

SUPERSEDED

IEEE Std 802.3ak™-2004

(Amendment to IEEE Std 802.3™-2002
as amended by
IEEE Stds 802.3ae™-2002,
802.3af™-2003,
and 802.3aj™-2003)

802.3ak™

**IEEE Standard for Information technology—
Telecommunications and information exchange between systems—
Local and metropolitan area networks—
Specific requirements**

**Part 3: Carrier Sense Multiple Access with
Collision Detection (CSMA/CD) Access Method
and Physical Layer Specifications**

**Amendment: Physical Layer and Management
Parameters for 10Gb/s Operation,
Type 10GBASE-CX4**

IEEE Computer Society

Sponsored by the
LAN/MAN Standards Committee



Published by
The Institute of Electrical and Electronics Engineers, Inc.
3 Park Avenue, New York, NY 10016-5997, USA

1 March 2004

Print: SH95214
PDF: SS95214

AVA Documents
Document Sharing Hub

SUPERSEDED



Documents
Document Sharing Hub

IEEE Std 802.3ak™-2004
(Amendment to IEEE Std 802.3™-2002
as amended by
IEEE Stds 802.3ae™-2002,
802.3af™-2003,
and 802.3aj™-2003)

**IEEE Standard for Information technology—
Telecommunications and information exchange between systems—
Local and metropolitan area networks—
Specific requirements**

Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications

Amendment: Physical Layer and Management Parameters for 10Gb/s Operation, Type 10GBASE-CX4

Sponsor
LAN/MAN Standards Committee
of the
IEEE Computer Society

Approved 9 February 2004
IEEE-SA Standards Board

Abstract: This amendment to IEEE Std 802.3-2002 as amended by IEEE Std 802.3ae-2002, IEEE Std 802.3af-2003 and IEEE Std 802.3aj-2003 specifies a new physical layer medium dependent sublayer interface for 10Gb/s Ethernet. 10GBASE-CX4 specifies an equipment interconnect based on the 10 Gigabit Attachment Unit Interface (XAUI) for up to 15m of balanced shielded cabling.

Keywords: 802.3ak, 10GBASE-CX4, 10 Gigabit Ethernet, cable assembly, physical medium dependent (PMD) sublayer, XAUI

"Superseded" standards are standards that are no longer useful or contain significant obsolete or erroneous information. All amendments or corrigenda associated with this standard have also been superseded.

WARNING: You are cautioned to USE AT YOUR OWN RISK, as the technology contained herein may not longer be accurate or may have been replaced.

Information on superseded standards is available in the IEEE-SA Standards Board Operations Manual
<<http://standards.ieee.org/guides/opman/index.html>>.

SUPERSEDED

IEEE Standards documents are developed within the IEEE Societies and the Standards Coordinating Committees of the IEEE Standards Association (IEEE-SA) Standards Board. The IEEE develops its standards through a consensus development process, approved by the American National Standards Institute, which brings together volunteers representing varied viewpoints and interests to achieve the final product. Volunteers are not necessarily members of the Institute and serve without compensation. While the IEEE administers the process and establishes rules to promote fairness in the consensus development process, the IEEE does not independently evaluate, test, or verify the accuracy of any of the information contained in its standards.

Use of an IEEE Standard is wholly voluntary. The IEEE disclaims liability for any personal injury, property or other damage, of any nature whatsoever, whether special, indirect, consequential, or compensatory, directly or indirectly resulting from the publication, use of, or reliance upon this, or any other IEEE Standard document.

The IEEE does not warrant or represent the accuracy or content of the material contained herein, and expressly disclaims any express or implied warranty, including any implied warranty of merchantability or fitness for a specific purpose, or that the use of the material contained herein is free from patent infringement. IEEE Standards documents are supplied **“AS IS.”**

The existence of an IEEE Standard does not imply that there are no other ways to produce, test, measure, purchase, market, or provide other goods and services related to the scope of the IEEE Standard. Furthermore, the viewpoint expressed at the time a standard is approved and issued is subject to change brought about through developments in the state of the art and comments received from users of the standard. Every IEEE Standard is subjected to review at least every five years for revision or reaffirmation. When a document is more than five years old and has not been reaffirmed, it is reasonable to conclude that its contents, although still of some value, do not wholly reflect the present state of the art. Users are cautioned to check to determine that they have the latest edition of any IEEE Standard.

In publishing and making this document available, the IEEE is not suggesting or rendering professional or other services for, or on behalf of, any person or entity. Nor is the IEEE undertaking to perform any duty owed by any other person or entity to another. Any person utilizing this, and any other IEEE Standards document, should rely upon the advice of a competent professional in determining the exercise of reasonable care in any given circumstances.

Interpretations: Occasionally questions may arise regarding the meaning of portions of standards as they relate to specific applications. When the need for interpretations is brought to the attention of IEEE, the Institute will initiate action to prepare appropriate responses. Since IEEE Standards represent a consensus of concerned interests, it is important to ensure that any interpretation has also received the concurrence of a balance of interests. For this reason, IEEE and the members of its societies and Standards Coordinating Committees are not able to provide an instant response to interpretation requests except in those cases where the matter has previously received formal consideration. At lectures, symposia, seminars, or educational courses, an individual presenting information on IEEE standards shall make it clear that his or her views should be considered the personal views of that individual rather than the formal position, explanation, or interpretation of the IEEE. Current interpretations can be accessed at the following URL: <http://standards.ieee.org/reading/ieee/interp/index.html>.

Errata, if any, for this and all other standards can be accessed at the following URL: <http://standards.ieee.org/reading/ieee/updates/errata/index.html>. Users are encouraged to check this URL for errata periodically.

Comments for revision of IEEE Standards are welcome from any interested party, regardless of membership affiliation with IEEE. Suggestions for changes in documents should be in the form of a proposed change of text, together with appropriate supporting comments. Comments on standards and requests for interpretations should be addressed to:

Secretary, IEEE-SA Standards Board
445 Hoes Lane
P.O. Box 1331
Piscataway, NJ 08855-1331 USA

NOTE—Attention is called to the possibility that implementation of this standard may require use of subject matter covered by patent rights. By publication of this standard, no position is taken with respect to the existence or validity of any patent rights in connection therewith. The IEEE shall not be responsible for identifying patents for which a license may be required by an IEEE standard or for conducting inquiries into the legal validity or scope of those patents that are brought to its attention.

Authorization to photocopy portions of any individual standard for internal or personal use is granted by the Institute of Electrical and Electronics Engineers, Inc., provided that the appropriate fee is paid to Copyright Clearance Center. To arrange for payment of licensing fee, please contact Copyright Clearance Center, Customer Service, 222 Rosewood Drive, Danvers, MA 01923 USA; +1 978 750 8400. Permission to photocopy portions of any individual standard for educational classroom use can also be obtained through the Copyright Clearance Center.

Introduction to IEEE Std 802.3ak-2004

(This introduction is not part of IEEE Std 802.3ak-2004, IEEE Standard for Information technology— Telecommunications and information exchange between systems—Local and metropolitan area networks—Specific requirements CSMA/CD Access Method and Physical Layer Specifications Amendment: Physical Layer and Management Parameters for 10Gb/s Operation, Type 10GBASE-CX4.)

IEEE Std 802.3™ was first published in 1985. Since the initial publication, many projects have added functionality or provided maintenance updates to the specifications and text included in the standard. Each IEEE 802.3 project/amendment is identified with a suffix (e.g., IEEE Std 802.3ae™). A historical listing of all projects that have added to or modified IEEE Std 802.3 follows as a part of this introductory material. The listing is in chronological order of project initiation and for each project describes: subject, clauses added (if any), approval dates, and committee officers.

The media access control (MAC) protocol specified in IEEE Std 802.3 is Carrier Sense Multiple Access with Collision Detection (CSMA/CD). This MAC protocol was included in the experimental Ethernet developed at Xerox Palo Alto Research Center. While the experimental Ethernet had a 2.94 Mb/s data rate, IEEE Std 802.3-1985 specified operation at 10 Mb/s. Since 1985 new media options, new speeds of operation, and new protocol capabilities have been added to IEEE Std 802.3.

Some of the major additions to IEEE Std 802.3 are identified with their project number. This is most common for projects adding higher speeds of operation or new protocols. For example, IEEE Std 802.3u™ added 100 Mb/s operation (also called Fast Ethernet), IEEE Std 802.3x™ specified full duplex operation and a flow control protocol, IEEE Std 802.3z™ added 1000 Mb/s operation (also called Gigabit Ethernet) and IEEE Std 802.3ad specified link aggregation. These major additions are all now included in IEEE Std 802.3-2002 and are not available as separate documents.

Recent additions such as IEEE Std 802.3ae (also called 10 Gigabit Ethernet) and IEEE Std 802.3af™ (also called Power over Ethernet) are currently published as separate documents. These recent amendments are part of IEEE Std 802.3 and they are dependent on and reference information published in IEEE Std 802.3-2002.

At the date of IEEE Std 802.3ak publication, IEEE Std 802.3 is comprised of the following documents:

IEEE Std 802.3-2002

Section One—Includes Clause 1 through Clause 20 and Annexes A through H. Section One includes the specifications for 10 Mb/s operation and the MAC, frame formats and service interfaces used for all speeds of operation.

Section Two—Includes Clause 21 through Clause 32 and Annexes 22A through 32A. Section Two includes the specifications for 100 Mb/s operation and management attributes for multiple protocols and operational speeds.

Section Three—Includes Clause 34 through Clause 43 and Annexes 36A through 43C. Section Three includes the specifications for 1000 Mb/s operation.

IEEE Std 802.3ae-2002

Includes changes to IEEE Std 802.3-2002, and adds Clauses 44 through 53 and Annexes 44A through 50A. This amendment includes specifications for 10 Gb/s operation.

IEEE Std 802.3af-2003

Includes changes to IEEE Std 802.3-2002, and adds Clause 33 and Annexes 33A through 33E. This amendment includes specifications for the provision of power over 10BASE-T, 100BASE-TX and 1000BASE-T cabling.

SUPERSEDED

IEEE Std 802.3aj™-2003

Includes changes to IEEE Std 802.3-2002 and IEEE Std 802.3ae-2002.

IEEE Std 802.3ak-2004

Includes changes to IEEE Std 802.3-2002, and IEEE Std 802.3ae-2002, and adds Clause 54. This amendment adds 10GBASE-CX4 specifications for 10 Gb/s operation over balanced shielded cabling.

IEEE 802.3 will continue to evolve. Revisions are anticipated to the above standards within the next few years to integrate approved changes into IEEE 802.3, to clarify existing material, to correct possible errors, and to incorporate new related material.

Conformance test methodology

An additional standard, IEEE Std 1802.3™ provides conformance test information for 10BASE-T.

IEEE Std 802.3ak-2004

IEEE Std 802.3ak-2004, Physical Layer and Management Parameters for 10Gb/s Operation, Type 10GBASE-CX4 is an amendment to IEEE Std 802.3. It includes changes to both IEEE Std 802.3-2002 and IEEE Std 802.3ae-2002. In a few cases, text published in IEEE Std 802.3-2002 is modified by IEEE Std 802.3ae-2002 and is subsequently modified by IEEE Std 802.3ak-2004. IEEE Std 802.3ak-2004 does not include any modifications to the text of IEEE Std 802.3af-2003 and IEEE Std 802.3aj-2003.

Historical listing of IEEE Std 802.3 projects

Included in IEEE Std 802.3-2002

IEEE Std 802.3 document	Date approved by IEEE and ANSI	Officers at the time of working group ballot
802.3-1985, Original 10 Mb/s standard, MAC, PLS, AUI, 10BASE5	23 June 1983 (IEEE) 31 December 1984 (ANSI)	Donald C. Loughry , <i>Working Group Chair</i>
802.3a-1988 (Clause 10), 10 Mb/s MAU 10BASE2	15 November 1985 (IEEE) 28 December 1987 (ANSI)	Donald C. Loughry , <i>Working Group Chair</i> Alan Flatman , <i>Task Force Chair</i>
802.3b-1985 (Clause 11), 10 Mb/s Broadband MAU, 10BROAD36	19 September 1985 (IEEE) 28 February 1986 (ANSI)	Donald C. Loughry , <i>Working Group Chair</i> Menachem Abraham , <i>Task Force Chair</i>
802.3c-1985 (9.1–9.8), 10 Mb/s Baseband Repeater	12 December 1985 (IEEE) 4 June 1986 (ANSI)	Donald C. Loughry , <i>Working Group Chair</i> Geoffrey O. Thompson , <i>Task Force Chair</i>
802.3d-1987 (9.9), 10 Mb/s Fiber MAU, FOIRL	10 December 1987 (IEEE) 9 February 1989 (ANSI)	Donald C. Loughry , <i>Working Group Chair</i> Steven Moustakas , <i>Task Force Chair</i>
802.3e-1987 (Clause 12), 1 Mb/s MAU and Hub 1BASE5	11 June 1987 (IEEE) 15 December 1987 (ANSI)	Donald C. Loughry , <i>Working Group Chair</i> Robert Galin , <i>Task Force Chair</i>
802.3h-1990 (Clause 5), 10 Mb/s Layer Management, DTEs	28 September 1990 (IEEE) 11 March 1991 (ANSI)	Donald C. Loughry , <i>Working Group Chair</i> Andy J. Luque , <i>Task Force Chair</i>
802.3i-1990 (Clauses 13 and 14), 10 Mb/s UTP MAU, 10 BASE-T	28 September 1990 (IEEE) 11 March 1991 (ANSI)	Donald C. Loughry , <i>Working Group Chair</i> Patricia Thaler , <i>Task Force Chair (initial)</i> Richard Anderson , <i>Task Force Chair (final)</i>

SUPERSEDED

IEEE Std 802.3 document	Date approved by IEEE and ANSI	Officers at the time of working group ballot
802.3j-1993 (Clauses 15–18), 10 Mb/s Fiber MAUs 10BASE-FP, FB, and FL	15 September 1993 (IEEE) 15 March 1994 (ANSI)	Patricia Thaler , <i>Working Group Chair</i> Keith Amundsen , <i>Task Force Chair (initial)</i> Frederick Scholl , <i>Task Force Chair (final)</i> Michael E. Lee , <i>Technical Editor</i>
802.3k-1993 (Clause 19), 10 Mb/s Layer Management, Repeaters	17 September 1992 (IEEE) 8 March 1993 (ANSI)	Patricia Thaler , <i>Working Group Chair</i> Joseph S. Skorupa , <i>Task Force Chair</i> Geoffrey O. Thompson , <i>Vice Chair and Editor</i>
802.3l-1992 (14.10), 10 Mb/s PICS Proforma 10BASE-T MAU	17 September 1992 (IEEE) 23 February 1993 (ANSI)	Patricia Thaler , <i>Working Group Chair</i> Mike Armstrong , <i>Task Force Chair and Editor</i> Paul Nikolich , <i>Vice Chair</i> William Randle , <i>Editorial Coordinator</i>
802.3m-1995, Maintenance 2	21 September 1995 (IEEE) 16 July 1996 (ANSI)	Patricia Thaler , <i>Working Group Chair</i> Gary Robinson , <i>Maintenance Chair</i>
802.3n-1995, Maintenance 3	21 September 1995 (IEEE) 4 April 1996 (ANSI)	Patricia Thaler , <i>Working Group Chair</i> Gary Robinson , <i>Maintenance Chair</i>
802.3p-1993™ (Clause 20), Management, 10 Mb/s Integrated MAUs	17 June 1993 (IEEE) 4 January 1994 (ANSI)	Patricia Thaler , <i>Working Group Chair</i> Joseph S. Skorupa , <i>Task Force Chair</i> Geoffrey O. Thompson , <i>Vice Chair and Editor</i>
802.3q-1993™ (Clause 5), 10 Mb/s Layer Management, GDMO Format	17 June 1993 (IEEE) 4 January 1994 (ANSI)	Patricia Thaler , <i>Working Group Chair</i> Joseph S. Skorupa , <i>Task Force Chair</i> Geoffrey O. Thompson , <i>Vice Chair and Editor</i>
802.3r-1996 (8.8), Type 10BASE5 Medium Attachment Unit PICS proforma	29 July 1996 (IEEE) 6 January 1997 (ANSI)	Patricia Thaler , <i>Working Group Chair</i> Imre Juhász , <i>Task Force Chair</i> William Randle , <i>Task Force Editor</i>
802.3s-1995, Maintenance 4	21 September 1995 (IEEE) 8 April 1996 (ANSI)	Geoffrey O. Thompson , <i>Working Group Chair</i> Gary Robinson , <i>Maintenance Chair</i>
802.3t-1995, 120 Ω informative annex to 10BASE-T	14 June 1995 (IEEE) 12 January 1996 (ANSI)	Geoffrey O. Thompson , <i>Working Group Chair</i> Jacques Christ , <i>Task Force Chair</i>
802.3u-1995 (Clauses 21–30), Type 100BASE-T MAC parameters, Physical Layer, MAUs, and Repeater for 100 Mb/s Operation	14 June 1995 (IEEE) 4 April 1996 (ANSI)	Geoffrey O. Thompson , <i>Working Group Chair</i> Peter Tarrant , <i>Task Force Chair (Phase 1)</i> Howard Frazier , <i>Task Force Chair (Phase 2)</i> Paul Sherer , <i>Editor-in-Chief (Phase 1)</i> Howard Johnson , <i>Editor-in-Chief (Phase 2)</i> Colin Mick , <i>Comment Editor</i>
802.3v-1995, 150 Ω informative annex to 10BASE-T	12 December 1995 (IEEE) 16 July 1996 (ANSI)	Geoffrey O. Thompson , <i>Working Group Chair</i> Larry Nicholson , <i>Task Force Chair</i>
802.3x-1997 and 802.3y-1997 (Revisions to 802.3, Clauses 31 and 32), Full Duplex Operation and Type 100BASE-T2	20 March 1997 (IEEE) 5 September 1997 (ANSI)	Geoffrey O. Thompson , <i>Working Group Chair</i> David J. Law , <i>Working Group Vice Chair</i> Rich Seifert , <i>Task Force Chair and Editor</i> (802.3x) J. Scott Carter , <i>Task Force Chair (802.3y)</i> Colin Mick , <i>Task Force Editor (802.3y)</i>
802.3z-1998™ (Clauses 34–39, 41– 42), Type 1000BASE-X MAC Parameters, Physical Layer, Repeater, and Management Parameters for 1000 Mb/s Operation	25 June 1998 (IEEE)	Geoffrey O. Thompson , <i>Working Group Chair</i> David J. Law , <i>Working Group Vice Chair</i> Howard M. Frazier, Jr. , <i>Task Force Chair and</i> <i>Editor</i> Howard W. Johnson , <i>Task Force Editor</i>

SUPERSEDED

IEEE Std 802.3 document	Date approved by IEEE and ANSI	Officers at the time of working group ballot
802.3aa-1998, Maintenance 5	25 June 1998 (IEEE)	Geoffrey O. Thompson , <i>Working Group Chair</i> Colin Mick , <i>Task Force Editor (100BASE-T Maintenance)</i>
802.3ab-1999 (Clause 40), Physical Layer Parameters and Specifications for 1000 Mb/s Operation Over 4 Pair of Category 5 Balanced Copper Cabling, Type 1000BASE-T	26 June 1999 (IEEE)	Geoffrey O. Thompson , <i>Working Group Chair</i> David J. Law , <i>Working Group Vice Chair</i> Robert M. Grow , <i>Working Group Secretary</i> George Eisler , <i>Task Force Chair</i> Colin Mick , <i>Task Force Editor</i>
802.3ac-1998, Frame Extensions for Virtual Bridged Local Area Network (VLAN) Tagging on 802.3 Networks	16 September 1998 (IEEE)	Geoffrey O. Thompson , <i>Working Group Chair</i> David J. Law , <i>Working Group Vice Chair</i> Andy J. Luque , <i>Working Group Secretary</i> Ian Crayford , <i>Task Force Chair</i> Rich Seifert , <i>Task Force Editor</i>
802.3ad-2000 (Clause 43), Aggregation of Multiple Link Segments	30 March 2000 (IEEE)	Geoffrey O. Thompson , <i>Working Group Chair</i> David J. Law , <i>Working Group Vice Chair</i> Robert M. Grow , <i>Working Group Secretary</i> Steven Haddock , <i>Task Force Chair</i> Tony Jeffree , <i>Co-Editor</i> Rich Seifert , <i>CoEditor</i>
802.3-2002 (802.3ag, Maintenance 6, Revision of the base), Carrier Sense Multiple Access with Collision Detection (CSMA/CD) access method and physical layer specifications	14 January 2002 (IEEE)	Geoffrey O. Thompson , <i>Working Group Chair</i> David J. Law , <i>Working Group Vice Chair</i> Robert M. Grow , <i>Working Group Secretary</i>

Temporarily published as separate documents

IEEE Std 802.3 document	Date approved by IEEE and ANSI	Officers at the time of working group ballot
802.3ae-2002, (Clauses 44–53) Media Access Control (MAC) Parameters, Physical Layers, and Management Parameters for 10 Gb/s Operation	13 June 2002 (IEEE)	Geoffrey O. Thompson , <i>Working Group Chair</i> David J. Law , <i>Working Group Vice Chair</i> Robert M. Grow , <i>Working Group Secretary</i> R. Jonathan Thatcher , <i>Task Force Chair</i> Stephen Haddock , <i>Task Force Vice Chair</i> Bradley J. Booth , <i>Task Force Editor</i> Lacreshia Laningham , <i>Task Force Assistant Editor</i> Benjamin Brown , <i>Logic Track Chair</i> Walter Thirion , <i>Optical Track Chair</i>
802.3af-2003, (Clause 33) Data Terminal Equipment (DTE) Power via Media Dependent Interface (MDI)	12 June 2003 (IEEE)	Geoffrey O. Thompson , <i>Working Group Chair—Phase 1</i> Robert M. Grow , <i>Working Group Chair—Phase 2</i> David J. Law , <i>Working Group Vice Chair</i> Robert M. Grow , <i>Secretary—Phase 1</i> Steven B. Carlson , <i>Secretary—Phase 2</i> Steven B. Carlson , <i>Task Force Chair</i> Michael S. McCormack , <i>Editor—Phase 1</i> John J. Jetzt , <i>Editor—Phase 2</i> Chad M. Jones , <i>Comment Editor</i>

SUPERSEDED

IEEE Std 802.3 document	Date approved by IEEE and ANSI	Officers at the time of working group ballot
802.3aj-2003, Maintenance 7	11 September 2003 (IEEE)	Robert M. Grow , <i>Working Group Chair</i> David J. Law , <i>Working Group Vice Chair, Task Force Chair</i> Steven B. Carlson , <i>Working Group Secretary</i> Catherine K. N. Berger , <i>Task Force Editor</i>
802.3ak-2004, Physical Layer and Management Parameters for 10Gb/s Operation, Type 10GBASE-CX4	9 February 2004 (IEEE)	Robert M. Grow , <i>Working Group Chair</i> David J. Law , <i>Working Group Vice Chair</i> Steven B. Carlson , <i>Working Group Secretary</i> Daniel J. Dove , <i>Task Force Chair</i> Howard A. Baumer , <i>Task Force Editor</i>

SUPERSEDED

Participants

The following is a list of chairs and editors during the development of this standard:

Robert M. Grow, *Working Group Chair*
David J. Law, *Working Group Vice Chair*
Steven B. Carlson, *Working Group Secretary*
Daniel J. Dove, *Chair IEEE 802.3ak Task Force*
Howard A. Baumer, *Editor IEEE 802.3ak Task Force*

The following is a list of voters at the time the IEEE 802.3 Working Group balloted this standard:

Ali Abaye	George Eisler	Greg LeCheminant	Shawn Rogers
Hamlet Abedmamoore	Kent English	Ying Lee	Dan Romascanu
Reza Alavi	John F. Ewen	Amir Lehr	Floyd Ross
Don Alderrou	Sabina Fanfoni	Amir Leshem	RundquistRon
Brian Arnold	Robert G. Finch	John O. Limb	Ron Rundquist
Doug Artman	Alan Flatman	Tom Lindsay	Dolors Sala
Ilan Atias	Brian Ford	Eric R. Lynskey	Sam Sambasivan
Shahar Bar-Or	Howard Frazier	Brian MacLeod	Mark Sankey
Eyal Barnea	Yukihiro Fujimoto	Ariel Maislos	Concita Saracino
Hugh Barrass	Robert D. Gaglianella	Arthur Marris	Raj Savara
Bob Barrett	Justin Gaither	David W. Martin	Sabit Say-Otun
Meir Bartur	John George	Thomas Mathey	Fred Schindler
Denis Beaudoin	Floyd Gerhardt	Kent McCammon	Peter Schwartz
Michall Beck	Moty Goldis	Michael S. McCormack	Lee Sendelbach
Edward Beili	Rich Graham	Tremont Miao	Koichiro Seto
Vincent Bemmell	Ajay Gummalla	Simon Moseley	Sunil Shah
Mike Bennett	Jonas Gustafsson	Robert Muir	Cheng-Chung Shih
David J. Berman	Russ Gyurek	Shimon Muller	Zion Shohet
Vipul Bhatt	Steven Haas	Ken Murakami	Scott Simon
Brad Booth	Tariq Haddad	Denis Murphy	Ran Soffer
Paul Bottorff	Stephen Haddock	Thomas Murphy	Jaeyeon Song
Al Braga	Chris Hansen	Gerard Nadeau	Jian Song
Richard Brand	Onn Haran	Ken Naganuma	Massimo Sorbara
Benjamin Brown	Adam Healey	Hari Naidu	Walt Soto
Kevin Brown	Jim Heckroth	Karl Nakamura	Matthew B. Squire
Scott Burton	Olli-Pekka Hiironen	Nersi Nazari	Patrick H. Stanley
Robert Busse	Henry Hinrichs	Erwan Nedellec	Richard Stuart
Roy Bynum	Ryan Hirth	Trung Nguyen	Hiroshi Suzuki
Jeff Cain	Michael Horvat	Paul Nikolich	Steve Swanson
Richard Cam	Thong Huynh	Bob Noseworthy	Mike Tate
Dan Carnine	Baldwin Ip	Barry O'Mahony	Jim Tatum
Justin Chang	Steve Jackson	Aidan O'Rourke	Pat Thaler
Xiaopeng Chen	Krista S. Jacobsen	Satoshi Obara	R. Jonathan Thatcher
Jacky Chow	Raj Jain	Vladimir Oksman	Walter Thirion
George Claseman	John Jetzt	PannellDon	Geoffrey O. Thompson
Terry Cobb	Wenbin Jiang	Don Pannell	David Thorne
Charles I. Cook	Chad Jones	Gabriel D. Papandrea	Bruce Tolley
George Cravens	Ulf Jonsson	Glenn Parsons	Bor-long Twu
Richard Cross	Thomas K. Jørgensen	Y. Lisa Peng	Marcos Tzannes
Chris Cullin	David Kabal	Gerry Pesavento	Sterling A. Vaden
Kevin Daines	Shinkyo Kaku	Antti Pietilainen	Schelto van Doorn
John Dallesasse	Hadriel Kaplan	Timothy R. Plunkett	Gérard Vergnaud
Yair Darshan	Roger Karam	Carl R. Posthuma	Chiung Hung Wang
Piers Dawe	John J. Kenny	William Quackenbush	Jeff Warren
Chris Di Minico	Chan Kim	Jim Quilici	Dong Wei
Wael Diab	Jin H. Kim	Patrick W. Quinn	Alan Weissberger
Thomas Dineen	Marc Kimpe	John Quirk	Erica Williamson
Mike Dudek	Neal King	Rick Rabinovich	Stefan M. Wurster
David Dwelley	KolesarPaul	Jerry K. Radcliffe	Steven Yang
J. Craig Easley	Glen Kramer	Naresh Raman	Osamu Yoshihara
Edward J. Eckert	Hans Lackner	Maurice Reintjes	Hong Yu
Frank J. Effenberger	Daun Langston	Duane Remein	Nelson Zagalsky
John Egan	Eric Lawrence	Lawrence Rennie	Bob Zona
	Yannick Le Goff	Behrooz Rezvani	

SUPERSEDED

The following members of the balloting committee voted on this amendment of the standard. Balloters may have voted for approval, disapproval, or abstention.

Don Alderrou
Howard A. Baumer
Jacob Ben Ary
Rahul Bhushan
Peter Bradshaw
Benjamin Brown
Jeff Cain
Edward Carley Jr.
Stephen B. Carlson
Keith Chow
André Sion Corr  a
Christopher DiMinico
Guru Dutt Dhingra
Wael Diab
Thomas Dineen
Daniel J. Dove
Sourav Dutta
Clint Early
Will Foulds
Martin Freedman
Justin Gaither
Bob Geiger

Robert M. Grow
Chris Guy
Stephen Haddock
Adam Healey
Atsushi Ito
Peeya Iwagoshi
Stanley Johnson
Joe Juisai
William Lane
David J. Law
Pi-Cheng Law
Randolph Little
Heyun H. Liu
Ryan Madron
Kyle Maus
Steve Methley
George Miao
Rajesh Moorkath
Shimon Muller
Trung Nguyen
Paul Nikolich
Stephen Palm

Glenn Parsons
Subbu Ponnuswamy
Vikram Punj
William Quackenbush
Maximilian Riegel
Calvin Roberts
David Rockwell
Floyd Ross
John Sargent
Marco Scorrano
Rich Seifert
Gil Shultz
Fulvio Spagna
Dimitry Taich
Pat Thaler
Geoffrey O. Thompson
Scott Valcourt
Schelto van Doorn
Dave Willow
Takahito Yoshizawa
Oren Yuen
Andrew Zenk

When the IEEE-SA Standards Board approved this standard on 9 February 2004, it had the following membership:

Don Wright, *Chair*

Chuck Adams
Stephen Berger
Mark D. Bowman
Joseph Bruder
Bob Davis
Judith Gorman
Arnold M. Greenspan
Mark S. Halpin
Raymond Hapeman

Richard J. Holleman
Richard Hulett
Lowell Johnson
Hermann Koch
Thomas J. McGean
Steve M. Mills
Daleep Mohla
Paul Nikolich
T. W. Olsen

Ronald C. Petersen
Gary S. Robinson
Frank Stone
Malcolm V. Thaden
Doug Topping
Joe D. Watson
Roberto de Boisson
Julian Forster*
Joseph Koepfinger*

*Member Emeritus

Also included are the following nonvoting IEEE-SA Standards Board liaisons:

Satish K. Aggarwal, NRC Representative
Richard DeBlasio, DOE Representative
Alan Cookson, NIST Representative

Michelle D. Turner
IEEE Standards Project Editor

Contents

1.	(Changes to) Introduction	2
1.3	Normative references	2
1.4	Definitions.....	2
30.	(Changes to) 10 Mb/s, 100 Mb/s, 1000 Mb/s, and 10 Gb/s Management	2
44.	(Changes to) Introduction to 10 Gb/s baseband network.....	4
45.	(Changes to) Management Data Input/Output (MDIO) Interface	7
46.	(Changes to) XGMII Extender Sublayer (XGXS) and 10 Gigabit Attachment Unit Interface (XAUI).....	11
48.	(Changes to) Physical Coding Sublayer (PCS) and Physical Medium Attachment (PMA) sublayer, type 10GBASE-X	12
	(Changes to) Annex 30B (normative) GDMO and ASN.1 definitions for management.....	14
	(Changes to) Annex 48B (informative) Jitter test methods	16
54.	Physical Medium Dependent (PMD) sublayer and baseband medium, type 10GBASE-CX4.....	17
54.1	Overview	17
54.2	Physical Medium Dependent (PMD) service interface	18
54.3	Delay constraints.....	18
54.4	PMD MDIO function mapping	18
54.5	PMD functional specifications.....	18
54.6	MDI Electrical specifications for 10GBASE-CX4.....	21
54.7	Cable assembly characteristics	29
54.8	MDI specification	35
54.9	Environmental specifications.....	36
54.10	Protocol Implementation Conformance Statement (PICS) proforma for Clause 54, Physical Medium Dependent (PMD) sublayer and baseband medium, type 10GBASE-CX4.....	37

SUPERSEDED

List of special symbols

For the benefit of those who have received this document by electronic means, what follows is a list of special symbols and operators. If any of these symbols or operators fail to display or print out correctly, the editors hope that this table will aid in interpreting any funny blobs and strokes appearing in the body of the document.

Special symbols and operators

Printed Character	Meaning	Font
*	Boolean AND	Symbol
+	Boolean OR, Arithmetic addition	Symbol
^	Boolean XOR	Times
!	Boolean NOT	Symbol
<	Less than	Symbol
≤	Less than or equal to	Symbol
=	Equal to	Symbol
≠	Not equal to	Symbol
≥	Greater than or equal to	Symbol
>	Greater than	Symbol
←	Assignment operator	Symbol
∈	Indicates membership	Symbol
∉	Indicates nonmembership	Symbol
±	Plus or minus (a tolerance)	Symbol
°	Degrees (as in degrees Celsius)	Symbol
∑	Summation	Symbol
—	Big dash (Em dash)	Times
–	Little dash (En dash)	Times
†	Dagger	Times
‡	Double dagger	Times

SUPERSEDED



Documents
Document Sharing Hub

IEEE Standard for Information technology—
Telecommunications and information exchange between systems—
Local and metropolitan area networks—
Specific requirements—

Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications

Amendment: Physical Layer and Management Parameters for 10Gb/s Operation, Type 10GBASE-CX4

[These changes are part of IEEE Std 802.3™-2002.]

EDITORIAL NOTE—This amendment is based on the current edition of IEEE Std 802.3-2002 as amended by IEEE Std 802.3ae™-2002, IEEE Std 802.3af™-2003, and IEEE Std 802.3aj™-2003. The editing instructions define how to merge the material contained here into this base document set to form the new comprehensive standard as created by the addition of IEEE Std 802.3ak™-2004.

Editing instructions are shown in ***bold italic***. Four editing instructions are used: change, delete, insert, and replace. ***Change*** is used to make small corrections in existing text or tables. The editing instruction specifies the location of the change and describes what is being changed either by using ~~strike through~~ (to remove old material) or underscore (to add new material). ***Delete*** removes existing material. ***Insert*** adds new material without disturbing the existing material. Insertions may require renumbering. If so, renumbering instructions are given in the editing instruction. Editorial notes will not be carried over into future editions. ***Replace*** is used to make large changes in existing text, subclauses, tables, or figures by removing existing material and replacing it with new material. Editorial notes will not be carried over into future editions because the changes will be incorporated into the base standard.

1. Introduction

1.3 Normative references

Insert the following alphabetically into 1.3.

IEC 61076-3-113, Ed. 1.0 (draft, 48B/1327/NP, 14 March 2003.) [48B Secretariat 1327]¹ Connectors for electronic equipment—Part 3-113: Screened, serial multi-conductor cable to board connectors suitable for 10 Gbit/sec data rates.

1.4 Definitions

Insert each of the following alphabetically into 1.4. Renumber as required.

1.4.xxx cable assembly: An assembly containing one or more insulated conductors, terminated in a connector at each end, for use as a link segment between MDIs.

1.4.xxx twinaxial cable: A cable similar to coaxial cable in construction but containing two insulated inner conductors rather than one.

1.4.xxx twinaxial cable assembly: An assembly containing multiple twinaxial cables, terminated in a connector at each end, for use as a link segment between MDIs, such as that used in 10GBASE-CX4.

30. 10 Mb/s, 100 Mb/s, 1000 Mb/s, and 10 Gb/s Management

30.5.1.1.2 aMAUType

Change 30.5.1.1.2 (as modified by IEEE 802.3ae-2002) as follows:

ATTRIBUTE

APPROPRIATE SYNTAX:

A GET-SET ENUMERATION that meets the requirements of the description below:

global	undefined
other	See 30.2.5
unknown	Initializing, true state or type not yet known
AUI	no internal MAU, view from AUI
10BASE5	Thick coax MAU as specified in Clause 8
FOIRL	FOIRL MAU as specified in 9.9
10BASE2	Thin coax MAU as specified in Clause 10
10BROAD36	Broadband DTE MAU as specified in Clause 11
10BASE-T	UTP MAU as specified in Clause 14, duplex mode unknown
10BASE-THD	UTP MAU as specified in Clause 14, half duplex mode
10BASE-TFD	UTP MAU as specified in Clause 14, full duplex mode
10BASE-FP	Passive fiber MAU as specified in Clause 16
10BASE-FB	Synchronous fiber MAU as specified in Clause 17
10BASE-FL	Asynchronous fiber MAU as specified in Clause 18, duplex mode unknown
10BASE-FLHD	Asynchronous fiber MAU as specified in Clause 18, half duplex mode
10BASE-FLFD	Asynchronous fiber MAU as specified in Clause 18, full duplex mode

¹Presently, IEC 61076-3-113 is a committee draft.

SUPERSEDED

CSMA/CD

IEEE
Std 802.3ak-2004

100BASE-T4	Four-pair Category 3 UTP as specified in Clause 23
100BASE-TX	Two-pair Category 5 UTP as specified in Clause 25, duplex mode unknown
100BASE-TXHD	Two-pair Category 5 UTP as specified in Clause 25, half duplex mode
100BASE-TXFD	Two-pair Category 5 UTP as specified in Clause 25, full duplex mode
100BASE-FX	X fiber over PMD as specified in Clause 26, duplex mode unknown
100BASE-FXHD	X fiber over PMD as specified in Clause 26, half duplex mode
100BASE-FXFD	X fiber over PMD as specified in Clause 26, full duplex mode
100BASE-T2	Two-pair Category 3 UTP as specified in Clause 32, duplex mode unknown
100BASE-T2HD	Two-pair Category 3 UTP as specified in Clause 32, half duplex mode
100BASE-T2FD	Two-pair Category 3 UTP as specified in Clause 32, full duplex mode
1000BASE-X	X PCS/PMA as specified in Clause 36 over undefined PMD, duplex mode unknown
1000BASE-XHD	X PCS/PMA as specified in Clause 36 over undefined PMD, half duplex mode
1000BASE-XFD	X PCS/PMA as specified in Clause 36 over undefined PMD, full duplex mode
1000BASE-LX	X fiber over long-wavelength laser PMD as specified in Clause 38, duplex mode unknown
1000BASE-LXHD	X fiber over long-wavelength laser PMD as specified in Clause 38, half duplex mode
1000BASE-LXFD	X fiber over long-wavelength laser PMD as specified in Clause 38, full duplex mode
1000BASE-SX	X fiber over short-wavelength laser PMD as specified in Clause 38, duplex mode unknown
1000BASE-SXHD	X fiber over short-wavelength laser PMD as specified in Clause 38, half duplex mode
1000BASE-SXFD	X fiber over short-wavelength laser PMD as specified in Clause 38, full duplex mode
1000BASE-CX	X copper over 150-Ohm balanced cable PMD as specified in Clause 39, duplex mode unknown
1000BASE-CXHD	X copper over 150-Ohm balanced cable PMD as specified in Clause 39, half duplex mode
1000BASE-CXFD	X copper over 150-Ohm balanced cable PMD as specified in Clause 39, full duplex mode
1000BASE-T	Four-pair Category 5 UTP PHY to be specified in Clause 40, duplex mode unknown
1000BASE-THD	Four-pair Category 5 UTP PHY to be specified in Clause 40, half duplex mode
1000BASE-TFD	Four-pair Category 5 UTP PHY to be specified in Clause 40, full duplex mode
10GBASE-X	X PCS/PMA as specified in Clause 48 over undefined PMD
10GBASE-LX4	X fibre over 4 lane 1310nm optics as specified in Clause 53
<u>10GBASE-CX4</u>	<u>X copper over 8 pair 100-Ohm balanced cable as specified in Clause 54</u>
10GBASE-R	R PCS/PMA as specified in Clause 49 over undefined PMD
10GBASE-ER	R fibre over 1550nm optics as specified in Clause 52
10GBASE-LR	R fibre over 1310nm optics as specified in Clause 52
10GBASE-SR	R fibre over 850nm optics as specified in Clause 52
10GBASE-W	W PCS/PMA as specified in Clauses 49 and 50 over undefined PMD
10GBASE-EW	W fibre over 1550nm optics as specified in Clause 52
10GBASE-LW	W fibre over 1310nm optics as specified in Clause 52
10GBASE-SW	W fibre over 850nm optics as specified in Clause 52
802.9a	Integrated services MAU as specified in IEEE Std 802.9 ISLAN-16T