



ISO/IEC 14776-224

Edition 1.0 2019-10

INTERNATIONAL STANDARD

**Information technology – Small computer system interface (SCSI) –
Part 224: Fibre Channel Protocol, fourth version (FCP-4)**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 35.200

ISBN 978-2-8322-7520-7

Warning! Make sure that you obtained this publication from an authorized distributor.

Contents

FOREWORD	8
INTRODUCTION	10
1 Scope	11
2 Normative references	11
3 Terms, definitions, abbreviations and conventions	12
3.1 Terms and definitions	12
3.2 Abbreviations	18
3.3 Keywords	20
3.4 Editorial conventions	21
4 General	23
4.1 Structure and concepts	23
4.2 FCP I/O operations	24
4.3 Bidirectional and unidirectional commands and FCP_RSP IU format	26
4.4 Precise delivery of commands	26
4.5 Confirmed completion of FCP I/O operations	27
4.6 Retransmission of unsuccessfully transmitted IUs	28
4.7 Task retry identification	28
4.8 Discovery of FCP capabilities	29
4.9 Task management functions	29
4.9.1 Task management functions overview	29
4.9.2 ABORT TASK task management function	31
4.9.3 QUERY TASK task management function	31
4.10 Clearing effects of task management, FCP, FC-FS-3, FC-LS-2, and FC-AL-2 actions	32
4.11 I_T nexus loss notification events	34
4.12 Transport Reset notification events	34
4.13 Port Login/Logout	34
4.14 Process Login and Process Logout	35
4.15 Link management	35
4.16 FCP addressing and Exchange identification	35
4.17 Use of Worldwide_Names	35
5 FC-FS-3 frame header	37
5.1 FC-FS-3 frame header overview	37
5.2 FC-FS-3 frame header fields	37
5.2.1 R_CTL field	37
5.2.2 D_ID field	37
5.2.3 CS_CTL field	37
5.2.4 S_ID field	37
5.2.5 TYPE field	37
5.2.6 F_CTL field	37
5.2.7 SEQ_ID field	38
5.2.8 DF_CTL field	38
5.2.9 SEQ_CNT field	38
5.2.10 OX_ID field	38
5.2.11 RX_ID field	38
5.2.12 PARAMETER field	38
6 FCP link service definitions	39
6.1 Overview of link service requirements	39
6.2 Overview of Process Login and Process Logout	39
6.3 PRLI ELS	40
6.3.1 Use of PRLI ELS by the Fibre Channel Protocol	40
6.3.2 New or repeated Process Login	40

6.3.3 PRLI ELS request FCP Service Parameter page format	41
6.3.4 PRLI ELS accept FCP Service Parameter page format	44
6.4 PRLO ELS	45
6.5 Read Exchange Concise (REC) ELS	45
7 FC-4 specific Name Server registration and objects	47
7.1 Overview of FC-4 specific objects for the Fibre Channel Protocol	47
7.2 FC-4 TYPEs object	47
7.3 FC-4 Features object	47
8 FCP FC-4 Link Service (FCP_LS) definitions	49
8.1 FCP_LS overview	49
8.2 Sequence Retransmission Request (SRR) FCP_LS request	49
8.3 FCP_LS Accept (FCP_ACC)	50
8.4 FCP_LS Reject (FCP_RJT)	51
9 FCP Information Unit (IU) usage and formats	53
9.1 FCP Information Unit (IU) usage	53
9.2 FCP_CMND IU	54
9.2.1 Overview and format of FCP_CMND IU	54
9.2.2 FCP_CMND IU field descriptions	55
9.2.2.1 FCP_LUN field	55
9.2.2.2 COMMAND REFERENCE NUMBER field	55
9.2.2.3 COMMAND PRIORITY field	56
9.2.2.4 TASK ATTRIBUTE field	56
9.2.2.5 TASK MANAGEMENT FLAGS FIELD	56
9.2.2.6 ADDITIONAL FCP_CDB LENGTH field	58
9.2.2.7 RDDATA bit and WRDATA bit	58
9.2.2.8 FCP_CDB field	59
9.2.2.9 ADDITIONAL_FCP_CDB field	59
9.2.2.10 FCP_DL field	59
9.2.2.11 FCP_BIDIRECTIONAL_READ_DL field	59
9.3 FCP_XFER_RDY IU	59
9.3.1 Overview and format of FCP_XFER_RDY IU	59
9.3.2 FCP_DATA_RO field	60
9.3.3 FCP_BURST_LEN field	60
9.4 FCP_DATA IU	60
9.4.1 FCP_DATA IU overview	60
9.4.2 FCP_DATA IUs for read and write operations	61
9.4.3 FCP_DATA IUs for bidirectional commands	62
9.4.4 FCP_DATA IU use of fill bytes	62
9.5 FCP_RSP IU	63
9.5.1 Overview and format of FCP_RSP IU	63
9.5.2 STATUS QUALIFIER field	64
9.5.3 FCP_BIDI_RSP bit	64
9.5.4 FCP_BIDI_READ_RESID_UNDER bit	64
9.5.5 FCP_BIDI_READ_RESID_OVER bit	65
9.5.6 FCP_CONF_REQ bit	65
9.5.7 FCP_RESID_UNDER bit	65
9.5.8 FCP_RESID_OVER bit	65
9.5.9 FCP_SNS_LEN_VALID bit	65
9.5.10 FCP_RSP_LEN_VALID bit	65
9.5.11 SCSI STATUS CODE field	65
9.5.12 FCP_RESID field	65
9.5.13 FCP_BIDIRECTIONAL_READ_RESID field	66
9.5.14 FCP_SNS_LEN field	67
9.5.15 FCP_RSP_LEN field	67
9.5.16 FCP_RSP_INFO field	67
9.5.17 FCP_SNS_INFO field	68

9.6 FCP_CONF IU	68
10 SCSI mode parameters for the Fibre Channel Protocol	69
10.1 Overview of mode pages for the Fibre Channel Protocol	69
10.2 Disconnect-Reconnect mode page	69
10.2.1 Overview and format of Disconnect-Reconnect mode page for FCP	69
10.2.2 BUFFER FULL RATIO field	70
10.2.3 BUFFER EMPTY RATIO field	70
10.2.4 BUS INACTIVITY LIMIT field	70
10.2.5 DISCONNECT TIME LIMIT field	71
10.2.6 CONNECT TIME LIMIT field	71
10.2.7 MAXIMUM BURST SIZE field	71
10.2.8 EMDP bit	71
10.2.9 FAA BIT, FAB BIT, AND FAC bit	72
10.2.10 FIRST BURST SIZE field	72
10.3 Fibre Channel Logical Unit Control mode page	73
10.4 Fibre Channel Port Control mode page	73
10.4.1 Overview and format of Fibre Channel Port Control mode page	73
10.4.2 DISABLE TARGET ORIGINATED LOOP INITIALIZATION (DTOLI) bit	74
10.4.3 DISABLE TARGET INITIATED PORT ENABLE (DTIPE) bit	74
10.4.4 ALLOW LOGIN WITHOUT LOOP INITIALIZATION (ALWLI) bit	74
10.4.5 REQUIRE HARD ADDRESS (RHA) bit	74
10.4.6 DISABLE LOOP MASTER (DLM) bit	75
10.4.7 DISABLE DISCOVERY (DDIS) bit	75
10.4.8 PREVENT LOOP PORT BYPASS (PLPB) bit	75
10.4.9 DISABLE TARGET FABRIC DISCOVERY (DTFD) bit	75
10.4.10 RR_TOV UNITS field	75
10.4.11 SEQUENCE INITIATIVE RESOURCE RECOVERY TIMEOUT VALUE (RR_TOVSEQ_INIT) field	76
11 Timers for FCP operation and recovery	77
11.1 Summary of timers for the Fibre Channel Protocol	77
11.2 Error_Detect Timeout (E_D_TOV)	78
11.3 Resource Allocation Timeout (R_A_TOV)	78
11.4 Resource Recovery Timeout (RR_TOV)	78
11.5 Read Exchange Concise Timeout Value (REC_TOV)	78
11.6 Upper Level Protocol Timeout (ULP_TOV)	79
12 Link error detection and error recovery procedures	80
12.1 Error detection and error recovery overview	80
12.1.1 Exchange level	80
12.1.2 Sequence level	80
12.2 FCP error detection	80
12.2.1 Overview of FCP-4 error detection	80
12.2.2 FCP-4 error detection using protocol errors for all classes of service	80
12.2.3 Error detection mechanisms for acknowledged classes of service	81
12.3 Exchange level recovery using ABTS-LS	81
12.3.1 ABTS-LS overview	81
12.3.2 Initiator FCP_Port Exchange termination	82
12.3.3 Target FCP_Port response to Exchange termination	82
12.3.4 Additional error recovery by initiator FCP_Port	83
12.3.5 Additional error recovery by target FCP_Port	83
12.4 Sequence level error detection and recovery	83
12.4.1 Using information from REC ELS to perform Sequence retransmission	83
12.4.1.1 Polling Exchange state with REC ELS	83
12.4.1.2 Detection of errors while polling with REC ELS	83
12.4.1.3 FCP_CMND IU recovery	84
12.4.1.4 FCP_XFER_RDY IU recovery	84
12.4.1.5 FCP_RSP IU recovery	84
12.4.1.6 FCP_DATA IU recovery - write operations	85

12.4.1.7 FCP_DATA IU recovery - read operations	86
12.4.1.8 FCP_CONF IU recovery	86
12.4.2 Additional error recovery requirements	87
12.4.2.1 Error indicated in ACK	87
12.4.2.2 Missing ACK	87
12.4.2.3 Distinguishing Exchange to be aborted	87
12.5 Second-level error recovery	87
12.5.1 ABTS error recovery	87
12.5.2 REC ELS request error recovery	87
12.5.3 SRR FCP_LS request error recovery	88
12.6 Responses to FCP type frames before port login or process login	88
Annex A (normative) SAM-5 mapping to FCP-4	89
Annex B (informative) FCP examples	91
B.1 Examples of the use of FCP Information Units (IUs)	91
B.1.1 Overview of examples	91
B.1.2 Read command	91
B.1.3 Write command	92
B.1.4 Command with no data transfer or with check condition	92
B.1.5 Read command with multiple FCP_DATA IUs	93
B.1.6 Write command with FCP_XFER_RDY disabled	93
B.1.7 Bidirectional command with write before read	94
B.1.8 Bidirectional command with read before write	94
B.1.9 Bidirectional command with write first and write FCP_XFER_RDY disabled	95
B.1.10 Bidirectional command with intermixed writes and reads	96
B.1.11 Write command with confirmed completion	96
B.1.12 Task management function	97
B.1.13 Class 2 write command example, frame level	98
B.1.14 Class 2 read command example, frame level	100
Annex C (informative) Error detection and recovery examples	102
Annex D (informative) FCP device discovery procedure	136
D.1 FCP Device Discovery Procedure	136
D.1.1 Initiator discovery of Fabric-attached target FCP_Ports	136
D.1.2 Initiator discovery of loop-attached target FCP_Ports	136
D.2 Fabric and device verification	137
D.3 Logical unit verification	137
Annex E (informative) FCP-4 examples of link service usage	138
E.1 Formats for recovery link services	138
E.2 Abort Sequence (ABTS) request	138
E.2.1 Abort Sequence (ABTS) request fields	138
E.2.2 Basic Accept (BA_ACC) frame to ABTS	139
E.2.3 Basic Reject (BA_RJT) frame to ABTS	139
E.3 Reinstate Recovery Qualifier (RRQ) ELS	140

Tables

Table 1 - Numbering conventions	21
Table 2 - SCSI and Fibre Channel Protocol functions	24
Table 3 - Discovery of FCP-4 capabilities	29
Table 4 - Task management functions, SAM-5 to FCP-4	30
Table 5 - SCSI Service Response mapping for FCP_CMND delivered task management functions	31
Table 6 - SCSI Service Response mapping for ABORT TASK	31
Table 7 - SCSI Service Response mapping for QUERY TASK	32
Table 8 - Clearing effects of link related actions	33
Table 9 - Clearing effects of initiator FCP_Port actions	34
Table 10 - FCP frame header	37
Table 11 - PRLI ELS request FCP Service Parameter page	41
Table 12 - PRLI ELS accept FCP Service Parameter page	44
Table 13 - FCP TYPE 08h definition of FC-4 Feature bits	47
Table 14 - Additional FCP Features TYPE 0Ah definition of FC-4 Feature bits	47
Table 15 - FCP_LS requests and responses	49
Table 16 - SRR FCP_LS request payload	50
Table 17 - FCP_ACC payload	51
Table 18 - FCP_RJT payload	51
Table 19 - FCP_RJT Reason Codes	52
Table 20 - FCP_RJT Reason Code Explanations	52
Table 21 - FCP Information Units (IUs) sent to target FCP_Ports	53
Table 22 - FCP Information Units (IUs) sent to initiator FCP_Ports	54
Table 23 - FCP_CMND IU payload	55
Table 24 - TASK ATTRIBUTE field	56
Table 25 - TASK MANAGEMENT FLAGS field	57
Table 26 - FCP_XFER_RDY IU payload	60
Table 27 - FCP_RSP IU payload	64
Table 28 - FCP_RSP_INFO field format	67
Table 29 - RSP_CODE field	68
Table 30 - Mode pages for FCP	69
Table 31 - Disconnect-Reconnect mode page (02h)	70
Table 32 - Fibre Channel Logical Unit Control mode page (18h)	73
Table 33 - Fibre Channel Port Control mode page (19h)	74
Table 34 - Values for RR_TOV UNITS	75
Table 35 - Timer summary	77
Table 36 - Initiator FCP_Port REC_TOV usage	79
Table 37 - Target FCP_Port REC_TOV usage	79
Table A.1 - Mapping of SAM-5 terms to FCP-4 objects and identifiers	89
Table A.2 - Procedure terms	89
Table B.1 - Read command example	91
Table B.2 - Write command example	92
Table B.3 - Command without data transfer example	92
Table B.4 - Read command with multiple FCP_DATA IUs example	93
Table B.5 - Write command with FCP_XFER_RDY disabled example	93
Table B.6 - Bidirectional command with write before read example	94
Table B.7 - Bidirectional command with read before write example	94
Table B.8 - Bidirectional command with write first and write FCP_XFER_RDY disabled example	95
Table B.9 - Bidirectional command with intermixed writes and reads example	96
Table B.10 - Write command with confirmed completion example	96
Table B.11 - Task management function example	97
Table E.1 - ABTS frame	138
Table E.2 - BA_ACC frame to ABTS	139
Table E.3 - BA_RJT frame to ABTS	139
Table E.4 - RRQ ELS request format	140

Figures

Figure B.1 - Class 2 write command example	98
Figure B.2 - Class 2 write data example	99
Figure B.3 - Class 2 read command example	100
Figure B.4 - Class 2 read data example	101
Figure C.1 - Lengthy FCP_CMND or lost ACK	103
Figure C.2 - FCP_CMND lost, unacknowledged classes	104
Figure C.3 - FCP_CMND lost, acknowledged classes	105
Figure C.4 - FCP_CMND ACK lost, acknowledged classes	106
Figure C.5 - FCP_XFER_RDY lost, unacknowledged classes	107
Figure C.6 - FCP_XFER_RDY lost, acknowledged classes	108
Figure C.7 - FCP_XFER_RDY received, ACK lost, acknowledged classes	109
Figure C.8 - FCP_RSP lost, FCP_CONF not requested, unacknowledged classes	110
Figure C.9 - FCP_RSP lost, FCP_CONF not requested, acknowledged classes	111
Figure C.10 - FCP_RSP lost read command, no FCP_CONF, acknowledged classes	112
Figure C.11 - FCP_RSP received, ACK lost, acknowledged classes, example 1	113
Figure C.12 - FCP_RSP received, ACK lost, acknowledged classes, example 2	114
Figure C.13 - Lost write data, last frame of Sequence, unacknowledged classes.	115
Figure C.14 - Lost write data, last frame of Sequence, acknowledged classes.	116
Figure C.15 - Lost write data, not last frame of Sequence, unacknowledged classes.	117
Figure C.16 - Lost write data, not last frame of Sequence, acknowledged classes.	118
Figure C.17 - Lost read data, last frame of Sequence, unacknowledged classes.	119
Figure C.18 - Lost read data, last frame of Sequence, acknowledged classes.	120
Figure C.19 - Lost read data, not last frame of Sequence, unacknowledged classes	121
Figure C.20 - Lost read data, not last frame of Sequence, acknowledged classes	122
Figure C.21 - ACK lost on read, acknowledged classes	123
Figure C.22 - ACK lost on write, acknowledged classes	124
Figure C.23 - FCP_CONF lost, unacknowledged classes	125
Figure C.24 - FCP_CONF lost, acknowledged classes	126
Figure C.25 - ACK lost on FCP_CONF, acknowledged classes	127
Figure C.26 - REC ELS request or REC ELS response lost, unacknowledged classes	128
Figure C.27 - REC ELS lost, acknowledged classes	129
Figure C.28 - REC ELS response lost, acknowledged classes	130
Figure C.29 - Two REC ELSs lost, unacknowledged classes, abort the original Exchange	131
Figure C.30 - SRR FCP_LS request lost, unacknowledged classes, abort original Exchange	132
Figure C.31 - SRR FCP_LS response lost, unacknowledged classes	133
Figure C.32 - SRR FCP_LS request lost, acknowledged classes	134
Figure C.33 - SRR FCP_LS response lost, acknowledged classes	135

INFORMATION TECHNOLOGY – SMALL COMPUTER SYSTEM INTERFACE (SCSI) – Part 224: Fibre Channel Protocol, fourth version (FCP-4)

FOREWORD

- 1) ISO (the International Organization for Standardization) and IEC (the 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 through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work. In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1.
- 2) 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 National Committees and ISO member bodies.
- 3) IEC, ISO and ISO/IEC publications have the form of recommendations for international use and are accepted by IEC National Committees 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.
- 4) In order to promote international uniformity, IEC National Committees 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 or ISO/IEC publication and the corresponding national or regional publication should be clearly indicated in the latter.
- 5) ISO and IEC do not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. ISO or IEC are not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) 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 National Committees 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.
- 8) 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.
- 9) Attention is drawn to the possibility that some of the elements of this ISO/IEC publication 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 14776-224 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 (SCSI)*, can be found on the IEC and ISO websites.

The text for this standard is based on the following document:

CDV	Report on voting
JTC1-SC25/2833/CDV	JTC1-SC25/2881/RVC

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2 except as indicated in 3.4.

A bilingual version of this publication may be issued at a later date.

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-3 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 terms, 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 FC-FS-3 frame header.

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 Name Server objects defined for FCP-4.

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

Clause 9 describes the Information Units used to transfer SCSI commands, data, and status across a Fibre Channel connection.

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

Clause 11 defines the timers used for FCP-4 operation and recovery.

Clause 12 defines the link error detection and error recovery procedures for FCP-4.

This standard has the following annexes:

Annex A is a normative description of the relationship between the services defined by SAM-5 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 FCP.

Annex C is an informative annex providing examples of the FCP-4 error recovery mechanisms.

Annex D is an informative annex describing techniques for discovering FCP device capabilities.

Annex E is an informative annex providing examples of the content of ELSs used during FCP-4 recovery operations.

This standard is part of ISO/IEC 14476 (all parts) 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 14776-415, *Information technology - Small computer system interface (SCSI) - Part 415: SCSI architecture model - 5 (SAM-5)*.

INFORMATION TECHNOLOGY – SMALL COMPUTER SYSTEM INTERFACE (SCSI) – Part 224: Fibre Channel Protocol, fourth version (FCP-4)

1 Scope

This part of ISO/IEC 14776 defines a fourth 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 - 5 (SAM-5). This fourth version includes additions and clarifications to the third version (ISO/IEC 14776-223:2008), 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 documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 14165-122, *Information technology - Fibre channel - Part 122: Arbitrated loop-2 (FC-AL-2)*

ISO/IEC 14776-415, *Information technology - Small computer system interface (SCSI) - Part 415: SCSI architecture model - 5 (SAM-5)*

ISO/IEC 14776-454, *Information technology - Small computer system interface (SCSI) - Part 454: SCSI Primary Commands - 4 (SPC-4)*

INCITS 463-2010, *Information Technology - Fibre Channel Generic Services - 6 (FC-GS-6)*

INCITS 470-2011, *Information Technology - Fibre Channel Framing and Signaling Interface - 3 (FC-FS-3)*

INCITS 477-2011, *Information Technology - Fibre Channel - Link Services - 2 (FC-LS-2)*

INCITS 540, *Information Technology - Fibre Channel - Non-Volatile Memory Express (FC-NVMe)*

INCITS 544, *Information technology - Fibre Channel - Single-Byte Command Code Sets Mapping Protocol - 6 (FC-SB-6)*

INCITS TR-49-2012, *INCITS Technical Report For Information Technology - Fibre Channel - Device Attach - 2 (FC-DA-2)*

SFF document SFF-8067, *40-pin SCA-2 Connector w/Bidirectional ESI*¹

1. SFF specifications are available from the SNIA SFF Technology Affiliate (see <http://www.snia.org/sff>).