INTERNATIONAL STANDARD

ISO/IEC 14776-412

First edition
2006-10

Information technology –
Small computer system interface (SCSI) –

Part 412:
Architecture model-2 (SAM-2)

Copyright © 2006 ISO/IEC, Geneva — All rights reserved

No part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from the publisher.

International Electrotechnical Commission, 3, rue de Varembé, PO Box 131, CH-1211 Geneva 20, Switzerland
Telephone: +41 22 919 02 11 Telefax: +41 22 919 03 00 E-mail: inmail@iec.ch Web: www.iec.ch

PRICE CODE X

For price, see current catalogue

Contents

Page

1 General ... 11
1.1 Scope ... 11
1.2 Precedence requirements ... 11

2 Normative reference ... 12

3 Definitions, symbols, abbreviations, and conventions ... 13
3.1 Definitions ... 13
3.2 Acronyms ... 23
3.3 Keywords ... 23
3.4 Editorial conventions ... 24
3.5 Numeric conventions ... 25
3.6 Notation conventions ... 25
3.6.1 Hierarchy diagram conventions ... 25
3.6.2 Notation for procedures and functions ... 26
3.6.3 Notation for state diagrams ... 27

4 SCSI Architecture Model ... 28
4.1 Introduction ... 28
4.2 The SCSI distributed service model ... 29
4.3 The SCSI client-server model ... 30
4.4 The SCSI structural model ... 31
4.5 SCSI domain ... 33
4.6 The service delivery subsystem ... 33
4.6.1 The service delivery subsystem object ... 33
4.6.2 Synchronizing client and server states ... 34
4.6.3 Request/Response ordering ... 34
4.7 SCSI devices ... 35
4.7.1 SCSI initiator device ... 35
4.7.2 SCSI target device ... 35
4.7.3 SCSI target/initiator device ... 37
4.7.4 SCSI port identifier ... 37
4.7.5 SCSI task router ... 37
4.7.6 SCSI device name ... 38
4.7.7 SCSI port name ... 38
4.8 Logical units ... 39
4.9 Logical unit numbers ... 40
4.9.1 Logical unit numbers overview ... 40
4.9.2 LUN 0 address ... 40
4.9.3 Single level logical unit number structure ... 40
4.9.4 Eight byte logical unit number structure ... 42
4.9.5 Logical unit addressing method ... 44
4.9.6 Peripheral device addressing method ... 44
4.9.7 Flat space addressing method ... 45
4.9.8 Extended logical unit addressing ... 45
4.9.9 Well known logical unit addressing ... 47
4.10 Tasks ... 48
4.10.1 The task object ... 48
4.10.2 Task tags ... 48
4.11 The nexus object ... 49
4.12 SCSI ports ... 50
4.12.1 SCSI port configurations ... 50
4.12.2 SCSI devices with multiple ports ... 50
4.12.3 Multiple port target SCSI device structure ... 51
4.12.4 Multiple port initiator SCSI device structure ... 52
4.12.5 Multiple port target/initiator SCSI device structure ... 53

4.12.6 SCSI initiator device view of a multiple port SCSI target device 53
4.12.7 SCSI target device view of a multiple port SCSI initiator device 55
4.13 Model for dependent logical units 56
4.14 The SCSI model for distributed communications 58

5 SCSI Command Model 61
5.1 The Execute Command remote procedure 61
5.2 Command descriptor block (CDB) 62
5.2.1 CDB format 62
5.2.2 OPERATION CODE byte 63
5.2.3 CONTROL byte 64
5.3 Status 65
5.3.1 Status codes 65
5.3.2 Status precedence 66
5.4 SCSI transport protocol services in support of Execute Command 67
5.4.1 Overview 67
5.4.2 Execute Command request/confirmation SCSI transport protocol services 67
5.4.3 Data transfer SCSI transport protocol services 69
5.4.3.1 Introduction 69
5.4.3.2 Data-In delivery service 70
5.4.3.3 Data-Out delivery service 70
5.5 Task and command lifetimes 71
5.6 Task management function lifetime 72
5.7 Aborting tasks 72
5.7.1 Mechanisms that cause tasks to be aborted 72
5.7.2 When a SCSI initiator port aborts its own tasks 72
5.7.3 When a SCSI initiator port aborts tasks from other SCSI initiator ports 73
5.8 Command processing examples 73
5.8.1 Unlinked command example 73
5.8.2 Linked command example 74
5.9 Command processing considerations and exception conditions 75
5.9.1 Contingent allegiance (CA) and auto contingent allegiance (ACA) 75
5.9.1.1 Overview 75
5.9.1.2 Establishing a CA or ACA 75
5.9.1.3 Handling tasks when neither CA or ACA is in effect 77
5.9.1.4 Handling new tasks from the faulted initiator port when CA or ACA is in effect 77
5.9.1.5 Handling new tasks from non-faulted initiator ports when CA or ACA is in effect 78
5.9.1.5.1 Commands permitted from non-faulted initiator ports during CA or ACA 78
5.9.1.5.2 Handling new tasks from non-faulted initiator ports when CA or ACA is in effect 79
5.9.1.6 Clearing a CA condition 81
5.9.1.7 Clearing an ACA condition 81
5.9.2 Overlapped commands 81
5.9.3 Incorrect logical unit selection 82
5.9.4 Sense data 82
5.9.4.1 Sense data introduction 82
5.9.4.2 Asynchronous event reporting 83
5.9.4.3 Autosense 83
5.9.5 Unit Attention condition 84
5.9.6 Hard reset 85
5.9.7 Logical unit reset 85

6 Task management functions 86
6.1 Introduction 86
6.2 ABORT TASK 87
6.3 ABORT TASK SET 87
6.4 CLEAR ACA 88
6.5 CLEAR TASK SET 88
6.6 LOGICAL UNIT RESET 89
6.7 TARGET RESET 89
6.8 WAKEUP 89

6.9 Task management SCSI transport protocol services 90
6.10 Task management function example 91

7 Task Set Management 92
7.1 Introduction to task set management 92
7.2 Controlling task set management 92
7.3 Task management events 93
7.4 Task states 93
7.4.1 Overview 93
7.4.1.1 Task state nomenclature 93
7.4.1.2 Suspended information 93
7.4.2 Enabled task state 93
7.4.3 Blocked task state 94
7.4.4 Dormant task state 94
7.4.5 Ended task state 94
7.4.6 Task states and task lifetimes 94
7.5 Task attributes 95
7.5.1 Simple task 95
7.5.2 Ordered task 95
7.5.3 Head of queue task 95
7.5.4 ACA task 95
7.6 Task state transitions 96
7.7 Task set management examples 97
7.7.1 Introduction 97
7.7.2 Head of queue tasks 98
7.7.3 Ordered tasks 99
7.7.4 ACA task 100

Annex A (informative)
Identifiers and names for objects 101
A.1 Identifiers and names overview 101
A.2 Identifiers and names 101
A.3 SCSI transport protocol acronyms and bibliography 103

Annex B (informative)
Terminology mapping 105

Bibliography 106

Tables

1 Single level logical unit number structure for 256 or fewer logical units 40
2 Single level logical unit number structure for 257 to 16 384 logical units 41
3 Eight byte logical unit number structure adjustments 42
4 Eight Byte logical unit number structure 43
5 Format of addressing fields 43
6 ADDRESS METHOD field values 43
7 Logical unit addressing 44
8 Peripheral device addressing 44
9 Flat space addressing 45
10 Extended logical unit addressing 46
11 LENGTH field values 46
12 Two byte extended logical unit addressing format 46
13 Four byte extended logical unit addressing format 46
14 Six byte extended logical unit addressing format 46
15 Eight byte extended logical unit addressing format 46
16 Logical unit extended address methods 47
17 Well known logical unit extended address format 47
18 Mapping nexus to SAM-2 identifiers 49
19 Command Descriptor Block (CDB) Format 63
20 OPERATION CODE byte 63
21 Group Code values 63
22 CONTROL byte 64
23 Status codes 65
24 Autosense, CA, and ACA Interactions 75
25 Blocking and aborting tasks when a CA or ACA is established 76
26 Task handling when neither CA nor ACA is in effect 77
27 Handling for new tasks from a faulted initiator port during CA 77
28 Handling for new tasks from a faulted initiator port during ACA 78
29 Handling for new tasks from non-faulted initiator ports during CA 79
30 Handling for new tasks from non-faulted initiator ports during ACA 80
31 Task Management Functions 86
32 Task State Nomenclature 93
33 Task attribute and state indications in examples 97
34 Dormant task blocking boundary requirements 99
A.1 Object size and support requirements 101
A.2 Object identifier size for each SCSI transport protocol 102
A.3 Object identifier format for each SCSI transport protocol 102
A.4 Object name size for each SCSI transport protocol 103
A.5 Object name format for each SCSI transport protocol 103
B.1 SAM-2 to SAM terminology mapping 105

Figures

Page
0 SCSI document structure 9
1 Requirements precedence 11
2 Example hierarchy diagram 25
3 Example state diagram 27
4 Client-Server model 29
5 SCSI client-server model 30
6 SCSI I/O system and domain model 31
7 Overall SCSI domain model 32
8 SCSI domain model 33
9 Service delivery subsystem model 33
10 SCSI initiator device model 35
11 SCSI target device model 36
12 SCSI target/initiator device model 37
13 Logical unit model 39
14 Eight Byte logical unit number structure adjustments 42
15 SCSI device functional models 50
16 Multiple port target SCSI device structure model 51
17 Multiple port SCSI initiator device structure model 52
18 Multiple port target/initiator SCSI device structure model 53
19 SCSI target device configured in a single SCSI domain 54
20 SCSI target device configured in multiple SCSI domains 54
21 SCSI target device and SCSI initiator device configured in a single SCSI domain 55
22 Dependent logical unit model 56
23 Example of hierarchical system diagram 57
24 Protocol service reference model 58
25 Protocol service model 59
26 Request-Response ULP transaction and related LLP services 60
27 Model for Data-In and Data-Out data transfers 69
28 Command processing events 73
29 Linked command processing events 74
30 Task management processing events 91
31 Example of Dormant state task behavior 94
32 Task states 96
33 Head of queue tasks and blocking boundaries (example 1) 98
34 Head of queue tasks and blocking boundaries (example 2) 98
35 Ordered tasks and blocking boundaries 99
36 ACA task example 100

INFORMATION TECHNOLOGY - SMALL COMPUTER SYSTEM INTERFACE (SCSI) -

Part 412: Architecture Model - 2 (SAM-2)

FOREWORD

1) ISO (International Organization for Standardization) and IEC (International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards. Their preparation is entrusted to technical committees; any ISO and IEC member body interested in the subject dealt with may participate in this preparatory work. International governmental and non-governmental orgnizations liaising with ISO and IEC also participate in this preparation.

2) In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1. Draft International Standards adopted by the joint technical committee are circulated to national bodies for voting. Publication as an International Standard requires approval by at least 75 % of the national bodies casting a vote.

3) The formal decisions or agreements of IEC and ISO on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC and ISO member bodies.

4) IEC, ISO and ISO/IEC Publications have the form of recommendations for international use and are accepted by IEC and ISO member bodies in that sense. While all reasonable efforts are made to ensure that the technical contenct of IEC, ISO and ISO/IEC Publications is accurate, IEC or ISO cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.

5) In order to promote international uniformity, IEC and ISO member bodies undertake to apply IEC, ISO and ISO/IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any ISO/IEC Publication and the corresponding national or regional publication should be clearly indicated in the latter.

6) ISO and IEC provide no marking procedure to indicate their approval and cannot be rendered responsible for any equipment declared to be in conformity with an ISO/IEC Publication.

7) All users should ensure that they have the latest edition of this publication.

8) No liability shall attach to IEC or ISO or its directors, employees, servants or agents including individual experts and members of their technical committees and IEC or ISO member bodies for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication of, use of, or reliance upon this ISO/IEC publication or any other IEC or IEC/ISO publications.

9) Attention is drawn to the normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.

10) Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. ISO and IEC shall not be held responsible for identifying any or all such patent rights.

International Standard ISO/IEC 14776-412 was prepared by subcommittee 25: Interconnection of information technology equipment, of ISO/IEC joint technical committee 1: Information technology.

This International Standard has been approved by vote of the memeber bodies, and the voting results may be obtained from the address given on the title page.

INTRODUCTION

General

The set of SCSI standards consists of this International Standard and the SCSI implementation standards (see SCSI standards family).

The set of SCSI standards specifies the interfaces, functions and operations necessary to ensure interoperability between conforming SCSI implementations. This standard is a functional description. Conforming implementations may employ any design technique that does not violate interoperability.

SCSI standards family

Figure 1 shows the relationship of this standard to the other standards and related projects in the SCSI family standards.

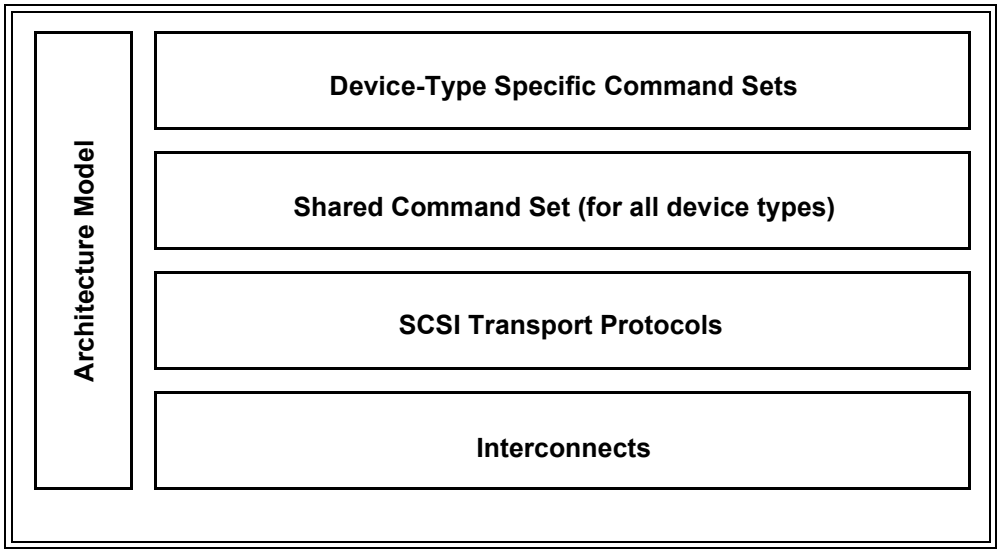

Figure 0 — SCSI document structure

Figure 0 shows the general applicability of the documents with respect to one another. Figure 0 does not imply a relationship such as a hierarchy, protocol stack or system architecture.

The functional areas identified in Figure 0 characterize the scope of standards within a group as follows:

Architecture Model: Defines the SCSI systems model, the functional partitioning of the SCSI standard set and requirements applicable to all SCSI implementations and implementation standards.

Device-Type Specific Command Sets: Implementation standards that define specific device types including a device model for each device type. These standards specify the required commands and behaviour that is specific to a given device type and prescribe the requirements to be followed by a SCSI initiator device when sending commands to a SCSI target device having the specific device type. The commands and behaviours for a specific device type may include reference commands and behaviours that are shared by all SCSI devices.

Shared Command Set: An implementation standard that defines a model for all SCSI device types. This standard specifies the required commands and behaviour that is common to all SCSI devices, regardless of device type, and prescribes the requirements to be followed by a SCSI initiator device when sending commands to any SCSI target device.

SCSI Transport Protocols: Implementation standards that define the requirements for exchanging information so that different SCSI devices are capable of communicating.

Interconnects: Implementation standards that define the communications mechanism employed by the SCSI transport protocols. These standards may describe the electrical and signaling requirements essential for SCSI devices to interoperate over a given interconnect.

For references, see bibliography.

The SCSI Architecture Model-2 (SAM-2) standard is divided into seven clauses and two annexes:

Clause 1	Scope
Clause 2	Normative references
Clause 3	Definitions, symbols and abbreviations
Clause 4	SCSI architecture model
Clause 5	SCSI command model of the SCSI architecture
Clause 6	Task management functions common to SCSI devices
Clause 7	Task set management capabilities common to SCSI devices
Annex A	Identifier and name definitions of the SCSI transport protocols
Annex B	Terminology mapping
Bibliography	

INFORMATION TECHNOLOGY - SMALL COMPUTER SYSTEM INTERFACE (SCSI) -

Part 412: Architecture Model - 2 (SAM-2)

1 General

1.1 Scope

This part of ISO/IEC 14776 defines a reference model that specifies common behaviours for SCSI devices and an abstract structure that is generic to all SCSI I/O system implementations.

This International Standard specifies generic requirements that pertain to SCSI implementation standards and implementation requirements.

1.2 Precedence requirements

An implementation requirement specifies behaviour in terms of measurable or observable parameters that apply to an implementation. Examples of implementation requirements defined in this International Standard are the command descriptor block format and the status values to be returned upon command completion.

Generic requirements are transformed to implementation requirements by an implementation standard. An example of a generic requirement is the hard reset behaviour specified in 5.9.6.

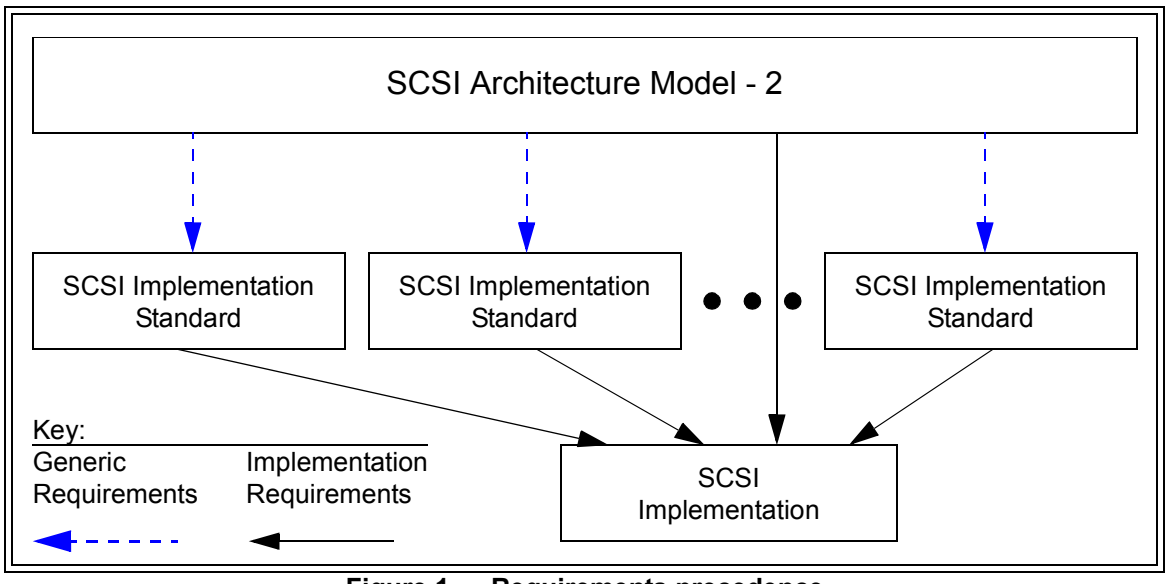

Figure 1 — Requirements precedence

As shown in figure 1, all SCSI implementation standards shall reflect the generic requirements defined herein. In addition, an implementation claiming SCSI compliance shall conform to the applicable implementation requirements defined in this standard and the appropriate SCSI implementation standards. In the event of a conflict between this document and other SCSI standards under the jurisdiction of ISO/IEC JTC 1/SC 25, the requirements of this standard shall apply.

2 Normative reference

The following referenced document is indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC 14776-452, *Information technology – Small Computer System Interface (SCSI) – Part 452: Primary Commands-2 (SPC-2)*

For all other references, see bibliography.