

INTERNATIONAL  
STANDARD

ISO/IEC  
14165-147

First edition  
2021-02

---

---

**Information technology – Fibre  
channel —**

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



Reference number  
ISO/IEC 14165-147:2021(E)

© ISO/IEC 2021



**COPYRIGHT PROTECTED DOCUMENT**

© ISO/IEC 2021

All rights reserved. Unless otherwise specified, or required in the context of its implementation, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office  
CP 401 • Ch. de Blandonnet 8  
CH-1214 Vernier; Geneva  
Phone: +41 22 749 01 11  
Email: [copyright@iso.org](mailto:copyright@iso.org)  
Website: [www.iso.org](http://www.iso.org)

Published in Switzerland

## Foreword

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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of document should be noted (see [www.iso.org/directives](http://www.iso.org/directives)).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO and IEC shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see [www.iso.org/patents](http://www.iso.org/patents)) or the IEC list of patent declarations received (see <http://patents.iec.ch>).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see [www.iso.org/iso/foreword.html](http://www.iso.org/iso/foreword.html).

This document was prepared by the InterNational Committee for Information Technology Standards (INCITS) (as INCITS 543-2019) and drafted in accordance with its editorial rules. It was assigned to Joint Technical Committee ISO/IEC JTC 1, *Information technology*, and adopted under the “fast-track procedure”.

A list of all parts in the ISO/IEC 14165 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at [www.iso.org/members.html](http://www.iso.org/members.html).



## Contents

|          |   |           |
|----------|---|-----------|
| <b>1</b> | <b>Scope</b>  | <b>1</b>  |
| <b>2</b> | <b>Normative references</b>                                   | <b>1</b>  |
| 2.1      | General   | 1         |
| 2.2      | Normative references  | 1         |
| 2.2.1    | Approved references   | 1         |
| 2.2.2    | References under development                                  | 2         |
| <b>3</b> | <b>Definitions and conventions</b>                            | <b>3</b>  |
| 3.1      | Definitions   | 3         |
| 3.2      | Editorial conventions   | 7         |
| 3.2.1    | Conventions   | 7         |
| 3.2.2    | Keywords  | 8         |
| 3.2.3    | Abbreviations, acronyms, and symbols                          | 8         |
| 3.2.3.1  | Acronyms and other abbreviations                              | 9         |
| 3.2.3.2  | Signaling rate abbreviations                                  | 10        |
| <b>4</b> | <b>FC-PI-7 functional characteristics</b>                     | <b>11</b> |
| 4.1      | General characteristics                                       | 11        |
| 4.2      | Compliance test points  | 11        |
| 4.3      | FC-0 functions  | 13        |
| 4.3.1    | Transmitter functions   | 13        |
| 4.3.2    | Receiver functions  | 13        |
| 4.4      | Limitations on invalid code                                   | 14        |
| 4.5      | Receiver stabilization time                                   | 14        |
| 4.6      | Loss of signal (Rx_LOS) function                              | 14        |
| 4.7      | Speed agile ports that support speed negotiation and training | 14        |
| 4.8      | Transmission codes  | 14        |
| 4.9      | Frame scrambling and emission lowering protocol               | 14        |
| 4.10     | Forward error correction (FEC)                                | 15        |
| 4.11     | Bit error ratio per link locations and segments               | 15        |
| 4.12     | FC-PI-7 variants  | 16        |
| <b>5</b> | <b>Optical interface specification</b>                        | <b>17</b> |
| 5.1      | TxRx connections  | 17        |
| 5.2      | Laser safety issues   | 17        |
| 5.3      | Optical signal modulation format                              | 17        |
| 5.4      | SM data links   | 18        |
| 5.4.1    | SM general information  | 18        |
| 5.4.2    | SM optical output interface                                   | 18        |
| 5.4.3    | SM optical input interface                                    | 18        |
| 5.4.4    | Transmitter transition time                                   | 18        |
| 5.4.5    | TDECQ Test  | 18        |
| 5.4.6    | SECQ Measurement  | 18        |
| 5.4.7    | SRS Test  | 18        |
| 5.5      | MM data links   | 20        |
| 5.5.1    | MM general information  | 20        |
| 5.5.2    | MM optical output interface                                   | 20        |
| 5.5.3    | MM optical input interface                                    | 20        |
| 5.5.4    | Transmitter transition time                                   | 20        |
| 5.5.5    | TDECQ Test  | 21        |

|                              |  |           |
|------------------------------|--|-----------|
| 5.5.6                        | SECQ Measurement   | 21        |
| 5.5.7                        | SRS Test   | 21        |
| 5.6                          | SM Cable Plant   | 23        |
| 5.6.1                        | Cable plant overview   | 23        |
| 5.6.2                        | Optical Return Loss  | 23        |
| 5.6.3                        | Connector and Splices  | 24        |
| 5.7                          | MM Cable Plant   | 24        |
| 5.7.1                        | Cable plant overview   | 24        |
| 5.7.2                        | Optical Return Loss  | 24        |
| 5.7.3                        | Connector and Splices  | 24        |
| <b>6</b>                     | <b>Electrical interface specification - single lane segments</b>       | <b>25</b> |
| 6.1                          | General electrical characteristics                                     | 25        |
| 6.2                          | Compliance test point definitions                                      | 25        |
| 6.2.1                        | Test method  | 25        |
| 6.2.2                        | Host test points   | 26        |
| 6.2.3                        | Module test points   | 26        |
| 6.2.4                        | Host input calibration point   | 27        |
| 6.2.5                        | Module input calibration point   | 28        |
| 6.3                          | Transmitted signal characteristics                                     | 29        |
| 6.4                          | Receive signal characteristics   | 30        |
| 6.5                          | Differential return loss and mode conversion requirements              | 31        |
| 6.5.1                        | Differential return loss   | 31        |
| 6.5.2                        | Common to differential-mode and differential to common-mode conversion | 31        |
| <b>7</b>                     | <b>Backplane variant, 64GFC-EA</b>                                     | <b>33</b> |
| 7.1                          | TxRx Connections   | 33        |
| 7.2                          | Test Fixtures  | 33        |
| 7.3                          | Transmitter specification  | 35        |
| 7.4                          | Receiver specification   | 37        |
| 7.4.1                        | Receiver input return loss   | 37        |
| 7.4.2                        | Receiver interference tolerance  | 38        |
| 7.4.3                        | Receiver jitter tolerance  | 39        |
| 7.5                          | Channel Specification  | 39        |
| 7.5.1                        | Channel Operating Margin   | 39        |
| 7.5.2                        | Channel Return Loss  | 41        |
| 7.5.3                        | Channel AC coupling  | 41        |
| <b>Annex A (informative)</b> |  |           |
|                              | <b>Optical cable plant usage</b>                                       | <b>42</b> |
| <b>Annex B (informative)</b> |  |           |
|                              | <b>Structured cabling environment</b>                                  | <b>44</b> |
| B.1                          | Specification of operating distances                                   | 44        |
| B.2                          | Alternate connection loss operating distances                          | 44        |
| <b>Annex C (informative)</b> |  |           |
|                              | <b>Electrical channel</b>  | <b>45</b> |

## List of Tables

|   |    |
|---|----|
| Table 1 - ISO convention . . . . .  | 7  |
| Table 2 - Acronyms and other abbreviations. . . . .   | 9  |
| Table 3 - Signaling rate abbreviations. . . . .   | 10 |
| Table 4 - BER per link Location / Segment. . . . .  | 15 |
| Table 5 - Fibre Channel Variants in FC-PI-7. . . . .  | 16 |
| Table 6 - Single-mode link parameters (OS2). . . . .  | 19 |
| Table 7 - Multimode link parameters. . . . .  | 22 |
| Table 8 - Maximum value of each discrete reflectance. . . . .   | 23 |
| Table 9 - General electrical characteristics. . . . .   | 25 |
| Table 10 - Transmitter compliance requirements at nominal signal rate of 28 900 MBd . . . . .                                 | 29 |
| Table 11 - Receiver compliance requirements . . . . .   | 30 |
| Table 12 - Transmitter electrical specifications at A . . . . .   | 35 |
| Table 13 - Summary of receiver characteristics at test point D. . . . .   | 37 |
| Table 14 - Receiver interference tolerance parameters . . . . .   | 39 |
| Table 15 - Receiver jitter tolerance parameters . . . . .   | 39 |
| Table 16 - Channel Operating Margin (COM) parameters . . . . .  | 40 |
| Table A.1 - Worst case (nominal bandwidth) multimode cable link power budget . . . . .  | 42 |
| Table A.2 - Worst-case single mode cable link power budget . . . . .  | 43 |
| Table B.1 - 64GFC-SW (MM) and 64GFC-LW (SM) max operating distance & loss<br>budget for different connection losses . . . . . | 44 |
| Table C.1 - Informative host to module channel characteristics, high loss channel . . . . .                                   | 45 |

## List of Figures

|  |    |
|--|----|
| Figure 1 - Fibre Channel hierarchy . . . . .   | 12 |
| Figure 2 - Compliance points for 64GFC PMDs . . . . .                                    | 13 |
| Figure 3 - BER per Section . . . . .   | 15 |
| Figure 4 - Optical Eye Diagram of a PAM4 Signal . . . . .                                | 17 |
| Figure 5 - Host Compliance Board . . . . .   | 26 |
| Figure 6 - Module Compliance Board . . . . .   | 27 |
| Figure 7 - Host input calibration point C" . . . . .                                     | 27 |
| Figure 8 - Module input calibration point B" . . . . .                                   | 28 |
| Figure 9 - SDD11 and SDD22 for all compliance points . . . . .                           | 31 |
| Figure 10 - SDC22 for transmitter output and SCD11 for receiver input. . . . .           | 32 |
| Figure 11 - Test fixture and test points . . . . .                                       | 33 |
| Figure 12 - Test fixture reference insertion loss . . . . .                              | 34 |
| Figure 13 - Test fixture differential return loss . . . . .                              | 34 |
| Figure 14 - Transmitter and receiver differential return loss limit . . . . .            | 36 |
| Figure 15 - Transmitter common-mode return loss . . . . .                                | 37 |
| Figure 16 - Receiver differential to common-mode return loss limit . . . . .             | 38 |
| Figure 17 - Channel return loss limit . . . . .  | 41 |
| Figure C.1 - Typical FC-PI-7 electrical channel construction . . . . .                   | 45 |
| Figure C.2 - FC-PI-7 full channel electrical reference model, high loss channel. . . . . | 45 |



**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.

This standard was processed and approved for submittal to ANSI by the National Committee for Information Technology Standards (INCITS). Committee approval of the standard does not necessarily imply that all committee members voted for its approval. At the time it approved this standard, INCITS had the following members:

Laura Lindsay, Chair  
Donald Deutsch, Vice-Chair  
Jennifer Garner, Secretary

| <i>Organization Represented</i>                    | <i>Name of Representative</i> |
|--|-------------------------------|
| Adobe Systems, Inc.....                            | Scott Foshee                  |
| AIM Global, Inc. ....                              | Steve Halliday                |
|  | Mary Lou Bosco (Alt.)         |
|  | Chuck Evanhoe (Alt.)          |
| Amazon Web Services, Inc. ....                     | Oliver Bell                   |
|  | John Britton (Alt.)           |
| Apple .....  | Helene Workman                |
|  | David Singer (Alt.)           |
|  | Anna Weinberg (Alt.)          |
| CA Technologies .....                              | Ron Doyle                     |
| Department of Commerce - NIST .....                | Michael Hogan                 |
|  | Wo Chang (Alt.)               |
|  | Sal Francomacaro (Alt.)       |
| Farance, Inc.....                                  | Frank Farance                 |
|  | Timothy Schoechele (Alt.)     |
| Futurewei Technologies, Inc.....                   | Wael Diab                     |
|  | Wilbert Adams (Alt.)          |
|  | Timothy Jeffries (Alt.)       |
| Google .....                                       | Catherine Nelson              |
|  | Tommy Ward (Alt.)             |
| GS1GO .....  | Steven Keddie                 |
|  | Edward Merrill (Alt.)         |
|  | Dan Mullen (Alt.)             |
| HP, Inc. ....                                      | Karen Higginbottom            |
|  | Paul Jeran (Alt.)             |
|  | Lonnie Mandigo (Alt.)         |
|  | Vanitha Venkateshlu (Alt.)    |
| IBM Corporation .....                              | Steve Holbrook                |
|  | Alexander Tarpinian (Alt.)    |
| Intel Corporation .....                            | Philip Wennblom               |
|  | Grace Wei (Alt.)              |
| Microsoft Corporation .....                        | Laura Lindsay                 |
|  | John Calhoon (Alt.)           |
| Oracle .....                                       | Donald Deutsch                |
|  | Anish Karmarkar (Alt.)        |
|  | Michael Kavanaugh (Alt.)      |
|  | Jim Melton (Alt.)             |
|  | Jan-Eike Michels (Alt.)       |
|  | Elaine Newton (Alt.)          |
| Qualcomm, Inc. ....                                | Michael Atlass                |
|  | Farrokh Khatibi (Alt.)        |
| Telecommunications Industry Association (TIA)..... | Florence Otieno               |
|  | Marianna Kramarikova (Alt.)   |

| <i>Organization Represented</i> | <i>Name of Representative</i>  |
|---------------------------------|--|
| VMware, Inc.....                | Stephen Diamond<br>Salim AbiEzzi (Alt.)<br>Eric Betts (Alt.)<br>Lawrence Lamers (Alt.) |

Technical Committee T11 on Lower Level Interfaces, which reviewed this standard, had the following members:

Steven Wilson, Chair  
Craig W. Carlson, Vice-Chair  
Richard Johnson, Secretary  
David Peterson, International Representative

| <i>Organization Represented</i> | <i>Name of Representative</i>   |
|---------------------------------|---|
| Amphenol Corporation.....       | Gregory McSorley<br>Brad Brubaker (Alt.)<br>Mike Davis (Alt.)<br>Daniel Dillow (Alt.)<br>Chris Lyon (Alt.)<br>Alex Persaud (Alt.)<br>Hu Silver (Alt.)<br>Michael Wingard (Alt.)   |
| Anritsu Corporation.....        | Ken Mochizuki   |
| Broadcom Limited.....           | Steven Wilson<br>David Baldwin (Alt.)<br>Evan Beauprez (Alt.)<br>Ben Chu (Alt.)<br>Adam Healey (Alt.)<br>Howard Johnson (Alt.)<br>Mark Jones (Alt.)<br>Scott Kipp (Alt.)<br>Anil Mehta (Alt.)<br>David Peterson (Alt.)<br>Rob Peterson (Alt.)<br>James Smart (Alt.) |
| CIENA.....                      | Stephen Shew<br>Sebastien Gareau (Alt.)   |
| Cisco Systems, Inc. ....        | Mike Blair<br>Harsha Bharadwaj (Alt.)<br>Rajesh LG (Alt.)<br>Fabio Maino (Alt.)<br>J. Metz (Alt.)<br>Landon Noll (Alt.)<br>Joe Pelissier (Alt.)   |
| CommScope.....                  | Sunny Xu<br>Gary Gibbs (Alt.)<br>Gary Irwin (Alt.)<br>Paul Kolesar (Alt.)   |
| Corning, Inc. ....              | Doug Coleman<br>Steven Swanson (Alt.)   |
| Data Center Systems .....       | Kevin Ehringer<br>Zach Nason (Alt.)<br>Todd Wheeler (Alt.)  |
| Dell, Inc.....                  | Louis Ricci<br>David Black (Alt.)<br>Gaurav Chawla (Alt.)<br>Alan Rajapa (Alt.)<br>Erik Smith (Alt.)<br>Joseph White (Alt.)<br>Jeff Young (Alt.)  |

| <i>Organization Represented</i>                   | <i>Name of Representative</i>   |
|---|---|
| Finisar Corporation.....                          | Chris Yien<br>Richard Johnson (Alt.)<br>Jonathan King (Alt.)  |
| Foxconn Interconnect Technology, Ltd. (FIT) ..... | John Petrilla<br>Eric Chu (Alt.)<br>Fred Fons (Alt.)<br>Glenn Moore (Alt.)<br>William Peters (Alt.)                                       |
| Fujitsu America, Inc.....                         | Mark Malcolm<br>Kun Katsumata (Alt.)<br>Osamu Kimura (Alt.)<br>Gene Owens (Alt.)  |
| Futurewei Technologies, Inc. ....                 | Philip Kufeldt<br>Victor Gissin (Alt.)<br>Yang Liu (Alt.)<br>Xu Qi-ming (Alt.)<br>Liu Qing (Alt.)<br>Xin Qiu (Alt.)<br>Eddy Zhou (Alt.)   |
| GlobalFoundries US2 LLC .....                     | Adrian Butter<br>John Ewen (Alt.)<br>Jon Garlett (Alt.)   |
| Hewlett-Packard Enterprise .....                  | Barry Maskas<br>Curtis Ballard (Alt.)<br>Rupin Mohan (Alt.)<br>Krishna Babu Puttagunta (Alt.)   |
| Hitachi Vantara.....                              | Eric Hibbard<br>Vincent Franceschini (Alt.)<br>Michael Hay (Alt.)<br>Akinobu Shimada (Alt.)<br>Erwin van Londen (Alt.)<br>Ken Wood (Alt.) |
| IBM Corporation .....                             | Roger Hathorn<br>Patty Driever (Alt.)   |
| Keysight Technologies, Inc. ....                  | Stephen Didde<br>Steven Sekel (Alt.)<br>Hajime Takahashi (Alt.)<br>Joachim Vobis (Alt.)   |
| Lumentum Operations.....                          | David Lewis   |
| Macom .....                                       | Thomas Palkert  |
| MediaTek USA, Inc. ....                           | Tamer Ali<br>Mau-Lin Wu (Alt.)  |
| Microsoft Corporation.....                        | Lee Prewitt<br>Paul Luber (Alt.)<br>Steve Olsson (Alt.)   |
| Molex, Inc. ....                                  | Alexandra Haser<br>Jay Neer (Alt.)<br>Scott Sommers (Alt.)  |
| NetApp, Inc. ....                                 | Frederick Knight<br>John Meneghini (Alt.)<br>Urmi Misra (Alt.)  |
| OFS Fitel LLC .....                               | Roman Shubochkin<br>Mabud Choudhury (Alt.)  |
| Panduit Corporation .....                         | Jose Castro<br>Bulent Kose (Alt.)<br>Robert Reid (Alt.)<br>Steve Skiest (Alt.)  |

| <i>Organization Represented</i>                  | <i>Name of Representative</i>   |
|--|---|
| QLogic Corporation .....                         | Craig Carlson<br>Anshul Agarwal (Alt.)<br>Girish Basrur (Alt.)<br>Kathy Caballero (Alt.)<br>Robert Friend (Alt.)<br>Duane Grigsby (Alt.)<br>Ali Khwaja (Alt.)<br>Stephen Lam (Alt.)<br>Ray Leung (Alt.)<br>Akinori Maeda (Alt.)<br>Praveen Midha (Alt.)<br>Trinh Nguyen (Alt.)<br>Raul Oteyza (Alt.)<br>Alan Spalding (Alt.)<br>Gourangadoss Sundar (Alt.)<br>Darren Trapp (Alt.)<br>Andrew Vasquez (Alt.)<br>Dean Wallace (Alt.) |
| SmartDV Technologies India Private Limited ..... | Deepak Kumar Tala<br>Tamil Selvan Ramanathan (Alt.)   |
| TE Connectivity .....                            | Nathan Tracy<br>Jeff Mason (Alt.)   |
| Teledyne LeCroy Corporation .....                | David Rodgers<br>Douglas Lee (Alt.)<br>Henry Poelstra (Alt.)  |
| Unisys Corporation .....                         | Jeffrey Dremann<br>Phil Shelton (Alt.)  |
| Viavi Solutions, Inc. ....                       | Jason Rusch<br>Scott Baxter (Alt.)<br>George Bullis (Alt.)<br>Paul Gentieu (Alt.)   |
| VMware, Inc.....                                 | Neil MacLean<br>Wenchao Cui (Alt.)<br>Ping Huang (Alt.)<br>Wenhua Liu (Alt.)<br>Murali Rajagopal (Alt.)<br>Ahmad Tawil (Alt.)   |

Members Emeritus

James Coomes  
William Ham  
Robert Kembel  
Robert Nixon  
Schelto Van Doorn

Task Group T11.2 on Fibre Channel Protocols, that developed and reviewed this standard, had the following members:

Tom Palkert, Chair  
 Dean Wallace, Vice-Chair  
 Richard Johnson, Secretary

| <i>Organization Represented</i>                  | <i>Name of Representative</i>  |
|--|--|
| Amphenol Corporation .....                       | Gregory McSorley<br>Brad Brubaker (Alt.)<br>Mike Davis (Alt.)<br>Daniel Dillow (Alt.)<br>Chris Lyon (Alt.)<br>Alex Persaud (Alt.)<br>Hu Silver (Alt.)<br>Michael Wingard (Alt.)                    |
| Anritsu Corporation .....                        | Ken Mochizuki  |
| Broadcom, Inc. ....                              | Evan Beauprez<br>David Baldwin (Alt.)<br>Ben Chu (Alt.)<br>Adam Healey (Alt.)<br>Howard Johnson (Alt.)<br>Scott Kipp (Alt.)<br>David Peterson (Alt.)<br>James Smart (Alt.)<br>Steven Wilson (Alt.) |
| Cisco Systems, Inc. ....                         | Mike Blair<br>Ziad Chaine (Alt.)<br>J Metz (Alt.)  |
| CommScope .....                                  | Sunny Xu<br>Gary Gibbs (Alt.)<br>Gary Irwin (Alt.)<br>Paul Kolesar (Alt.)  |
| Corning, Inc. ....                               | Doug Coleman<br>Steven Swanson (Alt.)  |
| Data Center Systems .....                        | Kevin Ehringer<br>Zach Nason (Alt.)<br>Todd Wheeler (Alt.)   |
| Dell, Inc. ....                                  | Louis Ricci<br>David Black (Alt.)<br>Gaurav Chawla (Alr.)<br>Alan Rajapa (Alt.)<br>Erik Smith (Alt.)<br>Joseph White (Alt.)<br>Jeff Young (Alt.)   |
| Finisar Corporation .....                        | Vipul Bhatt  |
| Foxconn Interconnect Technology Ltd. (FIT) ..... | Jonathan King (Alt.)<br>John Petrilla<br>Eric Chu (Alt.)<br>Glenn Moore (Alt.)<br>William Peters (Alt.)  |
| Fujitsu America, Inc. ....                       | Mark Malcolm<br>Kun Katsumata (Alt.)<br>Gene Owens (Alt.)  |
| Futurewei Technologies, Inc. ....                | Xu Qi ming<br>Eddy Zhou (Alt.)   |
| GlobalFoundries US2 LLC .....                    | Adrian Butter<br>John Ewen (Alt.)<br>Jon Garlett (Alt.)  |
| Hewlett Packard Enterprise .....                 | Barry Maskas<br>Rupin Mohan (Alt.)<br>Krishna Babu Puttagunta (Alt.)   |
| IBM Corporation .....                            | Roger Hathorn<br>Patty Driever (Alt.)  |

| <i>Organization Represented</i>                  | <i>Name of Representative</i>  |
|--|--|
| Keysight Technologies, Inc.....                  | Stephen Didde<br>Steven Sekel (Alt.)<br>Joachim Vobis (Alt.)   |
| Lumentum Operations .....                        | David Lewis  |
| Macom .....                                      | Thomas Palkert   |
| Marvell Semiconductor, Inc. ....                 | Craig Carlson<br>Anshul Agarwal (Alt.)<br>Girish Basrur (Alt.)<br>Michael Dudek (Alt.)<br>Ali Khwaja (Alt.)<br>Steven Lam (Alt.)<br>Akinori Maeda (Alt.)<br>Alan Spalding (Alt.)<br>Darren Trapp (Alt.)<br>Dean Wallace (Alt.) |
| MediaTek USA, Inc.....                           | Tamer Ali<br>Mau-Lin Wu (Alt.)   |
| Molex, Inc. ....                                 | Alexandra Haser<br>Jay Neer (Alt.)   |
| NetApp, Inc.....                                 | Frederick Knight   |
| OFS Fitel LLC.....                               | Roman Shubochkin<br>Mabud Choudhury (Alt.)   |
| Panduit Corporation.....                         | Jose Castro<br>Bulent Kose (Alt.)<br>Robert Reid (Alt.)<br>Steve Skiest (Alt.)   |
| SmartDV Technologies India Private Limited ..... | Deepak Kumar Tala  |
| TE Connectivity .....                            | Nathan Tracy<br>Jeff Mason (Alt.)  |
| Teledyne LeCroy Corporation .....                | David Rodgers<br>Douglas Lee (Alt.)<br>Henry Poelstra (Alt.)   |
| Viavi Solutions, Inc. ....                       | Jason Rusch  |
| <br><i>Members Emeritus</i>                      |  |
| James Coomes                                     |  |
| William Ham                                      |  |
| Schelto van Doorn                                |  |

**Acknowledgments**

The technical editor would like to thank the following individuals for their special contributions to this standard:

- Jonathan King for optical link budget;
- John Petrilla for electrical link budget;
- Mike Dudek for backplane solution;
- Richard Johnson for his support editing this document;
- Dean Wallace for leadership.

# 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

- [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- $\mu$ m Core Diameter/125- $\mu$ m Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers
- [14] **TIA-492AAD**, Detail Specification for 850-nm Laser-Optimized, 50- $\mu$ m Core Diameter/125- $\mu$ m Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers Suitable for Manufacturing OM4 Cabled Optical Fiber
- [15] **TIA-492AAAE**, Detail Specification for 50- $\mu$ m Core Diameter/125- $\mu$ m 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