

ISO/IEC 17760-302:2025-10 (E)

Information technology - AT Attachment - Part 302: Zoned Device ATA Command Set-2-(ZAC-2)

Contents	Page
Contents.....	iv
Tables	xiii
Figures	xv
1 Scope	1
2 Normative references.....	2
3 Definitions, abbreviations, and conventions.....	3
3.1 Definitions.....	3
3.2 Symbols and abbreviations.....	8
3.2.1 Abbreviations	8
3.2.2 Units	9
3.2.3 Symbols	9
3.2.4 Mathematical operators.....	9
3.3 Keywords.....	9
3.4 Conventions.....	10
3.4.1 Overview	10
3.4.2 Precedence	11
3.4.3 Lists.....	11
3.4.3.1 Lists overview	11
3.4.3.2 Unordered lists.....	11
3.4.3.3 Ordered lists	11
3.4.4 Numbering.....	12
3.4.5 Bit conventions.....	12
3.4.6 Number range convention.....	12
3.4.7 State diagram convention	13
3.4.8 Offset convention	13
4 Features.....	14
4.1 Feature set introduction.....	14
4.2 Basic zoned device model.....	15
4.3 Host Aware Zones feature set.....	16
4.4 Host Managed Zones feature set	17
4.5 Zone Domains feature set	18
4.5.1 Overview	18
4.5.2 Zone Domains.....	19
4.5.3 Zone domain 0	20
4.5.4 Zone domains other than zone domain 0.....	20
4.5.5 Zone activation in the Zone Domains feature set.....	21
4.6 Zone Realms feature set	22
4.6.1 Overview	22
4.6.2 Realm boundary considerations.....	24
4.6.3 Zone activation in the Zone Realms feature set.....	25
4.6.4 Realm attributes	25
4.6.4.1 Introduction.....	25
4.6.4.2 Restrict Write Pointer Reset	25
4.6.4.3 Restrict Zone Activate.....	26

4.7 Zone attributes.....	27
4.7.1 Summary.....	27
4.7.2 Zone Type zone attribute.....	27
4.7.3 Zone Condition zone attribute.....	29
4.7.4 WPointer zone attribute.....	29
4.7.5 RWP Recommended zone attribute.....	29
4.7.6 Non-Sequential Write Resources Active zone attribute.....	30
4.7.7 Predicted Unrecovered Errors Present zone attribute.....	30
4.8 Zone types.....	31
4.8.1 Overview.....	31
4.8.2 Conventional zones.....	31
4.8.2.1 Overview.....	31
4.8.2.2 Access Pattern Requirements.....	31
4.8.2.3 Conventional Zone state machine.....	32
4.8.2.3.1 Overview.....	32
4.8.2.3.2 CMR1: Not Write Pointer state.....	33
4.8.2.3.3 CMR2: Read Only state.....	33
4.8.2.3.4 CMR3: Offline state.....	34
4.8.3 Write pointer zones.....	34
4.8.3.1 Features common to all write pointer zones.....	34
4.8.3.1.1 General.....	34
4.8.3.1.2 Resetting the write pointer.....	35
4.8.3.1.3 Open zone resources.....	36
4.8.3.1.4 Errors common to access pattern requirements for all write pointer zones.....	36
4.8.3.2 Sequential Write Preferred zones.....	37
4.8.3.2.1 Overview.....	37
4.8.3.2.2 Access Pattern Requirements.....	37
4.8.3.2.2.1 Writing in Sequential Write Preferred zones.....	37
4.8.3.2.2.2 Reading in Sequential Write Preferred zones.....	39
4.8.3.2.2.3 Substitute data pattern for Sequential Write Preferred zones.....	39
4.8.3.3 Sequential Write Required zones.....	39
4.8.3.3.1 Overview.....	39
4.8.3.3.2 Access Pattern Requirements.....	39
4.8.3.3.2.1 Writing in Sequential Write Required zones.....	39
4.8.3.3.2.2 Reading in Sequential Write Required zones.....	40
4.8.3.3.2.3 Substitute data pattern for Sequential Write Required zones.....	41
4.8.3.3.2.4 Opening Sequential Write Required zones.....	41
4.8.3.4 Sequential Or Before Required zones.....	41
4.8.3.4.1 Overview.....	41
4.8.3.4.2 Access pattern requirements.....	41
4.8.3.4.2.1 Writing in Sequential Or Before Required zones.....	41
4.8.3.4.2.2 Reading in Sequential Or Before Required zones.....	42
4.8.3.4.2.3 Substitute data pattern for Sequential Or Before Required zones.....	42
4.8.3.5 Zone Condition state machine.....	42
4.8.3.5.1 Overview.....	42
4.8.3.5.2 ZC1: Empty state.....	45
4.8.3.5.3 ZC2: Implicit_Open state.....	46
4.8.3.5.4 ZC3: Explicit_Open state.....	47
4.8.3.5.5 ZC4: Closed state.....	48
4.8.3.5.6 ZC5: Full state.....	49
4.8.3.5.7 ZC6: Read_Only state.....	50
4.8.3.5.8 ZC7: Offline state.....	51
4.8.3.5.9 ZC8: Inactive state.....	51
4.8.3.5.10 Manage Open Zone Resources function.....	51
4.8.3.5.10.1 Overview.....	51
4.8.3.5.10.2 Processing a sequential write preferred zone.....	52
4.8.3.5.10.3 Processing a sequential write required zone.....	52
4.8.3.5.11 Explicitly Open Zone function.....	53
4.8.3.5.12 Close Zone function.....	53
4.8.3.5.13 Finish Zone function.....	53
4.8.3.5.14 Reset Write Pointer function.....	54

4.8.3.5.15 Sequentialize function	54
4.8.4 Gap zones	54
4.9 Additional feature set interactions.....	56
4.9.1 Introduction	56
4.9.2 Capacity reporting	56
4.9.3 Zoned device internal resource management.....	56
4.9.4 Unexpected power removal	56
4.9.5 Media failure.....	57
4.9.6 Interactions with volatile caches.....	57
4.9.7 Interactions with the Sanitize Device feature set	58
4.9.8 Interactions with the Power Management feature set	59
4.9.9 Interactions with the Security feature set	59
4.9.9.1 Interactions with the SECURITY ERASE UNIT command	59
4.9.9.2 Interactions with the SEC4: Security Enabled/Locked/Not Frozen state	60
4.9.10 Interactions with the SCT Write Same command	60
4.9.10.1 Overview.....	60
4.9.10.2 WRITE AND SET SUBSTITUTE DATA PATTERN bit.....	61
4.9.10.3 ZONE POST PROCESSING field	61
4.9.11 Interactions with the WRITE UNCORRECTABLE EXT command.....	61
4.9.12 Interactions with the SET SECTOR CONFIGURATION EXT command and MUTATE EXT command	62
4.9.13 Interactions with the Storage Element Depopulation feature set	62
4.9.13.1 Depopulation operations and depopulation restoration operations	62
4.9.13.2 Depopulation with zone modifications	63
4.9.13.2.1 Depopulation with zone modifications overview.....	63
4.9.13.2.2 Depopulation with zone modifications processing	63
4.9.13.2.2.1 Processing overview.....	63
4.9.13.2.2.2 Predicted unrecovered errors processing.....	64
4.9.13.2.3 Allowed commands during depopulation with zone modifications processing.....	64
4.9.13.2.4 Power-on reset handling	64
4.9.13.2.5 Progress checking during depopulation with zone modifications	65
4.9.13.2.6 Depopulation with zone modifications interactions with logs.....	65
4.9.13.2.7 Depopulation with zone modifications interactions with caches.....	65
5 Command descriptions	66
5.1 Command description introduction	66
5.2 Zone management commands.....	69
5.2.1 Overview	69
5.2.2 ZAC Management In command template, 4Ah, DMA	70
5.2.2.1 Feature Set	70
5.2.2.2 Description.....	70
5.2.2.3 Inputs	70
5.2.2.3.1 Overview	70
5.2.2.3.2 Action specific fields.....	70
5.2.2.3.3 ZM_ACTION field.....	71
5.2.2.3.4 RETURN PAGE COUNT field	71
5.2.2.4 Normal Outputs and Error Outputs	71
5.2.2.5 NCQ encapsulation for a DMA ZAC Management In command	71
5.2.3 ZAC Management Out command template, 9Fh, DMA	72
5.2.3.1 Feature Set	72
5.2.3.2 Description.....	72
5.2.3.3 Inputs	72
5.2.3.3.1 Overview	72
5.2.3.3.2 PAGES TO SEND field.....	72
5.2.3.4 Normal Outputs and Error Outputs	72
5.2.3.5 NCQ encapsulation for a DMA ZAC Management Out command.....	73
5.2.4 ZAC Management Out command template, 9Fh, Non-Data	74

5.2.4.1 Feature Set.....	74
5.2.4.2 Description.....	74
5.2.4.3 Inputs.....	74
5.2.4.3.1 Overview.....	74
5.2.4.3.2 ALL bit.....	74
5.2.4.3.3 Zone range specification fields.....	75
5.2.4.3.3.1 Overview.....	75
5.2.4.3.3.2 ZONE COUNT field.....	75
5.2.4.3.3.3 ZONE ID field.....	75
5.2.4.3.3.4 Zone range specification errors.....	75
5.2.4.4 Normal Outputs.....	75
5.2.4.5 Error Outputs.....	76
5.2.4.6 Non-Data NCQ encapsulation.....	76
5.2.5 CLOSE ZONE EXT command – 9Fh/01h, Non-Data.....	77
5.2.5.1 Feature Set.....	77
5.2.5.2 Description.....	77
5.2.5.3 Inputs.....	77
5.2.5.3.1 Overview.....	77
5.2.5.3.2 Zone range specification fields for the CLOSE ZONE EXT command.....	77
5.2.5.3.3 CLOSE ZONE EXT command processing.....	77
5.2.5.4 Normal Outputs.....	78
5.2.5.5 Error Outputs.....	78
5.2.6 FINISH ZONE EXT command – 9Fh/02h, Non-Data.....	79
5.2.6.1 Feature Set.....	79
5.2.6.2 Description.....	79
5.2.6.3 Inputs.....	79
5.2.6.3.1 Overview.....	79
5.2.6.3.2 Zone range specification fields for the FINISH ZONE EXT command.....	79
5.2.6.3.3 FINISH ZONE EXT command processing.....	80
5.2.6.4 Normal Outputs.....	80
5.2.6.5 Error Outputs.....	80
5.2.7 OPEN ZONE EXT command – 9Fh/03h, Non-Data.....	81
5.2.7.1 Feature Set.....	81
5.2.7.2 Description.....	81
5.2.7.3 Inputs.....	81
5.2.7.3.1 Overview.....	81
5.2.7.3.2 Zone range specification fields for the OPEN ZONE EXT command.....	81
5.2.7.3.3 OPEN ZONE EXT command processing.....	82
5.2.7.4 Normal Outputs.....	82
5.2.7.5 Error Outputs.....	82
5.2.8 REPORT REALMS EXT command – 4Ah/06h, DMA.....	83
5.2.8.1 Feature Set.....	83
5.2.8.2 Description.....	83
5.2.8.3 Inputs.....	83
5.2.8.3.1 Overview.....	83
5.2.8.3.2 REPORTING OPTIONS field.....	83
5.2.8.3.3 REALM LOCATOR field.....	84
5.2.8.4 Normal Outputs.....	84
5.2.8.5 Error Outputs.....	84
5.2.8.6 Input From the Device to the Host Data Structure.....	84
5.2.8.6.1 Overview.....	84
5.2.8.6.2 Report realms header.....	85
5.2.8.6.2.1 Overview.....	85
5.2.8.6.2.2 REALMS COUNT field.....	85
5.2.8.6.2.3 REALMS DESCRIPTOR LENGTH field.....	85
5.2.8.6.2.4 NEXT REALM LOCATOR field.....	85
5.2.8.6.3 Realm descriptor.....	85

5.2.8.6.3.1 Overview	85
5.2.8.6.3.2 REALM ID field	86
5.2.8.6.3.3 REALM RESTRICTIONS field	86
5.2.8.6.3.4 ACTIVE ZONE DOMAIN ID field	86
5.2.8.6.3.5 Realm start/end descriptor	86
5.2.8.6.4 Padding	87
5.2.9 REPORT ZONE DOMAINS EXT command – 4Ah/07h, DMA	88
5.2.9.1 Feature Set	88
5.2.9.2 Description	88
5.2.9.3 Inputs	88
5.2.9.3.1 Overview	88
5.2.9.3.2 REPORTING OPTIONS field	89
5.2.9.3.3 ZONE DOMAIN LOCATOR field	89
5.2.9.4 Normal Outputs	89
5.2.9.5 Error Outputs	89
5.2.9.6 Input From the Device to the Host Data Structure	89
5.2.9.6.1 Overview	89
5.2.9.6.2 Report zone domains header	90
5.2.9.6.2.1 Overview	90
5.2.9.6.2.2 LENGTH AVAILABLE field	90
5.2.9.6.2.3 LENGTH RETURNED field	90
5.2.9.6.2.4 NUMBER OF SUPPORTED DOMAINS field	90
5.2.9.6.2.5 ZONE DOMAINS REPORTED field	90
5.2.9.6.2.6 REPORTING OPTIONS field	90
5.2.9.6.2.7 ZONE DOMAIN LOCATOR field	90
5.2.9.6.3 Zone domain descriptor	91
5.2.9.6.3.1 Overview	91
5.2.9.6.3.2 ZONE DOMAIN ID field	91
5.2.9.6.3.3 ZONE COUNT field	91
5.2.9.6.3.4 START LBA field	91
5.2.9.6.3.5 END LBA field	91
5.2.9.6.3.6 ZONE DOMAIN ZONE TYPE field	91
5.2.9.6.3.7 VALID ZONE DOMAIN ZONE TYPE bit	91
5.2.9.6.3.8 SHIFTING REALM BOUNDARIES bit	92
5.2.10 REPORT ZONES EXT command – 4Ah/00h, DMA	93
5.2.10.1 Feature Set	93
5.2.10.2 Description	93
5.2.10.3 Inputs	93
5.2.10.3.1 Overview	93
5.2.10.3.2 PARTIAL bit	93
5.2.10.3.3 REPORTING OPTIONS field	94
5.2.10.3.4 ZONE LOCATOR field	94
5.2.10.4 Normal Outputs	94
5.2.10.5 Error Outputs	94
5.2.10.6 Input From the Device to the Host Data Structure	95
5.2.10.6.1 Overview	95
5.2.10.6.2 ZONE LIST LENGTH field	95
5.2.10.6.3 SAME field	96
5.2.10.6.4 MAXIMUM LBA field	96
5.2.10.6.5 Zone descriptor format	96
5.2.10.6.5.1 Overview	96
5.2.10.6.5.2 ZONE TYPE field	97
5.2.10.6.5.3 ZONE CONDITION field	98
5.2.10.6.5.4 PREDICTED UNRECOVERED ERRORS bit	98
5.2.10.6.5.5 NON_SEQ bit	98
5.2.10.6.5.6 RESET bit	98
5.2.10.6.5.7 ZONE LENGTH field	98

5.2.10.6.5.8 ZONE START LBA field	98
5.2.10.6.5.9 WRITE POINTER LBA field.....	98
5.2.11 RESET WRITE POINTER EXT command – 9Fh/04h, Non-Data	99
5.2.11.1 Feature Set.....	99
5.2.11.2 Description.....	99
5.2.11.3 Inputs.....	99
5.2.11.3.1 Overview	99
5.2.11.3.2 Zone range specification for the RESET WRITE POINTER EXT command.....	99
5.2.11.3.3 RESET WRITE POINTER EXT command processing.....	99
5.2.11.4 Normal Outputs.....	100
5.2.11.5 Error Outputs	100
5.2.12 SEQUENTIALIZE ZONE EXT command – 9Fh/05h, Non-Data	101
5.2.12.1 Feature Set.....	101
5.2.12.2 Description.....	101
5.2.12.3 Inputs.....	101
5.2.12.3.1 Overview	101
5.2.12.3.2 Zone range specification for the SEQUENTIALIZE ZONE EXT command.....	101
5.2.12.3.3 SEQUENTIALIZE ZONE EXT command processing.....	101
5.2.12.4 Normal Outputs.....	102
5.2.12.5 Error Outputs	102
5.2.13 ZONE ACTIVATE EXT command – 4Ah/08h, DMA	103
5.2.13.1 Feature Set.....	103
5.2.13.2 Description.....	103
5.2.13.2.1 Overview	103
5.2.13.2.2 Selecting the candidate zones to activate and deactivate	103
5.2.13.2.3 Prerequisites reported by sense codes.....	106
5.2.13.2.4 Prerequisites reported in the Zone Activation Results Header.....	106
5.2.13.2.5 Zone Activation processing	107
5.2.13.3 Inputs.....	109
5.2.13.3.1 Overview	109
5.2.13.3.2 OTHER ZONE DOMAIN ID field	109
5.2.13.3.3 ALL bit	109
5.2.13.3.4 NOZSRC field.....	109
5.2.13.3.5 RETURN PAGE COUNT field	110
5.2.13.3.6 ZONE ID field.....	110
5.2.13.3.7 AUXNOZ field.....	110
5.2.13.4 Normal Outputs.....	110
5.2.13.5 Error Outputs	110
5.2.13.6 Input From the Device to the Host Data Structure.....	110
5.2.13.6.1 Overview	110
5.2.13.6.2 Zone Activation Results Header.....	111
5.2.13.6.2.1 Overview.....	111
5.2.13.6.2.2 ZONE ACTIVATION RESULTS LENGTH field	112
5.2.13.6.2.3 ZONE ACTIVATION RESULTS RETURNED field.....	112
5.2.13.6.2.4 NZP_VALIDITY bit	112
5.2.13.6.2.5 ZIWUP_VALIDITY bit.....	112
5.2.13.6.2.6 ACTIVATED bit.....	112
5.2.13.6.2.7 SECURITY PREREQ bit	112
5.2.13.6.2.8 MULTIPLE DOMAINS bit	112
5.2.13.6.2.9 REALM RESTRICTIONS bit.....	112
5.2.13.6.2.10 MULTIPLE ZONE TYPES bit	113
5.2.13.6.2.11 REALM ALIGNMENT bit	113
5.2.13.6.2.12 NOT EMPTY bit.....	113
5.2.13.6.2.13 NOT INACTIVE bit.....	113
5.2.13.6.2.14 OTHER ZONE DOMAIN ID field.....	113
5.2.13.6.2.15 NOZSRC field	113
5.2.13.6.2.16 ALL bit.....	113

5.2.13.6.2.17 NUMBER OF ZONES TO PROCESS field.....	114
5.2.13.6.2.18 ZONE ID WITH UNMET PREREQUISITE field	114
5.2.13.6.3 Zone Activation Descriptor	114
5.2.13.6.3.1 Overview	114
5.2.13.6.3.2 ZONE TYPE field.....	115
5.2.13.6.3.3 ZONE CONDITION field	115
5.2.13.6.3.4 ZONE DOMAIN ID field	115
5.2.13.6.3.5 ZONE RANGE SIZE field.....	115
5.2.13.6.3.6 STARTING ZONE LOCATOR field	115
5.2.14 ZONE QUERY EXT command – 4Ah/09h, DMA	116
5.2.14.1 Feature Set.....	116
5.2.14.2 Description.....	116
5.2.14.3 Inputs	116
5.2.14.4 Normal Outputs.....	116
5.2.14.5 Error Outputs	116
5.2.14.6 Input From the Device to the Host Data Structure	116
5.3 REMOVE ELEMENT AND MODIFY ZONES – 7Eh, Non-Data	117
5.3.3.1 Overview	117
5.3.3.2 ELEMENT IDENTIFIER field.....	117
5.3.3.3 Normal Outputs.....	117
5.3.3.4 Error Outputs	117
5.4 SET FEATURES subcommand additions.....	119
5.4.1 Update urswrz	119
5.4.2 Zone Activation Control.....	119
6 Log definitions	120
6.1 Introduction.....	120
6.2 IDENTIFY DEVICE data log (Log Address 30h).....	120
6.2.1 Overview	120
6.2.2 Zoned Device Information (page 09h).....	120
6.2.2.1 Overview	120
6.2.2.2 REMOVE ELEMENT AND MODIFY ZONES SUPPORTED bit	122
6.2.2.3 URSWRZ bit	122
6.2.2.4 OPTIMAL NUMBER OF OPEN SEQUENTIAL WRITE PREFERRED ZONES field.....	122
6.2.2.5 OPTIMAL NUMBER OF NON-SEQUENTIALLY WRITTEN SEQUENTIAL WRITE PREFERRED ZONES field.....	122
6.2.2.6 MAXIMUM NUMBER OF OPEN SEQUENTIAL WRITE REQUIRED ZONES field	122
6.2.2.7 Version information.....	123
6.2.2.7.1 ZAC MINOR VERSION field	123
6.2.2.8 Zone Activation Capabilities	123
6.2.2.8.1 ZONE DOMAINS FEATURE SUPPORTED bit.....	123
6.2.2.8.2 ZONE REALMS FEATURE SUPPORTED bit	123
6.2.2.8.3 UPDATE URSWRZ SUPPORTED bit	123
6.2.2.8.4 ZONE ACTIVATION CONTROL SUPPORTED bit	123
6.2.2.8.5 NOZSRC SUPPORTED bit	124
6.2.2.8.6 REPORT REALMS COMMAND SUPPORTED bit.....	124
6.2.2.8.7 MAXIMUM ACTIVATION field	124
6.2.2.9 Subsequent Number Of Zones	124
6.2.2.9.1 SUBSEQUENT NUMBER OF ZONES field	124
6.2.2.10 Supported Zone Types	124
6.2.2.10.1 CONVENTIONAL SUPPORTED bit.....	124
6.2.2.10.2 SEQUENTIAL WRITE PREFERRED SUPPORTED bit	124
6.2.2.10.3 SEQUENTIAL WRITE REQUIRED SUPPORTED bit.....	124
6.2.2.10.4 SEQUENTIAL OR BEFORE SUPPORTED bit	124
6.2.2.10.5 GAP ZONE TYPE SUPPORTED bit.....	124
6.3 Device Statistics log (Log Address 04h).....	125
6.3.1 Overview	125

6.3.2 Zoned Device Statistics (page 08h)	125
6.3.2.1 Overview	125
6.3.2.2 Device Statistics Information Header	127
6.3.2.3 MAX OPEN ZONES field	127
6.3.2.3.1 Description	127
6.3.2.3.2 Update Interval	127
6.3.2.3.3 Measurement Units	127
6.3.2.3.4 Initialization	127
6.3.2.4 MAX EXPLICITLY OPEN ZONES field	127
6.3.2.4.1 Description	127
6.3.2.4.2 Update Interval	127
6.3.2.4.3 Measurement Units	128
6.3.2.4.4 Initialization	128
6.3.2.5 MAX IMPLICITLY OPEN ZONES field	128
6.3.2.5.1 Description	128
6.3.2.5.2 Update Interval	128
6.3.2.5.3 Measurement Units	128
6.3.2.5.4 Initialization	128
6.3.2.6 MIN EMPTY ZONES field	128
6.3.2.6.1 Description	128
6.3.2.6.2 Update Interval	128
6.3.2.6.3 Measurement Units	128
6.3.2.6.4 Initialization	128
6.3.2.7 MAX NON SEQUENTIAL ZONES field	129
6.3.2.7.1 Description	129
6.3.2.7.2 Update Interval	129
6.3.2.7.3 Measurement Units	129
6.3.2.7.4 Initialization	129
6.3.2.8 ZONES EMPTIED field	129
6.3.2.8.1 Description	129
6.3.2.8.2 Update Interval	129
6.3.2.8.3 Measurement Units	129
6.3.2.8.4 Initialization	129
6.3.2.9 SUBOPTIMAL WRITE CMDS field	129
6.3.2.9.1 Description	129
6.3.2.9.2 Update Interval	129
6.3.2.9.3 Measurement Units	130
6.3.2.9.4 Initialization	130
6.3.2.10 CMDS EXCEEDING OPTIMAL LIMIT field	130
6.3.2.10.1 Description	130
6.3.2.10.2 Update Interval	130
6.3.2.10.3 Measurement Units	130
6.3.2.10.4 Initialization	130
6.3.2.11 FAILED EXPLICIT OPENS field	130
6.3.2.11.1 Description	130
6.3.2.11.2 Update Interval	130
6.3.2.11.3 Measurement Units	130
6.3.2.11.4 Initialization	130
6.3.2.12 READ RULE VIOLATIONS field	130
6.3.2.12.1 Description	130
6.3.2.12.2 Update Interval	131
6.3.2.12.3 Measurement Units	131
6.3.2.12.4 Initialization	131
6.3.2.13 WRITE RULE VIOLATIONS field	131
6.3.2.13.1 Description	131
6.3.2.13.2 Update Interval	131
6.3.2.13.3 Measurement Units	131

6.3.2.13.4 Initialization	131
6.3.2.14 MAX IMPLICITLY OPEN SEQUENTIAL OR BEFORE REQUIRED ZONES field	131
6.3.2.14.1 Description	131
6.3.2.14.2 Update Interval	132
6.3.2.14.3 Measurement Units	132
6.3.2.14.4 Initialization	132
7 Normal and Error Outputs	133
7.1 Overview	133
7.2 Normal Outputs	133
7.3 Error Outputs	134
7.4 Sense code definitions	134
7.4.1 Overview	134
7.4.2 ATTEMPT TO ACCESS GAP ZONE	135
7.4.3 ATTEMPT TO READ INVALID DATA	135
7.4.4 DEPOPULATION INTERRUPTED	135
7.4.5 INSUFFICIENT ZONE RESOURCES	135
7.4.6 READ BOUNDARY VIOLATION	135
7.4.7 RESET WRITE POINTER NOT ALLOWED	135
7.4.8 UNALIGNED WRITE COMMAND	135
7.4.9 UNWRITTEN DATA IN ZONE	136
7.4.10 WRITE BOUNDARY VIOLATION	136
7.4.11 WRITE ERROR - INSUFFICIENT ZONE RESOURCES	136
7.4.12 WRITE ERROR - RECOVERY NEEDED	136
7.4.13 WRITE ERROR - RECOVERY SCAN NEEDED	136
7.4.14 ZONE IS INACTIVE	136
7.4.15 ZONE IS OFFLINE	136
7.4.16 ZONE IS READ ONLY	136
7.4.17 ZONE RESET WRITE POINTER RECOMMENDED	136
7.4.18 ZONE TRANSITION TO FULL	136
Annex A (informative) Host Considerations for Zoned Devices	137
A.1 Introduction	137
A.2 Writing to write pointer zones	137
A.3 Open zone considerations	137
A.3.1 Overview	137
A.3.2 Explicitly opened zones and implicitly opened zones	138
A.3.3 Opening and closing zones	139
A.3.4 Finish Zone function considerations	139
A.4 Open zone resources considerations based on zone type	139
A.4.1 Sequential Write Preferred zones	139
A.4.2 Sequential Write Required zones	140
A.5 Partial failures	140
A.5.1 Overview	140
A.5.2 Sanitize considerations	140
Annex B (informative) Zone Activation	142
B.1 Introduction	142
B.2 Differences between Zone Domains and Zone Realms	142
B.3 ZONE ACTIVATION EXT / ZONE QUERY EXT iteration example	142
B.4 Typical ZONE QUERY EXT process	143
B.5 ZONE QUERY EXT resulting in a failed security prerequisite	143
B.6 Typical ZONE ACTIVATION EXT process	143
B.7 ZONE ACTIVATION EXT resulting in no zones activated	145
B.8 ZONE ACTIVATE resulting in Realm boundaries moving	146
Bibliography	147

Tables

	Page
Table 1 - Numbering conventions	12
Table 2 - Zone domain ID values	19
Table 3 - Summary of realm attributes	25
Table 4 - Summary of zone attributes	27
Table 5 - Zone Type zone attribute	27
Table 6 - Relationships between zone attributes	28
Table 7 - Zone Condition zone attribute	29
Table 8 - Characteristics associated with zone state	32
Table 9 - Zone Condition state machine functions	43
Table 10 - Characteristics and attributes associated with zone state	44
Table 11 - ZAC OPTIONS field	60
Table 12 - ZONE POST PROCESSING field	61
Table 13 - Example Command Structure	66
Table 14 - Example Normal Output	67
Table 15 - Example Error Output	68
Table 16 - Zone management commands	69
Table 17 - ZAC Management In command template inputs	70
Table 18 - RECEIVE FPDMA QUEUED command encapsulation for the subcommand specific inputs used by the ZAC Management In command	71
Table 19 - ZAC Management Out, DMA command template inputs	72
Table 20 - SEND FPDMA QUEUED command encapsulation for the subcommand specific inputs used by the ZAC Management Out command	73
Table 21 - ZAC Management Out, Non-Data command template inputs	74
Table 22 - NCQ NON-DATA command encapsulation for the subcommand specific inputs used by the ZAC Management Out command	76
Table 23 - CLOSE ZONE EXT command inputs	77
Table 24 - CLOSE ZONE EXT command processing	78
Table 25 - FINISH ZONE EXT command inputs	79
Table 26 - FINISH ZONE EXT command processing	80
Table 27 - OPEN ZONE EXT command inputs	81
Table 28 - OPEN ZONE EXT command processing	82
Table 29 - REPORT REALMS EXT command inputs	83
Table 30 - REPORTING OPTIONS field	84
Table 31 - REPORT REALMS EXT input from device to host	84
Table 32 - Report realms header	85
Table 33 - Realm descriptor	86
Table 34 - REALM RESTRICTIONS field	86
Table 35 - Realm start/end descriptor	87
Table 36 - REPORT ZONE DOMAINS EXT command inputs	88
Table 37 - REPORT ZONE DOMAINS REPORTING OPTIONS field	89
Table 38 - REPORT ZONE DOMAINS input from device to host	89
Table 39 - Report zone domains header	90
Table 40 - Zone domain descriptor	91
Table 41 - REPORT ZONES EXT command inputs	93
Table 42 - REPORTING OPTIONS field	94
Table 43 - REPORT ZONES EXT input from device to host	95
Table 44 - SAME field	96
Table 45 - Zone descriptor format	97
Table 46 - ZONE TYPE field	97
Table 47 - ZONE CONDITION field	98
Table 48 - RESET WRITE POINTER EXT command inputs	99
Table 49 - RESET WRITE POINTER EXT command processing	100
Table 50 - SEQUENTIALIZE ZONE EXT command inputs	101
Table 51 - SEQUENTIALIZE ZONE EXT command processing	102
Table 52 - Selecting candidate zones to activate and deactivate with ALL bit cleared to zero	105

Table 53 - ZONE ACTIVATE EXT command and ZONE QUERY EXT command inputs	109
Table 54 - Zone Activation Results	110
Table 55 - Zone Activation Results Header	111
Table 56 - Zone Activation Descriptor	115
Table 57 - REMOVE ELEMENT AND MODIFY ZONES command inputs	117
Table 58 - Update urswrz subcommand inputs	119
Table 59 - Zone Activation Control subcommand inputs	119
Table 60 - Zoned Device Information	120
Table 61 - ZAC MINOR VERSION field	123
Table 62 - Zoned Device Statistics	125
Table 63 - Generic ZAC Extended Normal Output	133
Table 64 - Generic ZAC Extended Error Output	134
Table 65 - Additional sense codes	135
Table B.1 - Comparison between Zone Domains and Zone Realms	142

Figures

	Page
Figure 1 - ATA document relationships	1
Figure 2 - State diagram convention	13
Figure 3 - Zones in a zoned device	15
Figure 4 - Zone domain	19
Figure 5 - Example of two zone domains	20
Figure 6 - Example of zone activation in the Zone Domains feature set	21
Figure 7 - Zone Realms feature set model	22
Figure 8 - Example of conventional and shingled recording technologies using two zone domains	24
Figure 9 - Example of zone activation in the Zone Realms feature set	25
Figure 10 - Conventional zone state machine	33
Figure 11 - Write pointer zone and write pointer after Reset Write Pointer function with no subsequent writes	34
Figure 12 - Write pointer zone and write pointer example	34
Figure 13 - Example effects of host actions on a write pointer zone	35
Figure 14 - Example write command that starts at the write pointer	37
Figure 15 - Examples of write commands that do not start at the write pointer	38
Figure 16 - Zone Condition state machine	45
Figure B.1 - Example of typical zone activation	144
Figure B.2 - Example of ZONE ACTIVATION that results in no zones activated	145
Figure B.3 - Example of zone deactivation that results in realm boundaries moving	146