

ISO/IEC 17760-105:2024-03 (E)

Information technology - AT Attachment - Part 105: ATA Command Set - 5 (ACS-5)

Contents	Page
Contents.....	i
Tables	xii
Figures	xx
Foreword	xxi
Introduction	xxiv
1 Scope	1
2 Normative references	2
3 Definitions, abbreviations, and conventions	3
3.1 Definitions	3
3.2 Symbols and abbreviations	9
3.2.1 Abbreviations	9
3.2.2 Units	11
3.2.3 Symbols	11
3.2.4 Mathematical operators	11
3.3 Keywords	11
3.4 Conventions	12
3.4.1 Overview	12
3.4.2 Precedence	13
3.4.3 Lists	13
3.4.4 Numbering	14
3.4.5 Bit conventions	14
3.4.6 Number range convention	14
3.4.7 State diagram conventions	15
3.4.8 Byte, word, DWord, QWord, and DQWord Relationships	17
3.4.9 ATA string convention	18
3.4.10 Offset Convention	19
4 Feature set definitions	20
4.1 Overview	20
4.1.1 Feature set summary	20
4.1.2 Capacity reporting	21
4.2 General feature set	22
4.2.1 Overview	22
4.2.2 Unexpected power removal	22
4.2.3 Interactions with volatile caches	23
4.3 48-bit Address feature set	24
4.4 Accessible Max Address Configuration feature set	25
4.4.1 Overview	25
4.4.2 SET ACCESSIBLE MAX ADDRESS EXT description	25
4.4.3 Interactions with device statistics data	25
4.5 Advanced Background Operation feature set (ABO)	26
4.5.1 Overview	26
4.5.2 Host-initiated advanced background operations	26
4.5.3 Device-initiated advanced background operations	27
4.6 Advanced Power Management (APM) feature set	28
4.7 Command Duration Limits feature set	29
4.7.1 Overview	29

4.7.2	COMMAND DURATION LIMITS INDEX field	30
4.7.3	Command duration limits operation	30
4.7.4	High Priority Enhancement feature	31
4.8	Device Statistics Notification (DSN) feature set	33
4.8.1	Overview	33
4.8.2	DSN notifications	33
4.8.3	DSN notifications setup	34
4.9	Extended Power Conditions (EPC) feature set	35
4.9.1	Overview	35
4.9.2	Power conditions	35
4.9.3	Power condition timers	35
4.9.4	Interaction with resets, commands, and other features if the EPC feature set is enabled	36
4.10	Free-fall Control feature set	38
4.11	General Purpose Logging (GPL) feature set	39
4.12	Hybrid Information feature set	40
4.12.1	Hybrid Information feature overview	40
4.12.2	Syncing	42
4.12.3	Interactions with ATA power management	42
4.12.4	Other Hybrid conditions	43
4.13	Long Logical Sector (LLS) feature set	45
4.14	Long Physical Sector (LPS) feature set	47
4.15	Native Command Queuing (NCQ) feature set	49
4.15.1	Overview	49
4.15.2	Priority	49
4.15.3	Unload with NCQ commands outstanding	50
4.15.4	Command Phases	50
4.15.5	NCQ command processing order requirements	51
4.15.6	ATA device commands encapsulated in NCQ feature set commands	51
4.15.7	Returning sense data for successful NCQ feature set commands	51
4.16	Out Of Band Management Interface	53
4.17	Power Management feature set	55
4.17.1	Overview	55
4.17.2	Power management commands	55
4.17.3	Standby timer	55
4.17.4	Power Management states and transitions	56
4.18	Power-Up In Standby (PUIS) feature set	60
4.18.1	Overview	60
4.18.2	Interactions with the IDENTIFY DEVICE command	60
4.18.3	PUIS feature set device spin-up subcommand	60
4.19	Rebuild Assist feature set	61
4.19.1	Overview	61
4.19.2	Enabling the Rebuild Assist feature set	61
4.19.3	Using the Rebuild Assist feature set	61
4.19.4	Disabling the Rebuild Assist feature set	63
4.19.5	Testing the Rebuild Assist feature set	63
4.20	Sanitize Device feature set	64
4.20.1	Overview	64
4.20.2	Sanitize operation scope	64
4.20.3	Sanitize commands	64
4.20.4	Sanitize operations	64
4.20.5	Interactions of the Sanitize Device feature set and Security feature set	65
4.20.6	Command processing during sanitize operations	65
4.20.7	Sanitize Operation Completed Without Error value	66
4.20.8	Failure Mode Policy value	66
4.20.9	Sanitize Antifreeze value	67
4.20.10	Sanitize Device state machine	67
4.21	SATA Hardware Feature Control feature set	70

4.22 Security feature set	71
4.22.1 Overview	71
4.22.2 Disabling and enabling the Security feature set	71
4.22.3 Passwords	71
4.22.4 Master password capability	71
4.22.5 Frozen mode	72
4.22.6 Commands	72
4.22.7 Security initial setting	72
4.22.8 Password Rules	72
4.22.9 Password attempt counter and SECURITY COUNT EXPIRED bit	72
4.22.10 Master Password Identifier feature	73
4.22.11 Security states	73
4.23 Self-Monitoring, Analysis, and Reporting Technology (SMART) feature set	85
4.23.1 Overview	85
4.23.2 Background data collection	85
4.23.3 Off-line/Captive mode data collection	85
4.23.4 Threshold exceeded condition	85
4.23.5 SMART feature set commands	85
4.23.6 SMART operation with power management modes	85
4.23.7 SMART device error log reporting	85
4.24 Sense Data Reporting feature set	87
4.24.1 General	87
4.24.2 Current information sense data and deferred error sense data	88
4.25 Software Settings Preservation (SSP) feature set	89
4.26 Storage Element Depopulation feature set	90
4.26.1 Overview	90
4.26.2 Status change notification	90
4.26.3 Repurposing Depopulation	91
4.26.4 Repurposing Depopulation Restoration	92
4.26.5 Effects of storage depopulation commands on other commands	93
4.26.6 Interactions with logs	94
4.26.7 Interactions with caches	94
4.27 Streaming feature set	95
4.27.1 Streaming feature set overview	95
4.27.2 Streaming commands	95
4.28 Trusted Computing feature set	97
4.29 User Data Initialization feature set	98
4.29.1 Overview	98
4.29.2 User data initialization operation	98
4.29.3 MUTATE EXT command	100
4.30 Write-Read-Verify feature set	101
5 ATA protocols	102
6 Normal and Error Output field descriptions	103
6.1 Overview	103
6.2 STATUS field	103
6.2.1 Overview	103
6.2.2 ALIGNMENT ERROR bit	103
6.2.3 BUSY bit	103
6.2.4 DATA REQUEST bit	104
6.2.5 DEFERRED WRITE ERROR bit	104
6.2.6 DEVICE FAULT bit	104
6.2.7 DEVICE READY bit	104
6.2.8 ERROR bit	104
6.2.9 SENSE DATA AVAILABLE bit	104

6.2.11 Transport Dependent bits and fields	105
6.3 ERROR field	105
6.3.1 Overview	105
6.3.2 ABORT bit	105
6.3.3 COMMAND COMPLETION TIME OUT bit	106
6.3.4 ID NOT FOUND bit	106
6.3.5 INTERFACE CRC bit	106
6.3.6 UNCORRECTABLE ERROR bit	106
6.4 COUNT field	106
6.4.1 Overview	106
6.4.2 Contiguous stream logical sectors that contain potentially bad data	106
6.4.3 NCQ Tag	106
6.5 SACTIVE field	106
6.6 SATA STATUS field	107
6.7 LBA field	107
6.7.1 Overview	107
6.7.2 LBA of First Unrecoverable Error	107
6.8 Sense code definitions	107
6.8.1 Overview	107
6.8.2 ACCESS DENIED - NO ACCESS RIGHTS	108
6.8.3 COMMAND SEQUENCE ERROR	109
6.8.4 COMMAND TIMEOUT BEFORE PROCESSING	109
6.8.5 COMMAND TIMEOUT DURING PROCESSING	109
6.8.6 DATA CURRENTLY UNAVAILABLE	109
6.8.7 DEPOPULATION FAILED	109
6.8.8 DEPOPULATION IN PROGRESS	109
6.8.9 DEPOPULATION RESTORATION FAILED	109
6.8.10 DEPOPULATION RESTORATION IN PROGRESS	109
6.8.11 FAILURE PREDICTION THRESHOLD EXCEEDED	109
6.8.12 INFORMATION UNIT iuCRC ERROR DETECTED	109
6.8.13 INITIATOR RESPONSE TIMEOUT	109
6.8.14 INSUFFICIENT RESOURCES	109
6.8.15 INTERNAL TARGET FAILURE	110
6.8.16 INVALID COMMAND OPERATION CODE	110
6.8.17 INVALID FIELD IN CDB	110
6.8.18 INVALID FIELD IN PARAMETER LIST	110
6.8.19 LOGICAL BLOCK ADDRESS OUT OF RANGE	110
6.8.20 LOGICAL UNIT FAILED SELF-TEST	110
6.8.21 LOGICAL UNIT NOT READY, FORMAT IN PROGRESS	110
6.8.22 LOGICAL UNIT NOT READY, INITIALIZING COMMAND REQUIRED	110
6.8.23 LOGICAL UNIT NOT READY, MICROCODE ACTIVATION REQUIRED	110
6.8.24 LOGICAL UNIT NOT READY, POWER CYCLE REQUIRED	110
6.8.25 LOGICAL UNIT NOT READY, SANITIZE IN PROGRESS	110
6.8.26 MEDIUM FORMAT CORRUPTED	110
6.8.27 MULTIPLE READ ERRORS	111
6.8.28 MULTIPLE WRITE ERRORS	111
6.8.29 NO ADDITIONAL SENSE INFORMATION	111
6.8.30 NO DEFECT SPARE LOCATION AVAILABLE	111
6.8.31 OVERLAPPED COMMANDS ATTEMPTED	111
6.8.32 READ ERROR - LBA MARKED BAD BY APPLICATION CLIENT	111
6.8.33 UNRECOVERED READ ERROR	111
6.8.34 WARNING – DEVICE STATISTICS NOTIFICATION ACTIVE	111
6.8.35 WRITE ERROR	111
7 Command descriptions	112
7.1 Command description introduction	112
7.2 Accessible Max Address Configuration	119

7.2.1 Accessible Max Address Configuration overview	119
7.2.2 GET NATIVE MAX ADDRESS EXT – 78h/0000h, Non-Data	120
7.2.3 SET ACCESSIBLE MAX ADDRESS EXT – 78h/0001h, Non-Data	121
7.2.4 FREEZE ACCESSIBLE MAX ADDRESS EXT – 78h/0002h, Non-Data	123
7.3 CHECK POWER MODE – E5h, Non-Data	124
7.4 CONFIGURE STREAM – 51h, Non-Data	125
7.5 DATA SET MANAGEMENT – 06h, DMA	127
7.6 DATA SET MANAGEMENT XL – 07h, DMA	131
7.7 DOWNLOAD MICROCODE – 92h, PIO Data-Out/Non-Data	133
7.8 DOWNLOAD MICROCODE DMA – 93h, DMA/Non-Data	147
7.9 EXECUTE DEVICE DIAGNOSTIC – 90h, Execute Device Diagnostic	148
7.10 FLUSH CACHE – E7h, Non-Data	150
7.11 FLUSH CACHE EXT – EAh, Non-Data	151
7.12 GET PHYSICAL ELEMENT STATUS – 12h, DMA	152
7.13 IDENTIFY DEVICE – ECh, PIO Data-In	157
7.14 IDLE – E3h, Non-Data	191
7.15 IDLE IMMEDIATE – E1h, Non-Data	193
7.16 MUTATE EXT - 96h, Non-Data	195
7.17 NCQ NON-DATA – 63h, Non-Data	197
7.18 NOP – 00h, Non-Data	221
7.19 READ BUFFER – E4h, PIO Data-In	222
7.20 READ BUFFER DMA – E9h, DMA	223
7.21 READ DMA – C8h, DMA	224
7.22 READ DMA EXT – 25h, DMA	225
7.23 READ FPDMA QUEUED – 60h, DMA Queued	227
7.24 READ LOG EXT – 2Fh, PIO Data-In	229
7.25 READ LOG DMA EXT – 47h, DMA	231
7.26 READ SECTOR(S) – 20h, PIO Data-In	233
7.27 READ SECTOR(S) EXT – 24h, PIO Data-In	234
7.28 READ STREAM DMA EXT – 2Ah, DMA	235
7.29 READ STREAM EXT – 2Bh, PIO Data-In	238
7.30 READ VERIFY SECTOR(S) – 40h, Non-Data	239
7.31 READ VERIFY SECTOR(S) EXT – 42h, Non-Data	240
7.32 RECEIVE FPDMA QUEUED – 65h, DMA Queued	241
7.33 REMOVE ELEMENT AND TRUNCATE – 7Ch, Non-Data	243
7.34 REQUEST SENSE DATA EXT – 0Bh, Non-Data	245
7.35 RESTORE ELEMENTS AND REBUILD – 7Dh, Non-Data	246
7.36 Sanitize Device	248
7.36.1 Sanitize Device Overview	248
7.36.2 BLOCK ERASE EXT – B4h/0012h, Non-Data	249
7.36.3 CRYPTO SCRAMBLE EXT – B4h/0011h, Non-Data	252
7.36.4 OVERWRITE EXT – B4h/0014h, Non-Data	255
7.36.5 SANITIZE ANTIFREEZE LOCK EXT – B4h/0040h, Non-Data	258
7.36.6 SANITIZE FREEZE LOCK EXT – B4h/0020h, Non-Data	261
7.36.7 SANITIZE STATUS EXT – B4h/0000h, Non-Data	263
7.37 SECURITY DISABLE PASSWORD – F6h, PIO Data-Out	265
7.38 SECURITY ERASE PREPARE – F3h, Non-Data	267
7.39 SECURITY ERASE UNIT – F4h, PIO Data-Out	268
7.40 SECURITY FREEZE LOCK – F5h, Non-Data	271
7.41 SECURITY SET PASSWORD – F1h, PIO Data-Out	272
7.42 SECURITY UNLOCK – F2h, PIO Data-Out	275
7.43 SEND FPDMA QUEUED – 64h, DMA Queued	278
7.43.8 HYBRID EVICT – 64h/1h, DMA Queued	280
7.44 SET DATE & TIME EXT – 77h, Non-Data	284
7.45 SET FEATURES – EFh, Non-Data	285
7.45.1 Introduction	285
7.45.2 SET FEATURES subcommands	286

7.45.3	Enable/disable volatile write cache	288
7.45.4	Set transfer mode	289
7.45.5	Enable/disable the APM feature set	290
7.45.6	Enable/disable the PUIS feature set	290
7.45.7	PUIS feature set device spin-up	290
7.45.8	Enable/Disable Write-Read-Verify feature set	291
7.45.9	Enable/disable device life control	292
7.45.10	Enable/Disable Command Duration Limits feature set	292
7.45.11	Set Maximum Host Interface Sector Times	294
7.45.12	Set rate basis	294
7.45.13	Enable/disable read look-ahead	294
7.45.14	Enable/disable reverting to defaults	295
7.45.15	Enable/Disable the Free-fall Control feature set	295
7.45.16	Enable/Disable SATA feature	295
7.45.17	Enable/Disable the Sense Data Reporting feature set	299
7.45.18	Enable/Disable sense data return for successful NCQ commands	299
7.45.19	Long Physical Sector Alignment Error Reporting Control	300
7.45.20	Extended Power Conditions subcommand	301
7.45.21	Enable/Disable the DSN feature set	312
7.45.22	Advanced Background Operation Control	312
7.46	SET SECTOR CONFIGURATON EXT – B2h, Non-Data	315
7.47	SLEEP – E6h, Non-Data	318
7.48	SMART	319
7.48.1	Overview	319
7.48.2	SMART READ LOG – B0h/D5h, PIO Data-In	320
7.48.3	SMART RETURN STATUS – B0h/DAh, Non-Data	321
7.48.4	SMART WRITE LOG – B0h/D6h, PIO Data-Out	322
7.49	STANDBY – E2h, Non-Data	324
7.50	STANDBY IMMEDIATE – E0h, Non-Data	325
7.51	TRUSTED NON-DATA – 5Bh, Non-Data	326
7.52	TRUSTED RECEIVE – 5Ch, PIO Data-In	328
7.53	TRUSTED RECEIVE DMA – 5Dh, DMA	335
7.54	TRUSTED SEND – 5Eh, PIO Data-Out	336
7.55	TRUSTED SEND DMA – 5Fh, DMA	338
7.56	WRITE BUFFER – E8h, PIO Data-Out	339
7.57	WRITE BUFFER DMA – EBh, DMA	340
7.58	WRITE DMA – CAh, DMA	341
7.59	WRITE DMA EXT – 35h, DMA	342
7.60	WRITE DMA FUA EXT – 3Dh, DMA	343
7.61	WRITE FPDMA QUEUED – 61h, DMA Queued	345
7.62	WRITE LOG EXT – 3Fh, PIO Data-Out	347
7.63	WRITE LOG DMA EXT – 57h, DMA	349
7.64	WRITE SECTOR(S) – 30h, PIO Data-Out	351
7.65	WRITE SECTOR(S) EXT – 34h, PIO Data-Out	352
7.66	WRITE STREAM DMA EXT – 3Ah, DMA	353
7.67	WRITE STREAM EXT – 3Bh, PIO Data-Out	356
7.68	WRITE UNCORRECTABLE EXT – 45h, Non-Data	357
7.69	ZERO EXT – 44h, Non-Data	360
8	SCT Command Transport	362
8.1	Introduction	362
8.1.1	Overview	362
8.1.2	SCT command interactions with ATA commands	363
8.1.3	NCQ accesses to the SCT logs	363
8.1.4	Resets	363
8.2	Processing SCT commands	364
8.2.1	Processing SCT commands overview	364

8.2.2	SCT capability identification	364
8.2.3	SCT Command transfer	364
8.2.4	SCT data transfer	369
8.2.5	SCT status	375
8.3	SCT Command Set	382
8.3.1	Overview	382
8.3.2	SCT Write Same command	383
8.3.3	SCT Error Recovery Control command	388
8.3.4	SCT Feature Control command	393
8.3.5	SCT Data Table command.....	397
9	Log Definitions	401
9.1	Overview	401
9.2	General Purpose Log Directory (GPL Log Address 00h)	404
9.3	SMART Log Directory (SMART Logging Log Address 00h)	405
9.4	Comprehensive SMART Error log (Log Address 02h)	406
9.4.1	Overview	406
9.4.2	SMART error log version	406
9.4.3	Error log index	406
9.4.4	Error log data structure	406
9.4.5	Device error count	407
9.4.6	Data structure checksum	407
9.5	Device Statistics log (Log Address 04h)	408
9.5.1	Overview	408
9.5.2	FEATURE field for GPL commands	410
9.5.3	List of Supported Device Statistics log pages (log page 00h)	411
9.5.4	Command Duration Limits Statistics (log page 09h)	411
9.5.5	Free Fall Statistics (log page 02h)	419
9.5.6	General Statistics (log page 01h)	421
9.5.7	General Errors Statistics (log page 04h)	428
9.5.8	Rotating Media Statistics (log page 03h)	431
9.5.9	Solid State Device Statistics (log page 07h)	436
9.5.10	Temperature Statistics (log page 05h)	436
9.5.11	Transport Statistics (log page 06h)	444
9.5.12	Vendor Specific Statistics (log page FFh)	445
9.6	Device Vendor Specific logs (Log Addresses A0h-DFh)	447
9.7	Extended Comprehensive SMART Error log (Log Address 03h)	448
9.7.1	Overview	448
9.7.2	SMART error log version	448
9.7.3	Error log index	448
9.7.4	Extended Error log data structure	448
9.7.5	Device error count	452
9.7.6	Data structure checksum	452
9.8	Power Conditions log (Log Address 08h)	453
9.8.1	Overview	453
9.8.2	Idle power conditions (log page 00h)	453
9.8.3	Standby power conditions (log page 01h)	453
9.8.4	Power Conditions log descriptor	454
9.9	Host Specific logs (Log Addresses 80h-9Fh)	458
9.10	IDENTIFY DEVICE data log (Log Address 30h)	459
9.10.1	Overview	459
9.10.2	List of Supported IDENTIFY DEVICE data log pages (Page 00h)	460
9.10.3	Copy of IDENTIFY DEVICE data (page 01h)	460
9.10.4	Capacity (page 02)	461
9.10.5	Supported Capabilities (page 03h)	464
9.10.6	Current Settings (page 04h)	490
9.10.7	Strings (page 05h)	498

9.10.8 Security (page 06h)	499
9.10.9 Parallel ATA (page 07h)	504
9.10.10 Serial ATA (page 08h)	515
9.11 Command Duration Limits log (Log Address 18h)	525
9.11.1 Command Duration Limits log overview	525
9.11.2 Command Duration Limits Descriptor	527
9.12 LBA Status log (Log Address 19h)	532
9.12.1 Overview	532
9.12.2 Number of LBA Valid Ranges log page (Page 0000h)	532
9.12.3 LBA Status log pages	532
9.12.4 LBA Status Descriptor	533
9.13 LPS Mis-alignment log (Log Address 0Dh)	535
9.14 NCQ Command Error log (Log Address 10h)	537
9.14.1 Overview	537
9.14.2 NCQ TAG field	538
9.14.3 NQ bit	538
9.14.4 UNL bit	538
9.14.5 Return Fields	539
9.14.6 NCQ Autosense	539
9.14.7 FINAL LBA IN ERROR field	539
9.14.8 Checksum	539
9.14.9 WRITE POINTER VALID field	539
9.14.10 WRITE POINTER[0..31] fields	540
9.14.11 WRITE POINTER CHECKSUM field	540
9.15 Read Stream Error log (Log Address 22h)	541
9.16 SATA Phy Event Counters log (Log Address 11h)	543
9.16.1 Overview	543
9.16.2 Counter x Identifier	543
9.16.3 Counter x Value	543
9.16.4 Counter x Length	543
9.16.5 Checksum	543
9.17 SATA NCQ Non-Data log (Log Address 12h)	544
9.17.1 Overview	544
9.17.2 SUPPORTS ABORT NCQ QUEUE bit	546
9.17.3 SUPPORTS ABORT ALL AT bit	546
9.17.4 SUPPORTS ABORT STREAMING AT bit	546
9.17.5 SUPPORTS ABORT NON-STREAMING AT bit	546
9.17.6 SUPPORTS ABORT SELECTED TTAG AT bit	546
9.17.7 SUPPORTS DEADLINE HANDLING bit	546
9.17.8 SUPPORTS WDNC bit	546
9.17.9 SUPPORTS RDNC bit	546
9.17.10 SUPPORTS HYBRID DEMOTE BY SIZE bit	547
9.17.11 SUPPORTS HYBRID CHANGE BY LBA RANGE bit	547
9.17.12 SUPPORTS HYBRID CONTROL bit	547
9.17.13 QUEUED SET FEATURES SUPPORTED bit	547
9.17.14 QUEUED ZERO EXT SUPPORTED bit	547
9.17.15 SUPPORTS ZAC MANAGEMENT OUT bit	547
9.17.16 SUPPORTS DURABLE/ORDERED WRITE NOTIFICATION bit	547
9.17.17 SUPPORTS D/OW bit	547
9.18 SATA NCQ Send and Receive log (Log Address 13h)	548
9.18.1 Overview	548
9.18.2 QUEUED DATA SET MANAGEMENT XL SUPPORTED bit	548
9.18.3 SUPPORTS HYBRID EVICT bit	549
9.18.4 QUEUED DATA SET MANAGEMENT SUPPORTED bit	549
9.18.5 QUEUED DATA SET MANAGEMENT SUPPORTS TRIM bit	549
9.18.6 QUEUED READ LOG DMA EXT FEATURE FIELD SUPPORTED bit	549
9.18.7 SEQUENTIAL QUEUED READ LOG DMA EXT SUPPORTED bit	549

9.18.8 QUEUED READ LOG DMA EXT SUPPORTED bit	549
9.18.9 SEQUENTIAL QUEUED WRITE LOG DMA EXT SUPPORTED bit	549
9.18.10 QUEUED WRITE LOG DMA EXT SUPPORTED bit	549
9.18.11 SUPPORTS ZAC MANAGEMENT IN bit	550
9.18.12 SUPPORTS ZAC MANAGEMENT OUT bit	550
9.19 Hybrid Information log (Log Address 14h)	551
9.19.1 Hybrid Information log overview	551
9.19.2 Hybrid Information Header	552
9.19.3 Hybrid Information Descriptor	555
9.20 Rebuild Assist log (Log Address 15h)	557
9.20.1 Overview	557
9.20.2 MANAGE REBUILD ASSIST ENABLED bit	558
9.20.3 PHYSICAL ELEMENT LENGTH field	558
9.20.4 DISABLED PHYSICAL ELEMENT MASK field	558
9.20.5 DISABLED PHYSICAL ELEMENTS field	558
9.21 Selective Self-Test log (Log Address 09h)	559
9.21.1 Overview	559
9.21.2 REVISION NUMBER field	559
9.21.3 Test span starting LBA and ending LBA	559
9.21.4 CURRENT LBA UNDER TEST field	559
9.21.5 CURRENT SPAN UNDER TEST field	560
9.21.6 FEATURE FLAGS field	560
9.21.7 SELECTIVE SELF-TEST PENDING TIME field	560
9.21.8 CHECKSUM field	560
9.22 Summary SMART Error log (Log Address 01h)	561
9.22.1 Overview	561
9.22.2 SMART error log version	561
9.22.3 Error log index	561
9.22.4 Error log data structure	561
9.22.5 Device error count	564
9.22.6 Data structure checksum	564
9.23 Write Stream Error log (Log Address 21h)	565
9.24 Current Device Internal Status Data log (Log Address 24h)	566
9.24.1 Overview	566
9.24.2 Current Device Internal Status Data header page	567
9.24.3 Current Device Internal Status data pages	568
9.24.4 Examples of data area usage	569
9.25 Saved Device Internal Status Data log (Log Address 25h)	571
9.25.1 Overview	571
9.25.2 Saved Device Internal Status Data header page	571
9.25.3 Current Device Internal Status data pages	572
9.26 Device Statistics Notifications log (Log Address 0Ah)	573
9.27 Pending Defects log (Log Address 0Ch)	577
9.27.1 Overview	577
9.27.2 Detection of an uncorrectable media error	577
9.27.3 Adding descriptors to the Pending Defects log	577
9.27.4 Removing descriptors from the Pending Defects log	577
9.27.5 Contents of the Pending Defects log	577
9.27.6 NUMBER OF LOG DESCRIPTORS field	578
9.27.7 Pending Defects descriptor format	578
9.28 Sense Data for Successful NCQ Commands log (Log address 0Fh)	579
9.28.1 Overview	579
9.28.2 SENSE DATA VALID field	580
9.28.3 Successful Sense Data descriptor	581
9.29 Sector Configuration log (Log Address 2Fh)	582
9.29.1 Overview	582
9.29.2 Sector Configuration descriptors (log page 00h)	582

9.30 Mutate Configurations log (Log Address 42h)	584
9.30.1 Overview	584
9.30.2 Zero padding	584
9.30.3 Mutate Configurations header	584
9.30.4 Mutate Configuration descriptor	585
9.31 Concurrent Positioning Ranges log (Log Address 47h)	591
9.31.1 Concurrent Positioning Ranges log overview	591
9.31.2 Concurrent Positioning Ranges header	591
9.31.3 LBA range descriptor	591
9.31.4 Padding	592
9.31.5 Example Concurrent Positioning Ranges log	592
9.32 Sense Data log (Log Address 53h)	594
9.32.1 Overview	594
9.32.2 DEFERRED ERROR bit	595
9.32.3 Return Fields	595
9.32.4 SENSE KEY field, ADDITIONAL SENSE CODE field, and ADDITIONAL SENSE CODE QUALIFIER field	595
9.32.5 FINAL LBA IN ERROR field	595
9.32.6 Checksum	595
9.33 Out Of Band Management Control log (Log Address 16h)	596
9.33.1 Out Of Band Management Control log overview	596
9.33.2 NUMBER OF VALID DESCRIPTORS field	596
9.33.3 REPORTING ENABLED bit	596
9.33.4 VOLATILE bit	597
9.33.5 PROTOCOL REVISION CODE field	597
9.33.6 Attribute Control Descriptor	597
9.33.7 Temperature attribute control descriptor format	599
10 Normal and Error Outputs	602
10.1 Overview	602
10.2 Normal Outputs	602
10.3 Error Outputs	617
Annex A (informative) Command Set Summary	645
Annex B (informative) How to Use SCT Commands	672
B.1 How to Use SCT Commands Overview	672
B.2 Examples of Log Page Command Sequences	674
B.3 Issuing an SCT Command to a Device	679
B.3.1 Step 1 – Build a Key Page	679
B.3.2 Step 2 – Issue the SCT command	680
B.3.3 Step 3 – Transfer Data if Required	681
B.3.4 Step 4 – Final Status/SCT Command Completion	682
Annex C (informative) Implementation Guidelines for 1 024- and 4 096-Byte Sector Sizes	683
C.1 Scope	683
C.2 Overview	683
C.3 Implementation	685
C.3.1 4 096-Byte Physical Sector Size Implementation	685
C.3.2 Reporting Alignment (512-Byte LBA Only)	685
C.3.3 RMW operations (512-Byte LBA Only)	686
C.4 Implementation Issues (512-Byte LBA Only)	686
C.4.1 Overview	686
C.4.2 Drive Partitioning	687
C.4.3 File System Formatting	688
C.4.4 Virtual Memory accessing	688
C.4.5 Booting	688

Annex D (informative) The DATA SET MANAGEMENT command with Trim	689
D.1 Overview	689
D.2 Trim interaction with volatile caches	690
Annex E (informative) Using repurposing depopulation.....	692
Bibliography	693

Tables

	Page
Table 1 - Numbering conventions	14
Table 2 - ATA string byte swapping	18
Table 3 - FIRMWARE REVISION field example	19
Table 4 - Feature set summary	20
Table 5 - IDENTIFY DEVICE capacity reporting	21
Table 6 - Command Duration Limits descriptor selection	30
Table 7 - Caching Priority	40
Table 8 - Power Source interactions	43
Table 9 - Words transferred per COUNT field unit by command	45
Table 10 - PRIO field	50
Table 11 - Summary of Security States and Security Characteristics	73
Table 12 - Security Command Actions	74
Table 13 - Security page settings for the SEC1: Security Disabled/Not Locked/Not Frozen state	79
Table 14 - Security page settings for the SEC2: Security Disabled/Not Locked/Frozen state	80
Table 15 - Security page settings for the SEC4: Security Enabled/Locked/Not Frozen state	81
Table 16 - Security page settings for the SEC5: Security Enabled/Not Locked/Not Frozen state	82
Table 17 - Security page settings for the SEC6: Security Enabled/Not Locked/Frozen state	83
Table 18 - Preserved Feature Sets and Settings	89
Table 19 - STATUS field	103
Table 20 - ERROR field	105
Table 21 - COUNT field use for NCQ Tag	106
Table 22 - Sense Codes	108
Table 23 - Example Command Structure	113
Table 24 - Example Normal Output	114
Table 25 - Example Error Output	115
Table 26 - Summary of commands	116
Table 27 - Accessible Max Address Configuration FEATURE field values	119
Table 28 - GET NATIVE MAX ADDRESS EXT command inputs	120
Table 29 - SET ACCESSIBLE MAX ADDRESS EXT command inputs	121
Table 30 - FREEZE ACCESSIBLE MAX ADDRESS EXT command inputs	123
Table 31 - CHECK POWER MODE command inputs	124
Table 32 - CONFIGURE STREAM command inputs	125
Table 33 - DATA SET MANAGEMENT command inputs	127
Table 34 - DSM FUNCTION field	128
Table 35 - Data returned for trimmed logical sectors	128
Table 36 - LBA Range Entry page format	129
Table 37 - SEND FPDMA QUEUED command encapsulation for the subcommand specific inputs from a DATA SET MANAGEMENT command	130
Table 38 - DATA SET MANAGEMENT XL command inputs	131
Table 39 - XL LBA Range Entry page format	132
Table 40 - SEND FPDMA QUEUED command encapsulation for the subcommand specific inputs from a DATA SET MANAGEMENT XL command	132
Table 41 - SUBCOMMAND field	134
Table 42 - DOWNLOAD MICROCODE command inputs	145
Table 43 - COUNT field output for DOWNLOAD MICROCODE requesting the offset transfer method	146
Table 44 - DOWNLOAD MICROCODE DMA command inputs	147
Table 45 - EXECUTE DEVICE DIAGNOSTIC command inputs	148
Table 46 - Diagnostic codes	149
Table 47 - FLUSH CACHE command inputs	150
Table 48 - FLUSH CACHE EXT command inputs	151
Table 49 - GET PHYSICAL ELEMENT STATUS command inputs	152
Table 50 - FILTER field	153
Table 51 - REPORT TYPE field	153

Table 52 - GET PHYSICAL ELEMENT STATUS input from device to host	154
Table 53 - Physical element status descriptor	155
Table 54 - PHYSICAL ELEMENT TYPE field	155
Table 55 - PHYSICAL ELEMENT HEALTH field	156
Table 56 - IDENTIFY DEVICE command inputs	157
Table 57 - IDENTIFY DEVICE data	158
Table 58 - Specific configuration	175
Table 59 - Minor version number	181
Table 60 - Transport minor version number	190
Table 61 - IDLE command inputs	191
Table 62 - STANDBY TIMER PERIOD field	191
Table 63 - IDLE IMMEDIATE command inputs	193
Table 64 - IDLE IMMEDIATE with the Unload feature command inputs	194
Table 65 - MUTATE EXT command inputs	195
Table 66 - NCQ NON-DATA command inputs	197
Table 67 - NCQ NON-DATA Subcommands	198
Table 68 - HYBRID DEMOTE BY SIZE - Number of logical sectors affected	199
Table 69 - HYBRID DEMOTE BY SIZE command inputs	200
Table 70 - HYBRID INFORMATION field	201
Table 71 - Interactions with the requested caching priority level	202
Table 72 - Cache Behavior	206
Table 73 - HYBRID CHANGE BY LBA RANGE command inputs	208
Table 74 - HYBRID CONTROL command inputs	211
Table 75 - ABORT NCQ QUEUE command inputs	214
Table 76 - ABORT NCQ QUEUE Abort Types	215
Table 77 - DEADLINE HANDLING command inputs	216
Table 78 - DURABLE/ORDERED WRITE NOTIFICATION command inputs	219
Table 79 - NOP command inputs	221
Table 80 - READ BUFFER command inputs	222
Table 81 - READ BUFFER DMA command inputs	223
Table 82 - READ DMA command inputs	224
Table 83 - READ DMA EXT command inputs	225
Table 84 - READ FPDMA QUEUED command inputs	227
Table 85 - READ LOG EXT command inputs	229
Table 86 - READ LOG DMA EXT command inputs	231
Table 87 - RECEIVE FPDMA QUEUED command encapsulation for the subcommand specific inputs from a READ LOG DMA EXT command	232
Table 88 - READ SECTOR(S) command inputs	233
Table 89 - READ SECTOR(S) EXT command inputs	234
Table 90 - READ STREAM DMA EXT command inputs	235
Table 91 - READ STREAM EXT command inputs	238
Table 92 - READ VERIFY SECTOR(S) command inputs	239
Table 93 - READ VERIFY SECTOR(S) EXT command inputs	240
Table 94 - RECEIVE FPDMA QUEUED command inputs	241
Table 95 - RECEIVE FPDMA QUEUED Subcommands	242
Table 96 - REMOVE ELEMENT AND TRUNCATE command inputs	243
Table 97 - REQUEST SENSE DATA EXT command inputs	245
Table 98 - RESTORE ELEMENTS AND REBUILD command inputs	246
Table 99 - Sanitize Device FEATURE field values	248
Table 100 - BLOCK ERASE EXT command inputs	250
Table 101 - CRYPTO SCRAMBLE EXT command inputs	253
Table 102 - OVERWRITE EXT command inputs	256
Table 103 - SANITIZE ANTIFREEZE LOCK EXT command inputs	258
Table 104 - SANITIZE FREEZE LOCK EXT command inputs	261
Table 105 - SANITIZE STATUS EXT command inputs	263
Table 106 - SECURITY DISABLE PASSWORD command inputs	265
Table 107 - SECURITY DISABLE PASSWORD data content	266

Table 108 - SECURITY ERASE PREPARE command inputs	267
Table 109 - Erase Mode characteristics	268
Table 110 - SECURITY ERASE UNIT command inputs	269
Table 111 - SECURITY ERASE UNIT data content	270
Table 112 - SECURITY FREEZE LOCK command inputs	271
Table 113 - SECURITY SET PASSWORD command inputs	273
Table 114 - SECURITY SET PASSWORD data content	274
Table 115 - SECURITY UNLOCK command inputs	276
Table 116 - SECURITY UNLOCK data content	277
Table 117 - SEND FPDMA QUEUED command inputs	278
Table 118 - SEND FPDMA QUEUED Subcommands	279
Table 119 - HYBRID EVICT command inputs	281
Table 120 - Output from the host for the HYBRID EVICT command	282
Table 121 - SET DATE & TIME EXT command inputs	284
Table 122 - SET FEATURES command inputs	285
Table 123 - NCQ NON-DATA command encapsulation for the subcommand specific inputs from a SET FEATURES command	286
Table 124 - SET FEATURES command subcommand codes	286
Table 125 - Transfer modes	289
Table 126 - APM levels	290
Table 127 - Write-Read-Verify modes	291
Table 128 - Enable/Disable Command Duration Limits parameters	292
Table 129 - CDL ACTION field	293
Table 130 - Maximum Host Interface Sector Times	294
Table 131 - SATA features	295
Table 132 - Extended Uses of Hardware Feature Control	297
Table 133 - EPC subcommands	301
Table 134 - POWER CONDITION ID field	301
Table 135 - Restore Power Condition Settings inputs	302
Table 136 - Go To Power Condition inputs	304
Table 137 - Set Power Condition Timer inputs	306
Table 138 - Set Power Condition State inputs	308
Table 139 - Enable the EPC feature set inputs	309
Table 140 - Disable the EPC feature set inputs	310
Table 141 - Set EPC Power Source inputs	311
Table 142 - DSN feature set subcommands	312
Table 143 - SET FEATURES fields for Advanced Background Operation Control	312
Table 144 - ABO CONTROL field	313
Table 145 - SET SECTOR CONFIGURATION EXT command inputs	316
Table 146 - SLEEP command inputs	318
Table 147 - FEATURE field values	319
Table 148 - SMART READ LOG command inputs	320
Table 149 - SMART RETURN STATUS command inputs	321
Table 150 - SMART WRITE LOG command inputs	322
Table 151 - STANDBY command inputs	324
Table 152 - STANDBY IMMEDIATE command inputs	325
Table 153 - TRUSTED NON-DATA command inputs	326
Table 154 - TRUSTED RECEIVE command inputs	329
Table 155 - TRUSTED RECEIVE SECURITY PROTOCOL field	330
Table 156 - Security Protocol 00h SP SPECIFIC field	331
Table 157 - TRUSTED RECEIVE parameter data for SP Specific=0000h	331
Table 158 - TRUSTED RECEIVE parameter data for SP Specific=0001h	332
Table 159 - TRUSTED RECEIVE parameter data for SP Specific=0002h	333
Table 160 - Compliance Descriptor Type	333
Table 161 - Compliance Descriptor Header	333
Table 162 - Security Requirements for Cryptographic Modules descriptor	334
Table 163 - TRUSTED RECEIVE DMA command inputs	335

Table 164 - TRUSTED SEND command inputs.....	336
Table 165 - TRUSTED SEND – SECURITY PROTOCOL field.....	337
Table 166 - TRUSTED SEND DMA command inputs.....	338
Table 167 - WRITE BUFFER command inputs.....	339
Table 168 - WRITE BUFFER DMA command inputs.....	340
Table 169 - WRITE DMA command inputs.....	341
Table 170 - WRITE DMA EXT command inputs.....	342
Table 171 - WRITE DMA FUA EXT command inputs.....	343
Table 172 - WRITE FPDMA QUEUED command inputs.....	345
Table 173 - WRITE LOG EXT command inputs.....	347
Table 174 - WRITE LOG DMA EXT command inputs.....	349
Table 175 - SEND FPDMA QUEUED command encapsulation for the subcommand specific inputs from a WRITE LOG DMA EXT command.....	350
Table 176 - WRITE SECTOR(S) command inputs.....	351
Table 177 - WRITE SECTOR(S) EXT command inputs.....	352
Table 178 - WRITE STREAM DMA EXT command inputs.....	353
Table 179 - WRITE STREAM EXT command inputs.....	356
Table 180 - WRITE UNCORRECTABLE EXT command inputs.....	358
Table 181 - ZERO EXT command inputs.....	360
Table 182 - NCQ-NON-DATA command encapsulation for the subcommand specific inputs from a ZERO EXT command.....	361
Table 183 - Summary of SCT Command Transport logs.....	362
Table 184 - Summary of ATA commands used by the SCT Command Transport.....	362
Table 185 - Fields to send an SCT Command using SMART WRITE LOG.....	364
Table 186 - Fields to send an SCT Command using GPL write logs.....	365
Table 187 - Successful SCT Command response.....	366
Table 188 - SCT Command error response.....	367
Table 189 - EXTENDED STATUS CODE field.....	368
Table 190 - SCT data transfer using the SMART feature set.....	369
Table 191 - SCT data transfer using the GPL feature set.....	370
Table 192 - Successful SMART SCT data transfer response.....	371
Table 193 - Successful GPL SCT data transfer response.....	372
Table 194 - SMART SCT data transfer error response.....	373
Table 195 - GPL SCT data transfer error response.....	374
Table 196 - SCT status request using the SMART feature set.....	375
Table 197 - SCT status request using the GPL feature set.....	376
Table 198 - Successful SMART SCT status response.....	377
Table 199 - Successful GPL SCT status response.....	378
Table 200 - Format of SCT status response.....	379
Table 201 - SMART STATUS field.....	380
Table 202 - SMART and GPL SCT status error response.....	381
Table 203 - SCT command basic key page structure.....	382
Table 204 - ACTION CODE field.....	382
Table 205 - SCT Write Same command key page.....	386
Table 206 - SCT Write Same command status response.....	387
Table 207 - SCT Error Recovery Control command key page.....	389
Table 208 - SCT Error Recovery Control command status response.....	391
Table 209 - SCT ERROR RECOVERY CONTROL RETURNED VALUE field.....	392
Table 210 - SCT Feature Control command key page.....	393
Table 211 - Feature Code list.....	394
Table 212 - Options Flags for each Feature Code.....	395
Table 213 - SCT Feature Control command status response.....	396
Table 214 - SCT Data Table command.....	397
Table 215 - TABLE ID field.....	397
Table 216 - HDA Temperature History table.....	398
Table 217 - SCT Data Table command status response.....	400
Table 218 - Log address definition.....	401

Table 219 - General Purpose Log Directory	404
Table 220 - SMART Log Directory	405
Table 221 - Comprehensive SMART Error log	406
Table 222 - Defined Device Statistics log pages	408
Table 223 - Device Statistic format	408
Table 224 - DEVICE STATISTIC FLAGS field	409
Table 225 - FEATURE field for READ LOG EXT and READ LOG DMA EXT	410
Table 226 - List of supported Device Statistics log pages	411
Table 227 - Command Duration Limits Statistics	412
Table 228 - Free Fall Statistics	419
Table 229 - General Statistics	421
Table 230 - Workload Utilization device statistic	426
Table 231 - RATE VALIDITY field	426
Table 232 - RATE BASIS field	427
Table 233 - Utilization Usage Rate values	427
Table 234 - Random write resources values	428
Table 235 - General Error Statistics	429
Table 236 - Rotating Media Statistics	431
Table 237 - Solid State Device Statistics	436
Table 238 - Temperature Statistics	437
Table 239 - Transport Statistics	444
Table 240 - Vendor Specific Statistics	445
Table 241 - Extended Comprehensive SMART Error log	448
Table 242 - Extended Error log data structure	449
Table 243 - Command data structure	450
Table 244 - Error data structure	451
Table 245 - State field values	451
Table 246 - Idle Power Conditions log page	453
Table 247 - Standby Power Conditions log page	453
Table 248 - Power Conditions log descriptor	454
Table 249 - Defined IDENTIFY DEVICE data log pages	459
Table 250 - List of supported IDENTIFY DEVICE data log pages	460
Table 251 - Capacity	461
Table 252 - Supported Capabilities	464
Table 253 - Nominal Media Rotation Rate	479
Table 254 - NOMINAL FORM FACTOR field	479
Table 255 - World wide name format (word-based view)	480
Table 256 - IDENTIFY DEVICE data WWN format (word-based view)	481
Table 257 - IDENTIFY DEVICE data WWN format (byte-based view)	481
Table 258 - LOGICAL BLOCK MARKUPS SUPPORTED field	482
Table 259 - SCSI Block Commands logical block markup descriptor format	482
Table 260 - Operating system file logical block markup descriptor values	483
Table 261 - UTILIZATION TYPE field	484
Table 262 - UTILIZATION UNITS field	484
Table 263 - UTILIZATION INTERVAL field	485
Table 264 - Current Settings	490
Table 265 - POWER SOURCE field	494
Table 266 - ABO STATUS field	497
Table 267 - Strings	498
Table 268 - Security	499
Table 269 - Short format ENHANCED SECURITY ERASE TIME field	502
Table 270 - Extended format ENHANCED SECURITY ERASE TIME field	502
Table 271 - Short format NORMAL SECURITY ERASE TIME field	502
Table 272 - Extended format NORMAL SECURITY ERASE TIME field	503
Table 273 - Parallel ATA	504
Table 274 - PATA device number detected coded values	512
Table 275 - Serial ATA	515

Table 276 - CURRENT NEGOTIATED SERIAL ATA SIGNAL SPEED field	522
Table 277 - Command Duration Limits Log (page 0).....	525
Table 278 - PERFORMANCE VERSUS COMMAND DURATION GUIDELINES field	526
Table 279 - Command Duration Limits Descriptor	527
Table 280 - INACTIVE TIME LIMIT POLICY field	527
Table 281 - ACTIVE TIME LIMIT POLICY field	528
Table 282 - COMMAND DURATION GUIDELINE POLICY field	528
Table 283 - COMMAND DURATION LIMITS STATISTIC SELECTOR field.....	530
Table 284 - Defined LBA Status log pages.....	532
Table 285 - Number of Valid LBA Ranges log page	532
Table 286 - LBA Status log page	533
Table 287 - LBA Status Descriptor	533
Table 288 - LPS Mis-alignment log (log page 0).....	535
Table 289 - LPS Mis-alignment log (log pages 1..x)	536
Table 290 - NCQ Command Error log	537
Table 291 - Read Stream Error log	541
Table 292 - Stream Error Log Entry	542
Table 293 - SATA Phy Event Counters log Format	543
Table 294 - SATA NCQ Non-Data log (log page 00h).....	544
Table 295 - SATA NCQ Send and Receive log (log page 00h)	548
Table 296 - Hybrid Information Log data	551
Table 297 - Hybrid Information Header.....	552
Table 298 - ENABLED field.....	553
Table 299 - HYBRID HEALTH field	553
Table 300 - SUPPORTED OPTIONS field	554
Table 301 - Hybrid Information Descriptor	555
Table 302 - Rebuild Assist log (log page 00h)	557
Table 303 - MANAGE REBUILD ASSIST bit.....	558
Table 304 - Selective Self-Test log	559
Table 305 - FEATURE FLAGS field	560
Table 306 - Summary SMART Error log	561
Table 307 - Error log data structure	561
Table 308 - Command data structure	562
Table 309 - Error data structure.....	563
Table 310 - State values	563
Table 311 - Write Stream Error log	565
Table 312 - Current Device Internal Status Data header (page 0).....	567
Table 313 - Current Device Internal Status Data (pages 1..n).....	568
Table 314 - Saved Device Internal Status Data header (page 0)	571
Table 315 - Saved Device Internal Status Data (pages 1..n).....	572
Table 316 - Device Statistics Notifications pages	573
Table 317 - Summary page of the Device Statistics Notifications log.....	574
Table 318 - DSN Match Entry	574
Table 319 - Definition pages of the Device Statistics Notifications log	575
Table 320 - DSN CONDITION FLAGS field.....	576
Table 321 - Pending Defects log (page 0)	577
Table 323 - Pending Defects descriptor format	578
Table 322 - Pending Defects log (page 1..n)	578
Table 324 - Sense Data for Successful NCQ Commands log pages 0 and 1.....	579
Table 325 - Successful Sense Data descriptor format.....	581
Table 326 - Sector Configuration descriptors (log page 00h)	582
Table 327 - Sector Configuration descriptor	582
Table 328 - Mutate Configurations log	584
Table 329 - Mutate Configurations header	584
Table 330 - Mutate Configuration descriptor.....	585
Table 331 - CONFIGURATION IDENTIFIER field	586
Table 332 - SCHEMA TYPE field	587

Table 333 - Host aware zones schema type specific information.....	588
Table 334 - Host managed zones schema type specific information.....	588
Table 335 - Zone domains and zone realms schema type specific information	590
Table 336 - Concurrent Positioning Ranges log	591
Table 337 - Concurrent Positioning Ranges header.....	591
Table 338 - LBA range descriptor	592
Table 339 - Sense Data log	594
Table 340 - Out Of Band Management Control Log	596
Table 341 - Attribute control descriptor format.....	597
Table 342 - DESCRIPTOR IDENTIFIER field	598
Table 343 - Temperature attribute control descriptor format.....	599
Table 344 - TEST MODE field	601
Table 345 - Generic Normal Output (No LBA Return Value) for Normal Output.....	602
Table 346 - Download Microcode Normal Output.....	603
Table 347 - Check Power Mode Normal Output	604
Table 348 - Stream Normal Output.....	606
Table 349 - Device Signatures for Normal Output	607
Table 350 - IDLE Unload Normal Output.....	608
Table 351 - SMART Return Status Normal Output.....	609
Table 352 - Generic Extended Normal Output.....	610
Table 353 - NCQ Command Acceptance Normal Output	611
Table 354 - NCQ Normal Output	612
Table 355 - REQUEST SENSE DATA EXT Normal Output	613
Table 356 - GET NATIVE MAX ADDRESS EXT Normal Output.....	614
Table 357 - Sanitize Device Normal Output.....	615
Table 358 - Restore Physical Elements Normal Output.....	616
Table 359 - Unsupported Command Error.....	618
Table 360 - Check Power Mode Abort Error.....	619
Table 361 - Generic Abort wo/ICRC Error	620
Table 362 - Generic Abort Error.....	621
Table 363 - Trusted Abort Error	622
Table 364 - Configure Stream Error.....	623
Table 365 - Flush Cache Error.....	624
Table 366 - Flush Cache Ext Error	625
Table 367 - Read DMA Ext Error	626
Table 368 - Read Log Ext Error	627
Table 369 - Read PIO Error	628
Table 370 - Read Stream Error.....	629
Table 371 - Write Log Error	630
Table 372 - Write Log Ext Error or Data Set Management Error	631
Table 373 - Write Extended Error	632
Table 374 - Write Stream Error.....	633
Table 375 - Non-Data Write Extended Error	634
Table 376 - NOP Error	635
Table 377 - SMART Read Log.....	636
Table 378 - Read PIO Extended Error.....	637
Table 379 - SET ACCESSIBLE MAX ADDRESS EXT Error	638
Table 380 - Write Error	639
Table 381 - Write DMA Error	640
Table 382 - NCQ Command Acceptance Error.....	641
Table 383 - Generic NCQ Command Aborted Error	642
Table 384 - NCQ Read Command Aborted Error	643
Table 385 - Sanitize Device Error	644
Table A.1 - Command Code Usage Matrix	645
Table A.2 - Command codes (sorted by command code).....	646
Table A.3 - Command codes (sorted by command name)	651
Table A.4 - Historical Command Assignments.....	654

Table A.5 - Historical SET FEATURE Code Assignments.....	663
Table B.1 - SCT command using SMART WRITE LOG command	680
Table B.2 - SCT command using WRITE LOG EXT command	681

Figures

	Page
Figure 1 - ATA document relationships.....	1
Figure 2 - State diagram convention	15
Figure 3 - Byte, word, DWord, QWord, and DQWord relationships	17
Figure 4 - LLS and LPS Example	47
Figure 5 - Alignment 0.....	47
Figure 6 - Alignment 1.....	48
Figure 7 - Alignment 3.....	48
Figure 8 - Power management state diagram.....	56
Figure 9 - Sanitize Device state machine	67
Figure 10 - Security state diagram.....	78
Figure 11 - DOWNLOAD MICROCODE State Machine	136
Figure 12 - Example of a Device Internal Status log with data in all three data areas.....	569
Figure 13 - Example of a Device Internal Status log with no data	570
Figure 14 - Example of a Device Internal Status log with mixed data areas.....	570
Figure 15 - Example for Concurrent Positioning Ranges log with 4 LBA ranges.....	593
Figure B.1 - Example flowchart for SCT commands	673
Figure B.2 - Example sequence for foreground write same with a repeating write pattern.....	674
Figure B.3 - Example sequence for foreground write same with a repeating pattern	674
Figure B.4 - Example sequence for writing data using an SCT command with no background activity	675
Figure B.5 - Example sequence for reading data using an SCT command with no background activity.....	675
Figure B.6 - Example sequence for a Non-Data SCT command with no background activity	676
Figure B.7 - Example sequence for writing data using an SCT command with background activity	677
Figure B.8 - Example sequence for writing data using multiple write data transfers.....	678
Figure B.9 - Example sequence for a Non-Data SCT command with background activity	679
Figure C.1 - System Dependency Chain	683
Figure C.2 - Mapping Proposals	684
Figure C.3 - Logical Sector to Physical Mapping	684
Figure C.4 - Uncorrectable Error Handling.....	686
Figure C.5 - Typical HDD Layout Using A Master Boot Record.....	687