

ISO/IEC 14776-414:2009-06 (E)

Information technology – Small computer system interface (SCSI) – Part 414: Architecture model-4 (SAM-4)

Contents

	Page
FOREWORD.....	10
INTRODUCTION.....	11
General.....	11
SCSI standards family.....	11
1 Scope.....	12
2 Normative references.....	13
3 Terms, definitions, symbols, abbreviations, and conventions.....	13
3.1 Terms and definitions.....	13
3.2 Acronyms.....	25
3.3 Keywords.....	25
3.4 Editorial conventions.....	26
3.5 Numeric conventions.....	27
3.6 Notation conventions.....	28
3.6.1 UML notation conventions.....	28
3.6.1.1 Notation conventions overview.....	28
3.6.1.2 Constraint and note conventions.....	28
3.6.1.3 Class diagram conventions.....	29
3.6.1.4 Object diagram conventions.....	33
3.6.2 Notation for procedure calls.....	34
3.6.3 Notation for state diagrams.....	34
4 SCSI architecture model.....	36
4.1 Introduction.....	36
4.2 Compliance Requirements.....	36
4.3 The SCSI distributed service model.....	37
4.4 The SCSI client-server model.....	38
4.4.1 SCSI client-server model overview.....	38
4.4.2 Synchronizing client and server states.....	39
4.4.3 Request/Response ordering.....	39
4.5 The SCSI structural model.....	39
4.6 SCSI classes.....	41
4.6.1 SCSI classes overview.....	41
4.6.2 SCSI Domain class.....	41
4.6.3 Service Delivery Subsystem class.....	42
4.6.4 SCSI Device class.....	43
4.6.4.1 SCSI Device class overview.....	43
4.6.4.2 SCSI Device Name attribute.....	43
4.6.5 SCSI Port class.....	44
4.6.5.1 SCSI Port class overview.....	44
4.6.5.2 Relative Port Identifier attribute.....	45
4.6.6 SCSI Target Port class.....	45
4.6.6.1 SCSI Target Port class overview.....	45
4.6.6.2 Target Port Identifier attribute.....	45
4.6.6.3 Target Port Name attribute.....	45
4.6.7 SCSI Initiator Port class.....	46
4.6.7.1 SCSI Initiator Port class overview.....	46
4.6.7.2 Initiator Port Identifier attribute.....	46
4.6.7.3 Initiator Port Name attribute.....	46
4.6.8 Task Router class.....	46
4.6.9 SCSI Initiator Device class.....	47
4.6.10 Application Client class.....	47
4.6.11 Application Client Task Management Function class.....	48
4.6.11.1 Application Client Task Management Function class overview.....	48
4.6.11.2 Function Identifier attribute.....	48
4.6.11.3 Nexus attribute.....	48
4.6.11.4 Service Response attribute.....	48

4.6.11.5 Additional Response Information attribute	48
4.6.12 Application Client Task Set class	48
4.6.13 Application Client Command class	49
4.6.13.1 Application Client Command class overview	49
4.6.13.2 I_T_L_Q Nexus attribute	49
4.6.13.3 CDB attribute	49
4.6.13.4 Task Attribute attribute	49
4.6.13.5 Status attribute	49
4.6.13.6 Service Response attribute	49
4.6.13.7 Data-In Buffer attribute	49
4.6.13.8 Data-In Buffer Size attribute	49
4.6.13.9 Data-Out Buffer attribute	49
4.6.13.10 Data-Out Buffer size attribute	49
4.6.13.11 CRN attribute	49
4.6.13.12 Command Priority attribute	50
4.6.13.13 First Burst Enabled attribute	50
4.6.13.14 Sense Data attribute	50
4.6.13.15 Sense Data Length attribute	50
4.6.13.16 Status Qualifier attribute	50
4.6.14 SCSI Target Device class	50
4.6.15 Level 1 Hierarchical Logical Unit class	51
4.6.16 Level 2 Hierarchical Logical Unit class	52
4.6.17 Level 3 Hierarchical Logical Unit class	52
4.6.18 Level 4 Hierarchical Logical Unit class	53
4.6.19 Logical Unit class	53
4.6.19.1 Logical Unit class overview	53
4.6.19.2 LUN attribute	55
4.6.19.3 Logical Unit Name attribute	55
4.6.19.4 Dependent Logical Unit attribute	55
4.6.20 Device Server class	56
4.6.21 Task Manager class	56
4.6.22 Task Set class	56
4.6.23 Command class	56
4.6.23.1 Command class overview	56
4.6.23.2 I_T_L_Q Nexus attribute	56
4.6.23.3 Task Attribute attribute	56
4.6.23.4 CDB attribute	57
4.6.23.5 CRN attribute	57
4.6.23.6 Command Priority attribute	57
4.6.23.7 Status attribute	57
4.6.23.8 Sense Data attribute	57
4.6.23.9 Sense Data Length attribute	57
4.6.23.10 Service Response attribute	57
4.6.23.11 Status Qualifier attribute	57
4.6.23.12 First Burst Enabled attribute	57
4.6.23.13 Device Server Buffer attribute	57
4.6.23.14 Application Client Buffer Offset attribute	57
4.6.23.15 Request Byte Count attribute	57
4.6.23.16 Delivery Result attribute	58
4.6.24 Task Management Function class	58
4.6.24.1 Task Management Function class overview	58
4.6.24.2 Function Identifier attribute	58
4.6.24.3 Nexus attribute	58
4.6.24.4 Service Response attribute	58
4.6.24.5 Additional Response Information attribute	58
4.6.25 Well Known Logical Unit class	58
4.7 Logical unit number (LUN)	59
4.7.1 Introduction	59

4.7.2 Logical unit representation format.....	59
4.7.3 LUNs overview.....	59
4.7.4 Minimum LUN addressing requirements.....	59
4.7.5 Single level LUN structure	60
4.7.6 Eight byte LUN structure.....	62
4.7.7 Peripheral device addressing method.....	64
4.7.8 Flat space addressing method.....	65
4.7.9 Logical unit addressing method	66
4.7.10 Extended logical unit addressing	67
4.7.11 Well known logical unit addressing	70
4.7.12 Extended flat space addressing method.....	70
4.7.13 Logical unit not specified addressing	71
4.8 Nexus	71
4.8.1 Nexus overview.....	71
4.8.2 Command identifier.....	72
4.8.3 Nexus usage rules	72
4.9 SCSI ports	72
4.9.1 SCSI port configurations	72
4.9.2 SCSI devices with multiple ports.....	73
4.9.3 Multiple port SCSI target device structure	74
4.9.4 Multiple port SCSI initiator device structure	75
4.9.5 Multiple port SCSI device structure.....	76
4.9.6 SCSI initiator device view of a multiple port SCSI target device.....	77
4.9.7 SCSI target device view of a multiple port SCSI initiator device.....	79
4.10 The SCSI model for distributed communications	79
5 SCSI command model	84
5.1 The Execute Command procedure call	84
5.2 Command descriptor block (CDB).....	85
5.3 Status	86
5.3.1 Status codes	86
5.3.2 Status qualifier	87
5.3.3 Status precedence	89
5.4 SCSI transport protocol services in support of Execute Command.....	90
5.4.1 Overview	90
5.4.2 Command and status SCSI transport protocol services	90
5.4.2.1 Command and status SCSI transport protocol services overview	90
5.4.2.2 Send SCSI Command SCSI transport protocol service request	91
5.4.2.3 SCSI Command Received SCSI transport protocol service indication	91
5.4.2.4 Send Command Complete SCSI transport protocol service response	92
5.4.2.5 Command Complete Received SCSI transport protocol service confirmation	92
5.4.3 Data transfer SCSI transport protocol services.....	93
5.4.3.1 Introduction.....	93
5.4.3.2 Data-In delivery service.....	95
5.4.3.2.1 Send Data-In SCSI transport protocol service request.....	95
5.4.3.2.2 Data-In Delivered SCSI transport protocol service confirmation	95
5.4.3.3 Data-Out delivery service	95
5.4.3.3.1 Receive Data-Out SCSI transport protocol service request	95
5.4.3.3.2 Data-Out Received SCSI transport protocol service confirmation.....	96
5.4.3.4 Terminate Data Transfer service.....	96
5.4.3.4.1 Terminate Data Transfer SCSI transport protocol service request.....	96
5.4.3.4.2 Data Transfer Terminated SCSI transport protocol service confirmation	97
5.5 Command lifetimes.....	97
5.6 Aborting commands.....	98
5.7 Command processing example	103
5.8 Commands that complete with CHECK CONDITION status.....	103
5.8.1 Overview	103
5.8.2 Handling commands when ACA is not in effect.....	104
5.8.3 Aborting commands terminated with a CHECK CONDITION status without establishing an ACA	104

5.9 Auto contingent allegiance (ACA).....	105
5.9.1 ACA overview	105
5.9.2 Establishing an ACA	105
5.9.3 Handling new commands received on the faulted I_T nexus when ACA is in effect	106
5.9.4 Handling new commands received on non-faulted I_T nexuses when ACA is in effect	107
5.9.4.1 Command processing permitted for commands received on non-faulted I_T nexuses during ACA	107
5.9.4.2 Handling new commands received on non-faulted I_T nexuses when ACA is in effect.....	107
5.9.5 Clearing an ACA condition.....	108
5.10 Overlapped commands	109
5.11 Incorrect logical unit.....	109
5.12 Task attribute exception conditions	109
5.13 Sense data	110
5.14 Unit attention condition.....	110
6 SCSI events and event notification model	114
6.1 SCSI events overview	114
6.2 Establishing a unit attention condition subsequent to detection of an event	116
6.3 Conditions resulting from SCSI events.....	117
6.3.1 Power on.....	117
6.3.2 Hard reset	118
6.3.3 Logical unit reset.....	118
6.3.4 I_T nexus loss.....	118
6.3.5 Power loss expected.....	119
6.4 Event notification SCSI transport protocol services.....	119
7 Task management functions.....	121
7.1 Task management function procedure calls.....	121
7.2 ABORT TASK.....	122
7.3 ABORT TASK SET	123
7.4 CLEAR ACA	123
7.5 CLEAR TASK SET	123
7.6 I_T NEXUS RESET	124
7.7 LOGICAL UNIT RESET.....	124
7.8 QUERY TASK	124
7.9 QUERY TASK SET	125
7.10 QUERY ASYNCHRONOUS EVENT	125
7.11 Task management function lifetime.....	126
7.12 Task management SCSI transport protocol services	127
7.12.1 Task management SCSI transport protocol services overview	127
7.12.2 Send Task Management Request SCSI transport protocol service request.....	127
7.12.3 Task Management Request Received SCSI transport protocol service indication.....	128
7.12.4 Task Management Function Executed SCSI transport protocol service response.....	128
7.12.5 Received Task Management Function Executed SCSI transport protocol service confirmation..	129
7.13 Task management function example.....	130
8 Task set management.....	131
8.1 Introduction to task set management	131
8.2 Implicit head of queue	131
8.3 Command management model	131
8.4 Command management events	132
8.5 Command states	132
8.5.1 Overview.....	132
8.5.1.1 Command state nomenclature	132
8.5.1.2 Suspended information	133
8.5.2 Enabled command state	133
8.5.3 Blocked command state.....	133
8.5.4 Dormant command state.....	133
8.5.5 Completed command state.....	133
8.5.6 Command states and command lifetimes.....	133
8.6 Task attributes	134

8.6.1 Overview	134
8.6.2 Commands having the SIMPLE task attribute	134
8.6.3 Commands having the ORDERED task attribute	135
8.6.4 Commands having the HEAD OF QUEUE task attribute	135
8.6.5 Commands having the ACA task attribute	135
8.7 Command priority	135
8.8 Command state transitions	136
8.9 Task set management examples	137
8.9.1 Introduction	137
8.9.2 Commands having the HEAD OF QUEUE task attribute	138
8.9.3 Commands having the ORDERED task attribute	140
8.9.4 Commands having the ACA task attribute	141
Annex A (informative) Identifiers and names for objects	142
A.1 Identifiers and names overview	142
A.2 Identifiers and names	142
Annex B (informative) SCSI Initiator Port attributes and SCSI Target Port attributes supported by SCSI transport protocols	147
Annex C (informative) Terminology mapping to SAM-3	149
Annex D (informative) SCSI transport protocol acronyms	150
Bibliography	151

Table 1 — Numbering conventions.....	28
Table 2 — Constraint and note notation	28
Table 3 — Class diagram notation for classes.....	29
Table 4 — Multiplicity notation	30
Table 5 — Class diagram notation for associations.....	30
Table 6 — Class diagram notation for aggregations.....	31
Table 7 — Class diagram notation for generalizations	32
Table 8 — Class diagram notation for dependency.....	32
Table 9 — Object diagram notation for objects.....	33
Table 10 — Object diagram notation for link.....	33
Table 11 — Single level LUN structure using peripheral device addressing method	60
Table 12 — Single level LUN structure using flat space addressing method	60
Table 13 — Single level LUN structure using extended flat space addressing method.....	61
Table 14 — Eight byte LUN structure adjustments	62
Table 15 — Eight byte LUN structure	63
Table 16 — Format of addressing fields	63
Table 17 — ADDRESS METHOD field.....	64
Table 18 — Peripheral device addressing format.....	64
Table 19 — Flat space addressing format	66
Table 20 — Logical unit addressing format.....	66
Table 21 — Extended logical unit addressing format.....	68
Table 22 — LENGTH field and related sizes	68
Table 23 — Two byte extended logical unit addressing format	68
Table 24 — Four byte extended logical unit addressing format.....	69
Table 25 — Six byte extended logical unit addressing format	69
Table 26 — Eight byte extended logical unit addressing format.....	69
Table 27 — Logical unit extended addressing	70
Table 28 — Well known logical unit extended addressing format.....	70
Table 29 — Extended flat space addressing format	71
Table 30 — Logical unit not specified extended addressing format.....	71
Table 31 — Nexus	72
Table 32 — CONTROL byte.....	86
Table 33 — Status codes.....	86
Table 34 — Status qualifier format.....	87
Table 35 — SCOPE field	88
Table 36 — QUALIFIER field.....	89
Table 37 — SCSI device conditions that abort commands in a SCSI initiator device.....	98
Table 38 — SCSI device conditions that abort commands in a SCSI target device	99
Table 39 — Task management functions that abort commands.....	100
Table 40 — Command related conditions that abort commands.....	101
Table 41 — Command handling when ACA is not in effect	104
Table 42 — Aborting commands when an ACA is not established.....	104
Table 43 — Blocking and aborting commands when an ACA is established.....	106
Table 44 — Handling for new commands received on a faulted I_T nexus during ACA	107
Table 45 — Handling for new commands received on non-faulted I_T nexuses during ACA	108
Table 46 — Unit attention condition precedence level.....	111
Table 47 — Unit attention additional sense codes for events detected by SCSI target devices.....	117
Table 48 — Task Management Functions	121
Table 49 — Additional Response Information argument for QUERY ASYNCHRONOUS EVENT.....	126
Table 50 — UADE DEPTH field	126
Table 51 — Command management events that cause changes in command state.....	132
Table 52 — Command state nomenclature	132
Table 53 — Task attributes	134
Table 54 — Command priority	135
Table 55 — Task attribute and state indications in examples.....	137
Table 56 — Dormant command blocking boundary requirements.....	140
Table A.1 — Identifier attribute size and support requirements.....	142

Table A.2 — Name attribute size and support requirements	143
Table A.3 — Identifier attribute size for each SCSI transport protocol.....	143
Table A.4 — Identifier attribute format for each SCSI transport protocol.....	144
Table A.5 — Name attribute size for each SCSI transport protocol.....	145
Table A.6 — Name attribute format for each SCSI transport protocol	146
Table B.1 — SCSI Initiator Port attributes and SCSI Target Port attributes supported by SCSI transport protocols.....	148
Table C.1 — Terminology mapping to SAM-3	149

Figure 1 — SCSI standard structure	11
Figure 2 — Examples of association relationships in class diagrams.....	31
Figure 3 — Examples of aggregation relationships in class diagrams.....	31
Figure 4 — Example of generalization relationships in class diagrams	32
Figure 5 — Example of a dependency relationship in class diagrams.....	33
Figure 6 — Examples of link relationships for object diagrams	34
Figure 7 — Example state diagram.....	35
Figure 8 — Requirements precedence	37
Figure 9 — Client-server model	37
Figure 10 — SCSI client-server model.....	38
Figure 11 — SCSI I/O system and domain model	40
Figure 12 — SCSI Domain class diagram overview	41
Figure 13 — SCSI Domain class diagram	42
Figure 14 — SCSI domain object diagram.....	42
Figure 15 — SCSI Device class diagram.....	43
Figure 16 — SCSI Port class diagram	44
Figure 17 — SCSI Initiator Device class diagram	47
Figure 18 — SCSI Target Device class diagram	50
Figure 19 — Level 1 Hierarchical Logical Unit class.....	51
Figure 20 — Logical Unit class diagram	54
Figure 21 — Eight byte LUN structure adjustments.....	62
Figure 22 — Logical unit selection using the peripheral device addressing format	65
Figure 23 — Logical unit selection using the logical unit addressing format.....	67
Figure 24 — SCSI device functional models.....	73
Figure 25 — Multiple port target SCSI device structure model	74
Figure 26 — Multiple port SCSI initiator device structure model.....	75
Figure 27 — Multiple port SCSI device structure model	76
Figure 28 — SCSI target device configured in a single SCSI domain	77
Figure 29 — SCSI target device configured in multiple SCSI domains	78
Figure 30 — SCSI target device and SCSI initiator device configured in a single SCSI domain.....	78
Figure 31 — Protocol service reference model.....	79
Figure 32 — SCSI transport protocol service mode.....	80
Figure 33 — Request-Response SAL transaction and related STPL services	81
Figure 34 — SCSI transport protocol service model for data transfers.....	81
Figure 35 — Device server data transfer transaction and related STPL services	82
Figure 36 — SCSI transport protocol service model for Terminate Data Transfer	82
Figure 37 — Device server Terminate Data Transfer transaction and related STPL services	83
Figure 38 — Model for Data-In and Data-Out data transfers	93
Figure 39 — Command processing events.....	103
Figure 40 — Events and event notifications for SCSI target devices.....	115
Figure 41 — Events and event notifications for SCSI initiator devices	116
Figure 42 — Task management processing events.....	130
Figure 43 — Example of Dormant state command behavior	134
Figure 44 — Command states	136
Figure 45 — Commands having the HEAD OF QUEUE task attribute and blocking boundaries (example 1)...	138
Figure 46 — Commands having the HEAD OF QUEUE task attribute and blocking boundaries (example 2)...	139
Figure 47 — Commands having ORDERED task attributes and blocking boundaries.....	140
Figure 48 — Commands having ACA task attributes example	141