the algorithm index is undefined.

The encryption mode external status (EMES) bit shall be set to one if:

a) the ENCRYPTION STATUS field is set to either 5h or 6h;
b) the EAREM bit in the algorithm descriptor (see 6.7.2.3) for the algorithm specified by the ALGORITHM INDEX field is set to one; and
c) the next logical block is marked as having been written to the medium while the encryption mode was set to EXTERNAL.

The EMES bit shall be set to zero if:

a) the ENCRYPTION STATUS field is set to a value other than 5h or 6h;
b) the EAREM bit in the algorithm descriptor (see 6.7.2.3) for the algorithm specified by the ALGORITHM INDEX field is set to zero; or
c) the next logical block is marked as having been written to the medium while the encryption mode was set to ENCRYPT.

The raw decryption mode disabled status (RDMDS) bit shall be set to one if:

a) the device server supports raw decryption mode;
b) the ENCRYPTION STATUS field is set to either 5h or 6h; and
c) the next logical block is marked as disabled for raw decryption mode operations (see 4.2.22).

The RDMDS bit shall be set to zero if:

a) the device server does not support raw decryption mode;
b) the ENCRYPTION STATUS field is set to a value other than 5h or 6h; or
c) the next logical block is not marked as disabled for raw decryption mode operations.

If the value in the ENCRYPTION STATUS field indicates that the next logical block is encrypted by a supported algorithm, then the NEXT BLOCK KAD FORMAT field shall contain the KAD_FORMAT logical block encryption parameters associated with the encrypted logical block. If the value in the ENCRYPTION STATUS field does not indicate that the next logical object is an encrypted logical block, then the NEXT BLOCK KAD FORMAT field shall be ignored. If the encryption algorithm specified in the ALGORITHM INDEX field reports a KADF_C bit set to zero, then the NEXT BLOCK KAD FORMAT field shall be set to zero.

If the value in the ENCRYPTION STATUS field indicates that the next logical block is encrypted by a supported algorithm, then the device server shall include in the key-associated data descriptor list (see “Key-Associated Data (KAD) Descriptors” on page 388) all key-associated data that is associated with the encrypted logical block. If more than one key-associated data descriptor is included in the Next Block Encryption Status page, then they shall be in increasing numeric order of the value in the KEY DESCRIPTOR TYPE field.

An unauthenticated key-associated data descriptor (see 6.7.3.2.1) shall be included if any unauthenticated key-associated data is associated with the next logical block. The AUTHENTICATED field shall be set to 1. The KEY DESCRIPTOR field shall contain the U-KAD value associated with the encrypted logical block.

An authenticated key-associated data descriptor (see 6.7.3.2.2) shall be included if any authenticated key-associated data is associated with the next logical block. The AUTHENTICATED field shall indicate the status of the authentication done by the device entity. The KEY DESCRIPTOR field shall contain the A-KAD value associated with the encrypted logical block.

The Next Block Encryption Status page may include a nonce value descriptor (see 6.7.3.2.3). If a nonce value descriptor is included, then the AUTHENTICATED field shall indicate the status of the authentication done by the device entity. The KEY DESCRIPTOR field shall contain the nonce value associated with the encrypted logical block.

A metadata key-associated data descriptor (see 6.7.3.2.4) shall be included if any M-KAD is associated with the next logical block and the decryption mode is set to RAW in the saved logical block encryption parameters currently associated with the I_T_L nexus on which this command was received. The KEY DESCRIPTOR field shall contain the M-KAD value associated with the encrypted logical block.

The following table indicates valid combinations of record status, Decryption Mode and returned Key-Associated Descriptors reflecting the currently setup state of the device.

Table 308 — SPIN (20h[0021h]) - KAD Parameters by Mode

Record Information	Decryption Mode	Read Data	Status	Key-Associated Descriptors				Notes
				uKAD 00h	aKAD (DKi) 01h	Nonce 02h	Meta data 03h	
Unknown	any	?	1h	n/a	n/a	n/a	n/a	
Filemark	any	n/a	2h	n/a	n/a	n/a	n/a	may be unknown
EOD	any	n/a	2h	n/a	n/a	n/a	n/a	may be unknown
Error	any	n/a	1h	n/a	n/a	n/a	n/a	may be unknown
Cleartext	0h Disable	C	3h	n/a	n/a	n/a	n/a	
Cleartext	1h Raw	E	3h	n/a	n/a	n/a	n/a	not readable
Cleartext	2h Decrypt	E	3h	n/a	n/a	n/a	n/a	not readable
Cleartext	3h Mixed	C	3h	n/a	n/a	n/a	n/a	
Encrypted	0h Disable	E	4h 5h or 6h	N	Y	N	N	not readable
Encrypted	1h Raw	R		N	N	N	Y	
Encrypted	2h Decrypt	C[1]		N	Y	N	N	
Encrypted	3h Mixed	C[1]		N	Y	N	N	

Legend:
Y: element is required
O: element is optional
N: element is not present
n/a: not applicable (element is not present)
C: cleartext (not encrypted)
R: raw (compressed encoded/encrypted)
E: error condition, record cannot be read

Notes:
1: Data is decrypted

6.7.2.7.1 Key-Associated Data (KAD) Descriptors

See "Key-Associated Data (KAD) Descriptors" on page 388

6.7.2.8 SPIN (20h[0030h]) - Random Number page

Table 309 specifies the format of the Random Number page.

Table 309 — Random Number page

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	(MSB)							
1				PAGE CODE (0030h)				(LSB)
2	(MSB)							
3				PAGE LENGTH (32)				(LSB)
4	(MSB)							
35				RANDOM NUMBER				(LSB)

The RANDOM NUMBER field contains a secure random number, suitable for use as a random nonce, that is generated by the device server using a source of entropy available within the device. Each request for the Random Number page generates a new secure random number for the RANDOM NUMBER field.

6.7.3 SPOUT Pages (20h - Tape Data Encryption security protocol)

See SECURITY PROTOCOL OUT (SPOUT) - B5h (see 5.2.30 on page 141) for a description of how to send this page.

The Security Protocol Specific field (see Table 93, "SECURITY PROTOCOL OUT B5h CDB," on page 141) specifies the type of page that the application client is sending. Table 310 shows supported values.

Table 310 — Security Protocol Specific Definitions for Security Protocol 20h

Page Code	Description	Reference
0010h	Set Data Encryption	See page 385

6.7.3.1 SPOUT (20h[0010h]) - Set Data Encryption

See SECURITY PROTOCOL OUT (SPOUT) - B5h (see 5.2.30 on page 141) for a description of how to send this page.

Table 311 specifies the format of the Set Data Encryption page.

Table 311 — 0010h - Set Data Encryption page

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	(MSB)	PAGE CODE (0010h)						
1								(LSB)
2	(MSB)	PAGE LENGTH (m-3)						
3								(LSB)
4	SCOPE			Reserved				LOCK
5	CEEM		RDMC		SDK (0b)	CKOD	CKORP	CKORL
6	ENCRYPTION MODE							
7	DECRYPTION MODE							
8	ALGORITHM INDEX							
9	LOGICAL BLOCK ENCRYPTION KEY FORMAT							
10	KAD FORMAT							
11	Reserved							
17								
18	(MSB)	LOGICAL BLOCK ENCRYPTION KEY LENGTH (n-19)						
19								(LSB)
20	LOGICAL BLOCK ENCRYPTION KEY							
n								
Key-associated data descriptor list								
n+1	Key-associated data descriptor [first]							
	Key-associated data descriptor [last]							
m								

The following parameters apply:

- SCOPE

Value	Description
0h	Public
1h	Local
2h	All I_T Nexus

- LOCK
- CEEM (check external encryption mode)

Value	Description
01b	Do not check the encryption mode that was in use when the logical block was written to the medium.
10b	On read and verify commands, check the encryption mode that was in use when the logical block was written to the medium. Report an error if the logical block was written in EXTERNAL mode
11b	On read and verify commands, check the encryption mode that was in use when the logical block was written to the medium. Report an error if the logical block was written in ENCRYPT mode

  A CHECK CONDITION status, with the sense key set to ILLEGAL REQUEST, and the additional sense code set to INVALID FIELD IN PARAMETER DATA is returned if the CEEM field is set to either 10b or 11b, and:

  a) the DECRYPTION MODE field is set to DISABLE; or
  b) the EAREM bit in the algorithm descriptor (see 6.7.2.3) for the algorithm specified by the ALGORITHM INDEX field is set to zero.

- RDMC (raw decryption mode control)

  This field is ignored if the ENCRYPTION MODE field is not set to ENCRYPT.

Value	Description
00b	The device entity shall mark each encrypted logical block per the default setting for the algorithm.
10b	The device entity shall mark each encrypted logical block written to the medium as enabled for raw decryption mode operations.
11b	The device entity shall mark each encrypted logical block written to the medium as disabled for raw decryption mode operations.

A CHECK CONDITION status, with the sense key set to ILLEGAL REQUEST and the additional sense key set to INVALID FIELD IN PARAMETER DATA is returned if:

a) the ENCRYPTION MODE field is set to ENCRYPT;
b) the RDMC field is set to 10b or 11b; and
c) the RDMC_C field in the algorithm descriptor for the encryption algorithm selected by the value in the ALGORITHM INDEX field is set to 1h, 6h, or 7h.

- CKOD (clear key on demount)
- CKORP (clear key on reservation preempt)
- CKORL (clear key on reservation loss)
- ENCRYPTION MODE

Value	Description
0h	Disable
1h	External
2h	Encrypt

- DECRYPTION MODE

Value	Description
0h	Disable
1h	Raw
2h	Decrypt
3h	Mixed

- LOGICAL BLOCK ENCRYPTION KEY FORMAT
- KAD FORMAT

A non-zero value is only allowed if the algorithm in the ALGORITHM INDEX field reports a KADF_C bit set to one.

Value	Description
0h	Unspecified
1h	Binary logical block encryption key name
2h	ASCII logical block encryption key name

If the KAD FORMAT value is non-zero, then:

a) a) only an A-KAD descriptor is provided and the authenticated key-associated data is the key name;
b) b) only a U-KAD descriptor is provided and the unauthenticated key-associated data is the key name; or
c) c) both an A-KAD descriptor and a U-KAD descriptor is provided and the key name is formed by the authenticated key-associated data followed by the unauthenticated key-associated data.

- LOGICAL BLOCK ENCRYPTION KEY LENGTH

Value	Description
0000h	When no Key is specified
0020h	When Key is specified using Key Format 00h

- LOGICAL BLOCK ENCRYPTION KEY
- Key-Associated Descriptors List (See “Key-Associated Data (KAD) Descriptors” on page 388)

The following table indicates valid combinations of Encryption Mode and Decryption Mode and mandatory, optional and prohibited Key and Key-Associated Descriptors.

Table 312 — SPOUT (20h[0010h]) - KAD Parameters by Mode

Encryption Mode	Decryption Mode	R/W Data	Key	Key-Associated Descriptors				Notes
				uKAD 00h	aKAD (DKi) 01h	Nonce 02h	Meta data 03h	
0h Disable	0h Disable	C/C	P	P	P	P	P	
0h Disable	1h Raw	R/C	P	P	P	P	P	not recommended
0h Disable	2h Decrypt	C[4]/C	M [2]	P	P	P	P	not recommended
0h Disable	3h Mixed	C[6]/C	M [2]	P	P	P	P	
1h External	0h Disable	C/R	P	P	P	P	M [1]	not recommended
1h External	1h Raw	R/R	P	P	P	P	M [1]	
1h External	2h Decrypt	C[4]/R	M [2]	P	P	P	M [1]	not recommended
1h External	3h Mixed	C[6]/R	M [2]	P	P	P	M [1]	not recommended
2h Encrypt	0h Disable	C/C[4]	M [1]	P	O [1]	O [1,3]	P	
2h Encrypt	1h Raw	R/C[4]	M [1]	P	O [1]	O [1,3]	P	not recommended
2h Encrypt	2h Decrypt	C[5]/C[4]	M	P	O [1]	O [1,3]	P	
2h Encrypt	3h Mixed	C[6]/C[4]	M	P	O [1]	O [1,3]	P	

Legend:
M: element is mandatory (required)
P: element prohibited (must not be present)
O: element is optional (may be device generated)
I: element is ignored (may be present)
C: cleartext (not encrypted)
R: raw (compressed encoded/encrypted)

Notes:
1: Only used for writing
2: Only used for reading
3: May be partially ignored
4: Data is encrypted
5: Data is decrypted
6: Data is decrypted (if needed)

6.7.3.2 Key-Associated Data (KAD) Descriptors

6.7.3.2.1 KAD 00h - UKAD (Unathenticated KAD)

The UKAD field is an optional field which is used when writing and is recorded with each record.

Table 313 — KAD 00h - UKAD (Unathenticated KAD)

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	KEY DESCRIPTOR TYPE (00h)							
1	Reserved					AUTHENTICATED		
2	(MSB)	KEY DESCRIPTOR LENGTH (n-3)						
3								(LSB)
4	UNAUTHENTICATED DATA							
n								

The following parameters apply:

- AUTHENTICATED

Value	Description
0h	Reserved (must be set for Security Protocol Out - 0010h)
1h	Not Covered by Authentication (only Security Protocol In)

- KEY DESCRIPTOR LENGTH: Maximum size is determined by generation.
- UNATHENTICATED DATA

6.7.3.2.2 KAD 01h - DKi (Data Key Identifier)

The DKi KAD field is an optional field which is used when writing and is recorded with each record. This is the AKAD field.

Table 314 — KAD 01h - DKi (Data Key Identifier)

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	KEY DESCRIPTOR TYPE (01h)							
1	Reserved					AUTHENTICATED		
2	(MSB)	KEY DESCRIPTOR LENGTH (n-3)						
3								(LSB)
4	DKi							
n								

The following parameters apply:

- AUTHENTICATED

Value	Description
0h	Reserved (must be set for Security Protocol Out)
2h	No attempt has been made to authenticate (only Security Protocol In)

- KEY DESCRIPTOR LENGTH: may be up to 000Ch bytes
- DKi

6.7.3.2.3 KAD 02h - Nonce

The Nonce/IV is not technically KAD. The Nonce may be set to provide the initial value for IV generation for write operations. This field is optional and the device is capable of generating high quality random IV values. When an application specifies nonce values, it is possible that a systemic cryptographic weakness may be introduced into the system. It is strongly recommended that nonce values are not supplied by the application.

NOTE 60 - The Nonce KAD is only reported by the device in Security Protocol In X'0020' - Data Encryption Status, and the value returned is the exact value specified in X'0010' - Set Data Encryption. This may not reflect the actual nonce or IV used for writing encrypted data.

NOTE 61 - IV values are constructed using only part of the specified Nonce value and are altered for each write in a device dependent manner.

Table 315 — KAD 02h - Nonce

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	Key Descriptor Type (02h)							
1	Reserved					Authenticated		
2	(MSB)	KEY DESCRIPTOR LENGTH (000Ch)						
3								(LSB)
4		NONCE/IV						
n								

The following parameters apply:

- AUTHENTICATED

Value	Description
0h	Reserved (must be set for Security Protocol Out)
1h	Not Covered by Authentication (only Security Protocol In)

- KEY DESCRIPTOR LENGTH: the only supported length is 000Ch
- NONCE/IV

6.7.3.2.4 KAD 03h - MKAD (Metadata)

The MKAD field is used for a keyless copy operation (i.e., RAW decryption mode and EXTERNAL encryption mode).

Table 316 — KAD 03h - MKAD (Metadata)

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 lsb
0	KEY DESCRIPTOR TYPE (00h)							
1	Reserved					AUTHENTICATED (2h)		
2	(MSB)	KEY DESCRIPTOR LENGTH (n-3)						
3								(LSB)
4		KEY DESCRIPTOR						
n								

The following parameters apply:

- KEY DESCRIPTOR LENGTH
- KEY DESCRIPTOR: Data required by the encryption algorithm for a keyless copy operation.

Annex A. Summary of Drive Generation Differences

This chapter provides a summary of the differences in host attachment protocol between the Ultrium Internal Tape Drive (Generation 1), the TotalStorage® LTO Ultrium 2 Tape Drive (Generation 2), and the System Storage Ultrium 3 Tape Drive (Generation 3), the System Storage Ultrium 3 Half-High Tape Drive (Generation 3HH), the System Storage Ultrium 4 Tape Drive (Generation 4), and the System Storage Ultrium 5 Tape Drive (Generation 5).

The features of the Generation 2 drive that differ from the Generation 1 drive include:

a) 64-MB read-and-write cache
b) Speed matching
c) Channel calibration
d) SET CAPACITY SCSI command
e) Ultra160 SCSI interface
f) Drive external SCSI termination required
g) Fibre Channel 2-Gb/s interface
h) Fibre Channel support for direct connection to an F port (for example, a McData switch)
i) Parallel SCSI Ultra 320 interface

The features of the Ultrium 3 Tape Drive that differ from those of the Ultrium 2 Tape Drive include the following:

a) 128 MB read-and-write cache
b) New media, new media shell color (dark bluish gray, Pantone color number 7546C)
c) Expanded request sense length to 96 bytes
d) WORM capability
e) Fibre Channel 2Gbit/sec interface or 4Gbit/sec interface
f) Half-Height drive option with:
    A) Serial Attached SCSI (SAS) Interface, or
    B) Ultra160 SCSI Interface

The features of the Ultrium 4 Tape Drive that differ from those of the Ultrium 3 HH, Ultrium 3, and Ultrium 2 Tape Drive include the following:

a) Half-Height drive option with:
    A) Serial Attached SCSI (SAS) Interface, or
    B) Ultra160 SCSI Interface
b) 256 MB read-and-write cache
c) Encryption of data on Ultrium 4 cartridges
    A) T10 key management method
    B) Transparent management method
        a) when using IBM® device driver, or
        b) when in an IBM library
d) New log pages
    A) Device Statistics log page (14h)
    B) Tape Diagnostic data log page (16h)
    C) Performance Characteristics log page (37h)
e) Fibre Channel 4Gbit/sec interface
f) Serial Attached SCSI (SAS) interface
g) Ultra320 SCSI Interface (OEM model only)
h) WORM capability

The features of the Ultrium 5 Tape Drive that differ from those of the previous generations include the following:

a) Full-Height and Half-Height drive option with:
    A) Fibre Channel 8Gbit/sec Interface,or
    B) Serial Attached SCSI (SAS) 6Gbit/sec Interface
b) Full-Height 448 MB read-and-write cache
c) Half-Height 192 MB read-and-write cache
    A) Encryption of data on Ultrium 4 and Ultrium 5 cartridges
    B) T10 key management method

C) Transparent management method
   a) when using IBM device driver,
   b) when in an IBM library, or
   c) when using T10 External Encryption Control

d) Support for IKEv2-SCSI
e) 14 Speeds in Digital Speed Matching
f) Partition capability up to two partitions (see 6.5.12)
g) Data Safe Mode (i.e., Append-only mode) capability (see 4.1.3)
h) SkipSync capability (see 6.5.20.4.1)
i) Ideal Capacity (see 6.5.20.4.3)
j) Power Condition mode page for user controlled power management (see 6.5.15)
k) Ethernet port for configuration/debug (see 6.5.20.3)
l) Standards based setting of time (see 4.11)
m) Command timeout values reported at runtime with Report Supported Opcodes command (see 5.2.23)
n) New standardized log pages with expanded counters:
   A) Extended Device Statistics log page (14h) (see 6.3.10)
   B) Volume Statistics log page (17h) (see 6.3.12)
   C) Data Compression log page (1Bh) (see 6.3.14)

Table 317 compares features of the different generations of Ultrium tape drives.

Table 317 — Features of the IBM Ultrium Tape Drives and the IBM 3580 Ultrium Tape Drive

Feature	Ultrium 3	Ultrium 3 Half-Height	Ultrium 4	Ultrium 4 Half-Height	Ultrium 5	Ultrium 5 Half-Height
Native storage capacity	400 GB	400 GB	800 GB	800 GB	1500 GB	1500 GB
Storage capacity at 2:1 compression	800 GB	800 GB	1.6 TB	1.6 TB	3.0 TB	3.0 TB
Native sustained data transfer rate	80 MB/s	60 MB/s or 80 MB/s [e]	120 MB/s	120 MB/s	140 MB/s	140 MB/s
Data transfer rate at 2:1 compression	160 MB/s	120 MB/s or 160 MB/s [e]	240 MB/s	240 MB/s	280 MB/s	280 MB/s
Burst data transfer rate (1GFC)	100 MB/s	N/A	100 MB/s	100 MB/s	100 MB/s	100 MB/s
Burst data transfer rate (2GFC)	200 MB/S	N/A	200 MB/S	200 MB/S	200 MB/S	200 MB/S
Burst data transfer rate (4GFC)	400 MB/s	N/A	400 MB/s	400 MB/s	400 MB/s	400 MB/s
Burst data transfer rate (8GFC)	N/A	N/A	N/A	800 MB/s [e]	800 MB/s	800 MB/s
Burst data transfer rate (3G SAS)	N/A	300 MB/s	300 MB/s	300 MB/s	300 MB/s	300 MB/s
Burst data transfer rate (6G SAS)	N/A	600 MB/s [e]	N/A	600 MB/s [e]	600 MB/s	600 MB/s
Type of interface	U160 [d] LC-D [a]	U160 [d] SAS [b]	U160 [d] LC-D [a] SAS [b] U320 [c]	LC-D [a] SAS [b]	LC-D [a] SAS [b]	LC-D [a] SAS [b]

Note - All sustained data rates are dependent on the capabilities of the interconnect (for example, a 4GFC link is limited to less than 400MB/sec).

[a] LC-D: LC-Duplex Fibre Channel, with the use of SCSI protocol

[b] SAS: Serial-Attached SCSI

[c] U320: Ultra 320 LVD SCSI - Not on V2 drives

[d] U160: Ultra 160 LVD SCSI - Not on V2 drives

[e] V2 drives only

A.1. Differences in Command Timeout Values

Due to differences between each of the of the Ultrium drives, the maximum amount of time it takes for various SCSI commands to process and return status has changed. Table 318, “Command Timeout Values (Ultrium 1, 2, and 3 Full-Height) - OpCode Sort,” on page 394, Table 319, “Command Timeout Values (Ultrium 3 Half-Height and Ultrium 4) - OpCode Sort,” on page 396, Table 320, “Command Timeout Values (Ultrium 1, 2, and 3 Full-Height) - Alphabetic Sort,” on page 397, and Table 321, “Command Timeout Values (Ultrium 3 Half-Height and Ultrium 4) - Alphabetic Sort,” on page 399 each provides a list of all recommended host command time-outs from commands defined by the referenced SCSI-3 standard or by this product as vendor-unique for sequential access devices. The tables list the following information for each command: the operation code, recommended timeout, and notes.

It is strongly recommended that device drivers or host software implement device reservations using the Reserve or Persistent Reserve commands. Due to the sequential nature of tape devices, many host commands are

serialized, and command time-outs consequently have an additive effect. Using reservations will prevent this from causing application disruptions in a multi-initiator or SAN environment. Similar additive timeout effects can occur if the host is using command Queuing (that is, simple queuing).

The time-outs in the following tables are based on the time from the start of the processing of the command, to its reported completion. Since applications are generally concerned with the time from the command being issued, to its reported completion, it should be noted that this overall time may be affected by currently processing operations. Some of these conditions include:

a) A prior command was issued with the Immediate bit set in the CDB
b) Multiple concurrent commands with Simple queuing are processed
c) Multi-initiator configurations without reservations
d) Non-host operations, such as manual unloads, power-on self tests, and so on
e) Commands issued shortly after certain aborted commands
f) Commands that force flushes when unwritten write data is in the buffer

Ultrium 5 tape drives support the REPORT SUPPORTED OPERATION CODES - A3h[0Ch] (see 5.2.23 on page 119) command and provides command timeout values at run time. See the REPORT SUPPORTED OPERATION CODES command for Ultrium 5 tape drive command timeouts. Command timeout values for Ultrium 1 through Ultrium 4 tape drives are listed in the following tables:

Table 318, “Command Timeout Values (Ultrium 1, 2, and 3 Full-Height) - OpCode Sort,” on page 394
Table 319, “Command Timeout Values (Ultrium 3 Half-Height and Ultrium 4) - OpCode Sort,” on page 396
Table 320, “Command Timeout Values (Ultrium 1, 2, and 3 Full-Height) - Alphabetic Sort,” on page 397
Table 321, “Command Timeout Values (Ultrium 3 Half-Height and Ultrium 4) - Alphabetic Sort,” on page 399

Table 318 — Command Timeout Values (Ultrium 1, 2, and 3 Full-Height) - OpCode Sort (part 1 of 2)

OpCode	Command	Timeout for Ultrium Tape Drive (in minutes)	Timeout for Ultrium 2 Tape Drive (in minutes)		Timeout for Ultrium 3 Full-Height Tape Drive (in minutes)		
			Gen 1 Cartridge	Gen 2 Cartridge	Gen 1 Cartridge	Gen 2 Cartridge	Gen 3 Cartridge
00h	TEST UNIT READY	1	1	1	1	1	1
01h	REWIND	8	9	8	8	8	9
03h	REQUEST SENSE	1	1	1	1	1	1
05h	READ BLOCK LIMITS	1	1	1	1	1	1
08h	READ	18	18	18	16	16	17
0Ah	WRITE	18	18	18	N/A	16	18
0Bh	SET CAPACITY	N/A	13	13	N/A	11	12
10h	WRITE FILEMARK	15	15	15	N/A	15	17
11h	SPACE(6) (Normal)	16	15	14	14	14	16
	SPACE(6) (Slow)	173	138	151	127	165	140
12h	INQUIRY	1	1	1	1	1	1
13h	VERIFY	18	18	18			
15h/55h	MODE SELECT(6/10)	1	1	1	1	1	1
16h/56h	RESERVE UNIT(6/10)	1	1	1	1	1	1
17h/57h	RELEASE UNIT(6/10)	1	1	1	1	1	1
19h	ERASE	204	138	151	N/A	160	134
1Ah/5Ah	MODE SENSE(6/10)	1	1	1	1	1	1

Table 318 — Command Timeout Values (Ultrium 1, 2, and 3 Full-Height) - OpCode Sort (part 2 of 2)

OpCode	Command	Timeout for Ultrium Tape Drive (in minutes)	Timeout for Ultrium 2 Tape Drive (in minutes)		Timeout for Ultrium 3 Full-Height Tape Drive (in minutes)		
			Gen 1 Cartridge	Gen 2 Cartridge	Gen 1 Cartridge	Gen 2 Cartridge	Gen 3 Cartridge
1Bh	LOAD (Cartridge Insert -> BOM)	11	12	12	8	8	8
	LOAD (LP4 -> BOM)	8	9	8	8	8	9
	UNLOAD (BOM -> Cartridge Eject)	10	10	10	10	10	11
	UNLOAD (LP4 -> Cartridge Eject)	11	12	11	11	11	12
1Ch	RECEIVE DIAGNOSTIC RESULTS	1	1	1	1	1	1
1Dh	SEND DIAGNOSTIC	29	35	35	13	39	34
1Eh	PREVENT/ALLOW MEDIUM REMOVAL	1	1	1	1	1	1
2Bh/92h	LOCATE(10/16) (Normal)	16	15	14	14	14	16
	LOCATE(10/16) (Slow)	173	138	151	127	165	140
34h	READ POSITION	1	1	1	1	1	1
3Bh	WRITE BUFFER	8	8	8	8	8	8
3Ch	READ BUFFER	8	8	8	7	7	8
44h	REPORT DENSITY SUPPORT	1	1	1	1	1	1
4Ch	LOG SELECT	1	1	1	1	1	1
4Dh	LOG SENSE	1	1	1	1	1	1
5Eh	PERSISTENT RESERVE IN (PRIN)	1	1	1	1	1	1
5Fh	PERSISTENT RESERVE OUT (PROUT)	1	1	1	1	1	1
8Ch	READ ATTRIBUTE	1	1	1	1	1	1
8Dh	WRITE ATTRIBUTE	1	1	1	1	1	1
91h	SPACE(16) (Normal)	N/A	N/A	N/A	14	14	16
	SPACE(16) (Slow)	N/A	N/A	N/A	127	165	140
A0h	REPORT LUNS	1	1	1	1	1	1
A2h	SECURITY PROTOCOL IN (SPIN)	N/A	N/A	N/A	N/A	N/A	1
A3h:0Ch	REPORT SUPPORTED OPERATION CODES	N/A	N/A	N/A	1	1	1
A3h:0Dh	REPORT SUPPORTED TASK MANAGEMENT FUNCTIONS	N/A	N/A	N/A	1	1	1
A3h:0Fh	REPORT TIMESTAMP	N/A	N/A	N/A	1	1	1
A4h:0Fh	SET TIMESTAMP	N/A	N/A	N/A	1	1	1
B5h	SECURITY PROTOCOL OUT (SPOUT)	N/A	N/A	N/A	N/A	N/A	N/A

Table 319 — Command Timeout Values (Ultrium 3 Half-Height and Ultrium 4) - OpCode Sort (part 1 of 2)

OpCode	Command	Timeout for Ultrium 3 Half-Height Tape drive (in minutes)			Timeout for Ultrium 4 Tape Drive (in minutes)		
		Gen 1 Cartridge	Gen 2 Cartridge	Gen 3 Cartridge	Gen 2 Cartridge	Gen 3 Cartridge	Gen 4 Cartridge
00h	TEST UNIT READY	1	1	1	1	1	1
01h	REWIND	11	11	13	8	9	9
03h	REQUEST SENSE	1	1	1	1	1	1
05h	READ BLOCK LIMITS	1	1	1	1	1	1
08h	READ	21	21	23	16	17	22[c]
0Ah	WRITE	N/A	21	24	N/A	18	23[d]
0Bh	SET CAPACITY	N/A	14	16	N/A	12	12
10h	WRITE FILEMARK	N/A	21	23	N/A	17	22[e]
11h	SPACE(6) (Normal)	20	20	22	14	16	21
	SPACE(6) (Slow)	199	264	201	165	140	183
12h	INQUIRY	1	1	1	1	1	1
13h	VERIFY	21	21	23	16	17	22[c]
15h/55h	MODE SELECT (6/10)	1	1	1	1	1	1
16h/56h	RESERVE UNIT (6/10)	1	1	1	1	1	1
17h/57h	RELEASE UNIT (6/10)	1	1	1	1	1	1
19h	ERASE	N/A	191	255	N/A	134	180[a]
1Ah/5Ah	MODE SENSE (6/10)	1	1	1	1	1	1
1Bh	LOAD (Cartridge Insert -> BOM)	9	9	9	8	8	8[b]
	LOAD (LP4 -> BOM)	11	11	13	8	9	9[b]
	UNLOAD (BOM -> Cartridge Eject)	12	12	14	10	11	11
	UNLOAD (LP4 -> Cartridge Eject)	14	14	16	11	12	13
1Ch	RECEIVE DIAGNOSTIC RESULTS	1	1	1	1	1	1
1Dh	SEND DIAGNOSTIC	13	39	40	13	34	35
1Eh	PREVENT/ALLOW MEDIUM REMOVAL	1	1	1	1	1	1
2Bh/92h	LOCATE(10/16) (Normal)	20	20	22	14	16	21
	LOCATE(10/16) (Slow)	199	264	201	165	140	183
34h	READ POSITION	1	1	1	1	1	1
3Bh	WRITE BUFFER	10	10	11	8	8	8
3Ch	READ BUFFER	9	9	10	7	8	8
44h	REPORT DENSITY SUPPORT	1	1	1	1	1	1
4Ch	LOG SELECT	1	1	1	1	1	1
4Dh	LOG SENSE	1	1	1	1	1	1
5Eh	PERSISTENT RESERVE IN	1	1	1	1	1	1
5Fh	PERSISTENT RESERVE OUT	1	1	1	1	1	1
91h	SPACE(16) (NORMAL)	20	20	22	14	16	21
	SPACE(16) (SLOW)	199	264	201	165	140	183

Table 319 — Command Timeout Values (Ultrium 3 Half-Height and Ultrium 4) - OpCode Sort (part 2 of 2)

OpCode	Command	Timeout for Ultrium 3 Half-Height Tape drive (in minutes)			Timeout for Ultrium 4 Tape Drive (in minutes)		
		Gen 1 Cartridge	Gen 2 Cartridge	Gen 3 Cartridge	Gen 2 Cartridge	Gen 3 Cartridge	Gen 4 Cartridge
BCh	READ ATTRIBUTE	1	1	1	1	1	1
BDh	WRITE ATTRIBUTE	1	1	1	1	1	1
A0h	REPORT LUNS	1	1	1	1	1	1
A2h	SECURITY PROTOCOL IN	N/A	N/A	N/A	N/A	N/A	1
A3h:0Ch	REPORT SUPPORTED OP CODES	1	1	1	1	1	1
A3h:0Dh	REPORT SUPPORTED TASK MANAGEMENT FUNCTIONS	1	1	1	1	1	1
A3h:0Fh	REPORT TIMESTAMP	1	1	1	1	1	1
A4h:0Fh	SET TIMESTAMP	1	1	1	1	1	1
B5h	SECURITY PROTOCOL OUT	N/A	N/A	N/A	N/A	N/A	1

[a] ERASE (at BOP): The following commands require an increased timeout when encryption is active and an out-of-band key manager is used. The command timeout should be increased by 300 seconds. The following commands require an increased timeout when encryption is active and new wrapped or tracked keys are used. The command timeout should be increased by 600 seconds.

[b] LOAD (Unload): Special note: This command may require an increased timeout when encryption is active and the drive is set to request keys on mount, (the following commands require an increased timeout when encryption is active and an out-of-band key manager is used; the command timeout should be increased by 300 seconds), or when medium is loaded which has a drive detected key redundancy exposure (timeout increases by 900 seconds for recovery actions).

[c] READ/VERIFY: The following commands require an increased timeout when encryption is active and an out-of-band key manager is used. The command timeout should be increased by 300 seconds.

[d] WRITE: The following commands require an increased timeout when encryption is active and an out-of-band key manager is used. The command timeout should be increased by 300 seconds. The following commands require an increased timeout when encryption is active and new wrapped or tracked keys are used. The command timeout should be increased by 600 seconds, (at BOP with new key, longer if not at BOP with new key).

[e] WRITE FILEMARKS (at BOP): The following commands require an increased timeout when encryption is active and an out-of-band key manager is used. The command timeout should be increased by 300 seconds. The following commands require an increased timeout when encryption is active and new wrapped or tracked keys are used. The command timeout should be increased by 600 seconds.

Table 320 — Command Timeout Values (Ultrium 1, 2, and 3 Full-Height) - Alphabetic Sort (part 1 of 3)

OpCode	Command	Timeout for Ultrium Tape Drive (in minutes)	Timeout for Ultrium 2 Tape Drive (in minutes)		Timeout for Ultrium 3 Full-Height Tape Drive (in minutes)		
			Gen 1 Cartridge	Gen 2 Cartridge	Gen 1 Cartridge	Gen 2 Cartridge	Gen 3 Cartridge
19h	ERASE	204	138	151	N/A	160	134
12h	INQUIRY	1	1	1	1	1	1
1Bh	LOAD (Cartridge Insert -> BOM)	11	12	12	8	8	8
	LOAD (LP4 -> BOM)	8	9	8	8	8	9

Table 320 — Command Timeout Values (Ultrium 1, 2, and 3 Full-Height) - Alphabetic Sort (part 2 of 3)

OpCode	Command	Timeout for Ultrium Tape Drive (in minutes)	Timeout for Ultrium 2 Tape Drive (in minutes)		Timeout for Ultrium 3 Full-Height Tape Drive (in minutes)		
			Gen 1 Cartridge	Gen 2 Cartridge	Gen 1 Cartridge	Gen 2 Cartridge	Gen 3 Cartridge
2Bh/92h	LOCATE(10/16) (Normal)	16	15	14	14	14	16
	LOCATE(10/16) (Slow)	173	138	151	127	165	140
4Ch	LOG SELECT	1	1	1	1	1	1
4Dh	LOG SENSE	1	1	1	1	1	1
15h/55h	MODE SELECT(6/10)	1	1	1	1	1	1
1Ah/5Ah	MODE SENSE(6/10)	1	1	1	1	1	1
5Eh	PERSISTENT RESERVE IN (PRIN)	1	1	1	1	1	1
5Fh	PERSISTENT RESERVE OUT (PROUT)	1	1	1	1	1	1
1Eh	PREVENT/ALLOW MEDIUM REMOVAL	1	1	1	1	1	1
08h	READ	18	18	18	16	16	17
8Ch	READ ATTRIBUTE	1	1	1	1	1	1
05h	READ BLOCK LIMITS	1	1	1	1	1	1
3Ch	READ BUFFER	8	8	8	7	7	8
34h	READ POSITION	1	1	1	1	1	1
1Ch	RECEIVE DIAGNOSTIC RESULTS	1	1	1	1	1	1
17h/57h	RELEASE UNIT(6/10)	1	1	1	1	1	1
44h	REPORT DENSITY SUPPORT	1	1	1	1	1	1
A0h	REPORT LUNS	1	1	1	1	1	1
A3h:0Ch	REPORT SUPPORTED OPERATION CODES	N/A	N/A	N/A	1	1	1
A3h:0Dh	REPORT SUPPORTED TASK MANAGEMENT FUNCTIONS	N/A	N/A	N/A	1	1	1
A3h:0Fh	REPORT TIMESTAMP	N/A	N/A	N/A	1	1	1
03h	REQUEST SENSE	1	1	1	1	1	1
16h/56h	RESERVE UNIT(6/10)	1	1	1	1	1	1
01h	REWIND	8	9	8	8	8	9
A2h	SECURITY PROTOCOL IN (SPIN)	N/A	N/A	N/A	N/A	N/A	1
B5h	SECURITY PROTOCOL OUT (SPOUT)	N/A	N/A	N/A	N/A	N/A	N/A
1Dh	SEND DIAGNOSTIC	29	35	35	13	39	34
0Bh	SET CAPACITY	N/A	13	13	N/A	11	12
A4h:0Fh	SET TIMESTAMP	N/A	N/A	N/A	1	1	1
91h	SPACE(16) (Normal)	N/A	N/A	N/A	14	14	16
	SPACE(16) (Slow)	N/A	N/A	N/A	127	165	140
11h	SPACE(6) (Normal)	16	15	14	14	14	16
	SPACE(6) (Slow)	173	138	151	127	165	140
00h	TEST UNIT READY	1	1	1	1	1	1

Table 320 — Command Timeout Values (Ultrium 1, 2, and 3 Full-Height) - Alphabetic Sort (part 3 of 3)

OpCode	Command	Timeout for Ultrium Tape Drive (in minutes)	Timeout for Ultrium 2 Tape Drive (in minutes)		Timeout for Ultrium 3 Full-Height Tape Drive (in minutes)		
			Gen 1 Cartridge	Gen 2 Cartridge	Gen 1 Cartridge	Gen 2 Cartridge	Gen 3 Cartridge
1Bh	UNLOAD (BOM -> Cartridge Eject)	10	10	10	10	10	11
	UNLOAD (LP4 -> Cartridge Eject)	11	12	11	11	11	12
13h	VERIFY	18	18	18			
0Ah	WRITE	18	18	18	N/A	16	18
8Dh	WRITE ATTRIBUTE	1	1	1	1	1	1
3Bh	WRITE BUFFER	8	8	8	8	8	8
10h	WRITE FILEMARK	15	15	15	N/A	15	17

Table 321 — Command Timeout Values (Ultrium 3 Half-Height and Ultrium 4) - Alphabetic Sort (part 1 of 2)

OpCode	Command	Timeout for Ultrium 3 Half-Height Tape drive (in minutes)			Timeout for Ultrium 4 Tape Drive (in minutes)		
		Gen 1 Cartridge	Gen 2 Cartridge	Gen 3 Cartridge	Gen 2 Cartridge	Gen 3 Cartridge	Gen 4 Cartridge
19h	ERASE	N/A	191	255	N/A	134	180[a]
12h	INQUIRY	1	1	1	1	1	1
1Bh	LOAD (Cartridge Insert -> BOM)	9	9	9	8	8	8[b]
	LOAD (LP4 -> BOM)	11	11	13	8	9	9[b]
2Bh/92h	LOCATE(10/16) (Normal)	20	20	22	14	16	21
	LOCATE(10/16) (Slow)	199	264	201	165	140	183
4Ch	LOG SELECT	1	1	1	1	1	1
4Dh	LOG SENSE	1	1	1	1	1	1
15h/55h	MODE SELECT (6/10)	1	1	1	1	1	1
1Ah/5Ah	MODE SENSE (6/10)	1	1	1	1	1	1
5Eh	PERSISTENT RESERVE IN	1	1	1	1	1	1
5Fh	PERSISTENT RESERVE OUT	1	1	1	1	1	1
1Eh	PREVENT/ALLOW MEDIUM REMOVAL	1	1	1	1	1	1
08h	READ	21	21	23	16	17	22[c]
BCh	READ ATTRIBUTE	1	1	1	1	1	1
05h	READ BLOCK LIMITS	1	1	1	1	1	1
3Ch	READ BUFFER	9	9	10	7	8	8
34h	READ POSITION	1	1	1	1	1	1
1Ch	RECEIVE DIAGNOSTIC RESULTS	1	1	1	1	1	1
17h/57h	RELEASE UNIT (6/10)	1	1	1	1	1	1
44h	REPORT DENSITY SUPPORT	1	1	1	1	1	1
A0h	REPORT LUNS	1	1	1	1	1	1

Table 321 — Command Timeout Values (Ultrium 3 Half-Height and Ultrium 4) - Alphabetic Sort (part 2 of 2)

OpCode	Command	Timeout for Ultrium 3 Half-Height Tape drive (in minutes)			Timeout for Ultrium 4 Tape Drive (in minutes)		
		Gen 1 Cartridge	Gen 2 Cartridge	Gen 3 Cartridge	Gen 2 Cartridge	Gen 3 Cartridge	Gen 4 Cartridge
A3h:0Ch	REPORT SUPPORTED OP CODES	1	1	1	1	1	1
A3h:0Dh	REPORT SUPPORTED TASK MANAGEMENT FUNCTIONS	1	1	1	1	1	1
A3h:0Fh	REPORT TIMESTAMP	1	1	1	1	1	1
03h	REQUEST SENSE	1	1	1	1	1	1
16h/56h	RESERVE UNIT (6/10)	1	1	1	1	1	1
01h	REWIND	11	11	13	8	9	9
A2h	SECURITY PROTOCOL IN	N/A	N/A	N/A	N/A	N/A	1
B5h	SECURITY PROTOCOL OUT	N/A	N/A	N/A	N/A	N/A	1
1Dh	SEND DIAGNOSTIC	13	39	40	13	34	35
0Bh	SET CAPACITY	N/A	14	16	N/A	12	12
A4h:0Fh	SET TIMESTAMP	1	1	1	1	1	1
11h/91h	SPACE(16) (Normal)	20	20	22	14	16	21
	SPACE(16) (Slow)	199	264	201	165	140	183
00h	TEST UNIT READY	1	1	1	1	1	1
1Bh	UNLOAD (BOM -> Cartridge Eject)	12	12	14	10	11	11
	UNLOAD (LP4 -> Cartridge Eject)	14	14	16	11	12	13
13h	VERIFY	21	21	23	16	17	22[c]
0Ah	WRITE	N/A	21	24	N/A	18	23[d]
BDh	WRITE ATTRIBUTE	1	1	1	1	1	1
3Bh	WRITE BUFFER	10	10	11	8	8	8
10h	WRITE FILEMARK	N/A	21	23	N/A	17	22[e]

[a] ERASE (at BOP): The following commands require an increased timeout when encryption is active and an out-of-band key manager is used. The command timeout should be increased by 300 seconds. The following commands require an increased timeout when encryption is active and new wrapped or tracked keys are used. The command timeout should be increased by 600 seconds.

[b] LOAD (Unload): Special note: This command may require an increased timeout when encryption is active and the drive is set to request keys on mount, (the following commands require an increased timeout when encryption is active and an out-of-band key manager is used; the command timeout should be increased by 300 seconds), or when medium is loaded which has a drive detected key redundancy exposure (timeout increases by 900 seconds for recovery actions).

[c] READ/VERIFY: The following commands require an increased timeout when encryption is active and an out-of-band key manager is used. The command timeout should be increased by 300 seconds.

[d] WRITE: The following commands require an increased timeout when encryption is active and an out-of-band key manager is used. The command timeout should be increased by 300 seconds. The following commands require an increased timeout when encryption is active and new wrapped or tracked keys are used. The command timeout should be increased by 600 seconds, (at BOP with new key, longer if not at BOP with new key).

[e] WRITE FILEMARKS (at BOP): The following commands require an increased timeout when encryption is active and an out-of-band key manager is used. The command timeout should be increased by 300 seconds. The following commands require an increased timeout when encryption is active and new wrapped or tracked keys are used. The command timeout should be increased by 600 seconds.

A.2. Command and Parameter Differences Between Generations

Table A.1 shows commands and parameters added since Ultrium 1 and in which generation(s) it is applicable.

Table A.1 — Command and Parameter differences between generations

Command or Parameter	Description	Generation			
		2	3	4	5
ALLOW DATA OVERWRITE	Command used in Append-only mode (also know as DataSafe mode) to allow an explicit overwrite	-	-	-	Y
Volume Change Reference MAM Attribute	LTFS required MAM parameter	-	-	-	Y
Volume Coherency Information MAM Attribute	LTFS required MAM parameter	-	-	-	Y
FORMAT MEDIUM	This command is related to partitioning	-	-	-	Y
REPORT SUPPORTED OPERATION CODES		-	-	Y	Y
REPORT SUPPORTED TASK MANAGEMENT		-	-	Y	Y
SET CAPACITY	The minimum capacity allowed varies by generation (see SET CAPACITY (not Ultrium 1)).	Y	Y	Y	Y
Echo Buffer Support	Echo Buffer mode of the READ BUFFER and WRITE BUFFER commands (see READ BUFFER and WRITE BUFFER, respectively).	Y	Y	Y	Y
Volume Identifier	Volume Identifier Part of the Device Attribute of Medium Auxiliary Memory (VolSer or BarCode value set by the library)	-	-	Y	Y
SECURITY PROTOCOL IN (SPIN)	This command is related to managing encryption. See SECURITY PROTOCOL IN (SPIN) A2h.	-	-	Y	Y
SECURITY PROTOCOL OUT (SPOUT)	This command is related to managing encryption. See SECURITY PROTOCOL OUT (SPOUT) B5h.	-	-	Y	Y
Key: - Not Supported					

A.3. Data Changes Between Generations

The sections that follow describe the data changes between Generations of the Ultrium tape drive.

A.3.1. Standard Inquiry Data

The length of Standard Inquiry data on Ultrium 1 drives is less than on later generations. The Standard Inquiry data reported by Ultrium drives is shown in Table 11. The ADDITIONAL LENGTH field specifies how many bytes are returned. Currently, Ultrium 1 devices set this value to 33 (21h) and Ultrium 2 through Ultrium 4 devices set this value to 53 (35h). Ultrium 5 devices set this value to 65 (41h). This value is subject to change. It is strongly recommended that the user parse the data returned by using the ADDITIONAL LENGTH field instead of the published values.

Ultrium 5 drives add Protocol, Speed, and FIPS information as well as standardized version descriptors to Standard Inquiry.

Product Identification information returned is shown in Table 13.

For more information, see Standard Inquiry Data.

A.3.2. REPORT DENSITY SUPPORT Command

The REPORT DENSITY SUPPORT command has density values for all generations. Additionally, the units in which the Capacity value are returned changed in Ultrium 4 drives to match the SCSI standards and is carried forth in later generations to match the SCSI standards. See Table 272.

For more information, see REPORT DENSITY SUPPORT.

A.3.3. Mode Pages

On MODE SENSE commands the value returned in the MEDIUM TYPE field is shown in Table 157. On MODE SELECT commands any value is allowed and ignored.

Fibre Channel Port Control Page (19h) Page Length changed from 0Eh in Ultrium 1 drives to 06h in generation 2 drives. This matches the definition in the SCSI standards (FCP-2 and later). For more information, see Mode Page 19h: Protocol Specific Port Control Page.

A.3.4. READ POSITION Command

The READ POSITION command for all generation drives except Ultrium 1 behaves as described in the SCSI standards (SPC-2). Ultrium 5 added the Long data format and the extended data format parameter data. For more information, see READ POSITION.

A.3.5. Request Sense Changes

For Request Sense data, the Additional Sense Length is set to n-7, and is at least 10. When the sense data is associated with an Illegal Length read, the Additional Sense Length may be 10. In Ultrium 1 and Ultrium 2 drives, n can be as large as 35. In Ultrium 3 and later generation drives, n can be as large as 95. While this length is not anticipated to change, it is recommended that the Additional Sense Length be used to parse the data. For more information, see REQUEST SENSE.

A.4. Behavior Changes Between Generations

A.4.1. Cartridge Eject for Errors

Ultrium 1 drives auto-eject data cartridges when errors occur during loads. Later generation drives do not.

A.4.2. Queuing Issues

For all generations of drive later than Ultrium 1, when a cartridge is inserted into the drive through means other than SCSI commands to LUN 0, it is assumed that the host will poll the drive with TEST UNIT READY commands to determine its readiness before issuing in-order commands (for example, commands other than INQUIRY, TEST UNIT READY, REQUEST SENSE, or REPORT LUNS). If this is not the case, these commands may time out in ERP (Error Recovery Procedure) situations.

Annex B. Error Sense Information

This annex lists all possible combinations of Sense Keys, Additional Sense Codes (ASC), and Additional Sense Code Qualifiers (ASCQ) that are reported by this device.

NOTE 62 - ASCs of EEh and EFh are used for encryption related features and are only supported by encryption capable devices

NOTE 63 - When using encryption enabled devices in an in-band configuration (System method or key path), ASCs of EFh are used to initiate a key management session via a system proxy.

B.1. Sense Key 0 (No Sense)

Table 322 — ASC, and ASCQ Summary for Sense Key 0 (No Sense)

ASC ASCQ	Description
00 00	NO ADDITIONAL SENSE INFORMATION - (UNSOLICITED, NO CA/CC)
00 00	NO ADDITIONAL SENSE INFORMATION - EOM=1B (EARLY WARNING)
00 00	NO ADDITIONAL SENSE INFORMATION - ILI=1B
00 00	NO ADDITIONAL SENSE INFORMATION - FM=1B
00 01	FILEMARK DETECTED
00 02	END-OF-PARTITION/MEDIUM DETECTED, EARLY WARNING
00 04	BEGINNING-OF-PARTITION/MEDIUM DETECTED
00 07	PROGRAMMABLE EARLY WARNING DETECTED
00 16	OPERATION IN PROGRESS
82 82	DRIVE REQUIRES CLEARING
EF 13	ENCRYPTION - KEY TRANSLATE

Note - ASCs of EEh and EFh are used for encryption related features and are only supported by encryption capable devices

Note - When using encryption enabled devices in an in-band configuration (System method or key path), ASCs of EFh are used to initiate a key management session via a system proxy.

B.2. Sense Key 1 (Recovered Error)

Table 323 — ASC, and ASCQ Summary for Sense Key 1 (Recovered Error)

ASC ASCQ	Description
00 00	NO ADDITIONAL SENSE INFORMATION
00 17	DRIVE NEEDS CLEANING
0C 00	WRITE ERROR: A write error occurred, but was recovered. Data was successfully written to tape.
11 00	READ ERROR: A read error occurred, but was recovered. Data was successfully read from tape.
17 01	RECOVERED DATA WITH RETRIES
37 00	ROUNDED PARAMETER
5D 00	FAILURE PREDICTION THRESHOLD EXCEEDED
82 52	DEGRADED MEDIA

Note - Many additional ASC ASCQ combinations are possible if recovered error reporting is enabled via Mode Select. Recovered Error Reporting Enabled is the default option with some of the 3592 device drivers.

B.3. Sense Key 2 (Not Ready)

Table 324 — ASC, and ASCQ Summary for Sense Key 2 (Not Ready)

ASC ASCQ	Description
04 00	LOGICAL UNIT NOT READY, CAUSE NOT REPORTABLE
04 01	LOGICAL UNIT IS IN PROCESS OF BECOMING READY
04 02	INITIALIZING COMMAND REQUIRED: A tape is present in the drive, but it is not logically loaded
04 12	LOGICAL UNIT NOT READY, OFFLINE
04 13	LOGICAL UNIT NOT READY, SA CREATION IN PROGRESS
0B 01	WARNING - SPECIFIED TEMPERATURE EXCEEDED
30 03	CLEANING IN PROGRESS
30 07	CLEANING FAILURE
3A 00	MEDIUM NOT PRESENT
3A 04	NOT READY - MEDIUM AUXILIARY MEMORY ACCESSIBLE
3E 00	LOGICAL UNIT HAS NOT SELF-CONFIGURED
53 00	MEDIA LOAD OR EJECT FAILED
74 11	SA CREATION PARAMETER VALUE REJECTED

B.4. Sense Key 3 (Medium Error)

Table 325 — ASC, and ASCQ Summary for Sense Key 3 (Medium Error) (part 1 of 2)

ASC ASCQ	Description
04 10	LOGICAL UNIT NOT READY, AUXILIARY MEMORY NOT ACCESSIBLE
09 00	TRACK FOLLOWING ERROR
0C 00	WRITE ERROR
11 00	UNRECOVERED READ ERROR
11 12	AUXILIARY MEMORY READ ERROR
14 00	RECORDED ENTITY NOT FOUND
30 00	INCOMPATIBLE MEDIUM INSTALLED
30 01	CANNOT READ MEDIUM, UNKNOWN FORMAT
30 02	CANNOT READ MEDIUM, INCOMPATIBLE FORMAT
30 0D	WORM MEDIUM - TAMPERING DETECTED
31 00	MEDIUM FORMAT CORRUPTED
3B 00	SEQUENTIAL POSITIONING ERROR
50 00	WRITE APPEND ERROR
51 00	ERASE FAILURE
52 00	CARTRIDGE FAULT
53 00	MEDIA LOAD OR EJECT FAILED

Note - ASCs of EEh and EFh are used for encryption related features and are only supported by encryption capable devices

Note - When using encryption enabled devices in an in-band configuration (System method or key path), ASCs of EFh are used to initiate a key management session via a system proxy.

Table 325 — ASC, and ASCQ Summary for Sense Key 3 (Medium Error) (part 2 of 2)

ASC ASCQ	Description
53 04	MEDIUM THREAD OR UNTHREAD FAILURE
EE 60	ENCRYPTION - PROXY COMMAND ERROR
EE D0	ENCRYPTION - DATA READ DECRYPTION FAILURE
EE D1	ENCRYPTION - DATA READ AFTER WRITE DECRYPTION FAILURE
EE E0	ENCRYPTION - KEY TRANSLATION FAILURE
EE E1	ENCRYPTION - KEY TRANSLATION AMBIGUOUS
EE F0	ENCRYPTION - DECRYPTION FENCED (READ)
EE F1	ENCRYPTION - ENCRYPTION FENCED (WRITE)

Note - ASCs of EEh and EFh are used for encryption related features and are only supported by encryption capable devices

Note - When using encryption enabled devices in an in-band configuration (System method or key path), ASCs of EFh are used to initiate a key management session via a system proxy.

B.5. Sense Key 4 (Hardware Error)

Table 326 — ASC, and ASCQ Summary for Sense Key 4 (Hardware Error)

ASC ASCQ	Description
04 03	MANUAL INTERVENTION REQUIRED: A tape is present in the drive but could not be loaded or unloaded without manual intervention
10 01	LOGICAL BLOCK GUARD CHECK FAILED
40 XX	DIAGNOSTIC FAILURE: The Additional Sense Code Qualifier (i.e., XX) indicates the failing component
41 00	DATA PATH FAILURE
44 00	INTERNAL TARGET FAILURE Drive Needs Cleaning, Warning Threshold Exceeded
51 00	ERASE FAILURE
52 00	CARTRIDGE FAULT
53 00	MEDIA LOAD OR EJECT FAILED
53 04	MEDIUM THREAD OR UNTHREAD FAILURE
EE 0E	ENCRYPTION - KEY SERVICE TIME-OUT
EE 0F	ENCRYPTION - KEY SERVICE FAILURE

Note - ASCs of EEh and EFh are used for encryption related features and are only supported by encryption capable devices

Note - When using encryption enabled devices in an in-band configuration (System method or key path), ASCs of EFh are used to initiate a key management session via a system proxy.

B.6. Sense Key 5 (Illegal Request)

Table 327 — ASC, and ASCQ Summary for Sense Key 5 (Illegal Request) (part 1 of 2)

ASC ASCQ	Description
0E 03	INVALID FIELD IN COMMAND INFORMATION UNIT (e.g., FCP_DL error)
1A 00	PARAMETER LIST LENGTH ERROR
20 00	INVALID COMMAND OPERATION CODE
20 0C	ILLEGAL COMMAND WHEN NOT IN APPEND-ONLY MODE
24 00	INVALID FIELD IN CDB
25 00	LOGICAL UNIT NOT SUPPORTED
26 00	INVALID FIELD IN PARAMETER LIST
26 02	PARAMETER VALUE INVALID
26 04	INVALID RELEASE OF PERSISTENT RESERVATION
26 11	ENCRYPTION - INCOMPLETE KEY-ASSOCIATE DATA SET
26 12	VENDOR SPECIFIC KEY REFERENCE NOT FOUND
29 04	DEVICE INTERNAL RESET
2C 00	COMMAND SEQUENCE ERROR
2C 0B	NOT RESERVED - The OIR bit of the Sequential Access Device page is set and the I_T nexus attempting to communicate with the drive does not hold a reservation.
3B 00	SEQUENTIAL POSITIONING ERROR
3B 0C	POSITION PAST BEGINNING OF MEDIUM: A command that required the medium to be at BOP was attempted when the medium was not at BOP (for example, SET CAPACITY)
53 02	MEDIUM REMOVAL PREVENTED
55 08	MAXIMUM NUMBER OF SUPPLEMENTAL DECRYPTION KEYS EXCEEDED
74 08	DIGITAL SIGNATURE VALIDATION FAILURE
74 0C	UNABLE TO DECRYPT PARAMETER LIST
74 10	SA CREATION PARAMETER VALUE INVALID
74 11	SA CREATION PARAMETER VALUE REJECTED
74 12	INVALID SA USAGE
74 30	SA CREATION PARAMETER NOT SUPPORTED
82 83	BAD MICROCODE DETECTED: The data transferred to the drive during a firmware upgrade is corrupted or incompatible with the drive hardware
A3 01	OEM Vendor-specific
EE 00	ENCRYPTION - KEY SERVICE NOT ENABLED
EE 01	ENCRYPTION - KEY SERVICE NOT CONFIGURED
EE 02	ENCRYPTION - KEY SERVICE NOT AVAILABLE
EE 0D	ENCRYPTION - MESSAGE CONTENT ERROR
EE 10	ENCRYPTION - KEY REQUIRED
EE 20	ENCRYPTION - KEY COUNT EXCEEDED
EE 21	ENCRYPTION - KEY ALIAS EXCEEDED

Note - ASCs of EEh and EFh are used for encryption related features and are only supported by encryption capable devices

Note - When using encryption enabled devices in an in-band configuration (System method or key path), ASCs of EFh are used to initiate a key management session via a system proxy.

Table 327 — ASC, and ASCQ Summary for Sense Key 5 (Illegal Request) (part 2 of 2)

ASC ASCQ	Description
EE 22	ENCRYPTION - KEY RESERVED
EE 23	ENCRYPTION - KEY CONFLICT
EE 24	ENCRYPTION - KEY METHOD CHANGE
EE 25	ENCRYPTION - KEY FORMAT NOT SUPPORTED
EE 26	ENCRYPTION - UNAUTHORIZED REQUEST - DAK
EE 27	ENCRYPTION - UNAUTHORIZED REQUEST - DSK
EE 28	ENCRYPTION - UNAUTHORIZED REQUEST - EAK
EE 29	ENCRYPTION - AUTHENTICATION FAILURE
EE 2A	ENCRYPTION - INVALID RDKI
EE 2B	ENCRYPTION - KEY INCORRECT
EE 2C	ENCRYPTION - KEY WRAPPING FAILURE
EE 2D	ENCRYPTION - SEQUENCING FAILURE
EE 2E	ENCRYPTION - UNSUPPORTED TYPE
EE 2F	ENCRYPTION - NEW KEY ENCRYPTED WRITE PENDING
EE 30	ENCRYPTION - PROHIBITED REQUEST
EE 31	ENCRYPTION - MESSAGE CONTENT ERROR
EE 32	ENCRYPTION - UNAUTHORIZED REQUEST - dCERT
EE 42	ENCRYPTION - EKM CHALLENGE PENDING
EE E2	ENCRYPTION - KEY TRANSLATION DISALLOWED
EE FF	ENCRYPTION - SECURITY PROHIBITED FUNCTION
EF 01	ENCRYPTION - KEY SERVICE NOT CONFIGURED

Note - ASCs of EEh and EFh are used for encryption related features and are only supported by encryption capable devices

Note - When using encryption enabled devices in an in-band configuration (System method or key path), ASCs of EFh are used to initiate a key management session via a system proxy.

B.7. Sense Key 6 (Unit Attention)

Table 328 — ASC, and ASCQ Summary for Sense Key 6 (Unit Attention) (part 1 of 2)

ASC ASCQ	Description
28 00	NOT READY TO READY TRANSITION, MEDIUM MAY HAVE CHANGED
28 01	IMPORT OR EXPORT ELEMENT ACCESSED
29 00	POWER ON, RESET, OR BUS DEVICE RESET OCCURRED
29 04	DEVICE INTERNAL RESET
29 05	TRANSCEIVER MODE CHANGED TO SINGLE-ENDED
29 06	TRANSCEIVER MODE CHANGED TO LVD
2A 01	MODE PARAMETERS CHANGED
2A 02	LOG PARAMETERS CHANGED
2A 03	RESERVATIONS PREEMPTED
2A 04	RESERVATIONS RELEASED
2A 05	REGISTRATIONS PREEMPTED
2A 11	ENCRYPTION - DATA ENCRYPTION PARAMETERS CHANGED BY ANOTHER I_T NEXUS

Note - ASCs of EEh and EFh are used for encryption related features and are only supported by encryption capable devices

Note - When using encryption enabled devices in an in-band configuration (System method or key path), ASCs of EFh are used to initiate a key management session via a system proxy.

Table 328 — ASC, and ASCQ Summary for Sense Key 6 (Unit Attention) (part 2 of 2)

ASC ASCQ	Description
2A 12	ENCRYPTION - DATA ENCRYPTION PARAMETERS CHANGED BY VENDOR SPECIFIC EVENT
2A 14	SA CREATION CAPABILITIES DATA HAS CHANGED
2F 00	COMMANDS CLEARED BY ANOTHER INITIATOR
3B 12	MEDIUM MAGAZINE REMOVED
3B 13	MEDIUM MAGAZINE INSERTED
3F 01	MICROCODE HAS BEEN CHANGED
3F 02	CHANGED OPERATING DEFINITION
3F 03	INQUIRY DATA HAS CHANGED
3F 05	DEVICE IDENTIFIER CHANGED
3F 0E	REPORTED LUNS DATA HAS CHANGED
5D FF	FAILURE PREDICTION THRESHOLD EXCEEDED (FALSE)
EE 11	ENCRYPTION - KEY GENERATION
EE 12	ENCRYPTION - KEY CHANGE DETECTED
EE 13	ENCRYPTION - KEY TRANSLATION
EE 18	ENCRYPTION - CHANGED (READ)
EE 19	ENCRYPTION - CHANGED (WRITE)
EE 40	ENCRYPTION - EKM IDENTIFIER CHANGED
EE 41	ENCRYPTION - EKM CHALLENGE CHANGED
EE 50	ENCRYPTION - INITIATOR IDENTIFIER CHANGED
EE 51	ENCRYPTION - INITIATOR RESPONSE CHANGED
EF 01	ENCRYPTION - KEY SERVICE NOT CONFIGURED
EF 10	ENCRYPTION - KEY REQUIRED
EF 11	ENCRYPTION - KEY GENERATION
EF 13	ENCRYPTION - KEY TRANSLATION
EF 1A	ENCRYPTION - KEY OPTIONAL (i.e., chose encryption enabled/disabled)

Note - ASCs of EEh and EFh are used for encryption related features and are only supported by encryption capable devices

Note - When using encryption enabled devices in an in-band configuration (System method or key path), ASCs of EFh are used to initiate a key management session via a system proxy.

B.8. Sense Key 7 (Data Protect)

Table 329 — ASC, and ASCQ Summary for Sense Key 7 (Data Protect)

ASC ASCQ	Description
26 10	ENCRYPTION - DATA DECRYPTION KEY FAIL LIMIT
27 00	WRITE PROTECTED
2A 13	ENCRYPTION - DATA ENCRYPTION KEY INSTANCE COUNTER HAS CHANGED
30 05	CANNOT WRITE MEDIUM, INCOMPATIBLE FORMAT
30 06	CANNOT FORMAT MEDIUM - INCOMPATIBLE MEDIUM
30 0C	DATA PROTECT/WORM MEDIUM - OVERWRITE ATTEMPTED: Set when the drive rejects a Write operation because the rules for allowing WORM writes have not been met
30 0D	DATA PROTECT/WORM MEDIUM - INTEGRITY CHECK: Set when the drive rejects a Write operation because the current cartridge is a Suspicious WORM cartridge
50 01	WRITE APPEND POSITION ERROR (WORM)
52 00	CARTRIDGE FAULT
5A 02	OPERATOR SELECTED WRITE PROTECT
74 00	SECURITY ERROR
74 01	ENCRYPTION - UNABLE TO DECRYPT DATA
74 02	ENCRYPTION - UNENCRYPTED DATA ENCOUNTERED WHILE DECRYPTING
74 03	ENCRYPTION - INCORRECT DATA ENCRYPTION KEY
74 04	ENCRYPTION - CRYPTOGRAPHIC INTEGRITY VALIDATION FAILED
74 05	ENCRYPTION - ERROR DECRYPTING DATA
74 06	UNKNOWN SIGNATURE VERIFICATION KEY
74 07	ENCRYPTION PARAMETERS NOT USEABLE
74 09	ENCRYPTION MODE MISMATCH ON READ
74 0A	ENCRYPTED BLOCK NOT RAW READ ENABLED
74 0B	INCORRECT ENCRYPTION PARAMETERS
EF 10	ENCRYPTION - KEY REQUIRED
EF 11	ENCRYPTION - KEY GENERATION
EF 13	ENCRYPTION - KEY TRANSLATE
EF 1A	ENCRYPTION - KEY OPTIONAL
EF A0	ENCRYPTION - KEY REQUIRED (T10)
EF A1	ENCRYPTION - KEY GENERATION (T10)
EF C0	ENCRYPTION - NO OPERATION

Note - ASCs of EEh and EFh are used for encryption related features and are only supported by encryption capable devices

Note - When using encryption enabled devices in an in-band configuration (System method or key path), ASCs of EFh are used to initiate a key management session via a system proxy.

B.9. Sense Key 8 (Blank Check)

Table 330 — ASC, and ASCQ Summary for Sense Key 8 (Blank Check)

ASC ASCQ	Description
00 05	END-OF-DATA DETECTED

B.10. Sense Key B (Aborted Command)

Table 331 — ASC, and ASCQ Summary for Sense Key B (Aborted Command)

ASC ASCQ	Description
00 1E	CONFLICTING SA CREATION REQUEST
0B 01	WARNING - SPECIFIED TEMPERATURE EXCEEDED
2C 00	COMMAND SEQUENCE ERROR
3D 00	INVALID BITS IN IDENTIFY MESSAGE
3F 0F	ECHO BUFFER OVERWRITTEN
43 00	MESSAGE ERROR
45 00	SELECT OR RESELECT FAILURE
47 00	SCSI PARITY ERROR
47 03	INFORMATION UNIT iuCRC ERROR DETECTED
48 00	INITIATOR DETECTED ERROR MESSAGE RECEIVED
49 00	INVALID MESSAGE ERROR
4A 00	COMMAND PHASE ERROR
4B 00	DATA PHASE ERROR
4E 00	OVERLAPPED COMMANDS ATTEMPTED
74 40	AUTHENTICATION FAILED

B.11. Sense Key D (Volume Overflow)

Table 332 — ASC, and ASCQ Summary for Sense Key D (Volume Overflow)

ASC ASCQ	Description
00 02	END-OF-PARTITION/MEDIUM DETECTED

Annex C. Firmware Download

This annex describes how to compare a firmware level binary to information returned by a drive and determine which firmware is acceptable in which drive.

C.1. Identifying Level Hardware of Drive

The firmware that is loaded in the drive will report a LOAD ID and RU NAME in INQUIRY IP 03h: Firmware Designation (see 6.2.2 on page 192). The LOAD ID and RU NAME are used to designate the Level Hardware (i.e., Product). The following table defines the LOAD ID and RU NAME values for each Level Hardware.

Table 333 — Load ID and RU Name Designation for LTO2

Product (Level Hardware)	LOAD ID	RU NAME "EBCDIC" Hex	Product ID (Left-Aligned)		
			IBM	OEM	eServer
U160	A1700299	"AJEFGP99" 0xC1D1C5C6C7D7F9F9	ULT3580-TD2	ULTRIUM-TD2	-
FC2G	A170029A	"AJEFGP9A" 0xC1D1C5C6C7D7F9C1			
U160 RoHS	A1700D67	"AJEFAX67" 0xC1D1C5C6C1E7F6F7			
FC2G RoHS	A1700D68	"AJEFAX68" 0xC1D1C5C6C1E7F6F8			

- Not Applicable
HH - Half-High
U - Ultra

Table 334 — Load ID and RU Name Designation for LTO3

Product (Level Hardware)	LOAD ID	RU Name "EBCDIC" Hex	Product ID (Left-Aligned)		
			IBM	OEM	eServer
U160	A1700D50	"AJEFAX50" 0xC1D1C5C6C1E7F5F0	ULT3580-TD3	ULTRIUM-TD3	-
U160 RoHS[a]					
FC2G	A1700D52	"AJEFAX52" 0xC1D1C5C6C1E7F5F2			
FC4G RoHS[a]					
HH SAS	A1700D53	"AJEFAX53" 0xC1D1C5C6C1E7F5F3	-	-	HH LTO Gen 3
HH U160	A1700D69	"AJEFAX69" 0xC1D1C5C6C1E7F6F9			
HH SAS	A1700D64	"AJEFAX64" 0xC1D1C5C6C1E7F6F4	ULT3580-HH3	ULTRIUM-HH3	-
HH U160	A1700D63	"AJEFAX63" 0xC1D1C5C6C1E7F6F3			
HH SAS V2	A1700D79	"AJEFAX79" 0xC1D1C5C6C1E7F7F9			HH LTO Gen 3

- Not Applicable
HH - Half-High
U - Ultra
[a] Minimum level of firmware is 5BG2

Table 335 — Load ID and RU Name Designation for LTO4

Product (Level Hardware)	LOAD ID	RU Name "EBCDIC" Hex	Product ID (Left-Aligned)		
			IBM	OEM	eServer
U160	A1700D6A	"AJEFAX6A" 0xC1D1C5C6C1E7F6C1	ULT3580-TD4	ULTRIUM-TD4	-
FC4G	A1700D6B	"AJEFAX6B" 0xC1D1C5C6C1E7F6C2			
SAS	A1700D6C	"AJEFAX6C" 0xC1D1C5C6C1E7F6C3			
U320	A1700D70	"AJEFAX70" 0xC1D1C5C6C1E7F7F0			
HH SAS	A1700D71	"AJEFAX71" 0xC1D1C5C6C1E7F7F1	ULT3580-HH4	ULTRIUM-HH4	HH LTO Gen 4
HH U320	A1700D51	"AJEFAX51" 0xC1D1C5C6C1E7F5F1			
HH FC	A1700D66	"AJEFAX66" 0xC1D1C5C6C1E7F6F6			
HH FC V2	A1700D7B	"AJEFAX7B" 0xC1D1C5C6C1E7F7C2			
HH SAS V2	A1700D7A	"AJEFAX7A" 0xC1D1C5C6C1E7F7C1			

- Not Applicable
HH - Half-High
U - Ultra

Table 336 — Load ID and RU Name Designation for LTO5

Product (Level Hardware)	LOAD ID	RU Name "EBCDIC" Hex	Product ID (Left-Aligned)		
			IBM	OEM	eServer
FC8G	A1700D74	"AJEFAX74" 0xC1D1C5C6C1E7F7F4	ULT3580-TD5	ULTRIUM-TD5	-
SAS	A1700D75	"AJEFAX75" 0xC1D1C5C6C1E7F7F5			
HH SAS	A1700D76	"AJEFAX76" 0xC1D1C5C6C1E7F7F6	ULT3580-HH5	ULTRIUM-HH5	HH LTO Gen 5
HH SAS V2					
HH FC	A1700D77	"AJEFAX77" 0xC1D1C5C6C1E7F7F7			
HH FC V2					

- Not Applicable
HH - Half-High
U - Ultra

C.2. Identifying the product for which the firmware image is intended

The Firmware Image is defined in Table 398.

Table 337 — Firmware Image

Byte	Bit							
	7 msb	6	5	4	3	2	1	0 osb
0				Not Specified				
3								
4	(MSB)			FIRMWARE LENGTH + HEADER LENGTH (m)				
7								(LSB)
8	(MSB)			LOAD ID				
11				(See “IP 03h: Firmware Designation” on page 192.)				
12	(MSB)			FIRMWARE REVISION LEVEL				
15				(See Standard Inquiry Data bytes 32 - 35)				(LSB)
16				Reserved				
23								
24	(MSB)			RU NAME				
31				(See “IP 03h: Firmware Designation” on page 192.)				(LSB)
32				Not Specified				
m								

The LOAD ID and RU NAME fields in the Firmware Image are used to define the product (i.e., Level Hardware) for which the Firmware Image is intended.

C.3. Download Process

Confirm the Level Hardware of the Firmware Image (see C.2.) to be loaded matches the Level Hardware of the drive (see C.1.).

Download the Firmware Image using the WRITE BUFFER - 3Bh (see 5.2.39 on page 156) command.

Annex D. Sample C program to generate Reed-Solomon CRC

The following is sample C code for generating the Reed-Solomon CRC defined in ECMA-319

```
/*-----------------------------------------------------------------------
**  INPUTS:   crc   - initial crc (0 for fresh) (i.e., seed)
**            cnt   - the number of data bytes to compute CRC for
**           start - the starting address of the data bytes (e.g., data buffer)
**  OUTPUTS:  UINT32 - crc in big endian (MSB is first byte)
*/
UINT32 GenerateRSCRC(UINT32 crc, UINT32 cnt, const void *start)
{
 static const UINT32 crcTable[256]=
 { 0x00000000,0x38CF3801,0x70837002,0x484C4803,0xE01BE004,0xD8D4D805,
   0x90989006,0xA857A807,0xDD36DD08,0xE5F9E509,0xADB5AD0A,0x957A950B,
   0x3D2D3D0C,0x05E2050D,0x4DAE4D0E,0x7561750F,0xA76CA710,0x9FA39F11,
   0xD7EFD712,0xEF20EF13,0x47774714,0x7FB87F15,0x37F43716,0x0F3B0F17,
   0x7A5A7A18,0x42954219,0x0AD90A1A,0x3216321B,0x9A419A1C,0xA28EA21D,
   0xEAC2EA1E,0xD20DD21F,0x53D85320,0x6B176B21,0x235B2322,0x1B941B23,
   0xB3C3B324,0x8B0C8B25,0xC340C326,0xFB8FFB27,0x8EEE8E28,0xB621B629,
   0xFE6DFE2A,0xC6A2C62B,0x6EF56E2C,0x563A562D,0x1E761E2E,0x26B9262F,
   0xF4B4F430,0xCC7BCC31,0x84378432,0xBCF8BC33,0x14AF1434,0x2C602C35,
   0x642C6436,0x5CE35C37,0x29822938,0x114D1139,0x5901593A,0x61CE613B,
   0xC999C93C,0xF156F13D,0xB91AB93E,0x81D5813F,0xA6ADA640,0x9E629E41,
   0xD62ED642,0xEEE1EE43,0x46B64644,0x7E797E45,0x36353646,0x0EFA0E47,
   0x7B9B7B48,0x43544349,0x0B180B4A,0x33D7334B,0x9B809B4C,0xA34FA34D,
   0xEB03EB4E,0xD3CCD34F,0x01C10150,0x390E3951,0x71427152,0x498D4953,
   0xE1DAE154,0xD915D955,0x91599156,0xA996A957,0xDCF7DC58,0xE438E459,
   0xAC74AC5A,0x94BB945B,0x3CEC3C5C,0x0423045D,0x4C6F4C5E,0x74A0745F,
   0xF575F560,0xCDBACD61,0x85F68562,0xBD39BD63,0x156E1564,0x2DA12D65,
   0x65ED6566,0x5D225D67,0x28432868,0x108C1069,0x58C0586A,0x600F606B,
   0xC858C86C,0xF097F06D,0xB8DBB86E,0x8014806F,0x52195270,0x6AD66A71,
   0x229A2272,0x1A551A73,0xB202B274,0x8ACD8A75,0xC281C276,0xFA4EFA77,
   0x8F2F8F78,0xB7E0B779,0xFFACFF7A,0xC763C77B,0x6F346F7C,0x57FB577D,
   0x1FB71F7E,0x2778277F,0x51475180,0x69886981,0x21C42182,0x190B1983,
   0xB15CB184,0x89938985,0xC1DFC186,0xF910F987,0x8C718C88,0xB4BEB489,
   0xFCF2FC8A,0xC43DC48B,0x6C6A6C8C,0x54A5548D,0x1CE91C8E,0x2426248F,
   0xF62BF690,0xCEE4CE91,0x86A88692,0xBE67BE93,0x16301694,0x2EFF2E95,
   0x66B36696,0x5E7C5E97,0x2B1D2B98,0x13D21399,0x5B9E5B9A,0x6351639B,
   0xCB06CB9C,0xF3C9F39D,0xBB85BB9E,0x834A839F,0x029F02A0,0x3A503AA1,
   0x721C72A2,0x4AD34AA3,0xE284E2A4,0xDA4BDAA5,0x920792A6,0xAAC8AAA7,
   0xDFA9DFA8,0xE766E7A9,0xAF2AAFAA,0x97E597AB,0x3FB23FAC,0x077D07AD,
   0x4F314FAE,0x77FE77AF,0xA5F3A5B0,0x9D3C9DB1,0xD570D5B2,0xEDBFEDB3,
   0x45E845B4,0x7D277DB5,0x356B35B6,0x0DA40DB7,0x78C578B8,0x400A40B9,
   0x084608BA,0x308930BB,0x98DE98BC,0xA011A0BD,0xE85DE8BE,0xD092D0BF,
   0xF7EAF7C0,0xCF25CFC1,0x876987C2,0xBFA6BFC3,0x17F117C4,0x2F3E2FC5,
   0x677267C6,0x5FBD5FC7,0x2ADC2AC8,0x121312C9,0x5A5F5ACA,0x629062CB,
   0xCAC7CACC,0xF208F2CD,0xBA44BACE,0x828B82CF,0x508650D0,0x684968D1,
   0x200520D2,0x18CA18D3,0xB09DB0D4,0x885288D5,0xC01EC0D6,0xF8D1F8D7,
   0x8DB08DD8,0xB57FB5D9,0xFD33FDDA,0xC5FCC5DB,0x6DAB6DDC,0x556455DD,
   0x1D281DDE,0x25E725DF,0xA432A4E0,0x9CFD9CE1,0xD4B1D4E2,0xEC7EECE3,
   0x442944E4,0x7CE67CE5,0x34AA34E6,0x0C650CE7,0x790479E8,0x41CB41E9,
   0x098709EA,0x314831EB,0x991F99EC,0xA1D0A1ED,0xE99CE9EE,0xD153D1EF,
   0x035E03F0,0x3B913BF1,0x73DD73F2,0x4B124BF3,0xE345E3F4,0xDB8ADBF5,
   0x93C693F6,0xAB09ABF7,0xDE68DEF8,0xE6A7E6F9,0xAEEBAEFA,0x962496FB,
   0x3E733EFC,0x06BC06FD,0x4EF04EFE,0x763F76FF};

     UINT32  i;
```

```
     const UINT8*  d = start;

      for ( i=0; i<cnt; i++ )
      {
        crc = (crc << 8) ^ crcTable[*d ^ (crc >> 24)];
        d++;
      }
    return crc;
    }
```

Annex E. Notices

E.1. Trademarks

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

AIX®	OS/400®	i5/OS
AS/400®	pSeries®	RAA
eServer™	SP	zSeries
IBM®	RS/6000®	NetBackup (NBU)
iSeries®	TotalStorage®	

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

Linear Tape-Open

LTO

Ultrium

Intel® and Itanium are registered trademarks of Intel Corporation in the United States, or other countries (or regions), or both.

Linux is a register trademark of Linus Torvalds.

NetBackup is a trademark of Symantec

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

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

Index Of Counters (log parameters not in counter format are not included)

Page
"DEAD DRIVE" Flag {3Ch:000Dh} . . . 290
"DEAD MEDIA" Flag {3Ch:000Ch} . . . 290
"WORN MEDIA" Flag {3Ch:000Bh} . . . 290
Abort Count [by port] {37h:0Fp8h} . . . 280
Abort Time [by port] {37h:0Fp9h} . . . 280
Accumulated transitions to active . . . 262
Accumulated transitions to idle_c . . . 262
Active Capacity Efficiency {37h:7?00h} . . . 283
Active CQs Loss (on-the-fly) {37h:7?13h} . . . 283
Active Distance CQs (on-the-fly) {37h:7?23h} . . . 283
Active Distance DSS {37h:7?22h} . . . 283
Active Distance Skip {37h:7?21h} . . . 283
Active Distance Total {37h:7?2Fh} . . . 283
Active DSS Loss {37h:7?12h} . . . 283
Active Initiator Count {37h:0E00h} . . . 279
Active Skip Loss {37h:7?11h} . . . 283
Active Sync Loss {37h:7?10h} . . . 283
Activity duty cycle {14h:0013h} . . . 240
Approximate native capacity between BOP and EW of the current partition {0Ch:0005h} . . . 224
Approximate native capacity from BOP to EOD {0Ch:0004h} . . . 224
Approximate native capacity from BOP to the current position of the medium {0Ch:0007h} . . . 224
Approximate native capacity of partition(s) {17h:0202h} . . . 252
Approximate used native capacity of partition(s) {17h:0203h} . . . 252
Average Command Latency {37h:0DF0h} . . . 279
Average Comp Buffer Rate {37h:2?92h} . . . 282
Average Comp Sync Length {37h:2?9Ch} . . . 282
Average Comp Transfer Length {37h:2?98h} . . . 282
Average Comp Transfer Rate {37h:2?91h} . . . 282
Average Dequeue Latency {37h:0DF1h} . . . 279
Average Host Buffer Rate {37h:2?82h} . . . 282
Average Host Sync Length {37h:2?8Ch} . . . 282
Average Host Transfer Length {37h:2?88h} . . . 282
Average Host Transfer Rate {37h:2?81h} . . . 282
Average Tape Buffer Rate {37h:2?A1h} . . . 282
Band Change Count {37h:2?11h} . . . 281
Beginning of medium passes {17h:0101h} . . . 251
Bytes read from medium {1Bh:0005h} . . . 260
Bytes read from tape {32h:0005h} . . . 268
Bytes transferred from application client {1Bh:0007h} . . . 260
Bytes transferred from server {32h:0007h} . . . 268
Bytes transferred to application client {1Bh:0003j} . . . 260
Bytes transferred to server {32h:0003h} . . . 268
Bytes written to medium {1Bh:0009h} . . . 261
Bytes written to tape {32h:0009h} . . . 268
Cartridge Serial Number {3Ch:0015h} . . . 290
Clean Lifetime Mounts {3Dh:0060h} . . . 291
Clean Requested Flag {3Ch:0011h} . . . 290
Cleaning Requested {0Ch:0100h}: . . . 224
Command Count {37h:0Cp0h} . . . 278
Command Queue Count {37h:0CpCh} . . . 278
Command Queue Latency {37h:0CpDh} . . . 279
Command Queue Relative Time {37h:0CpEh} . . . 279
Command Relative Time {37h:0Cp2h} . . . 278
Command Timing {37h:0Cp1h} . . . 278
Command Transfer Byte Count from Host (out) {37h:0Cp9h} . . . 278

Command Transfer Byte Count to Host (in) {37h:0Cp5h} . . . 278
Command Transfer Count from Host (out) {37h:0Cp8h} . . . 278
Command Transfer Count to Host (in) {37h:0Cp4h} . . . 278
Command Transfer Timing from Host (out) {37h:0CpAh} . . . 278
Command Transfer Timing to Host (in) {37h:0Cp6h} . . . 278
Comp Buffer Efficiency {37h:2?94h} . . . 282
Compressed Data (Medium) {37h:2?71h} . . . 281
Compressed Data {37h:2?61h} . . . 281
Compression Ratio {37h:2?6Ch} . . . 281
Count {37h:0q00h} . . . 276
Cumulative Cartridge Loads Counter {3Ch:0006h} . . . 289
Cumulative Cleaning Counter {3Ch:000Ah} . . . 290
Cumulative Power On Time Counter {3Ch:0008h} . . . 290
Cumulative Time Tape is Loaded and Tensioned {3Ch:0009h} . . . 290
Current Initiator {37h:0E03h} . . . 279
Data Acquisition Temps {33h:0005h} . . . 269
Data Acquisition Temps {34h:0005h} . . . 271
Data compression enabled {1Bh:0100h} . . . 261
Data Temps {33h:0007h} . . . 269
Data Temps {34h:0007h} . . . 271
Data Transients {33h:0002h} . . . 269
Data Transients {34h:0002h} . . . 271
Datarate Performance Impacting ERPs {37h:2?50h} . . . 281
Dataset Overrun {34h:0019h} . . . 272
Dataset Underrun {33h:000Fh} . . . 270
Datasets Corrected {33h:0000h} . . . 269
Datasets Corrected {34h:0000h} . . . 271
Datasets Processed {37h:2?68h} . . . 281
Degate Data {37h:2?63h} . . . 281
Device Read Datasets Processed {38h:0006h} . . . 284
Device Read Datasets Transferred {38h:000Ah} . . . 284
Device Read Kilobytes Processed {38h:0007h} . . . 284
Device Read Kilobytes Transferred {38h:000Bh} . . . 284
Device Write Datasets Processed {38h:0004h} . . . 284
Device Write Datasets Transferred {38h:0008h} . . . 284
Device Write Kilobytes Processed {38h:0005h} . . . 284
Device Write Kilobytes Transferred {38h:0009h} . . . 284
Drive Efficiency {37h:0000h} . . . 275
Drive Lifetime Load Perms {3Dh:0092h} . . . 292
Drive Lifetime Load Temps {3Dh:00A2h} . . . 292
Drive Lifetime Megabytes Read {3Dh:0042h} . . . 291
Drive Lifetime Megabytes Written {3Dh:0041h} . . . 291
Drive Lifetime Mounts {3Dh:0040h} . . . 291
Drive Lifetime Read Perms {3Dh:0091h} . . . 292
Drive Lifetime Read Temps {3Dh:00A1h} . . . 292
Drive Lifetime Unload Perms {3Dh:0093h} . . . 292
Drive Lifetime Unload Temps {3Dh:00A3h} . . . 292
Drive Lifetime Write Perms {3Dh:0090h} . . . 292
Drive Lifetime Write Temps {3Dh:00A0h} . . . 292
Drive manufacturer's serial number {14h:0040h} . . . 240
Drive serial number {14h:0041h} . . . 240
DT device primary port status: . . . 226
Duty cycle sample time {14h:0010h}: . . . 240
ECC Corrections Counter {3Ch:0004h} . . . 289
ERP Servo Adjust Hi {34h:000Ch} . . . 272
ERP Servo Adjust Lo {34h:000Dh} . . . 272
FID Events {33h:000Dh} . . . 270

FID Events {34h:001Dh} 272
First encrypted logical object identifier(s) {17h:0200h} 252
First unencrypted logical object on the EOP side of the first encrypted logical object identifier(s) {17h:0201h} 252
Flush Buffer Hits {37h:15F0h} 281
Flush Count (Media) {37h:1580h} 281
Flush Count {37h:1500h} 281
Flush Relative Time (Media) {37h:15A0h} 281
Flush Relative Time {37h:1520h} 281
Flush Time (Media) {37h:1590h} 281
Flush Time {37h:1510h} 281
Fraction of Partition Traversed {38h:000Dh} 285
Fraction of Volume Traversed {38h:000Fh} 285
Hard read errors {14h:000Fh}: 239
Hard write errors {14h:000Eh}: 239
Host Aborts {39h:0007h} 286
Host Buffer Efficiency {37h:2?84h} 282
Host Protocol Errors {39h:000h} 286
Host Read Blocks Processed {38h:0002h} 284
Host Read Kilobytes Processed {38h:0003h} 284
Host Recoveries {39h:0010h} 286
Host Resets {39h:0008h} 286
Host Write Blocks Processed {38h:0000h} 284
Host Write Kilobytes Processed {38h:0001h} 284
Housekeeping Events {33h:000Ch} 270
Housekeeping Events {34h:0017h} 272
Last load read compression ratio {17h:0013h} 250
Last load write compression ratio {17h:0012h} 250
Last mount megabytes read {17h:000Fh} 250
Last mount megabytes written {17h:000Eh} 250
Last mount unrecovered read errors {17h:000Dh} 249
Last mount unrecovered write errors {17h:000Ch} 249
Library Interface Buffer Errors {3Dh:0083h} 292
Library Interface Efficiency {37h:001Ah} 275
Library Interface Framing Errors {3Dh:0085h} 292
Library Interface Loader Failures {3Dh:0088h} 292
Library Interface Logical Errors {3Dh:0087h} 292
Library Interface Messages Received {3Dh:0080h} 292
Library Interface Messages Transmitted {3Dh:0081h} 292
Library Interface Protocol Errors {3Dh:0086h} 292
Library Interface Resets {3Dh:0082h} 292
Library Interface Sync Errors {3Dh:0084h} 292
Lifetime cleaning cycles {0Ch:8002h}: 225
Lifetime cleaning operations {14h:0001h}: 238
Lifetime load cycles {0Ch:8001h}: 225
Lifetime medium motion (head) hours when incompatible medium was last loaded {14h:0005h}: 238
Lifetime medium motion (i.e., head) hours {14h:0003h}: 238
Lifetime megabytes read {17h:0011h} 250
Lifetime megabytes written {17h:0010h} 250
Lifetime meters of tape processed {14h:0004h}: 238
Lifetime power cycles {14h:000Ch}: 239
Lifetime power on hours {14h:0002h}: 238
Lifetime power on hours when the last operator initiated forced reset and/or emergency eject occurred {14h:000Bh}: . . 239
Lifetime power on hours when the last power consumption condition occurred (i.e., TapeAlert code 1Ch) {14h:0007h}: . . 238
Lifetime power on hours when the last temperature condition occurred (i.e., TapeAlert code 24h) {14h:0006h}: 238
Lifetime Power On Seconds {3Dh:0100h} 292
Lifetime Power-on time {0Ch:8003h}: 225

Lifetime volume loads {14h:0000h}: 238
Long Queue Latency Count [>1 sec] {37h:0DF8h} 279
Long Queue Latency Count [>10 sec] {37h:0DF9h} 279
Long Queue Latency Count [>100 sec] {37h:0DFAh} 279
Long Queue Latency Count [>1000 sec] {37h:0DFBh} 279
Match Filter ERP {33h:000Ah} 270
Match Filter ERP {34h:0016h} 272
Maximum Comp Transfer Rate {37h:2?90h} 282
Maximum Host Transfer Rate {37h:2?80h} 281
Maximum native capacity that is currently allowed to be in the device object buffer {0Ch:0008h} 224
Maximum recommended mechanism temperature exceeded {14h:0081h} 241
Maximum recommended tape path temperature exceeded {17h:0082h} 251
Maximum Tape Transfer Rate {37h:2?A0h} 282
Media Efficiency {37h:0001h} 275
Media Erase {37h:2003h} 281
Media Idle {37h:2000h} 281
Media Phase Cycles {37h:20?1h} 281
Media Phase Timing {37h:20?0h} 281
Media Position {37h:2004h} 281
Media Read {37h:2002h} 281
Media Write {37h:2001h} 281
Medium Clean Count {37h:0059h} 276
Medium Clean Time {37h:0049h} 276
Medium Dwell Count {37h:0058h} 276
Medium Dwell Time {37h:0048h} 276
Medium Eject Count {37h:0056h} 276
Medium Eject Time {37h:0046h} 275
Medium Empty Count {37h:0051h} 276
Medium Empty Time {37h:0041h} 275
Medium Extract Count {37h:0057h} 276
Medium Extract Time {37h:0047h} 275
Medium Insert Count {37h:0052h} 276
Medium Insert Time {37h:0042h} 275
Medium Load Count {37h:0054h} 276
Medium Load Time {37h:0044h} 275
Medium motion (i.e., head) hours for each medium type {14h:1000h} 241
Medium motion (i.e., head) hours since last successful cleaning operation {14h:0008h}: 239
Medium motion (i.e., head) hours since second to last successful cleaning operation {14h:0009h}: 239
Medium motion (i.e., head) hours since third to last successful cleaning operation {14h:000Ah}: 239
Medium Mount Count {37h:0053h} 276
Medium mount time {17h:0014h} 250
Medium Mount Time {37h:0043h} 275
Medium Ready Count {37h:0055h} 276
Medium ready time {17h:0015h} 250
Medium Ready Time {37h:0045h} 275
Medium removal prevented {14h:0080h} 241
Megabytes read from medium {1Bh:0004h} 260
Megabytes read from tape {32h:0004h} 268
Megabytes Read since Clean {3Dh:0062h} 291
Megabytes transferred from application client {1Bh:0006h} 260
Megabytes transferred from server {32h:0006h} 268
Megabytes transferred to application client {1Bh:0002h}: 260
Megabytes transferred to server {32h:0002h} 268
Megabytes Written since Clean {3Dh:0061h} 291
Megabytes written to medium {1Bh:0008h} 260
Megabytes written to tape {32h:0008h} 268
Middle of tape passes {17h:0102h} 251

Minimum native capacity between EW and LEOP of the current partition {0Ch:0006h} 224
Mounts since Clean {3Dh:0063h} 292
Moving Tape Buffer Efficiency {37h:2?A5h} 282
Moving Tape Buffer Rate {37h:2?A3h} 282
Nominal Capacity of Partition {38h:000Ch} 284
Nominal Capacity of Volume {38h:000Eh} 285
Number of mounts for the current volume 266
Padded Data (Medium) {37h:2?72h} 281
Padded Data {37h:2?62h} 281
Page valid {17h:000h} 249
Partition 0 Maximum Capacity {31h:0003h} 267
Partition 0 Remaining Capacity {31h:0001h} 267
Partition 1 Maximum Capacity {31h:0004h} 267
Partition 1 Remaining Capacity {31h:0002h} 267
Performance Impact by ERPs {37h:2?52h} 281
Performance Impacting ERPs {37h:2?51h} 281
Port Rate Changes {37h:0Dp7h} 279
Port Throughput Efficiency {37h:0Dp4h} 279
Port Throughput Rate {37h:0Dp3h} 279
Port Throughput Rate Maximum Bursting {37h:0Dp1h} 279
Port Throughput Rate Maximum Sustained {37h:0Dp2h} 279
Position Buffer Hits {37h:14F0h} 281
Position Count (Media) {37h:1480h} 280
Position Count {37h:1400h} 280
Position Relative Rate (Media) {37h:14B0h} 280
Position Relative Rate {37h:1430h} 280
Position Relative Time (Media) {37h:14A0h} 280
Position Relative Time {37h:1420h} 280
Position Time (Media) {37h:1490h} 280
Position Time {37h:1410h} 280
Power On Seconds {3Dh:0101h} 292
Primary Initiator {37h:0E01h} 279
Primary Interface Efficiency {37h:0010h} 275
Primary Interface Port 0 Efficiency {37h:0011h} 275
Primary Interface Port 1 Efficiency {37h:0012j} 275
Read Compression ratio {1Bh:0000h} 260
Read Compression ratio x 100 {32h:0000h} 268
Read Count {37h:0300h} 276
Read Cycle Relative Time {37h:1220h} 280
Read Cycle Time {37h:1210h} 280
Read Cycles {37h:1200h} 280
Read duty cycle {14h:0011h} 240
Read Exit Relative Time {37h:1224h} 280
Read Filemark (perf) Relative Time {37h:03D4h} 277
Read Media Blocks Counter {3Ch:0003h} 289
Read Pause Relative Time {37h:1223h} 280
Read Pauses {37h:1201h} 280
Read Performance Efficiency {37h:03D0h} 277
Read Ready Relative Time {37h:1222h} 280
Read Relative Time {37h:0302h} 277
Read Setup Relative Time {37h:1221h} 280
Read Timing {37h:0301h} 277
Read Traverse EM Relative Time {37h:1225h} 280
Ready duty cycle {14h:0015h} 240
Relative Time {37h:0q01h} 276
Remaining Capacity of Partition {38h:0011h} 285
Remaining Capacity of Volume {38h:0010h} 285

Reread Media Blocks Counter {3Ch:0005h} . . . 289
Reset Count [by port] {37h:0Fp3h} . . . 280
Reset Seconds {3Dh:0102h} . . . 292
Resource Recoveries [by port] {37h:0Fp2h} . . . 280
Rewrite Media Blocks Counter {3Ch:0002h} . . . 289
Secondary Initiator {37h:0E02h} . . . 279
Seek Block Count {37h:06D1h} . . . 278
Seek Count {37h:0600h} . . . 278
Seek Relative Time {37h:0602h} . . . 278
Seek Timing {37h:0601h} . . . 278
Sequence Errors {34h:0008h} . . . 271
Servo Acquisition Temps {33h:0004h} . . . 269
Servo Acquisition Temps {34h:0004h} . . . 271
Servo AGA Gain ERP {34h:0010h} . . . 272
Servo Opposite Gap ERP {34h:0012h} . . . 272
Servo Position Events {33h:0011h} . . . 270
Servo Position Events {34h:001Eh} . . . 272
Servo Skip Events {33h:000Bh} . . . 270
Servo Skip Events {34h:001Bh} . . . 272
Servo Speed Relative Time {37h:5Fs0h} . . . 282
Servo Temps {33h:0006h} . . . 269
Servo Temps {34h:0006h} . . . 271
Servo Transients {33h:0001h} . . . 269
Servo Transients {34h:0001h} . . . 271
Speed Changes {37h:2?F0h} . . . 282
Speed Forced {37h:2?F1h} . . . 282
Static Capacity Efficiency (Partition t) {37h:8t00h} . . . 283
Static Capacity Efficiency {37h:7000h} . . . 283
Static Datasets Media (Partition t) {37h:8t10h} . . . 283
Static Datasets Media {37h:7010h} . . . 283
Static Datasets Used (Partition t) {37h:8t11h} . . . 283
Static Datasets Used {37h:7011h} . . . 283
Static Distance Media (Partition t) {37h:8t20h} . . . 283
Static Distance Media {37h:7020h} . . . 283
Static Distance Used (Partition t) {37h:8t21h} . . . 283
Static Distance Used {37h:7021h} . . . 283
Static Remaining Capacity in SkipSync Buffer {37h:7030h} . . . 283
Sync Count [Host] {37h:0500h} . . . 277
Sync Count [Implicit] {37h:05D1h} . . . 278
Sync Relative Time [Host] {37h:0502h} . . . 278
Sync Relative Time [Implicit] {37h:05D4h} . . . 278
Sync Timing [Host] {37h:0501h} . . . 278
Sync Timing [Implicit] {37h:05D2h} . . . 278
Tape Buffer Efficiency {37h:2?A6h} . . . 282
Tape Efficiency {37h:2?A8h} . . . 282
Tape lot identifier {17h:0041h} . . . 250
Tape Thrashing {37h:2?A7h} . . . 282
Time {37h:0040h} . . . 275
Time Since Last Cleaning Counter {3Ch:0007h} . . . 290
Timing {37h:0q01h} . . . 276
Total Channel Read Bytes {0Ch:0003h}: . . . 224
Total Channel Write Bytes {0Ch:0000h}: . . . 224
Total Corrected Read Errors {03h:0003h} . . . 222
Total Corrected Write Errors {02h:0003h}: . . . 221
Total Device Read Bytes {0Ch:0002h}: . . . 224
Total Device Write Bytes {0Ch:0001h}: . . . 224
Total Megabytes Processed Since Cleaning {0Ch:8000h}: . . . 225

Total native capacity {17h:0016h} 250
Total Non-Medium Error Count {06h:0000h}: 223
Total Read Kilobytes Processed {03h:0005h} 222
Total Read Retries {03h:0004h} 222
Total Retries {33h:0008h} 269
Total Retries {34h:0015h} 272
Total Uncorrected Read Errors {03h:0006h} 222
Total Uncorrected Write Errors {02h:0006h}: 221
Total used native capacity {17h:0017h} 250
Total Write Kilobytes Processed {02h:0005h}: 221
Total Write Retries {02h:0004h}: 221
Transfer Byte Count from Host (out) {37h:0409h} 277
Transfer Byte Count from Host (out) {37h:0q09h} 276
Transfer Byte Count to Host (in) {37h:0305h} 277
Transfer Byte Count to Host (in) {37h:0405h} 277
Transfer Byte Count to Host (in) {37h:0505h} 278
Transfer Byte Count to Host (in) {37h:0605h} 278
Transfer Byte Count to Host (in) {37h:0q05h} 276
Transfer Count from Host (out) {37h:0408h} 277
Transfer Count from Host (out) {37h:0q08h} 276
Transfer Count to Host (in) {37h:0304h} 277
Transfer Count to Host (in) {37h:0404h} 277
Transfer Count to Host (in) {37h:0504h} 278
Transfer Count to Host (in) {37h:0604h} 278
Transfer Count to Host (in) {37h:0q04h} 276
Transfer Recover Time [by port] {37h:0Fp1h} 280
Transfer Recoveries [by port] {37h:0Fp0h} 280
Transfer Timing from Host (out) {37h:040Ah} 277
Transfer Timing from Host (out) {37h:0q0Ah} 276
Transfer Timing to Host (in) {37h:0306h} 277
Transfer Timing to Host (in) {37h:0406h} 277
Transfer Timing to Host (in) {37h:0506h} 278
Transfer Timing to Host (in) {37h:0606h} 278
Transfer Timing to Host (in) {37h:0q06h} 276
Uncompressed Data {37h:2?60h} 281
Velocity Events {33h:0003h} 269
Velocity Events {34h:0003h} 271
Vendor-Reserved 272
Vendor-Reserved (Blocks Lifted) {33h:000Eh} 270
Vendor-Reserved {34h:0009h} 271
Vendor-Reserved {34h:000Ah} 271
Vendor-Reserved {34h:000Bh} 272
Vendor-Reserved {34h:000Eh} 272
Vendor-Reserved {34h:000Fh} 272
Vendor-Reserved {34h:0013h} 272
Vendor-Reserved {34h:0018h} 272
Very high frequency data: 226
Very high frequency polling delay: 226
Volume barcode {17h:0042h} 251
Volume Datasets Read {17h:0007h} 249
Volume Datasets Read {30h:0007h}: 266
Volume Datasets Written {17h:0002h} 249
Volume Datasets Written {30h:0002h}: 266
Volume Fatal Suspended Reads {30h:000Bh}: 266
Volume Fatal Suspended Writes {30h:0006h}: 266
Volume license code {17h:0044h} 251
Volume Lifetime Megabytes Read {3Dh:0022h} 291

Volume Lifetime Megabytes Written {3Dh:0021h} 291
Volume Lifetime Mounts {3Dh:0020h} 291
Volume loads since last parameter reset {14h:000Dh}: 239
Volume manufacturer {17h:0043h} 251
Volume Mounts {17h:0001h} 249
Volume Mounts {30h:0001h} 266
Volume not present duty cycle {14h:0014h} 240
Volume personality {17h:0045h} 251
Volume Read Perms {30h:0009h}: 266
Volume Read Retries {30h:0008h}: 266
Volume Recovered Read Errors {17h:0008h} 249
Volume Recovered Write Data Errors {17h:0003h} 249
Volume serial number {17h:0040h} 250
Volume Suspended Reads {30h:000Ah} 266
Volume Suspended Writes {30h:0005h}: 266
Volume Unrecovered Read Errors (i.e., Read Perms) {17h:0009h} 249
Volume Unrecovered Write Data Errors (i.e., Write Perms) {17h:0004h} 249
Volume Unrecovered Write Servo Errors {17h:0006h} 249
Volume Write Perms {30h:0004h}: 266
Volume Write Retries {30h:0003h}: 266
Volume Write Servo Errors (updated on both temp and perm) {17h:0005h} 249
Window Buffer Efficiency {37h:2?85h} 282
Window Comp Buffer Efficiency {37h:2?95h} 282
Window Comp Buffer Rate {37h:2?93h} 282
Window Host Buffer Rate {37h:2?83h} 282
Window Tape Buffer Efficiency {37h:2?A4h} 282
Window Tape Buffer Rate {37h:2?A2h} 282
WORM {17h:0081h}: 251
Wrap Change Count {37h:2?10h} 281
Write Compression Ratio x 100 {1Bh:0001h} 260
Write Compression Ratio x 100 {32h:0001h} 268
Write Count {37h:0400h} 277
Write Cycle Relative Time {37h:1020h} 280
Write Cycle Time {37h:1010h} 280
Write Cycles {37h:1000h} 280
Write duty cycle {14h:0012h} 240
Write Exit Relative Time {37h:1024h} 280
Write Filemark Relative Time {37h:04D4j} 277
Write Media Blocks Counter {3Ch:0001h} 289
Write Pause Relative Time {37h:1023h} 280
Write Pauses {37h:1001h} 280
Write Performance Efficiency {37h:04D0h} 277
Write protect {17h:0080h} 251
Write Ready Relative Time {37h:1022h} 280
Write Relative Time {37h:0402h} 277
Write Setup Relative Time {37h:1021h} 280
Write Timing {37h:0401h} 277



Printed in USA

GA32-0928-00

