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Telecommunications and exchange between information technology systems — Requirements for local and metropolitan area networks —

Part 3: Standard for Ethernet

Télécommunications et échange entre systèmes informatiques — Exigences pour les réseaux locaux et métropolitains —

Partie 3: Norme pour Ethernet

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This fourth edition cancels and replaces the third edition (ISO/IEC/IEEE 8802-3:2021), which has been technically revised. It also incorporates the Amendments ISO/IEC/IEEE 8802-3:2021/Amd 2:2021, ISO/IEC/IEEE 8802-3:2021/Amd 3:2021, ISO/IEC/IEEE 8802-3:2021/Amd 4:2021, ISO/IEC/IEEE 8802-3:2021/Amd 5:2021, ISO/IEC/IEEE 8802-3:2021/Amd 6:2021, ISO/IEC/IEEE 8802-3:2021/Amd 7:2021, ISO/IEC/IEEE 8802-3:2021/Amd 8:2021, ISO/IEC/IEEE 8802-3:2021/Amd 9:2021, ISO/IEC/IEEE 8802-3:2021/Amd 10:2021, ISO/IEC/IEEE 8802-3:2021/Amd 11:2021, ISO/IEC/IEEE 8802-3:2021/Amd 12:2021, ISO/IEC/IEEE 8802-3:2021/Amd 13:2021, ISO/IEC/IEEE 8802-3:2021/Amd 14:2021, ISO/IEC/IEEE 8802-3:2021/Amd 1:2021.

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IEEE Std 802.3™-2022
(Revision of
IEEE Std 802.3-2018)

IEEE Standard for Ethernet

LAN/MAN Standards Committee
of the
IEEE Computer Society

Approved 13 May 2022

IEEE SA Standards Board

Abstract: Ethernet local area network operation is specified for selected speeds of operation from 1 Mb/s to 400 Gb/s using a common media access control (MAC) specification and management information base (MIB). The Carrier Sense Multiple Access with Collision Detection (CSMA/CD) MAC protocol specifies shared medium (half duplex) operation, as well as full duplex operation. Speed specific Media Independent Interfaces (MIIs) allow use of selected Physical Layer devices (PHYs) for operation over coaxial, twisted pair or fiber optic cables, or electrical backplanes. System considerations for multisegment shared access networks describe the use of Repeaters that are defined for operational speeds up to 1000 Mb/s. Local Area Network (LAN) operation is supported at all speeds. Other specified capabilities include: various PHY types for access networks, PHYs suitable for metropolitan area network applications, and the provision of power over selected twisted pair PHY types.

Keywords: 2.5 Gigabit Ethernet, 5 Gigabit Ethernet, 10 Gigabit Ethernet, 25 Gigabit Ethernet, 40 Gigabit Ethernet, 50 Gigabit Ethernet, 100 Gigabit Ethernet, 200 Gigabit Ethernet, 400 Gigabit Ethernet, AN, attachment unit interface, AUI, Auto-Negotiation, Backplane Ethernet, balanced cable, data processing, DTE Power via the MDI, EEE, Energy-Efficient Ethernet, EPoC, EPON, EPON protocol over coax, Ethernet, Ethernet in the first mile, Ethernet Passive Optical Network, express traffic, Fast Ethernet, FEC, forward error correction, Gigabit Ethernet, IEEE 802.3™, information exchange, isolation, LAN, local area network, management, MCRS, MDI, media independent interface, medium dependent interface, MIB, MII, MMF, MPCP, Multi-Channel Reconciliation Sublayer, multimode fiber, multipoint control protocol, P2MP, PCS, PD, PHY, physical coding sublayer, Physical Layer, Physical Layer Collision Avoidance, Physical Layer device, physical medium attachment, physical medium dependent, PLCA, PMA, PMD, PoDL, PoE, point to multipoint, Power over Data Lines, Power over Ethernet, Power Sourcing Equipment, Powered Device, PSE, reconciliation sublayer, repeater, RS, single-mode fiber, SMF, type field

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The following individuals were officers and members of the IEEE 802.3 working group at the beginning of the IEEE 802.3dc working group ballot.

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Adam Healey, *IEEE 802.3 Working Group Vice-Chair*
Jon Lewis, *IEEE 802.3 Working Group Secretary*
Steven B. Carlson, *IEEE 802.3 Working Group Executive Secretary*
Valerie Maguire, *IEEE 802.3 Working Group Treasurer*

Adam Healey, *IEEE P802.3 (IEEE 802.3dc) Task Force Chair and Editor-in-Chief*
Pete Anslow, *IEEE P802.3 (IEEE 802.3dc) Task Force Section Editor*
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Jon Lewis, *IEEE P802.3 (IEEE 802.3dc) Task Force Section Editor*
Adee Ran, *IEEE P802.3 (IEEE 802.3dc) Task Force Section Editor*

Historical participants

The following individuals participated in the IEEE 802.3 working group during various stages of the standard's development. Since the initial publication, many IEEE standards have added functionality or provided updates to material included in this standard. Included is a historical list of participants who have dedicated their valuable time, energy, and knowledge to the creation of this material:

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

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

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IEEE Std 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,** *Working Group Chair* **David J. Law,** *Working Group Vice Chair* **Robert M. Grow,** *Working Group Secretary* **George Eisler**, *Task Force Chair* **Colin Mick**, *Task Force Editor*
IEEE Std 802.3ac-1998, Frame Extensions for Virtual Bridged Local Area Network (VLAN) Tagging on IEEE 802.3 Networks	16 September 1998 (IEEE)	**Geoffrey O. Thompson,** *Working Group Chair* **David J. Law,** *Working Group Vice Chair* **Andy J. Luque,** *Working Group Secretary* **Ian Crayford,** *Task Force Chair* **Rich Seifert,** *Task Force Editor*
IEEE Std 802.3ad-2000 (Clause 43), Aggregation of Multiple Link Segments	30 March 2000 (IEEE)	**Geoffrey O. Thompson,** *Working Group Chair* **David J. Law,** *Working Group Vice Chair* **Robert M. Grow,** *Working Group Secretary* **Steven Haddock,** *Task Force Chair* **Tony Jeffree,** *Task Force Co-Editor* **Rich Seifert,** *Task Force CoEditor*
IEEE Std 802.3-2002 (IEEE 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,** *Working Group Chair* **David J. Law,** *Working Group Vice Chair* **Robert M. Grow,** *Working Group Secretary*
IEEE Std 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,** *Working Group Chair* **David J. Law,** *Working Group Vice Chair* **Robert M. Grow,** *Working Group Secretary* **R. Jonathan Thatcher,** *Task Force Chair* **Stephen Haddock,** *Task Force Vice Chair* **Bradley J. Booth,** *Task Force Editor* **Lacreshia Laningham,** *Task Force Assistant Editor* **Benjamin Brown,** *Logic Track Chair* **Walter Thirion,** *Optical Track Chair*
IEEE Std 802.3af-2003, (Clause 33) Data Terminal Equipment (DTE) Power via Media Dependent Interface (MDI)	12 June 2003 (IEEE)	**Geoffrey O. Thompson,** *Working Group Chair (Phase 1)* **Robert M. Grow,** *Working Group Chair (Phase 2)* **David J. Law,** *Working Group Vice Chair* **Robert M. Grow,** *Working Group Secretary (Phase 1)* **Steven B. Carlson,** *Working Group Secretary (Phase 2)* **Steven B. Carlson,** *Task Force Chair* **Michael S. McCormack,** *Task Force Editor (Phase 1)* **John J. Jetzt,** *Task Force Editor (Phase 2)* **Chad M. Jones,** *Task Force Comment Editor*
IEEE Std 802.3ah-2004, Media Access Control Parameters, Physical Layers, and Management Parameters for Subscriber Access Networks	6 April 2005 (IEEE)	**Robert M. Grow,** *Working Group Chair* **David J. Law,** *Working Group Vice Chair* **Steven B. Carlson,** *Working Group Secretary* **Howard Frazier,** *Task Force Chair* **Wael W. Diab,** *Task Force Editor-in-Chief* **Hugh Barrass,** *Task Force Vice-Chair* **Scott Simon,** *Task Force Recording Secretary* **Behrooz Rezvani,** *Task Force Executive Secretary*
IEEE Std 802.3aj-2003, Maintenance 7	11 September 2003 (IEEE)	**Robert M. Grow,** *Working Group Chair* **David J. Law,** *Working Group Vice Chair, Task Force Chair* **Steven B. Carlson,** *Working Group Secretary* **Catherine K. N. Berger,** *Task Force Editor*
IEEE Std 802.3ak-2004, Physical Layer and Management Parameters for 10Gb/s Operation, Type 10GBASE-CX4	9 February 2004 (IEEE)	**Robert M. Grow,** *Working Group Chair* **David J. Law,** *Working Group Vice Chair* **Steven B. Carlson,** *Working Group Secretary* **Daniel J. Dove,** *Task Force Chair* **Howard A. Baumer,** *Task Force Editor*

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IEEE Std 802.3-2005 (IEEE 802.3REVam, Revision of the base), Carrier Sense Multiple Access with Collision Detection (CSMA/CD) access method and Physical Layer specifications	9 June 2005 (IEEE)	**Robert M. Grow,** *Working Group Chair* **David J. Law,** *Working Group Vice Chair* **Wael W. Diab,** *Secretary* **Steven B. Carlson,** *Working Group Executive Secretary* **Piers Dawe,** *Review Editor*
IEEE Std 802.3an-2006, Physical Layer and Management Parameter for 10 Gb/s Operation, Type 10GBASE-T	8 June 2006 (IEEE)	**Robert M. Grow,** *Working Group Chair* **David J. Law,** *Working Group Vice Chair* **Wael William Diab,** *Working Group Secretary* **Steven B. Carlson,** *Working Group Executive Secretary* **Bradley Booth,** *Task Force Chair* **Sanjay Kasturia,** *Task Force Editor-in Chief* **George Eisler,** *Task Force Recording Secretary*
IEEE Std 802.3ap-2007, Ethernet Operation over Electrical Backplanes	22 March 2007 (IEEE)	**Robert M. Grow,** *Working Group Chair* **David J. Law,** *Working Group Vice-Chair* **Wael W. Diab**, *Working Group Secretary* **Steven B. Carlson,** *Working Group Executive Secretary* **Bradley Booth,** *Working Group Treasurer* **Adam Healey,** *Task Force Chair* **John D'Ambrosia,** *Task Force Secretary* **Schelto vanDoorn,** *Task Force Editor-in-Chief (Phase 1)* **Ilango S. Ganga,** *Task Force Editor-in-Chief (Phase 2)*
IEEE Std 802.3aq-2006, Physical Layer and Management Parameters for 10 Gb/s Operation, Type 10GBASE-LRM	15 September 2006 (IEEE)	**Robert M. Grow,** *Working Group Chair* **David J. Law,** *Working Group Vice Chair* **Wael William Diab,** *Working Group Secretary* **Steven B. Carlson,** *Working Group Executive Secretary* **David G. Cunningham,** *Task Force Chair* **Nick Weiner,** *Task Force Editor* **Piers Dawe,** *Task Force Contributing Editor*
IEEE Std 802.3as-2006, Frame format extensions	15 September 2006 (IEEE)	**Robert M. Grow,** *Working Group Chair* **David J. Law,** *Working Group Vice Chair* **Wael William Diab,** *Working Group Secretary* **Steven B. Carlson,** *Working Group Executive Secretary* **Kevin Q. Daines,** *Task Force Chair* **Glenn W. Parsons,** *Task Force Editor*
IEEE Std 802.3-2005/Cor 1-2006 (IEEE 802.3au), DTE Power via MDI Isolation corrigendum	8 June 2006 (IEEE)	**Robert M. Grow,** *Working Group Chair* **David J. Law,** *Working Group Vice Chair, Task Force Editor* **Wael W. Diab**, *Working Group Secretary* **Steven B. Carlson,** *Working Group Executive Secretary*
IEEE Std 802.3-2005/Cor 2-2007 (IEEE 802.3aw), 10GBASE-T corrigendum	7 June 2007 (IEEE)	**Robert M. Grow,** *Working Group Chair* **David J. Law,** *Working Group Vice Chair, Task Force Editor* **Wael W. Diab**, *Working Group Secretary* **Steven B. Carlson,** *Working Group Executive Secretary* **Bradley Booth,** *Working Group Treasurer*
IEEE Std 802.3-2008 (IEEE 802.3ay), Maintenance #9 (Revision of the base), Carrier Sense Multiple Access with Collision Detection (CSMA/CD) access method and Physical Layer specifications	26 September 2008 (IEEE)	**Robert M. Grow,** *Working Group Chair* **David J. Law,** *Working Group Vice Chair, Task Force Editor* **Wael William Diab,** *Working Group Secretary* **Steven B. Carlson,** *Working Group Executive Secretary* **Bradley Booth,** *Working Group Treasurer*
IEEE Std 802.3at-2009 Data Terminal Equipment (DTE) Power via the Media Dependent Interface (MDI) Enhancements	11 September 2009 (IEEE)	**David J. Law,** *Working Group Chair* **Wael William Diab,** *Working Group Vice Chair* **Adam Healey,** *Working Group Secretary* **Steven B. Carlson,** *Working Group Executive Secretary* **Bradley Booth,** *Working Group Treasurer* **Mike McCormack,** *Task Force Chair* **D. Matthew Landry,** *Task Force Chief Editor* **Chad Jones,** *Task Force Comment Editor*

IEEE Std 802.3 document	Date approved by IEEE and ANSI	Officers at the time of working group ballot
IEEE Std 802.3av-2009 Physical Layer Specifications and Management Parameters for 10 Gb/s Passive Optical Networks	11 September 2009 (IEEE)	**David J. Law,** *Working Group Chair* **Wael William Diab,** *Working Group Vice Chair* **Adam Healey,** *Working Group Secretary* **Steven B. Carlson,** *Working Group Executive Secretary* **Bradley Booth,** *Working Group Treasurer* **Glen Kramer,** *Task Force Chair* **Duane Remein,** *Task Force Chief Editor* **Marek Hajduczenia,** *Task Force Assistant Editor*
IEEE Std 802.3az-2010 Media Access Control Parameters, Physical Layers, and Management Parameters for Energy-Efficient Ethernet	30 September 2010 (IEEE)	**David J. Law,** *Working Group Chair* **Wael William Diab,** *Working Group Vice Chair* **Steven B. Carlson,** *Working Group Executive Secretary* **Adam Healey,** *Working Group Secretary* **Bradley Booth,** *Working Group Treasurer* **Michael Bennett,** *Task Force Chair* **Sanjay Kasturia,** *Task Force Editor-in-Chief*
IEEE Std 802.3ba Media Access Control Parameters, Physical Layers, and Management Parameters for 40 Gb/s and 100 Gb/s Operation	17 June 2010 (IEEE)	**David J. Law,** *Working Group Chair* **Wael William Diab,** *Working Group Vice-Chair* **Steven B. Carlson,** *Working Group Executive Secretary* **Adam Healey,** *Working Group Secretary* **Bradley Booth,** *Working Group Treasurer* **John D'Ambrosia,** *Task Force Chair* **Ilango S. Ganga,** *Task Force Editor-in-Chief*
IEEE Std 802.3-2008/Cor 1-2009 (IEEE 802.3bb) Pause Reaction Delay Corrigendum.	9 December 2009 (IEEE)	**David J. Law,** *Working Group Chair* **Wael William Diab,** *Working Group Vice-Chair* **Steven B. Carlson,** *Working Group Executive Secretary* **Adam Healey,** *Working Group Secretary* **Bradley Booth,** *Working Group Treasurer*
IEEE Std 802.3bc-2009 Ethernet Organizationally Specific Type, Length, Value (TLVs)	11 September 2009 (IEEE)	**David J. Law,** *Working Group Chair and Task Force Editor* **Wael W. Diab,** *Working Group Vice Chair, Task Force Chair* **Steven B. Carlson,** *Working Group Executive Secretary* **Adam Healey,** *Working Group Secretary* **Bradley Booth,** *Working Group Treasurer*
IEEE Std 802.3bd-2011 MAC Control Frame for Priority-based Flow Control	16 June 2011 (IEEE)	**Tony Jeffree,** *IEEE 802.1 Working Group Chair* **Paul Congdon,** *IEEE 802.1 Working Group Vice Chair* **David J. Law,** *IEEE 802.3 Working Group Chair* **Wael W. Diab,** *IEEE 802.3 Working Group Vice Chair* **Pat Thaler,** *Data Center Bridging Task Group Chair*
IEEE Std 802.3bf-2011 Media Access Control (MAC) Service Interface and Management Parameters to Support Time Synchronization Protocols	16 May 2011 (IEEE)	**David J. Law,** *Working Group Chair* **Wael William Diab,** *Working Group Vice-Chair* **Adam Healey,** *Working Group Secretary* **Steven B. Carlson,** *Working Group Executive Secretary* **Valerie Maguire,** *Working Group Treasurer* **Steven B. Carlson,** *Task Force Chair* **Marek Hajduczenia,** *Task Force Editor-in-Chief*
IEEE Std 802.3bg-2011 Physical Layer and Management Parameters for Serial 40 Gb/s Ethernet Operation Over Single-Mode Fiber	31 March 2011 (IEEE)	**David J. Law,** *Working Group Chair* **Wael William Diab,** *Working Group Vice-Chair* **Adam Healey,** *Working Group Secretary* **Steven B. Carlson,** *Working Group Executive Secretary* **Valerie Maguire,** *Working Group Treasurer* **Mark Nowell,** *Task Force Chair* **Pete Anslow,** *Task Force Editor-in-Chief*
IEEE Std 802.3-2012 (IEEE 802.3ah), Maintenance #10 (Revision of the base), Standard for Ethernet	28 December 2012 (IEEE)	**David J. Law,** *Working Group Chair* **Wael William Diab,** *Working Group Vice-Chair, Task Force Chair and Editor-in-Chief* **Adam Healey,** *Working Group Secretary* **Steven B. Carlson,** *Working Group Executive Secretary* **Valerie Maguire,** *Working Group Treasure*
IEEE Std 802.3bk-2013 Physical Layer Specifications and Management Parameters for Extended Ethernet Passive Optical Networks	23 August 2013 (IEEE)	**David J. Law,** *Working Group Chair* **Wael William Diab,** *Working Group Vice-Chair* **Adam Healey,** *Working Group Secretary* **Steven B. Carlson,** *Working Group Executive Secretary* **Valerie Maguire,** *Working Group Treasurer* **Marek Hajduczenia,** *Task Force Chair* **Susumu Nishihara,** *Task Force Editor-in-Chief*

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IEEE Std 802.3bj-2014 Physical Layer Specifications and Management Parameters for 100 Gb/s Operation Over Backplanes and Copper Cables	12 June 2014 (IEEE)	**David J. Law,** *Working Group Chair* **Wael William Diab,** *Working Group Vice-Chair (initial)* **Adam Healey,** *Working Group Secretary, (initial), Task Force Editor-in-Chief (initial), Working Group Vice-Chair (final), Task Force Chair (final)* **Pete Anslow,** *Working Group Secretary (final)* **Steven B. Carlson,** *Working Group Executive Secretary* **Valerie Maguire,** *Working Group Treasurer* **John D'Ambrosia,** *Task Force Chair (initial)* **Matthew Brown,** *Task Force Editor-in-Chief (final)*
IEEE Std 802.3bm-2015 Physical Layer Specifications and Management Parameters for 40 Gb/s and 100 Gb/s Operation Over Fiber Optic Cables	16 February 2015 (IEEE)	**David J. Law,** *Working Group Chair* **Adam Healey,** *Working Group Vice-Chair* **Pete Anslow,** *Working Group Secretary and Task Force Editor-in-Chief* **Steven B. Carlson,** *Working Group Executive Secretary* **Valerie Maguire,** *Working Group Treasurer* **Dan Dove,** *Task Force Chair* **Kapil Shrikhande,** *Task Force Vice-Chair*
IEEE Std 802.3-2015 (IEEE 802.3bx), Maintenance #11 (Revision of the base), Standard for Ethernet	3 September 2015	**David J. Law,** *Working Group Chair* **Adam Healey,** *Working Group Vice-Chair, Task Force Chair, and Task Force Editor-in-Chief* **Pete Anslow,** *Working Group Secretary* **Steven B. Carlson,** *Working Group Executive Secretary* **Valerie Maguire,** *Working Group Treasurer*
IEEE Std 802.3bw-2015 Physical Layer Specifications and Management Parameters for 100 Mb/s Operation over a Single Balanced Twisted Pair Cable (100BASE-T1)	26 October 2015	**David J. Law,** *Working Group Chair* **Adam Healey,** *Working Group Vice-Chair* **Pete Anslow,** *Working Group Secretary* **Steven B. Carlson,** *Working Group Executive Secretary and Task Force Chair, Phase 2* **Valerie Maguire,** *Working Group Treasurer* **Thomas Hogenmüller**, *Task Force Chair, Phase 1* **Mehmet Tazebay**, *Task Force Vice-Chair* **Curtis Donahue**, *Task Force Editor-in-Chief*
IEEE Std 802.3by-2016 Media Access Control Parameters, Physical Layers, and Management Parameters for 25 Gb/s Operation	30 June 2016	**David J. Law,** *Working Group Chair* **Adam Healey,** *Working Group Vice-Chair* **Pete Anslow,** *Working Group Secretary* **Steven B. Carlson,** *Working Group Executive Secretary* **Valerie Maguire,** *Working Group Treasurer* **Mark Nowell**, *Task Force Chair* **Matthew Brown**, *Task Force Editor-in-Chief*
IEEE Std 802.3bq-2016 Physical Layers and Management Parameters for 25 Gb/s and 40 Gb/s Operation, Types 25GBASE-T and 40GBASE-T	30 June 2016	**David J. Law,** *Working Group Chair* **Adam Healey,** *Working Group Vice-Chair* **Pete Anslow,** *Working Group Secretary* **Steven B. Carlson,** *Working Group Executive Secretary* **Valerie Maguire,** *Working Group Treasurer* **David Chalupsky**, *Task Force Chair* **George Zimmerman**, *Task Force Editor-in-Chief*
IEEE Std 802.3bp-2016 Physical Layer Specifications and Management Parameters for 1 Gb/s Operation over a Single Twisted-Pair Copper Cable	30 June 2016	**David J. Law,** *Working Group Chair* **Adam Healey,** *Working Group Vice-Chair* **Pete Anslow,** *Working Group Secretary* **Steven B. Carlson,** *Working Group Executive Secretary and Task Force Chair* **Valerie Maguire,** *Working Group Treasurer* **Marek Hajduczenia**, *Task Force Editor-in-Chief*
IEEE Std 802.3br-2016 Specification and Management Parameters for Interspersing Express Traffic	30 June 2016	**David J. Law,** *Working Group Chair* **Adam Healey,** *Working Group Vice-Chair* **Pete Anslow,** *Working Group Secretary* **Steven B. Carlson,** *Working Group Executive Secretary* **Valerie Maguire,** *Working Group Treasurer* **Ludwig Winkel**, *Task Force Chair* **Patricia Thaler**, *Task Force Editor-in-Chief*

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IEEE Std 802.3bn-2016 Physical Layer Specifications and Management Parameters for Ethernet Passive Optical Networks Protocol over Coax	22 September 2016	**David J. Law,** *Working Group Chair* **Adam Healey,** *Working Group Vice-Chair* **Pete Anslow,** *Working Group Secretary* **Steven B. Carlson,** *Working Group Executive Secretary* **Valerie Maguire,** *Working Group Treasurer* **Mark Laubach**, *Task Force Chair* **Duane Remein**, *Task Force Editor-in-Chief*
IEEE Std 802.3bz-2016 Media Access Control Parameters, Physical Layers, and Management Parameters for 2.5 Gb/s and 5 Gb/s Operation, Types 2.5GBASE-T and 5GBASE-T	22 September 2016	**David J. Law,** *Working Group Chair* **Adam Healey,** *Working Group Vice-Chair* **Pete Anslow,** *Working Group Secretary* **Steven B. Carlson,** *Working Group Executive Secretary* **Valerie Maguire,** *Working Group Treasurer* **David Chalupsky**, *Task Force Chair* **George Zimmerman**, *Task Force Editor-in-Chief*
IEEE Std 802.3bu-2016 Physical Layer and Management Parameters for Power over Data Lines (PoDL) of Single Balanced Twisted-Pair Ethernet	7 December 2016	**David J. Law,** *Working Group Chair* **Adam Healey,** *Working Group Vice-Chair* **Pete Anslow,** *Working Group Secretary* **Steven B. Carlson,** *Working Group Executive Secretary* **Valerie Maguire,** *Working Group Treasurer* **Dave Dwelley,** *Task Force Chair, Phase 1* **Dan Dove,** *Task Force Chair, Phase 2* **Andy Gardner**, *Task Force Editor-in-Chief*
IEEE Std 802.3bv-2017 Physical Layer Specifications and Management Parameters for 1000 Mb/s Operation Over Plastic Optical Fiber	14 February 2017	**David J. Law,** *Working Group Chair* **Adam Healey,** *Working Group Vice-Chair* **Pete Anslow,** *Working Group Secretary* **Steven B. Carlson,** *Working Group Executive Secretary* **Valerie Maguire,** *Working Group Treasurer* **Robert M. Grow,** *Task Force Chair* **Rubén Pérez-Aranda**, *Task Force Editor-in-Chief*
IEEE Std 802.3-2015/Cor 1-2017 (IEEE Std 802.3ce) Multilane Timestamping	23 March 2017	**David J. Law,** *Working Group Chair* **Adam Healey,** *Working Group Vice-Chair, Task Force Chair, and Task Force Editor-in-Chief* **Pete Anslow,** *Working Group Secretary* **Steven B. Carlson,** *Working Group Executive Secretary* **Valerie Maguire,** *Working Group Treasurer*
IEEE Std 802.3bs-2017 Media Access Control Parameters, Physical Layers, and Management Parameters for 200 Gb/s and 400 Gb/s Operation	6 December 2017	**David J. Law,** *Working Group Chair* **Adam Healey,** *Working Group Vice-Chair* **Pete Anslow,** *Working Group Secretary and Task Force Editor-in-Chief* **Steven B. Carlson,** *Working Group Executive Secretary* **Valerie Maguire,** *Working Group Treasurer* **John D'Ambrosia,** *Task Force Chair*
IEEE Std 802.3cc-2017 Physical Layer and Management Parameters for Serial 25 Gb/s Ethernet Operation Over Single-Mode Fiber	6 December 2017	**David J. Law,** *Working Group Chair* **Adam Healey,** *Working Group Vice-Chair* **Pete Anslow,** *Working Group Secretary* **Steven B. Carlson,** *Working Group Executive Secretary* **Valerie Maguire,** *Working Group Treasurer* **David Lewis,** *Task Force Chair* **Kohichi R. Tamura,** *Task Force Editor-in-Chief*
IEEE Std 802.3cb-2018 Physical Layer Specifications and Management Parameters for 2.5 Gb/s and 5 Gb/s Operation over Backplane	27 September 2018	**David J. Law,** *Working Group Chair* **Adam Healey,** *Working Group Vice-Chair* **Pete Anslow,** *Working Group Secretary* **Steven B. Carlson,** *Working Group Executive Secretary* **Valerie Maguire,** *Working Group Treasurer* **Yong Kim,** *Task Force Chair, Phase 1* **Daniel F. Smith,** *Task Force Chair, Phase 2* **William Lo,** *Task Force Editor-in-Chief, Phase 1* **Daniel F. Smith,** *Task Force Editor-in-Chief, Phase 2*

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IEEE Std 802.3bt-2018 Physical Layer and Management Parameters for Power over Ethernet over 4 pairs	27 September 2018	**David J. Law,** *Working Group Chair* **Adam Healey,** *Working Group Vice-Chair* **Pete Anslow,** *Working Group Secretary* **Steven B. Carlson,** *Working Group Executive Secretary* **Valerie Maguire,** *Working Group Treasurer* **Chad Jones,** *Task Force Chair* **Koussalya Balasubramanian,** *Task Force Editor-in-Chief, Phase 1* **Lennart Yseboodt,** *Task Force Editor-in-Chief, Phase 2*
IEEE Std 802.3cd-2018 Media Access Control Parameters for 50 Gb/s and Physical Layers and Management Parameters for 50 Gb/s, 100 Gb/s, and 200 Gb/s Operation	5 December 2018	**David J. Law,** *Working Group Chair* **Adam Healey,** *Working Group Vice-Chair* **Pete Anslow,** *Working Group Secretary* **Steven B. Carlson,** *Working Group Executive Secretary* **Valerie Maguire,** *Working Group Treasurer* **Mark Nowell,** *Task Force Chair* **Matt Brown,** *Task Force Editor-in-Chief*
IEEE Std 802.3cn-2019 Physical Layers and Management Parameters for 50 Gb/s, 200 Gb/s, and 400 Gb/s Operation over Single-Mode Fiber	7 November 2019	**David J. Law,** *Working Group Chair* **Adam Healey,** *Working Group Vice-Chair* **Pete Anslow,** *Working Group Secretary and Task Force Editor-in-Chief* **Steven B. Carlson,** *Working Group Executive Secretary* **Valerie Maguire,** *Working Group Treasurer* **John D'Ambrosia,** *Task Force Chair*
IEEE Std 802.3cg-2019 Physical Layers Specifications and Management Parameters for 10 Mb/s Operation and Associated Power Delivery over a Single Balanced Pair of Conductors	7 November 2019	**David J. Law,** *Working Group Chair* **Adam Healey,** *Working Group Vice-Chair* **Pete Anslow,** *Working Group Secretary* **Steven B. Carlson,** *Working Group Executive Secretary* **Valerie Maguire,** *Working Group Treasurer* **George Zimmerman,** *Task Force Chair* **Valerie Maguire,** *Task Force Editor-in-Chief*
IEEE Std 802.3cq-2020 Maintenance #13: Power over Ethernet over 2 pairs	30 January 2020	**David J. Law,** *Working Group Chair* **Adam Healey,** *Working Group Vice-Chair* **Pete Anslow,** *Working Group Secretary* **Steven B. Carlson,** *Working Group Executive Secretary* **Valerie Maguire,** *Working Group Treasurer* **Chad Jones,** *Task Force Chair* **Lennart Yseboodt,** *Task Force Editor-in-Chief*
IEEE Std 802.3cm-2020 Physical Layer and Management Parameters for 400 Gb/s over Multimode Fiber	30 January 2020	**David J. Law,** *Working Group Chair* **Adam Healey,** *Working Group Vice-Chair* **Pete Anslow,** *Working Group Secretary* **Steven B. Carlson,** *Working Group Executive Secretary* **Valerie Maguire,** *Working Group Treasurer* **Robert Lingle, Jr.,** *Task Force Chair* **Jonathan P. King,** *Task Force Editor-in-Chief, Phase 1* **Jonathan D. Ingham,** *Task Force Editor-in-Chief, Phase 2*
IEEE Std 802.3ch-2020 Physical Layer Specifications and Management Parameters for 2.5 Gb/s, 5 Gb/s, and 10 Gb/s Automotive Electrical Ethernet	4 June 2020	**David J. Law,** *Working Group Chair* **Adam Healey,** *Working Group Vice-Chair* **Pete Anslow,** *Working Group Secretary, Phase 1* **Jon Lewis,** *Working Group Secretary, Phase 2* **Steven B. Carlson,** *Working Group Executive Secretary* **Valerie Maguire,** *Working Group Treasurer* **Steven B. Carlson,** *Task Force Chair* **Natalie Wienckowski,** *Task Force Editor-in-Chief*
IEEE Std 802.3ca-2020 Physical Layer Specifications and Management Parameters for 25 Gb/s and 50 Gb/s Passive Optical Networks	4 June 2020	**David J. Law,** *Working Group Chair* **Adam Healey,** *Working Group Vice-Chair* **Pete Anslow,** *Working Group Secretary, Phase 1* **Jon Lewis,** *Working Group Secretary, Phase 2* **Steven B. Carlson,** *Working Group Executive Secretary* **Valerie Maguire,** *Working Group Treasurer* **Curtis Knittle,** *Task Force Chair* **Glen Kramer,** *Task Force Vice-Chair* **Marek Hajduczenia,** *Task Force Editor-in-Chief*

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IEEE Std 802.3cr-2021 Maintenance #14: Isolation	9 February 2021	**David J. Law,** *Working Group Chair* **Adam Healey,** *Working Group Vice-Chair* **Jon Lewis,** *Working Group Secretary, Task Force Chair, and Task Force Editor* **Steven B. Carlson,** *Working Group Executive Secretary* **Valerie Maguire,** *Working Group Treasurer*
IEEE Std 802.3cu-2021 Physical Layers and Management Parameters for 100 Gb/s and 400 Gb/s Operation over Single-Mode Fiber at 100 Gb/s per Wavelength	9 February 2021	**David J. Law,** *Working Group Chair* **Adam Healey,** *Working Group Vice-Chair* **Jon Lewis,** *Working Group Secretary* **Steven B. Carlson,** *Working Group Executive Secretary* **Valerie Maguire,** *Working Group Treasurer* **Mark Nowell,** *Task Force Chair* **Gary Nicholl,** *Editor-in-Chief*
IEEE Std 802.3cv-2021 Maintenance #15: Power over Ethernet	9 May 2021	**David J. Law,** *Working Group Chair* **Adam Healey,** *Working Group Vice-Chair* **Jon Lewis,** *Working Group Secretary and Task Force Editor-in-Chief* **Steven B. Carlson,** *Working Group Executive Secretary* **Valerie Maguire,** *Working Group Treasurer* **Chad Jones,** *Task Force Chair*
IEEE Std 802.3ct-2021 Physical Layers and Management Parameters for 100 Gb/s Operation over DWDM Systems	16 June 2021	**David J. Law,** *Working Group Chair* **Adam Healey,** *Working Group Vice-Chair* **Jon Lewis,** *Working Group Secretary* **Steven B. Carlson,** *Working Group Executive Secretary* **Valerie Maguire,** *Working Group Treasurer* **John D'Ambrosia,** *Task Force Chair* **Tom Issenhuth,** *Task Force Editor-in-Chief*
IEEE Std 802.3cp-2021 Bidirectional 10 Gb/s, 25 Gb/s, and 50 Gb/s Optical Access PHYs	16 June 2021	**David J. Law,** *Working Group Chair* **Adam Healey,** *Working Group Vice-Chair* **Jon Lewis,** *Working Group Secretary* **Steven B. Carlson,** *Working Group Executive Secretary* **Valerie Maguire,** *Working Group Treasurer* **Frank Effenberger,** *Task Force Chair* **Duane Remein,** *Task Force Editor-in-Chief, Phase 1* **Yuanqiu Luo,** *Task Force Editor-in-Chief, Phase 2*

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Abbas, Fazal
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Abramson, David
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Adams, Martin
Adriaennsens, Luc
Aekins, Rob
Aelmore, Don
Agarwal, Puneet
Agata, Akira
Agazzi, Oscar
Agee, John R.
Aggarwal, Nand
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Ahrens, Paul
Akasaka, Youichi
Akella, Vish
Alavi, Reza
Albrecht, Alan
Albright, Keith
Alderrou, Don
Alexander, Jan
Alexander, Thomas
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Allard, Michel
Allen, Brad
Allen, David
Allen, John
Alon, Zehavit
Alping, Arne
Altman, Michael
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Ambrose, Andrew
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Amin, Nitish
Amleshi, Peerouz
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An, Hongming
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Anderson, Arlan J.
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Anderson, Jon
Anderson, Paul
Anderson, Richard
Anderson, Stephen D.
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Andrae, Stefan
Andresen, Jack S.
Andrewartha, J. Michael
Angha, Ali
Anslow, Peter
Antz, Ekkehard
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Arai, Ken-ichi
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Armstrong, Mike
Armstrong, Susie
Arnold, Brian
Aronson, Joseph
Aronson, Lewis B.
Aronson, Simcha
Arst, Phil L.
Artman, Doug
Arunarthi, Venkat
Asmussen, Jes
Astorg, Jean-Pierre
Ataee, Mehran
Atias, Ilan
Augusta, Steve
Auld, Phil
Ayandeh, Siamack
Azadet, Kameran
Babanezhad, Joseph N.
Babenko, Oleksandr
Babla, Chet
Baca, Richard
Bachand, Gerard E.
Baden, Eric
Baek, Kwang-Hyun
Baggett, Tim
Bains, Amrik
Bala, Guna
Balakrishnam, R. V.
Balasubramanian, Koussalya
Balasubramanian, Vittal
Baldman, Andy
Baldwin, Thananya
Balmer, Keith
Balsby, Mogens Cash
Bandali, Bruce
Bandyopadhyay, Jaya

Barazande-Pour, Majid
Barbero, Fernando
Barkan, Ozdal
Barker, Ian
Barnea, Eyal
Barnett, Barry
Barnette, Jim
Barr, David
Barrass, Hugh
Barrett, Bob
Barrick, Scott
Bartur, Meir
Barzilai, Yoram
Bates, Stephen
Baumer, Howard
Baumgartner, Steven
Beaudoin, Denis
Beauregard, Francois
Beck, Michaël
Beckwith, Jonathan
Beia, Christian
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Beliaev, Alexei
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Bennett, Michael
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Bergmann, Ernest E.
Bergstrom, April
Berman, David J.
Bernstein, Gary
Bertoldi, Roberto
Beruto, Piergiorgio
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Bhugra, Harmeet
Bialkowski, Jan
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Birenbaum, Larry
Bisberg, Jeff E.
Bliss, William
Bo, Gao
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Bohrer, Mark
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Booth, Paul
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Bourque, David
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Bowers, Richard
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Bradshaw, Peter
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Brandner, Rudolf
Brandt, David
Braun, Ralf-Peter
Brehove, Richard S.
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Bridgers, Vince
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Brikovskis, Rhett
Brill, Charles
Brillhart, Theodore
Brink, Robert D.
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Brooks, Rick
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Brown, Jack
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Brown, Thomas
Brownlee, Phillip
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Brunn, Brian
Brunner, Robert
Brychta, Michal
Buck, Steve F.
Buckman, Lisa
Bugg, Mark
Bullock, Chris
Bulnes, Juan
Bunch, Bill
Burgess, James
Burrell, Gary
Burton, Scott
Busse, Robert A.
Bustos Heredia, Jairo
Butler, Thomas T.
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Bynum, Roy
Cady, Ed
Cafiero, Luca
Caggioni, Francesco
Cagle, John
Cain, Jeffrey C.
Calbone, Anthony
Calderon, Juan-Carlos
Caldwell, Donald
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Campbell, Robert R.
Canavese, Luigi
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Carlson, Craig
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Carnine, Dan
Carroll, J. Martin
Carter, J. Scott
Carty, Clark
Casher, Patrick
Castellano, Andrew
Cates, Ron
Catlin, Jeffrey D.
Chabot, Craig
Chacon Simon, Geoffrey
Chadha, Mandeep
Chalupsky, David
Champion, Bruce
Chang, Edward
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Chang, Edward S.
Chang, Frank
Chang, Fuhlim
Chang, Jacky
Chang, Justin
Chang, Kiwon
Chang, Luke
Chang, Samuel
Chang, Sun-Hyok
Chang, Xin
Chantrell, Thomas
Charney, Howard
Chen, Chan
Chen, Chung-Jue
Chen, David
Chen, Jian
Chen, Xiaopeng
Chen, Zinan (Nan)
Cheng, Linda
Cheng, Weiying
Cheng, Wheling
Cheong, Kok-Wui
Cherubini, Giovanni
Cherukuri, Rao
Chiang, Albert
Chin, David
Chin, Hon Wah
Chini, Ahmad
Cho, Jae hun
Choi, Francis
Choi, Jin-Seek
Chopra, Rahul
Chou, Joseph
Choudhury, Golam
Chow, Jacky
Chow, Kuen
Choy, Henry
Christ, Chris
Christ, Jacques
Chu, George
Chuang, Keng Hua
Chung, Hwan-Seok
Chzh, Yue-Der
Cideciyan, Roy
Claessen, Albert
Claessen, Guss
Clancy, G. J.
Clark, Brice
Clarke, Susan Roden
Claseman, George
Cobb, Terry
Coden, Michael
Coffey, Kelly B.
Cohen, Larry
Cole, Christopher R.
Coleman, Doug
Colla, Régis
Cone, Kevin
Congdon, Herbert V.
Congdon, Paul
Conlon, Patrick
Connor, Don
Conroy, Keith
Conte, Robert
Cook, Charles I.
Cooper, Ronald J.
Cooper, Stephen
Coote, Neil
Cornejo, Edward
Crane, Ronald
Cravens, George
Crayford, Ian
Creigh, John
Crepin, J. Francois
Cronin, Bill
Cross, Peter
Cross, Richard
Cruikshank, Brian
Crupnicoff, Diego
Cuesta, Emilio
Cui, Kai
Cullerot, David
Cullin, Chris
Cunningham, David G.
Curcio, Joe
Curtis, Robert A.
Cushin, Simon
Dabiri, Dariush
Dahlgren, Robert
Dahmouh, Saleem
Dai, Eugene
Dai, Shaoan
Daido, Fumio
Daines, Bernard
Daines, Kevin Q.
Dallesasse, John
Dalmia, Kamal
D'Ambrosia, John
Damouny, Nabil
Dance, Rupert S.
Darby, Mark
Darling, Mike
Darshan, Yair
Dartnell, Peter
Datta, Subrata
Davidson, John
Davies, David
Davis, Edward

Dawe, Peter
Dawe, Piers J. G.
Dawson, Fred
De Andrea, John
de Graaf, Kathryn
de Grace, Gerald
de la Garrigue, Michael
De Leon, Moshe
Deandrea, John
Dearing, Mark
Debbasch, Bernard O.
deBie, Michael
Debiec, Tom
DeCramer, John
Dedic, Ian
Dedrick, Joel
Deffley, Steve
Delaney, Dave
De-Leon, Moshe
Delveaux, William
DeMent, Ralph
den Besten, Gerrit
DeNicholas, Joe
DeNicolo, Tazio M.
Desai, Sanjay
Desanti, Claudio
Desaulniers, Peter
Devon, Mark
Dhawan, Sanjay
Di Minico, Chris
Diab, Wael William
Diamond, Patrick
DiBiaso, Eric
Dickens, Erik
Dickinson, John
Dietz, Bryan
Dillard, John
Dillow, Daniel
Diminico, Christopher
Dineen, Thomas J.
Ding, Zhemin
Dingman, Sean
Dinh, Thuyen
Dittler, Hans Peter
Djahanshahi, Hormoz
Dobson, Hamish
Dolfi, David W.
Donahue, Curtis
Donhowe, Mark
Dorris, Hank (H. N.)
Dove, Daniel
Doyle, James
Draper, Daniel S.
Dredge, Scott
Drever, Brian
Dreyer, Steve
Dring, John
Du, Liang
Dube, Kathryn
Dudek, Michael
Duelk, Marcus
Duer, Nick
Dugan, Richard
Duley, Raymond S.
Dunbar, Linda
Dupuis, Joseph E.
Dupuis, Marc R.
Dwelley, David
Easley, J. Craig
Eastman, Paul
Ebeling, Jeff
Ecclesine, Peter
Eckert, Edward J.
Eddings, Clay
Edholm, Phil
Edsall, Tom
Edwards, Dean
Edwards, Gareth
Effenberger, Frank J.
Egan, John
Eiliya, Herman
Eisler, George
Eitel, Cornelia
Elbakoury, Hesham
Elhøj, Martin
Elie-Dit-Cosaque, David
Elliff, Kevin M.
Elswick, Michael
Ely, Paul “Skip”
Ely, Richard
English, Kent
Ennis, Gregory
Enrico, Gianfranco
Ensign, Brian S.
Erba, Simone
Erbacher, Norman
Esmailian, Tooraj
Esser, Nick
Essig, Daniel
Estes, David
Estrin, Judith
Everitt, Jim
Evitts, Steve
Ewen, John F.
Eyal, Massad
Fabbri, Richard
Fallahi, Siavash
Faller, Josef
Fan, Dawei
Fanfoni, Sabina
Farhoodfar, Arash
Farjad, Ramin
Farkas, Janos
Farley, Rebecca
Fathi Moghadam, Borhan
Fedyk, Donald
Feist, Eldon
Feldman, Daniel
Feldman, Shahar
Feng, Dongning
Feng, Feifei (Felix)
Ferdun, Severn
Ferrant, Jean-Loup
Ferretti, Vincent
Feuerstraeter, Mark
Feyh, German
Fiedler, Jens
Fiere, Julien
Fife, James
Fifield, Dave
Figueira, Norival
Figueroa, Juan
Finch, Robert G.
Finn, Norman
Firoozmand, Farzin
Fischer, David
Fischer, Thomas
Fitzgerald, John
Flatman, Alan
Flickinger, Steve
Folkens, Norbert
Folting, Christian G.
Forbes, Harry
Ford, Brian
Franchuk, Brian
Fransen, Richard
Fraser, Roger
Frazier, Howard M.
Frazier, Robert
Freitag, Ladd
Friedenbach, Ken
Fritsche, Matthias
Fritz, Scott
Frojdh, Krister
Froke, Richard
Fromm, Ingrid
Frosch, Richard
Fu, Hongyan
Fu, Shiyong
Fuess, Judy
Fujimoto, Yukihiro
Fukuoka, Atsuhisa
Fukuoka, Takashi
Fuller, John
Furlong, Darrell
Furlong, Michael
Gable, Mel
Gaglianello, Robert D.
Gaither, Justin
Galin, Robert
Gandhi, Sharad
Gandy, Tom
Ganga, Ilango S.
Gangopadhya, Robin
Gao, Xiao Ming
Garavaglia, Andrea
Gardenhour, Clete
Gardner, Andrew
Gardner, Mike
Garner, Geoffrey M.
Gauthier, Claude
Geng, Lemon
Gentry, Denton
George, John
Gerhardt, Floyd H.
Gerhardt, Keith
Gerhold, Mark
Ghanwani, Anoop
Ghiasi, Ali
Ghoshal, Sajol
Giannakopoulos, Dimitrios
Giaretta, Giorgio
Gilliland, Pat
Ginis, George
Glanzner, Martin
Goergen, Joel
Goetz, Franz
Goetzfried, Volker
Golbert, Adi
Golden, Glenn
Goldis, Moty
Goldman, Matthew
Gong, Zhigang
Goodman, Timothy D.
Goody, Steve
Gore, Brandon
Gorshe, Steven
Goswami, Sanjay
Goto, Hideki
Gottron, Jens
Graba, James
Graber, Steffen
Graham, Rich
Granger, Russ
Grann, Eric B.
Grasmehr, Tom
Grau, Olaf
Gray, C. Thomas
Gray, Eric
Green, Larry
Green, Martin
Greenlaw, Jonathan E.
Gregory, Bryan
Grenier, Richard
Grewal, Karanvir
Grimwood, Michael R.
Grivna, Edward
Grow, Robert M.
Gubow, Martin
Gudz, Robert
Gulle, Andreas
Gulukota, Karunakar
Gummalla, Ajay
Gumpertz, Richard
Gundubogula, Sudhakar
Gunther, Craig
Guo, Bin
Guo, Yong
Gupta, Sandeep
Gupta, Sudhir
Gupta, Tanmay
Gusat, Mitch
Gustafsson, Jonas
Gustlin, Mark
Gyugyi, Paul J.
Gyurek, Russ
Haas, Steven
Hackert, Michael
Haddad, Tariq
Haddock, Stephen
Haile-Mariam, Atikem
Hajduczenia, Marek
Hakimi, Sharam
Hallatt, Clive
Hamano, Hiroshi
Hamidy, Farid
Hamilton, Kevin
Hammond, Bernie
Hanigal, Benny
Hankins, Greg

Hanna, Charaf
Hanna, G. Y.
Hansen, Chris
Hansen, Johannes
Hansen, Mogens
Hanson, Del
Haran, Onn
Hariti, Hacene
Harkins, Guy
Harper, Milton C.
Harshbarger, Doug
Hartley, G. R.
Hartmann, Stephan
Haser, Alexandra
Hashimoto, Tomohiro
Hasley, Lloyd
Hassoun, Marwan
Hatamian, Mehdi
Hatfield, W. B.
Hatley, Tom
Haughey, Stephen
Haung, Haw Ming
Hayakawa, Akinori
Hayashi, Takehiro
Hayden, Kirk
Hayek, Claude
Haynes, Hayden
Hays, Robert
Hayssen, Carl G.
Hazarika, Asif
He, Xiang
Healey, Adam
Heath, Jeffrey
Hecht, Gaby
Heck, Howard
Heckroth, Jim
Heegard, Chris
Hegde, Gopal
Hegde, Rajmohan
Heidasch, Wolfgang
Heldman, Ronen
Helster, David
Hendel, Ariel
Hendel, Itzik
Hennenfent, Susan
Herman, Carl
Herrity, Ken
Herve, Pierre
Hess, David
Hesson, James H.
Hickey, John
Hicks, Chip
Hidaka, Yasuo
Higuchi, Tetsuya
Hiironen, Olli-Pekka
Hill, John
Hill, Tricia
Hindi, Sammy
Hingston, William
Hinrichs, Henry
Hinzel, David
Hirai, Riu
Hirano, Kengo
Hirase, Hidenari
Hirth, Ryan
Hochstedler, Charlie
Hoffner, Charles
Hoge, Jay
Hogenmueller, Thomas
Hoglund, David
Holden, Brian
Hoover, Bryan
Hopkins, Gregory
Hopwood, Keith
Horner, Rita
Horowitz, Steven E.
Horrmeyer, Bernd
Horvat, Michael
Hotta, Yoshifumi
Hou, Victor
Hronik, Stanley
Hsiaw, Henry
Hsu, Jacob
Hua, Rui
Huang, Fred
Huang, Liang-wei
Huang, Xi
Huang, Xingang
Huber, Thomas
Hudson, Charles
Hudson, Chuck
Hudson, Todd
Hughes, Michael
Hurwitz, Walter K.
Huszak, Gergely
Huumala, Dean
Huynh, Thong
Hyakutake, Yasuhiro
Hyer, David W.
Ichino, Haruhiko
Ikeda, Hiroki
Ilyadis, Nicholas
Ingham, Jonathan
Ingrassia, Alessandro
Innis, James
Insler, Romain
Irwin, Scott
Ishibe, Kazuhiko
Ishida, Osamu
Isono, Hideki
Issenhuth, Tom
Ito, Hiroaki
Iwadate, Hirotake
Iwaoka, Mitsuru
Jackson, Kenneth
Jackson, Steve
Jacobsen, Krista S.
Jacobson, Michael R.
Jacobson, Mike
Jadeja, Ajit
Jaeger, John M.
Jaffa, Brent
Jain, Raj
Jain, Rajeev
James, David V.
Jang, Eric
Jang, Woo-Hyuk
Janshego, Stephen
Jedwab, Jonathan
Jeffree, Tony
Jelatis, George D.
Jensen, Ernie
Jetzt, John
Jewell, Jack L.
Jha, Pankaj
Jiang, Hongtao
Jiang, Jessica Xin
Jiang, Qiaofeng
Jiang, Wenbin
Jie, Ni
Jimenez, Andrew C.
Jin, Robert
Joh, Clarence
Johas Teener, Michael D.
John, Richard
Johnson, Donald C.
Johnson, Howard
Johnson, John
Johnson, Mize
Johnson, Scott
Jolly, Cristopher
Jones, Chad
Jones, Nick
Jones, Peter
Jones, William W.
Jonsson, Ragnar
Jonsson, Ulf
Joo, Bheom-Soon
Joo, Seong-Soon
Jordan, Anthony
Jørgensen, Thomas K.
Joseph, Antony
Jover, Juan
Juhász, Imre
Julyan, Jason
Jung, Kwi-Yung
Junkers, Dieter W.
Jury, Paul
Kabal, David
Kabra, Lokesh
Kadambi, Jayant
Kadry, Haysam
Kagami, Manabu
Kairis, Vic
Kaku, Shinkyo
Kal, Omer
Kalkunte, Mohan
Kalla, Amrit
Kalman, Joel S.
Kaltenbach, Matt
Kamat, Puru
Kamino, John
Kao, Ron
Kaplan, Hadriel
Kaps, Rainer
Karam, Roger
Karandikar, Abhay
Kardontchik, Jaime
Kareti, Upen
Kasai, Yuji
Kasapi, Athanasios
Kasey, Allen
Kashyap, Prakash
Kasturia, Sanjay
Kato, Toyoyuki
Katz, Harold W.
Katzenberg, Boris
Kaufman, Dave
Kaul, Sumesh
Kawahara, Keisuke
Kawatsu, Yasuaki
Kayser, Kevin
Keasler, William
Keeley, James
Keen, Hal
Kellam, Paul
Kelly, N. Patrick
Kelsen, Michael
Kennedy, Joe
Kenny, John J.
Kesler, Scott
Kesling, Dawson
Khermosh, Lior
Khuu, Tuan
Kidwell, Gary
Kikuta, Tomohiro
Kilcrease, Keti
Kilgore, Bob
Kim, Chan
Kim, Dae Young
Kim, Inho
Kim, Jin H.
Kim, Kihong (Joshua)
Kim, Seung-Hwan
Kim, Su-Hyung
Kim, Yongbum
Kimber, Eric
Kimber, Mark
Kimmitt, Myles
Kimpe, Marc
Kimura, Mitsunobu
Kincaid, John
Kind, Bill
King, Jonathan P.
King, Neal
Kinnard, Brian
Kinningham, Alan
Kipp, Scott G.
Kish, Paul
Kitayama, Tadayoshi
Klaus, Andrew
Klein, Philippe
Klempa, Michael
Kliger, Avi
Knight, Richard
Knittle, Curtis
Ko, Dylan
Ko, Mike
Kobayashi, Hiroshi
Kobayashi, Shigeru
Kobayashi, Shoukei
Kochuparambil, Elizabeth
Kocsis, Sam
Koczwara, Wojciech
Kodama, Satoshi
Koehler, Daniel
Koeman, Henriecus
Koenen, David J.
Koenig, Christine
Koeppendoerfer, Erwin

Kohl, David E.
Kojima, Keisuke
Kola, Srinivas
Kolesar, Paul F.
Koller, Steven
Kolze, Tom
Konda, Kishan Rao
Kondo, Taiji
Kono, Masashi
Kooistra, David
Koonce, Derek
Kopera, Paul
Koppermueller, Daniel
Kosanovich, Keith
Koshevoy, Leonid
Kosilek, Josef
Kota, Kishore
Kotas, Donald E.
Kous, William F.
Koyama, Tetsu
Kozaki, Seiji
Kozilek, Josef
Koziuk, Glen
Kramer, Glen
Krent, Daniel
Krieger, Olaf
Krishnamurthy, Subi
Krolner, Lars Paul
Kropp, Joerg-R
Kropveld, Simon
Kubovcik, George
Kumada, Taketo
Kumar, C.
Kumar, Pankaj
Kumar, Vinod
Kummert, Ted
Kundu, Aniruddha
Kung, David
Kuo, Albert
Kuo, Jeffrey
Kurcharczyk, David
Kurker, Christopher
Kuroda, Yasuyuki
Kurokawa, Hidetsune
Kusano, Toshihiko
Kuyt, Gerard
Kvist, Bengt
Kwan, Bruce
Kwentus, Alan
LaBarre, Lee
Labib, Adel Henry
LaCerte, Richard
Lackner, Hans
Lahat, Gadi
Laihonen, Kari
Lakshmikantha, Ashvin
Lamb, Lowell D.
Lambrecht, Frank
Lamers, Lawrence J.
Lander, Erik
Landry, D. Matthew
Lane, Brett
Lane, William
Langlands, Gordon
Langston, Daun
Lapak, Jeffrey
Lare, Ed
Lari, Ferdinando
Larios, Efstathios
Larsen, Loren
Larsen, Wayne
Larson, Donald C.
Latchman, Ryan
Lau, Tony
Laubach, Mark
Lauck, Tony
LaVigne, Bruce
Law, David J.
Lawrence, Eric
Lawton, Michael
Laynor, John
Le Cheminant, Greg
Le Goff, Yannick
Le, My
Le, Quang
Lebar, Michael
LeCheminant, Greg
Lee, Arthur
Lee, Changoo
Lee, Chun-Tsung
Lee, Dong-Soo
Lee, Eugene
Lee, Fu-Ho
Lee, Han Hyub
Lee, Hyeong Ho
Lee, Jack
Lee, June Hee
Lee, Kyusang
Lee, Michael
Lee, Sylvanus
Lee, Wesley
Lee, Ying
Lefebvre, Vincent
Lefkowitz, Richard
Lehr, Amir
Leizerovich, Hanan
Lemoff, Brian E.
Lemon, John
Lena, Richard
Lenkisch, Andreas
Leo, Lisa
Leonowich, Robert H.
Lerer, Michael
Lertniphonphun, Warayot
Leshem, Amir
Lessard, Andre
Leung, Raymond W. K.
Leung, Tommy
Levin, Alex
Levy, Avinoam
Lewing, Van
Lewis, David
Lewis, Jon
Lewis, Richard
Li, David
Li, Lei
Li, Mike-Peng
Li, Shaohua
Liang, Sam
Lichtenegger, Thomas
Lidinsky, William P.
Lim, Jane
Lim, Seyoun
Limb, John O.
Lin, Alex
Lin, Chan-De
Lin, George
Lin, Ray
Lin, Ru Jian
Linde, Yoseph L.
Lindquist, Wayne
Lindsay, Thomas A.
Lindsey, Laurie
Lingle, Robert
Lipshteyn, Marina
Liu, Alexander
Liu, Cathy
Liu, Chang-Chi
Liu, Dekun
Liu, Fengkun
Liu, Hai-Feng
Liu, James
Liu, Karen
Liu, Zhenyu
Livingston, William D.
Lo, William
Lobel, Martin
Lockyer, Terry
Logan, Hugh
Lokhandwala, Moiz
Lomelino, Larry
Long, Leland
Lorei, Sherry J.
Lotfi, Jahan
Lott, James A.
Lou, Dennis
Loughry, Don
Love, Bob
Loveless, Rick
Lozano, Raul
Lu, Ken
Lu, Yuchun
Lucas, Fred A.
Lucas, James A.
Lukacs, Miklos
Lum, Meilissa R.
Luo, Yuanqiu
Luque, Andy J.
Lusted, Kent
Lutz, Sharon
Lynch, Jeffrey
Lynn, Mark
Lynskey, Eric R.
Lyon, Ian
Lysdal, Henning
Lyubomirsky, Ilya
Mace, Gael
Mack-Crane, Ben
MacLeod, Brian
MacLeod, Kenneth
Madani, Sam
Madgar, Zahy
Magee, Anthony
Maggiolino, Joseph
Magliozzi, Randall
Maguire, Valerie
Maislos, Ariel
Makarem, Rabih
Maki, Jeffery J.
Malicoat, David
Malkemus, James
Malkiman, Yonatan
Mallette, Edwin
Malpass, Trey
Maltbie, Daniel
Mandin, Jeff
Mangin, Jim
Maniloff, Eric
Marchetti, Bob
Marchitto, Luciano
Mariotti, Carlo
Marques, Flavio
Marris, Arthur
Marsh, Charles
Marshall, Robert
Marsland, Robert A.
Martin, Arlen
Martin, Arlon
Martin, David W.
Martin, Jeff
Mash, Chris
Mashiko, Koichiro
Mason, Scott
Masuda, Takeo
Matheus, Kirsten
Mathey, Thomas
Matni, Ziad Albert
Matoglu, Erdem
Matola, Laurence
Matsuda, Naoki
Matsuda, Shougo
Matsuo, Hideyuki
Matthys, Bob
Matz, Bret A.
Mayer, Bob
Mazor, Joseph
Mazzini, Marco
McCallum, David S.
McCammon, Kent
McCarron, Philip L.
McCarthy, Frank
McCarthy, Mick
McClay, C. Phillip
McClellan, Brett
McClellan, Kelly
McConnell, Mike
McCool, John
McCormack, Michael S.
McCoy, Gary
Mcdermott, Thomas
McDonald, Andy
McDonough, John
McDowell, Jerry
McGrath, Jim
McGugan, Chris
McGuire, Alan
McIntosh, James
McKechnie, Keith
McMaster, Donna
McMillan, Larry

McNarney, Martin
McShane, Tim
McSorley, Greg
McVey, James D.
Measor, Grahame
Medina, Marcel
Meghelli, Mounir
Mehta, Mukesh
Mei, Richard Y.
Meier, Wolfgang
Melendy, Vince
Mellitz, Richard
Menachem, Avraham
Menuchery, Menucher
Merrill, Mark
Messenger, John
Metzger, Jo Beth
Metzger, Steve
Meyer, Jeffrey
Meyouhas, Yossi
Mezer, Amir
Mi, Guangcan
Miao, Tremont
Micallef, Joseph
Michaelis, Thomas
Michalowski, Richard
Mick, Colin
Miguelez, Phil
Milbury, Martin R.
Millar, Jim
Miller, Bruce D.
Miller, C. Kenneth
Miller, Larry D.
Miller, Martin
Misek, Brian
Mizrahi, Jacob (Kobi)
Mlinarsky, Fanny
Moattar, Reza
Moeller, Merrick
Moffitt, Bryan
Mohamadi, Fred
Mohammadian, Ardeshir
Mohl, Dirk S.
Molle, Mart L.
Mompoint, Ray
Monson, John
Montenegro, Gabriel
Montojo, Juan
Montreuil, Leo
Montstream, Cindy
Mooney, Paul
Moore, Charles
Moore, Paul B.
Moore, Robert
Moorwood, Andy
Mora, Matthew
Morales, Octavio
Mori, Kazuyuki
Moritake, Toshiyuki
Moriwaki, Shohei
Morrell, Robert L.
Morris, John
Mortonson, Robert
Moseley, Simon
Moses, Jack
Moustakas, Steven
Mueller, Harald
Mueller, Thomas
Mueller, Wayne A.
Muir, Robert
Muir, Ron
Mukherjee, Shankar
Muller, Shimon
Multanen, Eric
Munson, Carrie
Murakami, Ken
Murphy, Denis
Murphy, Sean
Murphy, Thomas
Murray, Brian
Murray, Dale
Murthy, Narayan
Murthy, Samba
Murty, Ramana
Muscat, Angela
Musk, Robert
Muth, Jim
Muyshondt, Henry
Nachman, Yaron
Nadeau, Gerard
Nadolny, James
Nagahori, Takeshi
Naganuma, Ken
Naidu, Hari
Nakagawa, Hideki
Nakamine, Wendell
Nakamoto, Edward
Nakamura, Karl
Nariya, Makoto
Nazari, Nersi
Neblett, W. P.
Nedellec, Erwan
Neer, Jay
Nelson, Darcy
Nelson, James
Nelson, Kristian
Nering, Raymond
Neulinger, Christian
Neveux, Paul
New, Anthony
Nguyen, Trung
Nguyenphu, Thinh
Nicholas, Henry T.
Nicholl, Gary
Nicholl, Shawn
Nicholson, Larry
Nielsen, Allan
Nikolich, Paul
Nim, David
Nishida, Glenn
Nishihara, Susumu
Nishimura, Shinji
Noh, George
Nojima, Kazuhiro
Nolan, John
Nolish, Kevin
Noll, Kevin
Nomura, Takumi
Nootbaar, Michael
Nordin, Ronald
Norton, Bob
Noseworthy, Bob
Nouri, Ahmad
Nowell, Mark
Oakley, Ivan
Obara, Satoshi
Oberstar, John
O'Connor, J. Michael
Ofelt, David
Oganessyan, Gourgen
Ogura, Ichiro
Oh, Stephen
O'Hara, Steven
Ohlén, Peter
Ohni, Josef
Ojha, Raj
Okabe, Ryo
Okada, Mitsuji
Oksman, Vladimir
Oliveira, Guy P.
Oliver, Chris
Oliver, Lloyd
Olsen, David
Olsson, Bengt-Erik
Oltmanns, Mike
O'Mahony, Barry
OMathuna, Padraig
Omori, Kumi
Onodera, Keith
Ooka, Toshio
Orlik, Philip
O'Rourke, Aidan
Ossman, Valy
Otaka, Akihiro
O'Toole, Michael
O'Toole, Tony
Ouellette, Michel
Oughton, George
Oulundsen, George
Overs, Pat
Ozawa, Kazuyuki
Pace, Paul
Pace, Robert R.
Palanzo, Charles
Palkert, Thomas
Pan, Hui
Pandey, Sujan
Panguluri, Sesha
Pannell, Donald
Panos, Bill
Papandrea, Gabriel D.
Pardo, Carlos
Parhi, Keshab K.
Park, Chul Soo
Park, Jisang
Park, Moon
Parker, Jim
Parnaby, Gavin
Parruck, Bidyut
Parsons, Earl
Parsons, Elwood T.
Parsons, Glenn W.
Parthasarathy, Vasu
Paslaski, Joel
Pate, Jerry
Patel, Bhavesh
Patel, Dipak M.
Patel, Piyush
Patel, Pravin
Patel, Sandeep
Patel, Shashi
Pathak, Vijay
Patoka, Martin
Paul, Aidan
Paul, Prasun K.
Pavlovsky, Alex
Payne, John
Peatfield, Tony
Peck, Anthony
Peers, Neil
Peeters-Weem, Jan P.
Peker, Arkadiy
Pelissier, Joseph
Pelster, Jim
Peng, Wanquan
Peng, Y. Lisa
Pepeljugoski, Petar
Pepper, Gerald
Perez De Aranda Alonso, Rubén
Perkins, Drew D.
Perrie, Randy
Pesavento, Gerry
Peters, Michael
Peters, William R.
Peterson, Brian
Peterson, David
Petrilla, John
Pham, Phong
Phanse, Abhijit
Phinney, Thomas L.
Picard, Jean
Piede, David
Piehler, David
Pierce, Roy
Pieters, Robert
Pietilainen, Antti
Pietsch, Christian
Pillai, Velu C.
Pimpinella, Rick
Pischl, Neven
Pittala, Fabio
Pitzer, Armin
Pivonka, Ed
Plunkett, Timothy R.
Poehmerer, Rainer
Pohl, Christopher
Poisner, David
Pondillo, Peter
Popescu, Petre
Porat, Hayim
Porter, Jeff
Posthuma, Carl R.
Poston, Bill
Potter, David
Potterf, Jason
Pottratz, Kimberly
Powell, Scott R.
Powell, William
Pozzebon, Dino
Prat, Gideon

Prediger, Bernd
Preis, Roland
Printis, Robert S.
Pritikin, Max
Prodan, Richard
Proffitt, John
Pryor, Steve
Qian, Haoli
Quackenbush, William
Quast, Holger
Quigley, Tomas J.
Quilici, Jim
Quinn, Patrick W.
Quirk, John
Rabinovich, Rick
Radcliffe, Jerry K.
Rado, Ted
Raghavan, Sreen
Rahman, Saifur
Rahman, Syed
Rahn, Jurgen
Rajabzadeh, Mohammad
Rajkotia, Purva
Raju, Parthasarathy
Rakib, Shlomo
Raman, Naresh
Ramelson, Brian
Ramsey, Brian J.
Ran, Adee
Randall, Karen
Randle, William
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Introduction

This introduction is not part of IEEE Std 802.3-2022, IEEE Standard for Ethernet.

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 802.3ba™-2010).

The half duplex Media Access Control (MAC) protocol specified in IEEE Std 802.3-1985 is Carrier Sense Multiple Access with Collision Detection (CSMA/CD). This MAC protocol was key to the experimental Ethernet developed at Xerox Palo Alto Research Center, which had a 2.94 Mb/s data rate. Ethernet at 10 Mb/s was jointly released as a public specification by Digital Equipment Corporation (DEC), Intel and Xerox in 1980. “Local Area Networks: Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications” was approved as an IEEE standard by the IEEE Standards Board in 1983 and subsequently published in 1985 as IEEE Std 802.3-1985. Since 1985, new media options, new speeds of operation, and new capabilities have been added to IEEE Std 802.3. A full duplex MAC protocol and the ability to use an EtherType to specify the MAC client protocol were added in 1997. The title was changed to Standard for Ethernet with the 2012 Revision.

Some of the major additions to IEEE Std 802.3 are identified in the marketplace 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 802.3z™ added 1000 Mb/s operation (also called Gigabit Ethernet), IEEE Std 802.3ae™ added 10 Gb/s operation (also called 10 Gigabit Ethernet), IEEE Std 802.3ah™ specified access network Ethernet (also called Ethernet in the First Mile) and IEEE Std 802.3ba added 40 Gb/s operation (also called 40 Gigabit Ethernet) and 100 Gb/s operation (also called 100 Gigabit Ethernet). These major additions are all now included in and are superseded by IEEE Std 802.3-2022 and are not maintained as separate documents.

At the date of IEEE Std 802.3-2022 publication, IEEE Std 802.3 was composed of the following documents:

IEEE Std 802.3-2022

Section One—Includes Clause 1 through Clause 20 and Annex A through Annex K and Annex 4A. 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 33 and Annex 22A through Annex 33A. Section Two includes management attributes for multiple protocols and speed of operation as well as specifications for providing power over twisted pair cabling for multiple operational speeds. It also includes general information on 100 Mb/s operation as well as most of the 100 Mb/s Physical Layer specifications.

Section Three—Includes Clause 34 through Clause 43 and Annex 36A through Annex 43C. Section Three includes general information on 1000 Mb/s operation as well as most of the 1000 Mb/s Physical Layer specifications.

Section Four—Includes Clause 44 through Clause 55 and Annex 44A through Annex 55B. Section Four includes general information on 10 Gb/s operation as well as most of the 10 Gb/s Physical Layer specifications.

Section Five—Includes Clause 56 through Clause 77 and Annex 57A through Annex 76A. Clause 56 through Clause 67 and Clause 75 through Clause 77, as well as associated annexes, specify subscriber access and other Physical Layers and sublayers for operation from 512 kb/s to 10 Gb/s, and defines services and protocol elements that enable the exchange of IEEE Std 802.3 format frames between stations in a subscriber access network. Clause 68 specifies a 10 Gb/s Physical Layer specification. Clause 69 through Clause 74 and associated annexes specify Ethernet operation over electrical backplanes at speeds of 1000 Mb/s and 10 Gb/s.

Section Six—Includes Clause 78 through Clause 95 and Annex 83A through Annex 93C. Clause 78 specifies Energy-Efficient Ethernet. Clause 79 specifies IEEE 802.3 Organizationally Specific Link Layer Discovery Protocol (LLDP) type, length, and value (TLV) information elements. Clause 80 through Clause 95 and associated annexes include general information on 40 Gb/s and 100 Gb/s operation as well as 40 Gb/s and 100 Gb/s Physical Layer specifications. Clause 90 specifies Ethernet support for time synchronization protocols.

Section Seven—Includes Clause 96 through Clause 115 and Annex 97A through Annex 115A. Clause 96 through Clause 98, Clause 104, and associated annexes, specify Physical Layers and optional features for 100 Mb/s and 1000 Mb/s operation over a single twisted pair. Clause 100 through Clause 103, as well as associated annexes, specify Physical Layers for the operation of the EPON protocol over coaxial distribution networks. Clause 105 through Clause 114 and associated annexes include general information on 25 Gb/s operation as well as 25 Gb/s Physical Layer specifications. Clause 99 specifies a MAC merge sublayer for the interspersing of express traffic. Clause 115 and its associated annex specify a Physical Layer for 1000 Mb/s operation over plastic optical fiber.

Section Eight—Includes Clause 116 through Clause 140 and Annex 119A through Annex 136D. Clause 116 through Clause 124 and associated annexes include general information on 200 Gb/s and 400 Gb/s operation as well as 200 Gb/s and 400 Gb/s Physical Layer specifications. Clause 125 includes general information on 2.5 Gb/s and 5 Gb/s operation. Clause 126 through Clause 130 and associated annexes include 2.5 Gb/s and 5 Gb/s Physical Layer specifications. Clause 131 provides general information on 50 Gb/s operation. Clause 132 through Clause 140 and associated annexes include 50 Gb/s Physical Layer specifications and additional 100 Gb/s, 200 Gb/s, and 400 Gb/s Physical Layer specifications.

Section Nine—Includes Clause 141 through Clause 160 and Annex 142A through Annex 154A. Clause 141 through Clause 144 and associated annexes specify symmetric and asymmetric operation of Ethernet passive optical networks over multiple 25 Gb/s channels. Clause 145 and associated annexes specify increased power delivery using all four pairs in the structured wiring plant. Clause 146 through Clause 149 and associated annexes specify Physical Layers for 10 Mb/s, 2.5 Gb/s, 5 Gb/s, and 10 Gb/s operation over a single balanced pair of conductors. Clause 150 and Clause 151 include additional 400 Gb/s Physical Layer specifications. Clause 153 and Clause 154 specify 100 Gb/s operation over DWDM channels. Clause 157 through Clause 160 include 10 Gb/s, 25 Gb/s, and 50 Gb/s bidirectional Physical Layer specifications.

Two companion documents exist, IEEE Std 802.3.1 and IEEE Std 802.3.2. IEEE Std 802.3.1 describes Ethernet management information base (MIB) modules for use with the Simple Network Management Protocol (SNMP). IEEE Std 802.3.2 describes YANG data models for Ethernet. IEEE Std 802.3.1 and IEEE Std 802.3.2 are updated to add management capability for enhancements to IEEE Std 802.3 after approval of those enhancements.

IEEE Std 802.3 will continue to evolve. New Ethernet capabilities are anticipated to be added within the next few years as amendments to this standard.

Acknowledgments

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IEEE Standard for Ethernet

Contents

IEEE Standard for Ethernet

1. Introduction

1.1 Overview

This is an international standard for Local and Metropolitan Area Networks (LANs and MANs), employing CSMA/CD as the shared media access method and the IEEE 802.3 (Ethernet) protocol and frame format for data communication. This international standard is intended to encompass several media types and techniques for a variety of MAC data rates as shown in Figure 1–1 and in 4.4.2.

1.1.1 Scope

This standard defines Ethernet local area, access and metropolitan area networks. Ethernet is specified at selected speeds of operation; and uses a common media access control (MAC) specification and management information base (MIB). The Carrier Sense Multiple Access with Collision Detection (CSMA/CD) MAC protocol specifies shared medium (half duplex) operation, as well as full duplex operation. Speed specific Media Independent Interfaces (MIIs) provide an architectural and optional implementation interface to selected Physical Layer devices (PHYs). The Physical Layer encodes frames for transmission and decodes received frames with the modulation specified for the speed of operation, transmission medium and supported link length. Other specified capabilities include: control and management protocols, and the provision of power over selected twisted pair PHY types.

1.1.2 Basic concepts

This standard provides for two distinct modes of operation: half duplex and full duplex. A given IEEE 802.3 instantiation operates in either half or full duplex mode at any one time. The term “CSMA/CD MAC” is used throughout this standard synonymously with “802.3 MAC,” and may represent an instance of either a half duplex or full duplex mode data terminal equipment (DTE), even though full duplex mode DTEs do not implement the CSMA/CD algorithms traditionally used to arbitrate access to shared-media LANs.

1.1.2.1 Half duplex operation

In half duplex mode, the CSMA/CD media access method is the means by which two or more stations share a common transmission medium. To transmit, a station waits (defers) for a quiet period on the medium (that is, no other station is transmitting) and then sends the intended message in bit-serial form. If, after initiating a transmission, the message collides with that of another station, then each transmitting station intentionally transmits for an additional predefined period to ensure propagation of the collision throughout the system. The station remains silent for a random amount of time (backoff) before attempting to transmit again. Each aspect of this access method process is specified in detail in subsequent clauses of this standard.

Half duplex operation can be used with certain media types and configurations as defined by this standard. For allowable configurations, see 4.4.2.

1.1.2.2 Full duplex operation

Full duplex operation allows simultaneous communication between a pair of stations using point-to-point media (dedicated channel). Full duplex operation does not require that transmitters defer, nor do they monitor or react to receive activity, as there is no contention for a shared medium in this mode. Full duplex mode can only be used when all of the following are true:

a) The physical medium is capable of supporting simultaneous transmission and reception without interference.
b) There are exactly two stations connected with a full duplex point-to-point link. Since there is no contention for use of a shared medium, the multiple access (i.e., CSMA/CD) algorithms are unnecessary.
c) Both stations on the LAN are capable of, and have been configured to use, full duplex operation.

The most common configuration envisioned for full duplex operation consists of a central bridge (also known as a switch) with a dedicated LAN connecting each bridge port to a single device. Repeaters as defined in this standard are outside the scope of full duplex operation.

Full duplex operation constitutes a proper subset of the MAC functionality required for half duplex operation.

1.1.3 Architectural perspectives

There are two important ways to view network design corresponding to the following:

a) *Architecture.* Emphasizing the logical divisions of the system and how they fit together.
b) *Implementation.* Emphasizing actual components, their packaging, and interconnection.

This standard is organized along architectural lines, emphasizing the large-scale separation of the system into two parts: the Media Access Control (MAC) sublayer of the Data Link Layer and the Physical Layer. These layers are intended to correspond closely to the lowest layers of the ISO/IEC Model for Open Systems Interconnection (see Figure 1–1). (See ISO/IEC 7498-1:1994.[6]) The Logical Link Control (LLC) sublayer, or other MAC client, and MAC sublayer together encompass the functions intended for the Data Link Layer as defined in the OSI model.

1.1.3.1 Architectural rationale

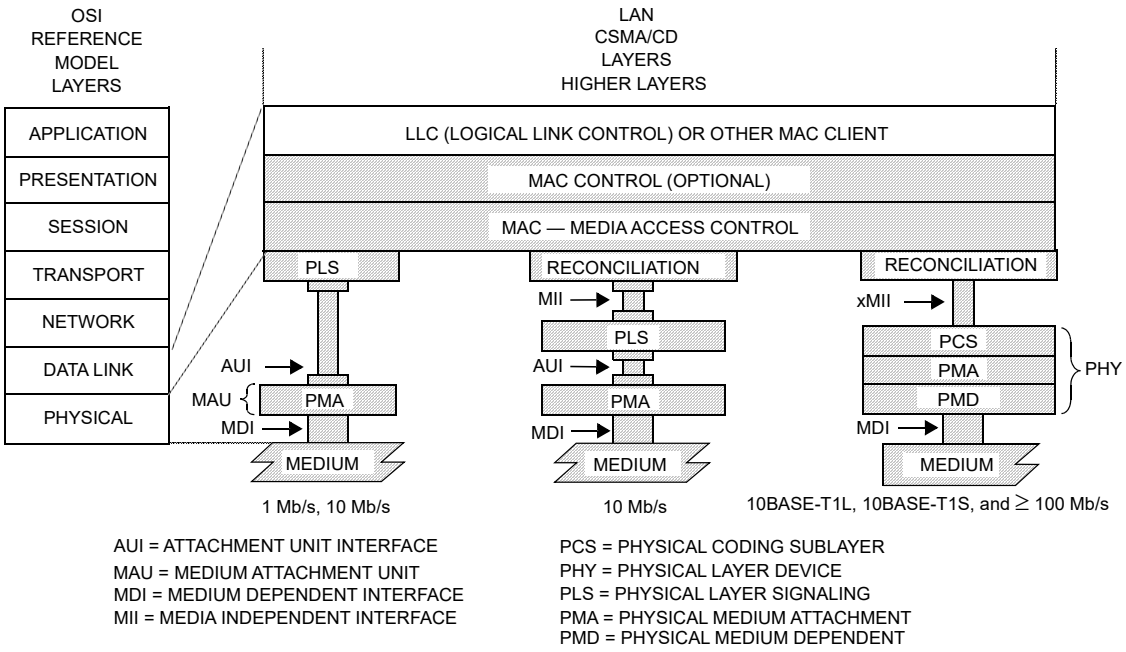
An architectural organization of the standard has two main advantages:

a) *Clarity.* A clean overall division of the design along architectural lines makes the standard clearer.
b) *Flexibility.* Segregation of medium-dependent aspects in the Physical Layer allows the LLC and MAC or equivalent sublayers to apply to a family of transmission media.

Partitioning the Data Link Layer allows various media access methods within the family of LAN standards.

The architectural model is based on a set of interfaces that may be different from those emphasized in implementations. One critical aspect of the design, however, shall be addressed largely in terms of the implementation interfaces: compatibility.

[6]For information about references, see 1.3.



NOTE—In this figure, the xMII is used as a generic term for the Media Independent Interfaces for implementations of 10BASE-T1L, 10BASE-T1S, and 100 Mb/s and above. For example: for 100 Mb/s implementations this interface is called MII; for 1 Gb/s implementations it is called GMII; for 10 Gb/s implementations it is called XGMII; etc.

Figure 1–1—IEEE 802.3 standard relationship to the ISO/IEC Open Systems Interconnection (OSI) reference model

1.1.3.2 Compatibility interfaces

The following important compatibility interfaces are defined within what is architecturally the Physical Layer.

a) *Medium Dependent Interfaces (MDI).* To communicate in a compatible manner, all stations shall adhere rigidly to the exact specification of physical media signals defined in the appropriate clauses in this standard, and to the procedures that define correct behavior of a station. The medium-independent aspects of the LLC sublayer and the MAC sublayer or equivalent should not be taken as detracting from this point; communication in an Ethernet Local Area Network requires complete compatibility at the Physical Medium interface (that is, the physical cable interface).

b) *Attachment Unit Interface (AUI).* Some DTEs are located some distance from their connection to the physical cable. A small amount of circuitry will exist in the Medium Attachment Unit (MAU) directly adjacent to the physical cable, while the majority of the hardware and all of the software will be placed within the DTE. The AUI is defined as a second compatibility interface. While conformance with this interface is not strictly necessary to ensure communication, it is recommended, since it allows maximum flexibility in intermixing MAUs and DTEs. The AUI may be optional or not specified for some implementations of this standard that are expected to be connected directly to the medium and so do not use a separate MAU or its interconnecting AUI cable. The PLS and PMA are then part of a single unit, and no explicit AUI implementation is required.

c) *Media Independent Interface (MII).* It is anticipated that some DTEs will be connected to a remote PHY, and/or to different medium dependent PHYs. The MII is defined as a third compatibility interface. While conformance with implementation of this interface is not strictly necessary to ensure

communication, it is recommended, since it allows maximum flexibility in intermixing PHYs and DTEs. The MII is optional.

d) *Gigabit Media Independent Interface (GMII).* The GMII is designed to connect a 1 Gb/s capable MAC or repeater unit to a 1 Gb/s PHY. While conformance with implementation of this interface is not strictly necessary to ensure communication, it is recommended, since it allows maximum flexibility in intermixing PHYs and DTEs at 1 Gb/s speeds. The GMII is intended for use as a chip-to-chip interface. No mechanical connector is specified for use with the GMII. The GMII is optional.

e) *Ten-bit Interface (TBI).* The TBI is provided by the 1000BASE-X PMA sublayer as a physical instantiation of the PMA service interface. The TBI is recommended for 1000BASE-X systems, since it provides a convenient partition between the high-frequency circuitry associated with the PMA sublayer and the logic functions associated with the PCS and MAC sublayers. The TBI is intended for use as a chip-to-chip interface. No mechanical connector is specified for use with the TBI. The TBI is optional.

f) *10 Gigabit Media Independent Interface (XGMII).* The XGMII is designed to connect a 2.5 Gb/s, 5 Gb/s, or 10 Gb/s capable MAC to a PHY of the same rate. While conformance with implementation of this interface is not necessary to ensure communication, it allows maximum flexibility in intermixing PHYs and DTEs at 2.5 Gb/s, 5 Gb/s, and 10 Gb/s speeds. The XGMII is intended for use as a chip-to-chip interface. No mechanical connector is specified for use with the XGMII. The XGMII is optional.

g) *10 Gigabit Attachment Unit Interface (XAUI).* The XAUI is designed to extend the connection between a 10 Gb/s capable MAC and a 10 Gb/s PHY. While conformance with implementation of this interface is not necessary to ensure communication, it is recommended, since it allows maximum flexibility in intermixing PHYs and DTEs at 10 Gb/s speeds. The XAUI is intended for use as a chip-to-chip interface. No mechanical connector is specified for use with the XAUI. The XAUI is optional.

h) *10 Gigabit Sixteen-Bit Interface (XSBI).* The XSBI is provided as a physical instantiation of the PMA service interface for 10GBASE-R and 10GBASE-W PHYs. While conformance with implementation of this interface is not necessary to ensure communication, it provides a convenient partition between the high-frequency circuitry associated with the PMA sublayer and the logic functions associated with the PCS and MAC sublayers. No mechanical connector is specified for use with the XSBI. The XSBI is optional.

i) *25 Gigabit Media Independent Interface (25GMII).* The 25GMII is designed to connect a 25 Gb/s capable MAC to a 25 Gb/s PHY. While conformance with implementation of this interface is not necessary to ensure communication, it allows flexibility in intermixing PHYs and DTEs at 25 Gb/s speeds. The 25GMII is a logical interconnection intended for use as an intra-chip interface. No mechanical connector is specified for use with the 25GMII. The 25GMII is optional.

j) *25 Gigabit Attachment Unit Interface (25GAUI).* The 25GAUI is a physical instantiation of the PMA service interface to extend the connection between 25 Gb/s capable PMAs. While conformance with implementation of this interface is not necessary to ensure communication, it is recommended, since it allows maximum flexibility in intermixing PHYs and DTEs at 25 Gb/s speeds. The 25GAUI is intended for use as a chip-to-chip or a chip-to-module interface. No mechanical connector is specified for use with the 25GAUI. The 25GAUI is optional.

k) *40 Gb/s Media Independent Interface (XLGMII).* The XLGMII is designed to connect a 40 Gb/s capable MAC to a 40 Gb/s PHY. While conformance with implementation of this interface is not necessary to ensure communication, it allows flexibility in intermixing PHYs and DTEs at 40 Gb/s speeds. The XLGMII is a logical interconnection intended for use as an intra-chip interface. No mechanical connector is specified for use with the XLGMII. The XLGMII is optional.

l) *40 Gb/s Attachment Unit Interface (XLAUI).* The XLAUI is a physical instantiation of the PMA service interface to extend the connection between 40 Gb/s capable PMAs. While conformance with implementation of this interface is not necessary to ensure communication, it is recommended, since it allows maximum flexibility in intermixing PHYs and DTEs at 40 Gb/s speeds. The XLAUI is

intended for use as a chip-to-chip or a chip-to-module interface. No mechanical connector is specified for use with the XLAUI. The XLAUI is optional.

m) *40 Gb/s Parallel Physical Interface (XLPPI)*. The XLPPI is provided as a physical instantiation of the PMD service interface for 40GBASE-SR4 and 40GBASE-LR4 PMDs. The XLPPI has four lanes. While conformance with implementation of this interface is not necessary to ensure communication, it allows flexibility in connecting the 40GBASE-SR4 or 40GBASE-LR4 PMDs. The XLPPI is intended for use as a chip-to-module interface. No mechanical connector is specified for use with the XLPPI. The XLPPI is optional.

n) *50 Gb/s Media Independent Interface (50GMII).* The 50GMII is designed to connect a 50 Gb/s capable MAC to a 50 Gb/s PHY. While conformance with implementation of this interface is not necessary to ensure communication, it allows flexibility in intermixing PHYs and DTEs at 50 Gb/s speeds. The 50GMII is a logical interconnection intended for use as an intra-chip interface. No mechanical connector is specified for use with the 50GMII. The 50GMII is optional.

o) *50 Gb/s Attachment Unit Interface (LAUI-2/50GAUI-n).* The LAUI-2/50GAUI-n is a physical instantiation of the PMA service interface to extend the connection between 50 Gb/s capable PMAs. While conformance with implementation of this interface is not necessary to ensure communication, it is recommended, since it allows maximum flexibility in intermixing PHYs and DTEs at 50 Gb/s speeds. The LAUI-2/50GAUI-n is intended for use as a chip-to-chip or a chip-to-module interface. Two widths of 50GAUI-n are defined: a two-lane version (50GAUI-2) in Annex 135D and Annex 135E, and a one-lane version (50GAUI-1) in Annex 135F and Annex 135G. No mechanical connector is specified for use with the LAUI-2/50GAUI-n. The LAUI-2/50GAUI-n is optional.

p) *100 Gb/s Media Independent Interface (CGMII).* The CGMII is designed to connect a 100 Gb/s capable MAC to a 100 Gb/s PHY. While conformance with implementation of this interface is not necessary to ensure communication, it allows flexibility in intermixing PHYs and DTEs at 100 Gb/s speeds. The CGMII is a logical interconnection intended for use as an intra-chip interface. No mechanical connector is specified for use with the CGMII. The CGMII is optional.

q) *100 Gb/s Attachment Unit Interface (CAUI-n/100GAUI-n).* The CAUI-n/100GAUI-n is a physical instantiation of the PMA service interface to extend the connection between 100 Gb/s capable PMAs. While conformance with implementation of this interface is not necessary to ensure communication, it is recommended, since it allows maximum flexibility in intermixing PHYs and DTEs at 100 Gb/s speeds. The CAUI-n is intended for use as a chip-to-chip or a chip-to-module interface. Three widths of CAUI-n are defined: a ten-lane version (CAUI-10) in Annex 83A and Annex 83B, a four-lane version (CAUI-4/100GAUI-4) in Annex 83D, Annex 83E, Annex 135D, and Annex 135E, and a two-lane version (100GAUI-2) in Annex 135F and Annex 135G. No mechanical connector is specified for use with the CAUI-n/100GAUI-n. The CAUI-n/100GAUI-n is optional.

r) *100 Gb/s Parallel Physical Interface (CPPI)*. The CPPI is provided as a physical instantiation of the PMD service interface for 100GBASE-SR10 PMDs. The CPPI has ten lanes. While conformance with implementation of this interface is not necessary to ensure communication, it allows flexibility in connecting the 100GBASE-SR10 PMDs. The CPPI is intended for use as a chip-to-module interface. No mechanical connector is specified for use with the CPPI. The CPPI is optional.

s) *200 Gb/s Media Independent Interface (200GMII).* The 200GMII is designed to connect a 200 Gb/s capable MAC to a 200 Gb/s PHY. While conformance with implementation of this interface is not necessary to ensure communication, it allows flexibility in intermixing PHYs and DTEs at 200 Gb/s speeds. The 200GMII is a logical interconnection intended for use as an intra-chip interface. No mechanical connector is specified for use with the 200GMII. The 200GMII is optional.

t) *200 Gb/s Attachment Unit Interface (200GAUI-n).* The 200GAUI-n is a physical instantiation of the PMA service interface to extend the connection between 200 Gb/s capable PMAs. While conformance with implementation of this interface is not necessary to ensure communication, it is recommended, since it allows maximum flexibility in intermixing PHYs and DTEs at 200 Gb/s speeds. The 200GAUI-n is intended for use as a chip-to-chip or a chip-to-module interface. Two widths of 200GAUI-n are defined: an eight-lane version (200GAUI-8) in Annex 120B and

Annex 120C, and a four-lane version (200GAUI-4) in Annex 120D and Annex 120E. No mechanical connector is specified for use with the 200GAUI-n. The 200GAUI-n is optional.

u) *400 Gb/s Media Independent Interface (400GMII).* The 400GMII is designed to connect a 400 Gb/s capable MAC to a 400 Gb/s PHY. While conformance with implementation of this interface is not necessary to ensure communication, it allows flexibility in intermixing PHYs and DTEs at 400 Gb/s speeds. The 400GMII is a logical interconnection intended for use as an intra-chip interface. No mechanical connector is specified for use with the 400GMII. The 400GMII is optional.

v) *400 Gb/s Attachment Unit Interface (400GAUI-n).* The 400GAUI-n is a physical instantiation of the PMA service interface to extend the connection between 400 Gb/s capable PMAs. While conformance with implementation of this interface is not necessary to ensure communication, it is recommended, since it allows maximum flexibility in intermixing PHYs and DTEs at 400 Gb/s speeds. The 400GAUI-n is intended for use as a chip-to-chip or a chip-to-module interface. Two widths of 400GAUI-n are defined: a sixteen-lane version (400GAUI-16) in Annex 120B and Annex 120C, and an eight-lane version (400GAUI-8) in Annex 120D and Annex 120E. No mechanical connector is specified for use with the 400GAUI-n. The 400GAUI-n is optional.

1.1.4 Layer interfaces

In the architectural model used here, the layers interact by way of well-defined interfaces, providing services as specified in Clause 2 and Clause 6. In general, the interface requirements are as follows:

a) The interface between the MAC sublayer and its client includes facilities for transmitting and receiving frames, and provides per-operation status information for use by higher-layer error recovery procedures.
b) The interface between the MAC sublayer and the Physical Layer includes signals for framing (carrier sense, receive data valid, transmit initiation) and contention resolution (collision detect), facilities for passing a pair of serial bit streams (transmit, receive) between the two layers, and a wait function for timing.

These interfaces are described more precisely in 4.3. Additional interfaces are necessary to provide for MAC Control services, and to allow higher level network management facilities to interact with these layers to perform operation, maintenance, and planning functions. Network management functions are described in Clause 30.

1.1.5 Application areas

Use of this standard is not restricted to any specific environments or applications.

In the context of this standard, the term “LAN” is used to indicate all networks that utilize the IEEE 802.3 (Ethernet) protocol for communication. These may include (but are not limited to) LANs and MANs.

1.1.6 Word usage

The word *shall* indicates mandatory requirements strictly to be followed in order to conform to the standard and from which no deviation is permitted (*shall* equals *is required to*).[7] [8]

The word *should* indicates that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others; or that a certain course of action is preferred but not necessarily required (*should* equals *is recommended that*).

[7]The use of the word *must* is deprecated and cannot be used when stating mandatory requirements, *must* is used only to describe unavoidable situations.

[8]The use of *will* is deprecated and cannot be used when stating mandatory requirements, *will* is only used in statements of fact.

The word *may* is used to indicate a course of action permissible within the limits of the standard (*may* equals *is permitted to*).

The word *can* is used for statements of possibility and capability, whether material, physical, or causal (*can* equals *is able to*).

1.2 Notation

1.2.1 State diagram conventions

The operation of a protocol can be described by subdividing the protocol into a number of interrelated functions. The operation of the functions can be described by state diagrams. Each diagram represents the domain of a function and consists of a group of connected, mutually exclusive states. Only one state of a function is active at any given time (see Figure 1–1).

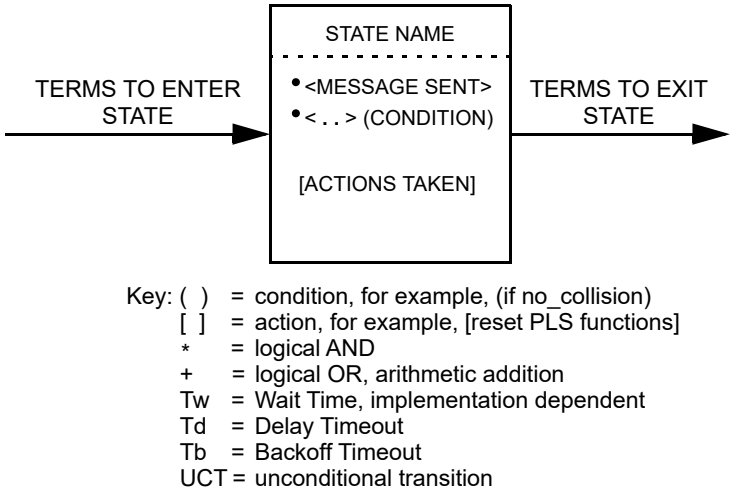


Figure 1–1—State diagram notation example

Each state that the function can assume is represented by a rectangle. These are divided into two parts by a horizontal line. In the upper part the state is identified by a name in capital letters. The lower part contains the name of any ON signal that is generated by the function. Actions are described by short phrases and enclosed in brackets.

All permissible transitions between the states of a function are represented graphically by arrows between them. A transition that is global in nature (for example, an exit condition from all states to the IDLE or RESET state) is indicated by an open arrow. Labels on transitions are qualifiers that have to be fulfilled before the transition will be taken. The label UCT designates an unconditional transition. Qualifiers described by short phrases are enclosed in parentheses.

State transitions and sending and receiving of messages occur instantaneously. When a state is entered and the condition to leave that state is not immediately fulfilled, the state executes continuously, sending the messages and executing the actions contained in the state in a continuous manner.

Some devices described in this standard (e.g., repeaters) are allowed to have two or more ports. State diagrams that are capable of describing the operation of devices with an unspecified number of ports require a qualifier notation that allows testing for conditions at multiple ports. The notation used is a term that

includes a description in parentheses of which ports have to meet the term for the qualifier to be satisfied (e.g., ANY and ALL). It is also necessary to provide for term-assignment statements that assign a name to a port that satisfies a qualifier. The following conventions are used to describe a term-assignment statement that is associated with a transition:

a) The character ":" (colon) is a delimiter used to denote that a term assignment statement follows.
b) The character "⇐" (left arrow) denotes assignment of the value following the arrow to the term preceding the arrow.

The state diagrams contain the authoritative statement of the functions they depict; when apparent conflicts between descriptive text and state diagrams arise, the state diagrams are to take precedence. This does not override, however, any explicit description in the text that has no parallel in the state diagrams.

The models presented by state diagrams are intended as the primary specifications of the functions to be provided. It is important to distinguish, however, between a model and a real implementation. The models are optimized for simplicity and clarity of presentation, while any realistic implementation may place heavier emphasis on efficiency and suitability to a particular implementation technology. It is the functional behavior of any unit that has to match the standard, not its internal structure. The internal details of the model are useful only to the extent that they specify the external behavior clearly and precisely.

1.2.2 Service specification method and notation

The service of a layer or sublayer is the set of capabilities that it offers to a user in the next higher (sub)layer. Abstract services are specified here by describing the service primitives and parameters that characterize each service. This definition of service is independent of any particular implementation (see Figure 1–2).

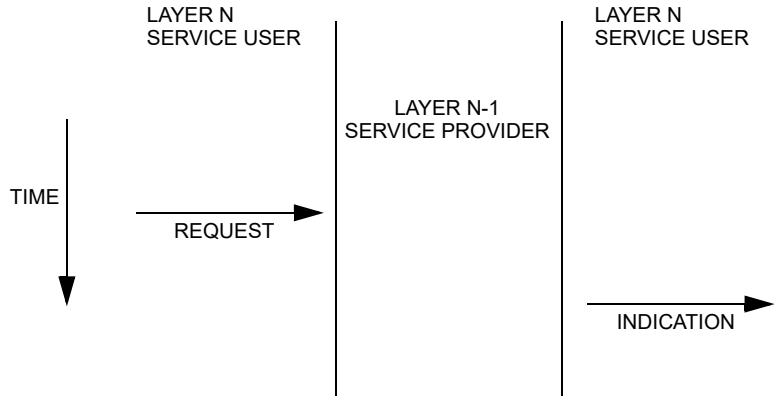


Figure 1–2—Service primitive notation

Specific implementations may also include provisions for interface interactions that have no direct end-to-end effects. Examples of such local interactions include interface flow control, status requests and indications, error notifications, and layer management. Specific implementation details are omitted from this service specification both because they will differ from implementation to implementation and because they do not impact the peer-to-peer protocols.

1.2.2.1 Classification of service primitives

Primitives are of two generic types:

a) REQUEST. The request primitive is passed from layer N to layer N-1 to request that a service be initiated.
b) INDICATION. The indication primitive is passed from layer N-1 to layer N to indicate an internal layer N-1 event that is significant to layer N. This event may be logically related to a remote service request, or may be caused by an event internal to layer N-1.

The service primitives are an abstraction of the functional specification and the user-layer interaction. The abstract definition does not contain local detail of the user/provider interaction. For instance, it does not indicate the local mechanism that allows a user to indicate that it is awaiting an incoming call. Each primitive has a set of zero or more parameters, representing data elements that shall be passed to qualify the functions invoked by the primitive. Parameters indicate information available in a user/provider interaction; in any particular interface, some parameters may be explicitly stated (even though not explicitly defined in the primitive) or implicitly associated with the service access point. Similarly, in any particular protocol specification, functions corresponding to a service primitive may be explicitly defined or implicitly available.

1.2.3 Physical Layer and media notation

Users of this standard need to reference which particular implementation is being used or identified. Therefore, a means of identifying each implementation is given by a simple, three-field, type notation that is explicitly stated at the beginning of each relevant clause. In general, the Physical Layer type is specified by these fields:

<data rate> <modulation type> <additional distinction>

The data rate, if only a number, is in Mb/s, and if suffixed by a “G”, is in Gb/s. The modulation type (e.g., BASE) indicates how encoded data is transmitted on the medium. The additional distinction may identify characteristics of transmission or medium and, in some cases, the type of PCS encoding used (examples of additional distinctions are “T” for twisted pair, “B” for bidirectional optics, and “X” for a block PCS coding used for that speed of operation). Expansions for defined Physical Layer types are included in 1.4.

1.2.4 Physical Layer message notation

Messages generated within the Physical Layer, either within or between PLS and the MAU (that is, PMA circuitry), are designated by an italic type to designate either form of physical or logical message used to execute the Physical Layer signaling process (for example, *input_idle* or *mau_available*).

1.2.5 Hexadecimal notation

Numerical values designated by the 0x prefix indicate a hexadecimal interpretation of the corresponding number. For example: 0x0F represents an 8-bit hexadecimal value of the decimal number 15 and 0x00000000 represents a 32-bit hexadecimal value of the decimal number 0.

Numerical values designated with a 16 subscript indicate a hexadecimal interpretation of the corresponding number. For example: $0F_{16}$ represents an 8-bit hexadecimal value of the decimal number 15.

Hexadecimal values may also be indicated in text as hexadecimal or hex.

Hexadecimal numbers and values use upper case for hexadecimal digits A through F.

Separators may be used to improve readability of numbers—typically after every two or four hex digits counting from right to left. When hexadecimal is used for a fixed length value, protocol field, etc., where the value is not a multiple of 4 bits, the leftmost hexadecimal digit is truncated to fit the value's length (e.g., an 11 bit value of 0x25F is 010 0101 1111 in binary).

1.2.6 Accuracy and resolution of numerical quantities

Unless otherwise stated, numerical limits in this standard are to be taken as exact, with the number of significant digits and trailing zeros having no significance.

1.2.7 Qm.n number format

The Qm.n number format is a fixed-point number format where the number of fractional bits is specified by n and optionally the number of integer bits is specified by m. For example, a Q14 number has 14 fractional bits; a Q2.14 number has 2 integer bits and 14 fractional bits. Preceding the "Q" with a "U" indicates an unsigned number.

1.2.8 Em dash (—) in a table cell

A table cell containing an em-dash (—) indicates a lack of data for that cell, or:

— For a units cell, that there is no unit for that parameter
— For a maximum cell, that there is no requirement on the maximum value of that parameter
— For a minimum cell, that there is no requirement on the minimum value of that parameter

1.3 Normative references

The following standards contain provisions that, through reference in this text, constitute provisions of this standard. Standards may be subject to revision, and parties subject to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid international standards. For undated references, the latest edition of the referenced document (including any amendments or corrigenda) applies.

ANSI INCITS 230-1994 (R1999), Information Technology—Fibre Channel—Physical and Signaling Interface (FC-PH) [formerly ANSI X3.230-1994 (R1999)].[9]

ANSI INCITS 263-1995 (S2010), Fibre Distributed Data Interface (FDDI)—Token Ring Twisted Pair Physical Layer Medium Dependent (TP-PMD) [formerly INCITS 263-1995 (R2005)].

ANSI/TIA-568-C.0 (February 2009), Generic Telecommunications Cabling for Customer Premises.[10]

ANSI/TIA-568-C.2-1 (July 2016), Balanced Twisted-Pair Telecommunications Cabling and Components Standard, Addendum 1: Specifications for 100 Ω Next Generation Cabling.

ANSI/TIA-568-C.2 (August 2009), Commercial Building Telecommunications Cabling Standard Part 2: Balanced Twisted-Pair Cabling Components.

ANSI/TIA-568-C.3 (June 2008), Optical Fiber Cabling Components Standard.

ANSI/TIA-568.0-D, Generic Telecommunications Cabling for Customer Premises.

ANSI/TIA-604-18:2015, FOCIS 18—Fiber Optic Connector Intermateability Standard—Type MPO-16.

ANSI/TIA-604-18-A:2018, FOCIS 18—Fiber Optic Connector Intermateability Standard—Type MPO-16.

[9]ANSI publications are available from the American National Standards Institute (https://www.ansi.org/).
[10]ANSI/TIA publications are available from the IHS Standards Store (https://global.ihs.com/) or from the Telecommunications Industry Association (https://www.tiaonline.org/).

ANSI/TIA/EIA-455-95-2019, Absolute Optical Power Test for Optical Fibers and Cables.

ANSI/TIA/EIA-455-204-2013, Measurement of Bandwidth on Multimode Fiber..

ANSI/TIA/EIA-568-A-1995, Commercial Building Telecommunications Cabling Standard.

ASTM D4728, Standard Test Method for Random Vibration Testing of Shipping Containers.[11]

ATIS-0300269.2006(S2016), Structure and Representation of Trace Message Formats for Information Exchange.[12]

ATIS-0600416.1999(R2010), Network to Customer Installation Interfaces—Synchronous Optical NETwork (SONET)—Physical Layer Specification: Common Criteria.

ATIS-0600417.2003(S2015), Spectrum Management for Loop Transmission Systems.

ATIS-0600424.2004(S2015), Interface Between Networks and Customer Installation Very-high-bit-rate Digital Subscriber Lines (VDSL) Metallic Interface (DMT based).

ATIS-0600601.1999(S2015), Integrated Services Digital Network (ISDN)—Basic Access Interface for Use on Metallic Loops for Application on the Network Side of the NT (Layer 1 Specification).

ATIS-0600605.1991(S2015), Integrated Services Digital Network (ISDN)—Basic Access Interface for S and T Reference Points (Layer 1 Specification).

ATIS-0900105.2008, Synchronous Optical Network (SONET)—Basic Description including Multiplex Structure, Rates, and Formats.

CFR 76, Code of Federal Regulations, Title 47, Part 76, October 2005.

CISPR 22: 1993, Limits and Methods of Measurement of Radio Interference Characteristics of Information Technology Equipment.[13]

CISPR 25: Vehicles, boats and internal combustion engines—Radio disturbance characteristics—Limits and methods of measurement for the protection of on-board receivers.

EIA/JEDEC Standard EIA/JESD8-6, High Speed Transceiver Logic (HSTL), August 1995.[14]

ETSI TS 101 270-1 (1999), Transmission and Multiplexing (TM); Access transmission systems on metallic access cables; Very high speed Digital Subscriber Line (VDSL); Part 1: Functional requirements.[15]

IEC 60060 (all parts), High-voltage test techniques.[16]

IEC 60068, Basic environmental testing procedures.

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[11]ASTM publications are available from the American Society for Testing and Materials (https://www.astm.org/).
[12]ATIS publications are available from the Alliance for Telecommunications Industry Solutions (https://atis.org/).
[13]CISPR documents are available from the International Electrotechnical Commission (https://www.iec.ch/). CISPR documents are also available in the United States from the American National Standards Institute (https://www.ansi.org/).
[14]EIA publications are available from the IHS Standards Store (https://global.ihs.com/). JEDEC publications are available from the JEDEC Solid State Technology Association (https://www.jedec.org/).
[15]ETSI publications are available the European Telecommunications Standards Institute (https://www.etsi.org/).
[16]IEC publications are available from the International Electrotechnical Commission (https://www.iec.ch/). IEC publications are also available in the United States from the American National Standards Institute (https://www.ansi.org/).

IEC 60068-2-1:2007, Environmental testing—Part 2-1: Tests—Test A: Cold.

IEC 60068-2-2:2007, Environmental testing—Part 2-2: Tests—Test B: Dry heat.

IEC 60068-2-6:2007, Environmental testing—Part 2-6: Tests—Test Fc: Vibration (sinusoidal).

IEC 60068-2-14:2009, Environmental testing—Part 2-14: Tests—Test N: Change of temperature.

IEC 60068-2-27:2008, Environmental testing—Part 2-27: Tests—Test Ea and guidance: Shock.

IEC 60068-2-30:2005, Environmental testing—Part 2-30: Tests—Test Db: Damp heat, cyclic (12 h + 12 h cycle).

IEC 60068-2-31:2008, Environmental testing—Part 2-31: Tests—Test Ec: Rough handling shocks, primarily for equipment-type specimens.

IEC 60068-2-38:2009, Environmental testing—Part 2-38: Tests—Test Z/AD: Composite temperature/humidity cyclic test.

IEC 60068-2-52:2017, Environmental testing—Part 2-52: Tests—Test Kb: Salt mist, cyclic (sodium chloride solution).

IEC 60068-2-64:2008, Environmental testing—Part 2-64: Tests—Test Fh: Vibration, broadband random and guidance.

IEC 60068-2-78:2012, Environmental testing—Part 2-78: Tests—Test Cab: Damp heat, steady state.

IEC 60079-0:2017, Explosive atmospheres—Part 0: Equipment—General requirements.

IEC 60079-11:2011, Explosive Atmospheres—Part 11: Equipment protection by intrinsic safety.

IEC 60096-1:1986, Radio-frequency cables, Part 1: General requirements and measuring methods and Amd. 2:1993.

IEC 60169-16:1982, Radio-frequency connectors, Part 16: R.F. coaxial connectors with inner diameter of outer conductor 7 mm (0.276 in) with screw coupling—Characteristic impedance 50 ohms (75 ohms) (Type N).

IEC 60529:2013, Degrees of Protection Provided by Enclosures (IP Code).

IEC 60603-7, Connectors for electronic equipment—Part 7: Detail specification for 8-way, unshielded, free and fixed connectors.

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IEC 60603-7-5, Connectors for electronic equipment—Part 7-5: Detail specification for 8-way, shielded, free and fixed connectors, for data transmissions with frequencies up to 250 MHz.

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NOTE—Local and national standards such as those supported by ANSI, EIA, MIL, NFPA, and UL are not a formal part of this standard except where no international standard equivalent exists. A number of local and national standards are

[26]For information on MATLAB, contact The MathWorks (https://www.mathworks.com/).

[27]NAMUR publications are available from the User Association of Automation Technology in Process Industries (https://www.namur.net/).

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[30]Notes in text, tables, and figures are given for information only and do not contain requirements needed to implement this standard.
[31]The *IEEE Standards Dictionary Online* is available at https://dictionary.ieee.org/.