
**Information technology – Fibre
channel —**

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

iTeh Standards
(<https://standards.iteh.ai>)
Document Preview

ISO/IEC 14165-147:2021

<https://standards.iteh.ai/catalog/standards/iso/4ece9f7d-ca7d-4670-a8ac-bb8bb17aed28/iso-iec-14165-147-2021>



iTeh Standards
(<https://standards.iteh.ai>)
Document Preview

ISO/IEC 14165-147:2021

<https://standards.iteh.ai/catalog/standards/iso/4ece9f7d-ca7d-4670-a8ac-bb8bb17aed28/iso-iec-14165-147-2021>



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
Website: 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).

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) 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.

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.

Contents

1 Scope	1
2 Normative references	1
2.1 General	1
2.2 Normative references	1
2.2.1 Approved references	1
2.2.2 References under development	2
3 Definitions and conventions	3
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
4 FC-PI-7 functional characteristics	11
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
5 Optical interface specification	17
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
6	Electrical interface specification - single lane segments	25
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
7	Backplane variant, 64GFC-EA	33
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
Annex A	(informative)	
	Optical cable plant usage	42
Annex B	(informative)	
	Structured cabling environment	44
B.1	Specification of operating distances	44
B.2	Alternate connection loss operating distances	44
Annex C	(informative)	
	Electrical channel	45

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 budget for different connection losses	44
Table C.1 - Informative host to module channel characteristics, high loss channel	45

iteh Standards
 (https://standards.iteh.ai)
 Document Preview

ISO/IEC 14165-147:2021

<https://standards.iteh.ai/catalog/standards/iso/4ece9f7d-ca7d-4670-a8ac-bb8bb17aed28/iso-iec-14165-147-2021>

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

iTeh Standards
(<https://standards.iteh.ai>)
Document Preview

[ISO/IEC 14165-147:2021](https://standards.iteh.ai/catalog/standards/iso/4ece9f7d-ca7d-4670-a8ac-bb8bb17aed28/iso-iec-14165-147-2021)

<https://standards.iteh.ai/catalog/standards/iso/4ece9f7d-ca7d-4670-a8ac-bb8bb17aed28/iso-iec-14165-147-2021>

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

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

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

Members Emeritus

James Coomes
William Ham
Robert Kembel
Robert Nixon
Schelto Van Doorn

ISO/IEC 14165-147:2021

<https://standards.iso.org/standards/catalog/standards/iso/4ece9f7d-ca7d-4670-a8ac-bb8bb17aed28/iso-iec-14165-147-2021>

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

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