



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

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

**Amendment 2: Physical Layer and Management
Parameters for 10 Gb/s Operation,
Type 10GBASE-LRM**

IEEE Computer Society

Sponsored by the
LAN/MAN Standards Committee

IEEE
3 Park Avenue
New York, NY 10016-5997, USA

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IEEE Std 802.3aq™-2006
(Amendment to
IEEE Std 802.3™-2005)

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**LAN/MAN Standards Committee
of the
IEEE Computer Society**

Approved 15 September 2006
IEEE-SA Standards Board

Abstract: This amendment to IEEE Std 802.3-2005 specifies a new PMD, 10GBASE-LRM, for serial, 10 Gb/s operation over up to 220 m of 62.5 μm and 50 μm multimode fiber, including installed, FDDI grade multimode fiber.

Keywords: 802.3aq, 10GBASE-LRM, 10 Gigabit Ethernet, multimode fiber, physical medium dependent (PMD) sublayer

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Introduction

This introduction is not part of IEEE Std 802.3aq-2006, IEEE Standard for Information technology—Telecommunications and information exchange between systems—Local and metropolitan area networks—Specific requirements CSMA/CD Access Method and Physical Layer Specifications, Amendment 2: Physical Layer and Management Parameters for 10 Gb/s Operation, Type 10GBASE-LRM.

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 802.3aq-2006). A historical listing of projects that have added to or modified IEEE Std 802.3 is included in IEEE Std 802.3-2005.

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

Some of the major additions to IEEE Std 802.3 are identified 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 802.3x™ specified full duplex operation and a flow control protocol, 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) and IEEE Std 802.3ah™ specified access network Ethernet (also called Ethernet in the First Mile). These major additions are all now included in IEEE Std 802.3-2005 and are not maintained as separate documents. This amendment adds additional capabilities for 10 Gb/s operation.

At the date of IEEE Std 802.3aq-2006 publication, IEEE Std 802.3 is comprised of the following documents:

Section One—Includes Clause 1 through Clause 20 and Annex A through Annex H and Annex 4a. Section One includes 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 33E. 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. It also includes specification of 802.3 link aggregation.

Section Four—Includes Clause 44 through Clause 54 and Annex 44A through Annex 50A. 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 67 and Annex 58A through Annex 67A. Section Five includes subscriber access physical layers and sublayers for operation from 512 kb/s to 1000 Mb/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.

IEEE Std 802.3-2005/Cor 1-2006

This corrigendum clarifies and corrects isolation text for twisted pair Ethernet physical interfaces, including harmonization for both powered and unpowered Medium Dependent interfaces.

IEEE Std 802.3anTM-2006

This amendment includes changes to IEEE Std 802.3-2005 and adds Clause 55 and Annex 55A and Annex 55B. This amendment adds a new Physical Layer for 10 Gb/s operation over balanced twisted-pair structured cabling systems.

IEEE Std 802.3aq-2006

This amendment includes changes to IEEE Std 802.3-2005 and adds Clause 68. This amendment adds a new Physical Layer for 10 Gb/s operation over installed multimode fiber.

IEEE Std 802.3asTM-2006

This amendment includes changes to IEEE Std 802.3-2005. It extends the size of the IEEE 802.3 frame format with an envelope frame.

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.

Conformance test methodology

An additional standard, IEEE Std 1802.3TM-2001, provides conformance test information for 10BASE-T.

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Errata, if any, for this and all other standards can be accessed at the following URL:

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

Printed Character	Meaning	Font
*	Boolean AND	Symbol
+	Boolean OR, arithmetic addition	Symbol
^	Boolean XOR	Times New Roman
!	Boolean NOT	Symbol
×	Multiplication	Symbol
<	Less than	Symbol
≤	Less than or equal to	Symbol
>	Greater than	Symbol
≥	Greater than or equal to	Symbol
=	Equal to	Symbol
≠	Not equal to	Symbol
←	Assignment operator	Symbol
∈	Indicates membership	Symbol
∉	Indicates nonmembership	Symbol
±	Plus or minus (a tolerance)	Symbol
°	Degrees	Symbol
∑	Summation	Symbol
√	Square root	Symbol
—	Big dash (em dash)	Times New Roman
–	Little dash (en dash), subtraction	Times New Roman
	Vertical bar	Times New Roman
†	Dagger	Times New Roman
‡	Double dagger	Times New Roman
α	Lower case alpha	Symbol
β	Lower case beta	Symbol
γ	Lower case gamma	Symbol
δ	Lower case delta	Symbol
ε	Lower case epsilon	Symbol
λ	Lambda	Symbol
μ	Micro	Times New Roman
Ω	Omega	Symbol

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

Amendment 2: Physical Layer and Management Parameters for 10 Gb/s Operation, Type 10GBASE-LRM

NOTE—The editing instructions contained in this amendment define how to merge the material contained therein into the existing base standard and its amendments to form the comprehensive standard.

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

1. Introduction

1.3 Normative references

Insert the following new entries into the reference list, in alphanumeric order:

IEC 60793-2-10 (2004), Optical fibres—Part 2-10: Product specifications—Sectional specification for category A1 multimode fibres.

IEC 60794-2-11 (2005), Optical fibre cables—Part 2-11: Indoor cables—Detailed specification for simplex and duplex cables for use in premises cabling.

IEC 60794-3-12 (2005), Optical fibre cables—Part 3-12: Outdoor fibre cables—Detailed specification for duct and directly buried optical telecommunication cables for use in premises cabling.

IEC 61280-1-4 (2003), Fibre optic communication subsystem test procedures—Part 1-4: General communication subsystems—Collection and reduction of two-dimensional nearfield data for multimode fibre laser transmitters.

IEC 61280-4-1 (2003), Fiber-optic communication subsystem test procedures—Part 4-1: Cable plant and links—Multimode fibre-optic cable plant attenuation measurement.

ITU-T Recommendation O.153, 1992—Basic parameters for the measurement of error performance at bit rates below the primary rate.

1.4 Definitions

Insert the following new definitions in alphanumerical order:

1.4.x.x 10GBASE-LRM: IEEE 802.3 Physical Layer specification for 10 Gb/s using 10GBASE-R encoding and long wavelength optics for multimode fiber (see IEEE 802.3 Clause 68).

1.4.x.x encircled flux: The optical power within a specified radius of a fiber center, as a percentage of that within 36 μm (for 62.5 μm fiber) or 29 μm (for 50 μm fiber).

1.5 Abbreviations

Insert the following new entries into the abbreviations list, in alphabetical order:

CRU clock recovery unit

TWDP transmitter waveform and dispersion penalty

30. Management

30.5.1.1.2 aMAUType

Insert a new entry into the list, following the 10GBASE-SR entry:

10GBASE-LRM R fiber over 1310 nm optics as specified in Clause 68

44. Introduction to 10 Gb/s baseband network

44.1.1 Scope

Change the first paragraph to include 10GBASE-LRM in list of Physical Layer entities, as follows (IEEE Std 802.3anTM-2006):

10 Gigabit Ethernet uses the IEEE 802.3 MAC sublayer, connected through a 10 Gigabit Media Independent Interface (XGMII) to Physical Layer entities such as 10GBASE-SR, 10GBASE-LX4, 10GBASE-CX4, 10GBASE-LRM, 10GBASE-LR, 10GBASE-ER, 10GBASE-SW, 10GBASE-LW, 10GBASE-EW, and 10GBASE-T.

44.1.3 Relationship of 10 Gigabit Ethernet to the ISO OSI reference model

Change list item d) to include Clause 68 and 10GBASE-LRM, as follows (IEEE Std 802.3an-2006):

d) The MDI as specified in Clause 53 for 10GBASE-LX4, in Clause 54 for 10GBASE-CX4, in Clause 55 for 10GBASE-T, in Clause 68 for 10GBASE-LRM, and in Clause 52 for other PMD types.

44.1.4.4 Physical Layer signaling systems

Change the third paragraph of this subclause to insert Clause 68 and 10GBASE-LRM into family of 10GBASE-R physical layers, as follows:

The term 10GBASE-R, specified in Clause 49, Clause 51, ~~and~~ Clause 52 and Clause 68, refers to a specific family of physical layer implementations based upon 64B/66B data coding method. The 10GBASE-R family of physical layer implementations is composed of 10GBASE-SR, 10GBASE-LR, ~~and~~ 10GBASE-ER and 10GBASE-LRM.

Change the fifth paragraph of this subclause as follows (IEEE Std 802.3an-2006):

Physical layer device specifications are contained in Clause 52, Clause 53, Clause 54, ~~and~~ Clause 55, and Clause 68.

Change Table 44–1 to include a column for Clause 68 and a row for 10GBASE-LRM, as given below (IEEE Std 802.3an-2006).

Table 44–1—Nomenclature and clause correlation

Nomenclature	Clause										
	48 8B/10B PCS & PMA	49 64B/66B PCS	50 WIS	51 Serial PMA	52 850 nm Serial PMD1310 nm Serial PMD1550 nm Serial PMD			53 1310 nm WDM PMD	54 4-Lane electrical PMD	55 Twisted- pair PCS & PMA	68 1310 nm Serial MMF PMD
10GBASE-SR		M ^a		M	M						
10GBASE-SW		M	M	M	M						
10GBASE-LX4	M							M			
10GBASE-CX4	M								M		
10GBASE-LR		M		M		M					
10GBASE-LW		M	M	M		M					
10GBASE-ER		M		M			M				
10GBASE-EW		M	M	M			M				
10GBASE-T										M	
10GBASE-LRM		M		M							M

^aM = Mandatory

44.3 Delay constraints

Change Table 44–2 as follows (IEEE Std 802.3an-2006):

Table 44–2—Round-trip delay constraints (informative)

Sublayer	Maximum (bit time)	Maximum (pause_quanta)	Notes
MAC, RS and MAC Control	8192	16	See 46.1.4.
XGXS and XAUI	4096	8	Round-trip of 2 XGXS and trace for both directions. See 47.2.2.
10GBASE-X PCS and PMA	2048	4	See 48.5.
10GBASE-R PCS	3584	7	See 49.2.15.
WIS	14336	28	See 50.3.7.
LX4 PMD	512	1	Includes 2 meters of fiber. See 53.2.
CX4 PMD	512	1	See 54.3
Serial PMA and PMD <u>(except LRM)</u>	512	1	Includes 2 meters of fiber. See 52.2.
<u>LRM PMA and PMD</u>	<u>9216</u>	<u>18</u>	<u>Includes 2 meters of fiber. See 68.2.</u>
10GBASE-T PHY	25 600	50	See 55.11.

44.4 Protocol implementation conformance statement (PICS) proforma

Change the first paragraph to include Clause 68 in the PICS list, as follows (IEEE Std 802.3an-2006):

The supplier of a protocol implementation that is claimed to conform to any part of IEEE Std 802.3, Clause 45 through Clause 55 and Clause 68, demonstrates compliance by completing a protocol implementation conformance statement (PICS) proforma.