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Information technology — Fibre channel

Part 147: Physical interfaces — 7 (FC-PI-7)

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Foreword (This foreword is not part of American National Standard INCITS 543-2019.)

This standard was developed by Task Group T11.2 of Accredited Standards Committee INCITS during 2016, 2017, and 2018. The standards approval process will be started in 2018. This document includes annexes that are informative and are not considered part of the standard.

Requests for interpretation, suggestions for improvements or addenda, or defect reports are welcomed. They should be sent to the INCITS Secretariat, Information Technology Industry Council, 700 K Street NW, Suite 600, Washington DC 20001.

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Fibre Channel – Physical Interface-7 (FC-PI-7)

1 Scope

This standard describes the physical interface portions of high performance optical link variants that support the higher level Fibre Channel protocols including FC-FS-4 (reference [1]) and FC-FS-5 (reference [2]).

FC-PI-7 specifies 64GFC. 32GFC and 128GFC are described in FC-PI-6 (reference [3]) and FC-PI-6P (reference [4]), respectively.16GFC, 8GFC and 4GFC are described in FC-PI-5 (reference [5]).

2 Normative references

2.1 General

The following standards contain provisions that, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. Standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the following list of standards. Members of IEC and ISO maintain registers of currently valid International Standards.

Copies of the following documents can be obtained from ANSI: Approved ANSI standards, approved and draft international and regional standards (ISO, IEC), and other approved standards (including JIS and DIN).

2.2 Normative references

2.2.1 Approved references

[1] INCITS 488-2016, FC-FS-4, Fibre Channel Framing and Signaling - 4

[2] INCITS 545-2018, FC-FS-5, Fibre Channel Framing and Signaling - 5

[3] INCITS 512-2015, FC-PI-6, Fibre Channel Physical Interfaces - 6

[4] INCITS 533-2016, FC-PI-6P, Fibre Channel Physical Interfaces - 6P

[5] INCITS 479-2011, FC-PI-5, Fibre Channel Physical Interfaces - 5

[6] INCITS TR-46-2011, FC-MSQS, Fibre Channel Methodologies for Signal Quality Specification

[7] INCITS TR-50-2014, FC-MSQS-2, Fibre Channel Methodologies for Signal Quality Specification 2

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

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[9] **IEC 60793-2-10,** Optical fibers - Part 2-10: Product specifications - Sectional specification for category A1 multimode fibers

[10] **IEC 60793-2-50,** Optical fibers - Part 2-50: Product specifications - Sectional specification for class B single-mode fibers

[11] **IEC 60825-1,** Safety of laser products - Part 1: Equipment classification and requirements, latest edition.

[12] **IEC 60825-2,** Safety of laser products - Part 2: Safety of optical fiber communication systems, latest edition.

[13] **TIA-492AAAC,** Detail Specification for 850-nm Laser-Optimized, 50-μm Core Diameter/125-μm Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers

[14] **TIA-492AAAD,** Detail Specification for 850-nm Laser-Optimized, 50-μm Core Diameter/125-μm Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers Suitable for Manufacturing OM4 Cabled Optical Fiber

[15] **TIA-492AAAE,** Detail Specification for 50-μm Core Diameter/125-μm Cladding Diameter Class 1a Graded-Index Multimode Optical Fibers with Laser-Optimized Bandwidth Characteristics Specified for Wavelength Division Multiplexing

[16] **IEEE 802.3™-2018,** IEEE Standard for Ethernet

[17] **OIF-CEI-04.0,** Clause 21 CEI-56G-LR PAM4 Long Reach Interface

2.2.2 References under development

At the time of publication, the following referenced standards were still under development. For information on the current status of the documents, or regarding availability, contact the relevant standards body or other organization as indicated.

[18] **IEEE 802.3cd** 50Gb/s and 200 Gb/s Ethernet Task Force

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3 Definitions and conventions

For the purposes of this standard, the following definitions, conventions, abbreviations, acronyms, and symbols apply.

3.1 Definitions

3.1.1 α_T, α_R**:** alpha T, alpha R; reference points used for establishing signal budgets at the chip contacts of the transmitter and receiver in an FC device or retiming element.

3.1.2 γ_T, γ_R**:** gamma T, gamma R; interoperability points used for establishing signal budgets. Gamma T is the optical transmitter interface compliant point defined as the output of a 0.5 m to 2 m patchcord connected to the external enclosure connector.

3.1.3 δ_T, δ_R**:** delta T, delta R; interoperability points used for establishing signal budget at the internal connector of a removable PMD element.

3.1.4 alpha T, alpha R: See α_T, α_R (3.1.1).

3.1.5 attenuation: The transmission medium power or amplitude loss expressed in units of dB.

3.1.6 average power: The optical power measured using an average-reading power meter when transmitting valid transmission characters.

3.1.7 bandwidth: The difference between the upper -3 dB frequency and the lower -3 dB frequency of the amplitude response of a Fibre Channel component.

3.1.8 baud: A unit of signaling speed, expressed as the maximum number of times per second the signal may change the state of the transmission line or other medium. (Units of baud are symbols/sec.)

3.1.9 bit error ratio (BER): The probability of a correct transmitted bit being erroneously received in a communication system. For purposes of this standard, BER is the number of bits output from a receiver that differ from the correct transmitted bits, divided by the number of transmitted bits.

3.1.10 bit synchronization: The condition that a receiver is delivering retimed serial data at the required BER.

3.1.11 byte: An eight-bit entity prior to encoding, or after decoding, with its least significant bit denoted as bit 0 and most significant bit as bit 7. The most significant bit is shown on the left side unless specifically indicated otherwise.

3.1.12 cable plant: All passive communications elements (e.g., optical fiber, cable, connectors, splices, etc.) between a transmitter and a receiver.

3.1.13 center wavelength (laser): The value of the central wavelength of the operating, modulated laser. This is the wavelength where the effective optical power resides. See IEC 61280-1-3 (reference [8]).

3.1.14 character: A defined set of *n* contiguous bits where *n* is determined by the encoding scheme.

3.1.15 component: Entities that make up the link. Examples are connectors, cable assemblies, transceivers, port bypass circuits, and hubs.

3.1.16 connector: Electro-mechanical or opto-mechanical components consisting of a receptacle and a plug that provide a separable interface between two transmission media segments. Connectors may introduce physical disturbances to the transmission path due to impedance mismatch, crosstalk, and the like.These disturbances may introduce jitter under certain conditions.

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3.1.17 delta T, delta R: See δ_T, δ_R (3.1.3).

3.1.18 device: See FC device.

3.1.19 dispersion: A term in this document used to denote pulse broadening and distortion from optical causes. The causes of dispersion in optical transmissions are modal, chromatic and polarization mode dispersion. Modal dispersion is caused by the difference in the propagation velocity of the guided modes in a multimode fiber. Chromatic dispersion, due to the difference in propagation of the various spectral components, of the signal and optical source. Polarization mode dispersion is caused by fiber defects, that makes the propagation velocity dependent of the light polarization state.

all

3.1.20 external connector: A bulkhead connector, whose purpose is to carry the FC signals into and out of an enclosure, that exits the enclosure with only minor compromise to the shield effectiveness of the enclosure.

3.1.21 extinction ratio outer: The ratio of the highest optical power to the lowest optical power in the presence of a PAM4 signal (i.e., levels 3 and 0 in Figure 4(B), clause 5). See IEEE 802.3™-2018,(reference [16]), clause 121.8.6.

3.1.22 FC-0 level: The level in the Fibre Channel architecture and standards that defines transmission media, transmitters and receivers, and their interfaces. See Figure 1 (clause 4.1) and FC-FS-4 (reference [1]) clause 4.

3.1.23 FC-1 level: The level in the Fibre Channel architecture and standards that defines the transmission protocol that includes the serial encoding, decoding, and error control. See FC-FS-4 (reference [1]).

3.1.24 FC device: An entity that contains the FC protocol functions and that has one or more of the connectors defined in this document. Examples are: host bus adapters, disk drives, and switches. Devices may have internal and external connectors.

3.1.25 FC device connector: A connector defined in this document that carries the FC serial data signals into and out of the FC device.

3.1.26 fiber optic cable: A jacketed optical fiber or fibers.

3.1.27 gamma T, gamma R: See γ_T, γ_R (3.1.2).

3.1.28 insertion loss: The ratio (expressed in dB) of incident power at one port to transmitted power at a different port, when a component or assembly with defined ports is introduced into a link or system. May refer to optical power or to electrical power in a specified frequency range. Note the dB magnitude of S12 or S21 is the negative of insertion loss in dB.

3.1.29 interoperability point: Points in a link or TxRx connection for which this standard defines signal requirements to enable interoperability. This includes both compliance points and reference points. See α_T, α_R, γ_T, γ_R, δ_T, δ_R.

3.1.30 level:
1. A document artifice, e.g., FC-0, used to group related architectural functions. No specific correspondence is intended between levels and actual implementations.
2. In FC-PI-7 context, a specific value of voltage or optical power (e.g., voltage level).
3. The type of measurement: level 1 is a measurement intended for compliance, level 2 is a measurement intended for characterization/diagnosis.

3.1.31 link: A duplex or parallel optics TxRx Connection, using two or more fibers to transport optical signals.

3.1.32 MB/s: An abbreviation for megabytes (10^6 bytes) per second.

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