

ISO/IEC 17760-103:2021-06 (E)

Information technology - AT Attachment - Part 103: ATA/ATAPI Command Set - 3 (ACS-3)

Contents

Page

FOREWORD.....	16
INTRODUCTION	18
1 Scope	20
2 Normative references	20
3 Terms, definitions, abbreviations, and conventions	21
3.1 Terms and definitions	21
3.2 Symbols and abbreviations.....	30
3.2.1 Abbreviations	30
3.2.2 Units:	31
3.2.3 Mathematical operators:	31
3.2.4 Other Symbols	31
3.3 Conventions.....	31
3.3.1 Overview	31
3.3.2 Precedence	32
3.3.3 Lists	32
3.3.4 Keywords	33
3.3.5 Numbering	34
3.3.6 Bit conventions	35
3.3.7 Number range convention	35
3.3.8 State diagram conventions	35
3.3.9 Byte, word, DWord, QWord, and DQWord Relationships	37
3.3.10 ATA string convention	38
3.3.11 Offset Convention	39
4 Feature set definitions	40
4.1 Overview.....	40
4.1.1 Feature set summary	40
4.1.2 Capacity reporting	41
4.2 General feature set	42
4.3 The PACKET feature set	42
4.3.1 Overview	42
4.3.2 Identification of PACKET feature set devices	43
4.3.3 Signature for ATAPI devices	43
4.3.4 The PACKET command	43
4.4 48-bit Address feature set.....	43
4.5 Accessible Max Address Configuration feature set	44
4.5.1 Overview	44
4.5.2 SET ACCESSIBLE MAX ADDRESS EXT description	44
4.5.3 Device Statistics data	44
4.6 Advanced Power Management (APM) feature set	44
4.7 CompactFlash Association (CFA) feature set.....	45
4.8 Device Statistics Notification (DSN) feature set.....	45
4.8.1 Overview	45
4.8.2 DSN notifications	46
4.8.3 DSN notifications setup	46
4.9 Extended Power Conditions (EPC) feature set.....	47
4.9.1 Overview	47
4.9.2 Power conditions	47
4.9.3 Power condition timers	47
4.9.4 Interaction with resets, commands, and other features if the EPC feature set is enabled	48

4.10	Free-fall Control feature set	49
4.11	General Purpose Logging (GPL) feature set	49
4.12	Long Logical Sector (LLS) feature set	50
4.13	Long Physical Sector (LPS) feature set	51
4.14	Native Command Queuing (NCQ) feature set	53
4.14.1	Overview	53
4.14.2	Priority	54
4.14.3	Unload with NCQ commands outstanding	54
4.14.4	Command Phases	54
4.15	Power Management feature set.....	55
4.15.1	Overview	55
4.15.2	Power management commands	55
4.15.3	Standby timer	56
4.15.4	Power Management states and transitions	57
4.16	Power-Up In Standby (PUIS) feature set.....	60
4.16.1	Overview	60
4.16.2	Interactions with IDENTIFY DEVICE and IDENTIFY PACKET DEVICE commands	60
4.16.3	PUIS feature set device spin-up subcommand	60
4.17	Sanitize Device feature set	61
4.17.1	Overview	61
4.17.2	Sanitize operation scope	61
4.17.3	Sanitize commands	61
4.17.4	Sanitize operations	61
4.17.5	Command processing during sanitize operations	62
4.17.6	Sanitize Operation Completed Without Error value	62
4.17.7	Failure Mode Policy value	62
4.17.8	Sanitize Antifreeze value	63
4.17.9	Sanitize Device state machine	63
4.18	Security feature set.....	66
4.18.1	Overview	66
4.18.2	Disabling and enabling the Security feature set	66
4.18.3	Passwords	66
4.18.4	Master password capability	67
4.18.5	Frozen mode	67
4.18.6	Commands	67
4.18.7	Security initial setting	67
4.18.8	Password Rules	67
4.18.9	Password attempt counter and SECURITY COUNT EXPIRED bit	68
4.18.10	Master Password Identifier feature	68
4.18.11	Security states	69
4.19	Self-Monitoring, Analysis, and Reporting Technology (SMART) feature set	78
4.19.1	Overview	78
4.19.2	Device SMART data structure	78
4.19.3	Background data collection	78
4.19.4	Off-line/Captive mode data collection	78
4.19.5	Threshold exceeded condition	79
4.19.6	SMART feature set commands	79
4.19.7	SMART operation with power management modes	79
4.19.8	SMART device error log reporting	79
4.20	Sense Data Reporting feature set	79
4.21	Software Settings Preservation (SSP) feature set.....	80
4.22	SATA Hardware Feature Control.....	81
4.23	Streaming feature set	82
4.23.1	Streaming feature set overview	82
4.23.2	Streaming commands	82
4.24	Trusted Computing feature set	83
4.25	Write-Read-Verify feature set	84

5 ATA protocols	85
6 Normal and Error Output field descriptions	86
6.1 Overview	86
6.2 STATUS field	86
6.2.1 Overview	86
6.2.2 ALIGNMENT ERROR bit	86
6.2.3 BUSY bit	87
6.2.4 CHECK CONDITION bit	87
6.2.5 DATA REQUEST bit	87
6.2.6 DEFERRED WRITE ERROR bit	87
6.2.7 DEVICE FAULT bit	87
6.2.8 DEVICE READY bit	87
6.2.9 ERROR bit	87
6.2.10 SENSE DATA AVAILABLE bit	88
6.2.11 STREAM ERROR bit	88
6.2.12 Transport Dependent bits and fields	88
6.3 ERROR field	89
6.3.1 Overview	89
6.3.2 ABORT bit	89
6.3.3 COMMAND COMPLETION TIME OUT bit	89
6.3.4 END OF MEDIA bit	89
6.3.5 ID NOT FOUND bit	89
6.3.6 ILLEGAL LENGTH INDICATOR bit	90
6.3.7 INTERFACE CRC bit	90
6.3.8 SENSE KEY field	90
6.3.9 UNCORRECTABLE ERROR bit	90
6.4 INTERRUPT REASON field	90
6.4.1 Overview	90
6.4.2 COMMAND/DATA bit	90
6.4.3 INPUT/OUTPUT bit	90
6.5 COUNT field	90
6.5.1 Overview	90
6.5.2 Contiguous stream logical sectors that contain potentially bad data	90
6.5.3 NCQ Tag	91
6.6 SACTIVE field	91
6.7 SATA STATUS field	91
6.8 LBA field	91
6.8.1 Overview	91
6.8.2 LBA of First Unrecoverable Error	91
7 Command descriptions	92
7.1 Command description introduction	92
7.1.1 Overview	92
7.1.10 Command Code Usage	96
7.2 Accessible Max Address Configuration	97
7.2.1 Accessible Max Address Configuration overview	97
7.2.2 GET NATIVE MAX ADDRESS EXT – 78h/0000h, Non-Data	97
7.2.3 SET ACCESSIBLE MAX ADDRESS EXT – 78h/0001h, Non-Data	98
7.2.4 FREEZE ACCESSIBLE MAX ADDRESS EXT – 78h/0002h, Non-Data	99
7.3 CHECK POWER MODE – E5h, Non-Data	100
7.4 CONFIGURE STREAM – 51h, Non-Data	101
7.5 DATA SET MANAGEMENT – 06h, DMA	103
7.6 DEVICE RESET – 08h, Device Reset	106
7.7 DOWNLOAD MICROCODE – 92h, PIO Data-Out/Non-Data	107
7.8 DOWNLOAD MICROCODE DMA – 93h, DMA	120
7.9 EXECUTE DEVICE DIAGNOSTIC – 90h, Execute Device Diagnostic	121

7.10	FLUSH CACHE – E7h, Non-Data	123
7.11	FLUSH CACHE EXT – EAh, Non-Data	124
7.12	IDENTIFY DEVICE – ECh, PIO Data-In	125
7.13	IDENTIFY PACKET DEVICE – A1h, PIO Data-In	162
7.14	IDLE – E3h, Non-Data	182
7.15	IDLE IMMEDIATE – E1h, Non-Data	184
7.16	NCQ QUEUE MANAGEMENT – 63h, Non-Data	186
7.16.8	ABORT NCQ QUEUE – 63h/0h, Non-Data	188
7.16.9	DEADLINE HANDLING – 63h/1h, Non-Data	191
7.17	NOP – 00h, Non-Data	194
7.18	PACKET – A0h, Packet	195
7.19	READ BUFFER – E4h, PIO Data-In	198
7.20	READ BUFFER DMA – E9h, DMA	199
7.21	READ DMA – C8h, DMA	200
7.22	READ DMA EXT – 25h, DMA	201
7.23	READ FPDMA QUEUED – 60h, DMA Queued	202
7.24	READ LOG EXT – 2Fh, PIO Data-In	204
7.25	READ LOG DMA EXT – 47h, DMA	206
7.26	READ MULTIPLE – C4h, PIO Data-In	207
7.27	READ MULTIPLE EXT – 29h, PIO Data-In	208
7.28	READ SECTOR(S) – 20h, PIO Data-In	209
7.29	READ SECTOR(S) EXT – 24h, PIO Data-In	210
7.30	READ STREAM DMA EXT – 2Ah, DMA	211
7.31	READ STREAM EXT – 2Bh, PIO Data-In	214
7.32	READ VERIFY SECTOR(S) – 40h, Non-Data	215
7.33	READ VERIFY SECTOR(S) EXT – 42h, Non-Data	216
7.34	RECEIVE FPDMA QUEUED – 65h, DMA Queued	217
7.35	REQUEST SENSE DATA EXT – 0Bh, Non-Data	219
7.36	Sanitize Device	220
7.36.2	BLOCK ERASE EXT – B4h/0012h, Non-Data	221
7.36.3	CRYPTO SCRAMBLE EXT – B4h/0011h, Non-Data	224
7.36.4	OVERWRITE EXT – B4h/0014h, Non-Data	226
7.36.5	SANITIZE ANTIFREEZE LOCK EXT – B4h/0040h, Non-Data	229
7.36.6	SANITIZE FREEZE LOCK EXT – B4h/0020h, Non-Data	231
7.36.7	SANITIZE STATUS EXT – B4h/0000h, Non-Data	232
7.37	SECURITY DISABLE PASSWORD – F6h, PIO Data-Out	234
7.38	SECURITY ERASE PREPARE – F3h, Non-Data	236
7.39	SECURITY ERASE UNIT – F4h, PIO Data-Out	237
7.40	SECURITY FREEZE LOCK – F5h, Non-Data	239
7.41	SECURITY SET PASSWORD – F1h, PIO Data-Out	240
7.42	SECURITY UNLOCK – F2h, PIO Data-Out	242
7.43	SEND FPDMA QUEUED – 64h, DMA Queued	244
7.43.4	SFQ DATA SET MANAGEMENT – 64h/00h, DMA Queued	246
7.44	SET DATE & TIME EXT – 77h, Non-Data	248
7.45	SET FEATURES – EFh, Non-Data	249
7.45.6	SET FEATURES subcommands	250
7.45.7	Enable/disable volatile write cache	252
7.45.8	Set transfer mode	253
7.45.9	Enable/disable the APM feature set	254
7.45.10	Enable/disable the PUIS feature set	254
7.45.11	PUIS feature set device spin-up	254
7.45.12	Enable/Disable Write-Read-Verify feature set	255
7.45.13	Set Maximum Host Interface Sector Times	256
7.45.14	Enable/disable read look-ahead	256
7.45.15	Enable/disable reverting to defaults	256
7.45.16	Enable/Disable the Free-fall Control feature set	257
7.45.17	Enable/Disable SATA feature	257

7.45.18	Enable/Disable the Sense Data Reporting feature set	259
7.45.19	Long Physical Sector Alignment Error Reporting Control	259
7.45.20	Extended Power Conditions subcommand	260
7.45.21	Enable/Disable the DSN feature set	270
7.46	SET MULTIPLE MODE – C6h, Non-Data	271
7.47	SLEEP – E6h, Non-Data	273
7.48	SMART	274
7.48.2	SMART DISABLE OPERATIONS – B0h/D9h, Non-Data	275
7.48.3	SMART ENABLE/DISABLE ATTRIBUTE AUTOSAVE – B0h/D2h, Non-Data	276
7.48.4	SMART ENABLE OPERATIONS – B0h/D8h, Non-Data	278
7.48.5	SMART EXECUTE OFF-LINE IMMEDIATE – B0h/D4h, Non-Data	279
7.48.6	SMART READ DATA – B0h/D0h, PIO Data-In	283
7.48.7	SMART READ LOG – B0h/D5h, PIO Data-In	288
7.48.8	SMART RETURN STATUS – B0h/DAh, Non-Data	289
7.48.9	SMART WRITE LOG – B0h/D6h, PIO Data-Out	290
7.49	STANDBY – E2h, Non-Data	291
7.50	STANDBY IMMEDIATE – E0h, Non-Data	292
7.51	TRUSTED NON-DATA – 5Bh, Non-Data	293
7.52	TRUSTED RECEIVE – 5Ch, PIO Data-In	295
7.53	TRUSTED RECEIVE DMA – 5Dh, DMA	302
7.54	TRUSTED SEND – 5Eh, PIO Data-Out	303
7.55	TRUSTED SEND DMA – 5Fh, DMA	305
7.56	WRITE BUFFER – E8h, PIO Data-Out	306
7.57	WRITE BUFFER DMA – EBh, DMA	307
7.58	WRITE DMA – CAh, DMA	308
7.59	WRITE DMA EXT – 35h, DMA	309
7.60	WRITE DMA FUA EXT – 3Dh, DMA	310
7.61	WRITE FPDMA QUEUED – 61h, DMA Queued	311
7.62	WRITE LOG EXT – 3Fh, PIO Data-Out	313
7.63	WRITE LOG DMA EXT – 57h, DMA	315
7.64	WRITE MULTIPLE – C5h, PIO Data-Out	316
7.65	WRITE MULTIPLE EXT – 39h, PIO Data-Out	317
7.66	WRITE MULTIPLE FUA EXT – CEh, PIO Data-Out	319
7.67	WRITE SECTOR(S) – 30h, PIO Data-Out	321
7.68	WRITE SECTOR(S) EXT – 34h, PIO Data-Out	322
7.69	WRITE STREAM DMA EXT – 3Ah, DMA	323
7.70	WRITE STREAM EXT – 3Bh, PIO Data-Out	326
7.71	WRITE UNCORRECTABLE EXT – 45h, Non-Data	327
8	SCT Command Transport	329
8.1	Introduction	329
8.1.1	Overview	329
8.1.2	SCT command interactions with ATA commands	330
8.1.3	Resets	330
8.2	Processing SCT commands	331
8.2.1	Processing SCT commands overview	331
8.2.2	SCT capability identification	331
8.2.3	SCT Command transfer	331
8.2.4	SCT data transfer	336
8.2.5	SCT status	342
8.3	SCT Command Set	348
8.3.1	Overview	348
8.3.2	SCT Write Same command	349
8.3.3	SCT Error Recovery Control command	354
8.3.4	SCT Feature Control command	356
8.3.5	SCT Data Table command	360

9 Normal and Error Outputs	364
9.1 Overview	364
9.2 Normal Outputs.....	364
9.3 Error Outputs	380
Annex A (normative) Log Definitions	409
A.1 Overview	409
A.2 General Purpose Log Directory (GPL Log Address 00h)	412
A.3 SMART Log Directory (SMART Logging Log Address 00h)	412
A.4 Comprehensive SMART Error log (Log Address 02h)	413
A.5 Device Statistics log (Log Address 04h)	414
A.5.1 Overview	414
A.5.2 List of Supported Device Statistics log pages (log page 00h)	416
A.5.3 Free Fall Statistics (log page 02h)	417
A.5.4 General Statistics (log page 01h)	419
A.5.5 General Errors Statistics (log page 04h)	423
A.5.6 Rotating Media Statistics (log page 03h)	425
A.5.7 Solid State Device Statistics (log page 07h)	430
A.5.8 Temperature Statistics (log page 05h)	431
A.5.9 Transport Statistics (log page 06h)	439
A.5.10 Reserved (log page 08h..FFh)	441
A.6 Device Vendor Specific logs (Log Addresses A0h-DFh)	441
A.7 Extended Comprehensive SMART Error log (Log Address 03h)	441
A.8 Power Conditions log (Log Address 08h)	445
A.8.2 Idle power conditions (log page 00h)	445
A.8.3 Standby power conditions (log page 01h)	446
A.8.4 Power Conditions log descriptor	446
A.9 Extended SMART Self-Test log (Log Address 07h)	449
A.10 Host Specific logs (Log Addresses 80h-9Fh)	451
A.11 IDENTIFY DEVICE data log (Log Address 30h)	452
A.11.1 Overview	452
A.11.2 List of Supported IDENTIFY DEVICE data log pages (Page 00h)	452
A.11.3 Copy of IDENTIFY DEVICE data (page 01h)	453
A.11.4 Capacity (page 02)	453
A.11.5 Supported Capabilities (page 03h)	456
A.11.6 Current Settings (page 04h)	469
A.11.7 Strings (page 05h)	477
A.11.8 Security (page 06h)	478
A.11.9 Parallel ATA (page 07h)	484
A.11.10 Serial ATA (page 08h)	496
A.12 LBA Status log (Log Address 19h)	502
A.12.1 Overview	502
A.12.2 Number of LBA Valid Ranges log page (Page 0000h)	503
A.12.3 LBA Status log pages	503
A.12.4 LBA Status Descriptor	504
A.13 LPS Mis-alignment log (Log Address 0Dh)	505
A.14 NCQ Command Error log (Log Address 10h)	507
A.14.1 Overview	507
A.14.2 NCQ TAG field	507
A.14.3 NQ bit	507
A.14.4 UNL bit	508
A.14.5 Return Fields	508
A.14.6 NCQ Autosense	508
A.14.7 Checksum	508
A.15 Read Stream Error log (Log Address 22h)	509
A.16 SATA Phy Event Counters log (Log Address 11h)	510
A.17 SATA NCQ Queue Management log (Log Address 12h)	512

A.17.1	Overview	512
A.17.2	SUPPORTS ABORT NCQ QUEUE bit	512
A.17.3	SUPPORTS ABORT ALL AT bit	512
A.17.4	SUPPORTS ABORT STREAMING AT bit	512
A.17.5	SUPPORTS ABORT NON-STREAMING AT bit	513
A.17.6	SUPPORTS ABORT SELECTED TTAG AT bit	513
A.17.7	SUPPORTS DEADLINE HANDLING bit	513
A.17.8	SUPPORTS WDNC bit	513
A.17.9	SUPPORTS RDNC bit	513
A.18	SATA NCQ Send and Receive log (Log Address 13h)	514
A.18.1	Overview	514
A.18.2	SFQ DATA SET MANAGEMENT SUPPORTED bit	514
A.18.3	SFQ DATA SET MANAGEMENT SUPPORTS TRIM bit	514
A.19	Selective Self-Test log (Log Address 09h)	515
A.20	SMART Self-Test log (Log Address 06h)	517
A.21	Summary SMART Error log (Log Address 01h)	518
A.22	Write Stream Error log (Log Address 21h)	521
A.23	Current Device Internal Status Data log (Log Address 24h)	522
A.23.1	Overview	522
A.23.2	Current Device Internal Status Data header page	523
A.23.3	Current Device Internal Status data pages	525
A.23.4	Examples of data area usage	525
A.24	Saved Device Internal Status Data log (Log Address 25h)	527
A.24.1	Overview	527
A.24.2	Saved Device Internal Status Data header page	527
A.24.3	Current Device Internal Status data pages	528
A.25	Device Statistics Notifications log (Log Address 0Ah)	528
Annex B	(informative) Command Set Summary	532
Annex C	(informative) How to Use SCT Commands	559
C.1	How to Use SCT Commands Overview	559
C.2	Examples of Log Page Command Sequences	561
C.3	Issuing an SCT Command to a Device	566
C.3.1	Step 1 – Build a Key Page	566
C.3.2	Step 2 – Issue the SCT command	567
C.3.3	Step 3 – Transfer Data if Required	568
C.3.4	Step 4 – Final Status/SCT Command Completion	569
Annex D	(informative) Implementation Guidelines for 1 024- and 4 096-Byte Sector Sizes	570
D.1	General	570
D.2	Overview	570
D.3	Implementation	572
D.3.1	4 096-Byte Physical Sector Size Implementation	572
D.3.2	Reporting Alignment (512-Byte LBA Only)	572
D.3.3	RMW operations (512-Byte LBA Only)	573
D.4	Implementation Issues (512-Byte LBA Only)	573
D.4.1	Overview	573
D.4.2	Drive Partitioning	574
D.4.3	File System Formatting	575
D.4.4	Virtual Memory accessing	575
D.4.5	Bootting	575
Bibliography	576