

This is a preview - [click here to buy the full publication](#)



ISO/IEC 14776-223

Edition 1.0 2008-05

INTERNATIONAL STANDARD

**Information technology –
Small computer system interface (SCSI) –
Part 223: Fibre channel protocol, third version (FCP-3)**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

PRICE CODE

XB

ICS 35.200

ISBN 2-8318-9817-X

FOREWORD	10
INTRODUCTION	12
1 Scope	14
2 Normative references	14
3 Definitions, abbreviations and conventions	14
3.1 Terms and definitions	14
3.2 Abbreviations	18
3.3 Keywords	19
3.4 Editorial conventions	20
4 General	22
4.1 Structure and concepts	22
4.2 FCP I/O operations	23
4.3 Bidirectional and unidirectional commands and FCP_RSP IU format	25
4.4 Precise delivery of SCSI commands	25
4.5 Confirmed completion of FCP I/O operations	26
4.6 Retransmission of unsuccessfully transmitted IUs	27
4.7 Task retry identification	27
4.8 Discovery of FCP capabilities	28
4.9 Task management	28
4.10 Clearing effects of task management, FCP, FC-FS-2, FC-LS, and FC-AL-2 actions	29
4.11 I_T nexus loss notification events	31
4.12 Transport Reset notification events	31
4.13 Port Login/Logout	31
4.14 Process Login and Process Logout	32
4.15 Link management	32
4.16 FCP addressing and Exchange identification	32
4.17 Use of World Wide Names	32
5 FC-FS-2 frame header	33
5.1 FC-FS-2 frame header overview	33
5.2 FC-FS-2 frame header fields	33
5.2.1 r_ctl field	33
5.2.2 d_id field	33
5.2.3 cs_ctl field	33
5.2.4 s_id field	33
5.2.5 type field	33
5.2.6 f_ctl field	34
5.2.7 seq_id field	34
5.2.8 df_ctl field	34
5.2.9 seq_cnt field	34
5.2.10 ox_id field	34
5.2.11 rx_id field	34
5.2.12 parameter field	34
6 FCP link service definitions	35
6.1 Overview of link service requirements	35
6.2 Overview of Process Login and Process Logout	35
6.3 PRLI	36
6.3.1 Use of PRLI by the Fibre Channel Protocol	36
6.3.2 Process_Associator requirements	36
6.3.3 New or repeated Process Login	36
6.3.4 PRLI request FCP Service Parameter page format	37

6.3.5 PRLI accept FCP Service Parameter page format	40
6.4 PRLO	41
6.5 Read Exchange Concise (REC)	41
7 FC-4 specific Name Server registration and objects	42
7.1 Overview of FC-4 specific objects for the Fibre Channel Protocol	42
7.2 FC-4 TYPEs object	42
7.3 FC-4 Features object	42
8 FC-4 Link Service definitions	43
8.1 FC-4 Link Services for the Fibre Channel Protocol	43
8.2 Sequence Retransmission Request (SRR)	43
8.3 FCP FC-4 Link Service Reject (FCP_RJT)	45
9 FCP Information Unit (IU) usage and formats	47
9.1 FCP Information Unit (IU) usage	47
9.2 FCP_CMND IU	48
9.2.1 Overview and format of FCP_CMND IU	48
9.2.2 FCP_CMND IU field descriptions	49
9.2.2.1 fcp_lun field	49
9.2.2.2 COMMAND REFERENCE NUMBER field	49
9.2.2.3 priority field	50
9.2.2.4 task attribute field	50
9.2.2.5 TASK MANAGEMENT FLAGS FIELD	50
9.2.2.6 additional fcp_cdb length field	52
9.2.2.7 rddata and wrdata bits	52
9.2.2.8 fcp_cdb field	53
9.2.2.9 additional_fcp_cdb field	53
9.2.2.10 fcp_dl field	53
9.2.2.11 fcp_bidirectional_read_dl field	53
9.3 FCP_XFER_RDY IU	54
9.3.1 Overview and format of FCP_XFER_RDY IU	54
9.3.2 fcp_data_ro field	54
9.3.3 fcp_burst_len field	55
9.4 FCP_DATA IU	55
9.4.1 FCP_DATA IU overview	55
9.4.2 FCP_DATA IUs for read and write operations	56
9.4.3 FCP_DATA IUs for bidirectional commands	56
9.4.4 FCP_DATA IU use of fill bytes	57
9.5 FCP_RSP IU	57
9.5.1 Overview and format of FCP_RSP IU	57
9.5.2 retry delay timer field	59
9.5.3 fcp_bidi_rsp bit	59
9.5.4 fcp_bidi_read_resid_under bit	59
9.5.5 fcp_bidi_read_resid_over bit	59
9.5.6 FCP_CONF_REQ BIT	59
9.5.7 fcp_resid_under bit	59
9.5.8 fcp_resid_over bit	59
9.5.9 fcp_sns_len_valid bit	59
9.5.10 fcp_rsp_len_valid bit	59
9.5.11 SCSI status code field	60
9.5.12 fcp_resid field	60
9.5.13 fcp_bidirectional_read_resid field	61

9.5.14 fcp_sns_len field	61
9.5.15 fcp_rsp_len field	61
9.5.16 fcp_rsp_info field	61
9.5.17 fcp_sns_info field	62
9.6 FCP_CONF IU	63
10 SCSI mode parameters for the Fibre Channel Protocol	64
10.1 Overview of mode pages for the Fibre Channel Protocol	64
10.2 Disconnect-Reconnect mode page	64
10.2.1 Overview and format of Disconnect-Reconnect mode page for FCP	64
10.2.2 buffer full ratio field	65
10.2.3 buffer empty ratio field	65
10.2.4 bus inactivity limit field	66
10.2.5 disconnect time limit field	66
10.2.6 connect time limit field	66
10.2.7 maximum burst size field	66
10.2.8 emdp bit	66
10.2.9 FAA, FAB, FAC BITS	67
10.2.10 first burst size field	67
10.3 Fibre Channel Logical Unit Control mode page	68
10.4 Fibre Channel Port Control mode page	68
10.4.1 Overview and format of Fibre Channel Port Control mode page	68
10.4.2 DISABLE TARGET ORIGINATED LOOP INITIALIZATION (DTOLI) bit	69
10.4.3 DISABLE TARGET INITIATED PORT ENABLE (DTIPE) bit	69
10.4.4 ALLOW LOGIN WITHOUT LOOP INITIALIZATION (ALWLI) bit	69
10.4.5 REQUIRE HARD ADDRESS (RHA) bit	70
10.4.6 disable loop master (dIm) bit	70
10.4.7 DISABLE DISCOVERY (DDIS) bit	70
10.4.8 PREVENT LOOP PORT BYPASS (PLPB) bit	70
10.4.9 DISABLE TARGET FABRIC DISCOVERY (DTFD) bit	70
10.4.10 sequence initiative resource recovery timeout value (rr_tovseq_init) field	71
11 Timers for FCP operation and recovery	72
11.1 Summary of timers for the Fibre Channel Protocol	72
11.2 Error_Detect Timeout (E_D_TOV)	73
11.3 Resource Allocation Timeout (R_A_TOV)	73
11.4 Resource Recovery Timeout (RR_TOV)	73
11.5 Read Exchange Concise Timeout Value (REC_TOV)	73
11.6 Upper Level Protocol Timeout (ULP_TOV)	74
12 Link error detection and error recovery procedures	75
12.1 Error detection and error recovery overview	75
12.1.1 Exchange level	75
12.1.2 Sequence level	75
12.2 FCP error detection	75
12.2.1 Overview of FCP-3 error detection	75
12.2.2 FCP-3 error detection using protocol errors for all classes of service	75
12.2.3 Error detection mechanisms for acknowledged classes of service	76
12.3 Exchange level recovery using recovery abort	77
12.3.1 Recovery abort overview	77
12.3.2 Initiator FCP_Port invocation of recovery abort	77
12.3.3 Target FCP_Port response to recovery abort	77
12.3.4 Additional error recovery by initiator FCP_Port	78

12.3.5 Additional error recovery by target FCP_Port	78
12.4 Sequence level error detection and recovery	78
12.4.1 Using information from REC to perform Sequence level recovery	78
12.4.1.1 Polling Exchange state with REC	78
12.4.1.2 Detection of errors while polling with REC	79
12.4.1.3 FCP_CMND IU recovery	79
12.4.1.4 FCP_XFER_RDY IU recovery	79
12.4.1.5 FCP_RSP IU recovery	79
12.4.1.6 FCP_DATA IU recovery - write operations	80
12.4.1.7 FCP_DATA IU recovery - read operations	81
12.4.1.8 FCP_CONF IU recovery	81
12.4.2 Additional error recovery requirements	82
12.4.2.1 Error indicated in ACK	82
12.4.2.2 Missing ACK	82
12.4.2.3 Distinguishing Exchange to be aborted	82
12.5 Second-level error recovery	82
12.5.1 ABTS error recovery	82
12.5.2 REC error recovery	83
12.5.3 SRR error recovery	83
12.6 Responses to FCP type frames before PLOGI or PRLI	83
Annex A - FCP-3 mapping to SAM-3	84
A.1 Definition of procedure terms	84
Annex B - FCP examples	86
B.1 Examples of the use of FCP Information Units (IUs)	86
B.1.1 Overview of examples	86
B.1.2 SCSI FCP read operation	86
B.1.3 SCSI FCP write operation	87
B.1.4 SCSI FCP operation with no data transfer or with check condition	87
B.1.5 SCSI FCP read operation with multiple FCP_DATA IUs	88
B.1.6 SCSI FCP write operation with FCP_XFR_RDY disabled	88
B.1.7 SCSI FCP bidirectional command with write before read	89
B.1.8 SCSI FCP bidirectional command with read before write	89
B.1.9 SCSI FCP bidirectional command, write first, write FCP_XFER_RDY disabled	90
B.1.10 SCSI FCP bidirectional command with intermixed writes and reads	91
B.1.11 SCSI linked commands	92
B.1.12 SCSI WRITE command with confirmed completion	93
B.1.13 SCSI FCP task management function	93
B.2 FCP write example, frame level	94
B.3 FCP read example, frame level	96
Annex C - Error detection and recovery action examples	98
C.1 Introduction	98
Annex D - FCP Device Discovery Procedure	132
D.1 FCP Device Discovery Procedure	132
D.1.1 Initiator discovery of Fabric-attached target FCP_Ports	132
D.1.2 Initiator discovery of loop-attached target FCP_Ports	132
D.2 Fabric and Device Authentication	133
D.3 Logical unit authentication	133
Annex E - FCP-3 examples of link service usage	134
E.1 Formats for recovery link services	134
E.2 Abort Sequence (ABTS) Request	134

E.2.1 Abort Sequence (ABTS) Request fields	134
E.2.2 Basic Accept (BA_ACC) Frame to ABTS	135
E.2.3 Basic Reject (BA_RJT) Frame to ABTS	135
E.3 Reinstate Recovery Qualifier (RRQ)	136
E.3.1 RRQ request format	136

Table 1 - SCSI and Fibre Channel Protocol functions	23
Table 2 - Discovery of FCP-3 capabilities	28
Table 3 - Task management functions, SAM-3 to FCP-3	29
Table 4 - Clearing effects of link related functions	30
Table 5 - Clearing effects of initiator FCP_Port actions	31
Table 6 - FCP frame header	33
Table 7 - FCP Service Parameter page, PRLI request	37
Table 8 - FCP Service Parameter page, PRLI accept	40
Table 9 - FCP definition of FC-4 Feature bits	42
Table 10 - FCP FC-4 Link Service Requests and Responses	43
Table 11 - SRR Payload	44
Table 12 - SRR Accept Payload	44
Table 13 - FCP_RJT Payload	45
Table 14 - FCP_RJT reason codes	45
Table 15 - FCP_RJT reason code explanations	46
Table 16 - FCP Information Units (IUs) sent to target FCP_Ports	47
Table 17 - FCP Information Units (IUs) sent to initiator FCP_Ports	48
Table 18 - FCP_CMND IU Payload	49
Table 19 - TASK ATTRIBUTE field values	50
Table 20 - task management flags field	51
Table 21 - FCP_XFER_RDY IU payload	54
Table 22 - FCP_RSP IU Payload	58
Table 23 - FCP_RSP_INFO field format	62
Table 24 - RSP_CODE definitions	62
Table 25 - Mode pages for FCP	64
Table 26 - Disconnect-Reconnect mode page (02h)	65
Table 27 - Fibre Channel Logical Unit Control mode page (18h)	68
Table 28 - Fibre Channel Port Control mode page (19h)	69
Table 29 - Values for RR_TOV UNITS	71
Table 30 - Timer summary	72
Table 31 - Initiator FCP_Port REC_TOV Usage	74
Table 32 - Target FCP_Port REC_TOV usage	74
Table A.1 - FCP-3 procedure terms mapped to terms from SAM-3 standard	84
Table A.2 - Procedure terms	85
Table B.1 - FCP read operation, example	86
Table B.2 - FCP write operation, example	87
Table B.3 - FCP operation without data transfer, example	87
Table B.4 - FCP read operation, example	88
Table B.5 - FCP write operation with FCP_XFER_RDY disabled, example	88
Table B.6 - FCP bidirectional command with write before read, example	89
Table B.7 - FCP bidirectional command with read before write, example	89
Table B.8 - FCP bidirectional command, write FCP_XFER_RDY disabled, example	90
Table B.9 - FCP bidirectional command with intermixed writes and reads, example	91
Table B.10 - FCP linked commands, example	92
Table B.11 - FCP write command with confirmed completion	93
Table B.12 - FCP task management function, example	93
Table C.1 - Diagram Drawing Conventions	98
Table E.2 - BA_ACC Frame to ABTS	135
Table E.3 - BA_RJT Frame to ABTS	135
Table E.4 - Reinstate Recovery Qualifier	136

Figure B.1 - Example of class 2 FCP write operation	94
Figure B.2 - Example of class 2 FCP_DATA write	95
Figure B.3 - Example of class 2 FCP read operation	96
Figure B.4 - Example of class 2 FCP_DATA read	97
Figure C.1 - Lengthy FCP_CMND or Lost ACK	99
Figure C.2 - FCP_CMND Lost, Unacknowledged Classes	100
Figure C.3 - FCP_CMND Lost, Acknowledged Classes	101
Figure C.4 - FCP_CMND Acknowledgement Lost, Acknowledged Classes	102
Figure C.5 - FCP_XFER_RDY Lost, Unacknowledged Classes	103
Figure C.6 - FCP_XFER_RDY Lost, Acknowledged Classes	104
Figure C.7 - FCP_XFER_RDY Received, ACK Lost, Acknowledged Classes	105
Figure C.8 - FCP_RSP Lost, FCP_CONF not requested, Unacknowledged Classes	106
Figure C.9 - FCP_RSP Lost, FCP_CONF not requested, Acknowledged Classes	107
Figure C.10 - FCP_RSP Lost Read Command, no FCP_CONF, Acknowledged Classes	108
Figure C.11 - FCP_RSP Received, ACK Lost, Acknowledged Classes, Example 1	109
Figure C.12 - FCP_RSP Received, ACK Lost, Acknowledged Classes, Example 2	110
Figure C.13 - Lost Write Data, Last Frame of Sequence, Unacknowledged Classes	111
Figure C.14 - Lost Write Data, Last Frame of Sequence, Acknowledged Classes	112
Figure C.15 - Lost Write Data, Not Last Frame of Sequence, Unacknowledged Classes	113
Figure C.16 - Lost Write Data, Not Last Frame of Sequence, Acknowledged Classes	114
Figure C.17 - Lost Read Data, Last Frame of Sequence, Unacknowledged Classes	115
Figure C.18 - Lost Read Data, Last Frame of Sequence, Acknowledged Classes	116
Figure C.19 - Lost Read Data, Not Last Frame of Sequence, Unacknowledged Classes	117
Figure C.20 - Lost Read Data, Not Last Frame of Sequence, Acknowledged Classes	118
Figure C.21 - ACK Lost on Read (Acknowledged Classes)	119
Figure C.22 - ACK Lost on Write (Acknowledged Classes)	120
Figure C.23 - FCP_CONF Lost, Unacknowledged Classes	121
Figure C.24 - FCP_CONF Lost, Acknowledged Classes	122
Figure C.25 - ACK lost on FCP_CONF, Acknowledged Classes	123
Figure C.26 - REC or REC Response Lost, Unacknowledged Classes	124
Figure C.27 - REC Lost, Acknowledged Classes	125
Figure C.28 - REC Response Lost, Acknowledged Classes	126
Figure C.29 - Two RECs Lost, Unacknowledged Classes, Abort the original Exchange	127
Figure C.30 - SRR Lost, Unacknowledged Classes, Abort original Exchange	128
Figure C.31 - SRR Response Lost, Unacknowledged Classes	129
Figure C.32 - SRR Lost, Acknowledged Classes	130
Figure C.33 - SRR Response Lost, Acknowledged Classes	131

INFORMATION TECHNOLOGY – SMALL COMPUTER SYSTEM INTERFACE (SCSI) –

Part 223: Fibre channel protocol, third version (FCP-3)

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 organizations 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 content 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, ISO or ISO/IEC 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 14776-223 was prepared by subcommittee 25: Interconnection of information technology equipment, of ISO/IEC joint technical committee 1: Information technology.

The list of all currently available parts of the ISO/IEC 14776 series, under the general title *Information*

technology – Small computer system interface, can be found on the IEC web site.

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

INTRODUCTION

The Small Computer System Interface (SCSI) command set is widely used and applicable to a wide variety of device types. The transmission of SCSI command set information across Fibre Channel links allows the large body of SCSI application and driver software to be successfully used in the high performance Fibre Channel environment.

This standard describes the protocol for transmitting SCSI commands, data and status using Fibre Channel FC-FS-2 Exchanges and Information Units. Fibre Channel is a high speed serial architecture that allows either optical or electrical connections. The topologies supported by Fibre Channel include point-to-point, fabric switched and arbitrated loop. All Fibre Channel connections use the same standard frame format and standard hierarchy of transmission units to transmit the Information Units that carry SCSI information.

This standard is divided into the following clauses:

Clause 1 is the scope of this standard.

Clause 2 enumerates the normative references that apply to this standard.

Clause 3 describes the definitions, abbreviations and conventions used in this standard.

Clause 4 provides an overview of the protocol for transmitting SCSI information over Fibre Channel.

Clause 5 describes the Information Units used to transfer SCSI commands, data and status across a Fibre Channel connection.

Clause 6 describes the Basic Link Services and Extended Link Services used by the protocol for transmitting SCSI information over Fibre Channel.

Clause 7 describes the FC-GS-4 Name Server objects defined for FCP-3.

Clause 8 describes the FCP FC-4 Link Service definitions for the protocol for transmitting SCSI information over Fibre Channel.

Clause 9 describes the details of the Information Unit formats.

Clause 10 defines the SCSI management features for Fibre Channel, including the SCSI mode pages used by the protocol for transmitting SCSI information over Fibre Channel.

Clause 11 defines the timers used for FCP-3 error recovery algorithms.

Clause 12 defines the error recovery algorithms for FCP-3.

The Fibre Channel Protocol for SCSI, Third revision (FCP-3) standard has the following annexes:

Annex A is a normative description of the relationship between the services defined by SAM-3 and the corresponding functions defined by this standard.

Annex B is an informative annex that provides examples of the protocol for transmitting SCSI information over Fibre Channel.

Annex C is an informative annex providing examples of the FCP-3 error recovery mechanisms.

Annex D is an informative annex describing techniques for discovering SCSI device capabilities over Fibre Channel.

Annex E is an informative annex providing examples of the content of ELSs used during FCP-3 recovery operations.

This standard is part of the SCSI family of standards developed to facilitate the use of the SCSI command sets for many different types of devices across many different types of physical interconnects. The architectural

model for the family of standards is ISO/IEC 14776-413, *Information technology - SCSI Architecture Model - 3 (SAM-3)*.

INFORMATION TECHNOLOGY – SMALL COMPUTER SYSTEM INTERFACE (SCSI) –

Part 223: Fibre channel protocol, third version (FCP-3)

1 Scope

This standard defines a third version of the SCSI Fibre Channel Protocol (FCP). This standard is a mapping protocol for applying the SCSI command set to Fibre Channel. This standard defines how the Fibre Channel services and the defined Information Units (IUs) are used to perform the services defined by the SCSI Architecture Model - 3 (SAM-3). This third version includes additions and clarifications to the second version, removes information that is now contained in other standards, and describes additional error recovery capabilities for the Fibre Channel Protocol.

2 Normative references

The following referenced documents are 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.

The provisions of the referenced specifications other than ISO/IEC, IEC, ISO and ITU documents, as identified in this clause, are valid within the context of this International Standard. The reference to such a specification within this International Standard does not give it any further status within ISO or IEC. In particular, it does not give the referenced specification the status of an International Standard.

ISO/IEC 14165-122, *Information technology - Fibre Channel - Part 122: Arbitrated Loop - 2 (FC-AL-2)* [INCITS 332:1999]

ISO/IEC 14165-252, *Information technology - Fibre Channel - Part 252: Framing and Signaling - 2 (FC-FS-2) (under consideration)* [ANSI/INCITS 424-2007/AM1-2007]

ISO/IEC 14165-261, *Information technology - Fibre Channel - Part 261: Link Services (FC-LS) (under consideration)* [ANSI/INCITS 433-2007]

ISO/IEC 14165-414, *Information technology - Fibre Channel - Part 414: Generic Services - 4 (FC-GS-4)* [ANSI/INCITS 414-2007]

ISO/IEC 14165-341, *Information technology - Fibre Channel - Part 341: Device Attach (FC-DA) (under consideration)* [INCITS TR-36-2004]

ISO/IEC 14776-413, *Information technology - Small Computer System Interface - Part 413: SCSI Architecture Model - 3 (SAM-3)* [ANSI/INCITS 402-2005]

ISO/IEC 14776-453, *Information technology - Small Computer System Interface - Part 453: SCSI Architecture Model - SCSI Primary Commands-3 (SPC-3)(under consideration)* [ANSI/INCITS 408-2005]

INCITS Project 1683-D, *SCSI Architecture Model - 4 (SAM-4)*

SFF document SFF-8067, *40-pin SCA-2 Connector w/Bidirectional ESI*