

INTERNATIONAL STANDARD

ISO/IEC 14165-115

First edition
2006-02

Information technology – Fibre channel –

Part 115: Physical interfaces (FC-PI)

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

FOREWORD	8
INTRODUCTION	9
1 Scope	11
2 Normative references	11
2.1 Overview	11
2.2 International Standards	11
2.3 Other references	12
3 Definitions and conventions	13
3.1 Definitions	13
3.2 Editorial conventions	20
3.2.1 Abbreviations, acronyms and symbols	21
3.2.2 signaling rate abbreviations	21
3.2.3 Synonyms	21
3.2.4 Acronyms and other abbreviations	22
3.3 Symbols	23
4 Structure and concepts	24
4.1 General	24
4.2 FC-0 general description	25
4.3 FC-0 interface overview	27
4.4 Data flow stages	28
5 FC-PI functional characteristics	29
5.1 General	29
5.2 General characteristics	29
5.3 FC-0 States	30
5.3.1 Transmitter FC-0 states	30
5.3.2 Receiver States	30
5.4 Response to input data phase jumps	30
5.5 Limitations on invalid code	31
5.6 Receiver initialization time	31
5.7 Loss of signal (Rx_LOS) function	31
5.8 Speed agile Ports that support Speed Negotiation	31
5.9 FC-PI nomenclature	32
5.10 Interoperability points	32
5.11 FC-PI technology options	40
6 Optical interface specification	41
6.1 General	41
6.2 Laser safety issues	41
6.3 SM data links	41
6.3.1 General	41
6.3.2 SM optical output interface	41
6.3.3 SM optical input interface	44
6.3.4 SM jitter budget	44
6.3.5 SM trade-offs	47
6.4 MM data links	49
6.4.1 General	49
6.4.2 MM optical output interface	49
6.4.3 MM optical input interface	53
6.4.4 MM jitter budget	53

7 Optical interface receptacle specifications	55
7.1 Optical interface general information	55
7.2 SC optical interface	55
7.2.1 SC performance information	55
7.2.2 SC optical plug	55
7.2.3 SC Duplex optical receptacle	56
7.3 SG optical interface	56
7.4 LC optical interface	57
7.5 MT-RJ optical interface	58
7.6 MU connector	58
8 Optical fibre cable plant specification	59
8.1 SM cable plant specification	59
8.1.1 SM optical fibre type	59
8.1.2 SM cable plant loss budget	59
8.1.3 SM optical return loss	59
8.2 MM cable plant specification	59
8.2.1 General	59
8.2.2 MM optical fibre types	60
8.2.3 MM modal bandwidth	60
8.2.4 MM cable plant loss budget	60
8.2.5 MM optical return loss	61
8.3 Connectors and splices	61
9 Electrical cable interface specification	62
9.1 General	62
9.2 Transmitted signal characteristics	62
9.3 Received signal characteristics	64
9.4 Jitter characteristics	65
9.5 Eye masks	67
9.5.1 General	67
9.5.2 Transmitted eye mask at β_T , δ_T and γ_T	67
9.5.3 Received eye mask at β_R , δ_R and γ_R	68
9.5.4 Jitter tolerance masks	68
9.6 Impedance specifications	70
9.7 Electrical TxRx Connections	71
9.8 Compliance points	71
9.9 Driver characteristics	72
9.10 Receiver characteristics	73
9.11 Example TxRx Connections	74
10 Electrical cable plant and connector specifications	75
10.1 General	75
10.2 Shielding	75
10.3 Cable interoperability	75
10.4 Unbalanced cable connectors	75
10.4.1 Inter-enclosure connectors for unbalanced cable	75
10.4.2 Intra-enclosure connectors for unbalanced cable	76
10.5 Balanced cable connectors	77
10.5.1 General	77
10.5.2 Inter-enclosure connectors for balanced cable	77
10.5.3 Intra-enclosure connectors for balanced cable	79
10.5.4 Non-device inter-enclosure connectors	81
Annex A (informative) Test methods	82
Annex B (informative) SERDES electrical interface example	91

Annex C (normative) Optical cable plant usage	100
Annex D (normative) Tx-Off and Rx-Loss of Signal detection	102
Bibliography	106

Table 1 – ISO/IEC rules	20
Table 2 – Signaling rate abbreviations.....	21
Table 3 – Acronyms and other abbreviations	22
Table 4 – Symbols	23
Table 5 – FC-PI technology options.....	40
Table 6 – Single-mode link classes	43
Table 7 – Transmit pulse noise filter	44
Table 8 – Tx Pulse Noise Filter Attenuation Tolerance	44
Table 9 – SM jitter output, peak to peak, max.	45
Table 10 – SM jitter tolerance, peak to peak, min.	46
Table 11 – Multimode 50 μm link classes.....	50
Table 12 – Multimode 62,5 μm link classes.....	52
Table 13 – MM jitter output, peak to peak, max.....	53
Table 14 – MM jitter tolerance, peak to peak, min.....	54
Table 15 – Single-mode cable plant	59
Table 16 – Multimode cable plant.....	60
Table 17 – Multimode fibre types.....	60
Table 18 – Multimode OFL bandwidth	60
Table 19 – General electrical characteristics	62
Table 20 – Transmitted signal characteristics at β_T , δ_T and γ_T	63
Table 21 – Delivered signal characteristics to β_R , δ_R and γ_R	64
Table 22 – Jitter output	65
Table 23 – Jitter tolerance.....	66
Table 24 – FC-PI measured impedance	70
Table 25 – Optional inter-enclosure contact uses	77
Table A.1 – Filter 3 dB point.....	86
Table C.1 – Worst case (nominal bandwidth) multimode cable link power budget.....	100
Table C.2 – Alternate (lower bandwidth) multimode cable link power budget.....	100
Table C.3 – Alternate (higher bandwidth) multimode cable link power budget.....	101
Table E.1 – Tx-Off timing	103
Table E.2 – Rx-LOS timing.....	103
Table E.3 – Optical Rx_LOS detection thresholds	104
Table E.4 – Electrical Rx_LOS detection thresholds.....	104

Figure 1 – Fibre channel structure	24
Figure 2 – Node functional configuration	25
Figure 3 – FC-0 Link	25
Figure 4 – Fabric	26
Figure 5 – FC-0 Path	26
Figure 6 – Fibre channel building wiring	27
Figure 7 – Data flow stages	28
Figure 8 – FC variant nomenclature	32
Figure 9 – Example of physical location of reference and interoperability points	33
Figure 10 – Use of internal connectors and retimers	34
Figure 11 – Tx interoperability points (examples)	35
Figure 12 – Rx interoperability points (examples)	36
Figure 13 – Hub interoperability points (example)	37
Figure 14 – Examples of interoperability points	38
Figure 15 – Overview of the signal specification architecture	39
Figure 16 – SM transmitter eye diagram mask	42
Figure 17 – Sinusoidal jitter mask	45
Figure 18 – 1,06 GBd SM 10 km link	47
Figure 19 – 2,12 GBd SM 10 km link	48
Figure 20 – 4,25 GBd SM 10 km link	48
Figure 21 – MM transmitter eye diagram mask	49
Figure 22 – Duplex SC optical interface	55
Figure 23 – SG interface	56
Figure 24 – Duplex LC interface	57
Figure 25 – MT-RJ connector and receptacle	58
Figure 26 – MU connector plug envelope dimensions	58
Figure 27 – Normalized (left) and absolute (right) eye diagram masks at β_T , δ_T and γ_T	67
Figure 28 – Eye diagram mask at β_R , δ_R and γ_R	68
Figure 29 – Deriving the tolerance mask at the interoperability T points	68
Figure 30 – Deriving the tolerance masks at the interoperability R points	69
Figure 31 – Sinusoidal jitter mask	69
Figure 32 – Inter-enclosure transmitter compliance point γ_T	71
Figure 33 – Inter-enclosure receiver compliance point γ_R	72
Figure 34 – Intra-enclosure transmitter compliance point β_T	72
Figure 35 – Intra-enclosure receiver compliance point β_R	72
Figure 36 – Test loads	73
Figure 37 – Example xxx-SE-EL-S inter-enclosure TxRx with 75. unbalanced cable	74
Figure 38 – Example xxx-DF-EL-S inter-enclosure TxRx with 150. balanced cable	74
Figure 39 – Balanced cable wiring	77
Figure 40 – Style-1 balanced connector plug contact locations	78
Figure 41 – Style-2 plug and receptacle	78
Figure 42 – Style-2 balanced connector receptacle contact locations	79
Figure 43 – Intra-enclosure integral Fibre Channel device connector	80
Figure 44 – Contact numbering for integral FC device connector	80
Figure A.1 – RIN (OMA) test setup	85
Figure A.2 – Optical modulation amplitude test equipment configuration	88
Figure A.3 – OMA measurement	88
Figure A.4 – Required characteristics of the conformance test signal at γ_R	89
Figure A.5 – Apparatus for generating stressed receive conformance test signal at γ_R	90
Figure A.6 – Test setup for receiver bandwidth measurement	90
Figure B.1 – Fibre channel electrical interface example block diagram	92
Figure B.2 – PECL communication levels	93
Figure B.3 – SSTL_2 compatible communication levels	93
Figure B.4 – Recovered interface signal timing	94
Figure B.5 – Transmit parallel interface timings: 106,25 MBd	95
Figure B.6 – Transmit parallel interface timings: 212,5 MBd	95
Figure B.7 – Receive parallel interface timings: 106,25 MBd	97
Figure B.8 – Receive parallel interface timings: 212,5 MBd	97

**INFORMATION TECHNOLOGY –
FIBRE CHANNEL –
Part 115: Physical interfaces (FC-PI)**

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 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.
- 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) All users should ensure that they have the latest edition of this publication.
- 4) 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.
- 5) 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.
- 6) 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 14165-115 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 member bodies, and the voting results can be obtained from the address given on the title page.

INTRODUCTION

This International Standard describes the physical interface portions of a high performance serial link that supports the higher Upper Level Protocols (ULPs) associated with HIPPI, IPI, SCSI, IP and others.

Figure 0 shows the relationship of this standard (highlighted rectangle) with other Fibre Channel standards. For the full reference of publication numbers and titles, see bibliography.

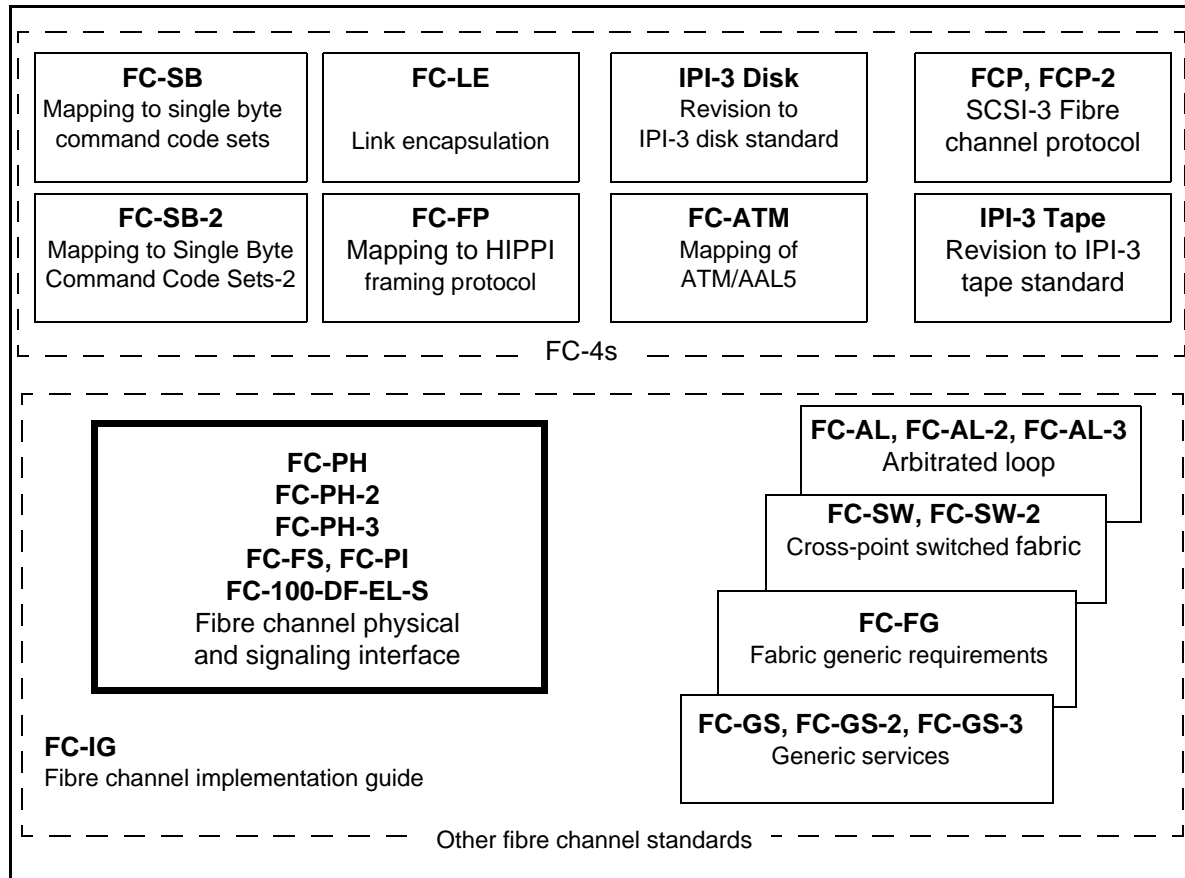


Figure 0 - Document relationship

The information presented in this document is grouped into clauses:

Clause 1 gives a general introduction to the document.

Clause 2 lists the standards which are referenced in the text and which constitute provisions of this document.

Clause 3 describes the basic elements, acronyms, naming conventions and terminology used in this document.

Clause 4 provides an overview of the structure, concepts, configurations and mechanisms used in this document.

Clause 5 describes the physical link, the lowest level, in the Fibre Channel system. It is designed for flexibility and allows the use of several physical interconnect technologies to meet a wide variety of system application requirements.

Clause 6 defines the optical signal characteristics at the interface connector. Each conforming optical FC attachment shall be compatible with this optical interface to allow interoperability within an FC environment.

Fibre Channel links shall not exceed the BER objective (10^{-12}) under any conditions. The parameters specified in this clause support meeting that requirement under all conditions including the minimum input power level.

Clause 7 describes how the optical interface connector aligns the optical transmission fibre mechanically to an optical port on a component such as a receiver or a transmitter.

Clause 8 specifies a single-mode cable plant for the Fibre Channel signaling rates of 1,06 GBd, 2,12 GBd and 4,25 GBd at their rated distance of 10 km.

Clause 9 defines the interfaces of the serial electrical signal at the reference points α and at the inter-operability points β , δ and γ in a TxRx Connection. The existence of a β , δ or γ point is determined by the existence of a connector at that point in a TxRx Connection.

Clause 10 defines the TxRx Connection requirements for a Fibre Channel electrical cable plant and its connectors.

Annex A defines terms, measurement techniques and conditions for testing jitter and wave shapes. It deals with issues specific to Fibre Channel and is not intended to supplant standard test procedures referenced in the specifications.

Annex B describes an example implementation of the electrical SERDES interface to meet the requirements of FC-PI.

Annex C provides information on the use of an alternative multimode cable plant to those described in 6.4.

Annex D extends the optical and electrical interface specifications of clause 6 and clause 9, in the areas of transmitter-off behavior and the (optional) receiver loss-of-signal function. It gives the background, scope and qualitative and quantitative requirements for Tx-off and Rx-LOS in FC physical interfaces.

**INFORMATION TECHNOLOGY –
FIBRE CHANNEL –
Part 115: Physical interfaces (FC-PI)**

1 Scope

This part of ISO/IEC 14165 describes the physical interface portions of a high performance serial link that supports the higher Upper Level Protocols (ULPs) associated with HIPPI, IPI, SCSI, IP and others.

This International Standard incorporates features described in other international standards (see clause 2 and bibliography).

2 Normative references

2.1 Overview

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.

2.2 International Standards

IEC 60169-8, *Radio-frequency connectors - Part 8: R.F. coaxial connectors with inner diameter of outer conductor 6,5 mm (0,256 in) with Bayonet Lock (Type BNC)*

IEC 60169-15, *Radio-frequency connectors - Part 15: R.F. coaxial connectors with inner diameter of outer conductor 4,13 mm (0,163 in) with screw coupling - Characteristic impedance (Type SMA)*

IEC 60169-17, *Radio-frequency connectors - Part 17: R.F. coaxial connectors with inner diameter of outer conductor 6,5 mm (0,256 in) with screw coupling - Characteristic impedance 50 Ω (Type TNC)*

IEC 60793-1-20, *Optical fibres - Part 1-20: Measurement methods and test procedures - Fibre geometry*

NOTE All fibre geometry methods have been consolidated into IEC 60793-1-20.

IEC 60793-1-41, *Optical fibres - Part 2-41: Measurement methods and test procedures - Bandwidth*

IEC 60793-1-43, *Optical fibres - Part 2-43: Measurement methods and test procedures - Numerical aperture*

IEC 60793-2, *Optical fibres - Part 2: Product specifications - General*

IEC 60793-2-10, *Optical fibres - Part 2-10: Product specifications - Sectional specification for category A1 multimode fibres (ANSI/TIA/EIA-492AAAA and ANSI/TIA/EIA-492AAAB)*

IEC 60793-2-50, *Optical fibres - Part 2-50: Product specifications - Sectional specification for class B single-mode fibres*

IEC 60807-3, *Rectangular connectors for frequencies below 3 MHz - Part 3: Detail specification for a range of connectors with trapezoidal shaped metal shells and round contacts - Removable crimp contact types with closed crimp barrels, rear insertion/rear extraction*

IEC 60825-1, *Safety of laser products - Part 1: Equipment classification, requirements and user's guide*

IEC 61076-3-103, *Connectors for electronic equipment - Part 3-103: Rectangular connectors - Detail specification for single row connectors with non-removable ribbon cable contacts on 1,25 mm pitch used for high speed serial data (HSSDC)*

IEC 61280-1-1, *Fibre optic communication subsystem basic test procedures - Part 1-1: Test procedures for general communication subsystems - Transmitter output optical power measurement for single-mode optical fibre cable*

IEC 61280-1-3, *Fibre optic communication subsystem basic test procedures - Part 1-3: Test procedures for general communication subsystems - Central wavelength and spectral width measurement*

IEC 61280-2-2, *Fibre optic communication subsystem test procedures - Part 2-2: Digital systems - Optical eye pattern, waveform and extinction ratio measurement*

IEC 61280-4-1, *Fibre optic communication subsystem test procedures - Part 4-1: Cable plant and links - Multimode fibre-optic cable plant attenuation measurement*

IEC 61300-2-5, *Fibre optic interconnecting devices and passive components - Basic test and measurement procedures - Part 2-5: Tests - Torsion/Twist*

IEC 61300-2-17, *Fibre optic interconnecting devices and passive components - Basic test and measurement procedures - Part 2-17: Tests - Cold*

IEC 61300-3-3, *Fibre optic interconnecting devices and passive components - Basic test and measurement procedures - Part 3-3: Examinations and measurements - Active monitoring of changes in attenuation and return loss*

IEC 61300-3-6, *Fibre optic interconnecting devices and passive components - Basic test and measurement procedures - Part 3-6: Examinations and measurements - Return loss*

IEC 61300-3-11, *Fibre optic interconnecting devices and passive components - Basic test and measurement procedures - Part 3-11: Examinations and measurements - Engagement and separation forces*

IEC 61754-4, *Fibre optic connector interfaces - Part 4: Type SC connector family*

IEC 61754-6, *Fibre optic connector interfaces - Part 6: Type MU connector family*

IEC 61754-18, *Fibre optic connector interfaces - Part 18: Type MT-RJ connector family*

IEC 61754-19, *Fibre optic connector interfaces - Part 19: Type SG connector family*

IEC 61754-20, *Fibre optic connector interfaces - Part 20: Type LC connector family*

ISO/IEC 11801, *Information technology - Generic cabling for customer premises*

2.3 Other references

All references in this subclause were correct at the time of approval of this International Standard. The provisions of the referenced specifications, as identified in this subclause, are valid within the context of this International Standard. The reference to a specification within this International Standard does not give it any further status within ISO/IEC; in particular, it does not give the referenced specification the status of an International Standard.

EIA-700-A0AF - [SP-3652] Integral FC Device Connector

SFF-8451, Specification for SCA-2 Unshielded Connections ¹

SFF-8045, 40-pin SCA-2 Connector with Parallel Selection ¹

¹. SFF documents are available by FAX access from 408-741-1600 or may be purchased from Global Engineering at 303-792-2181. These documents may become international standards at a later date; they are currently new work proposals.