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AMENDMENT 5
2021-12

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

Part 3: Standard for Ethernet

AMENDMENT 5: Physical layers specifications and management parameters for 10 Mb/s operation and associated power delivery over a single balanced pair of conductors

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

Partie 3: Norme pour Ethernet

AMENDEMENT 5: Spécifications des couches physiques et paramètres de gestion pour fonctionnement à 10 Mb/s et fourniture de puissance associée sur une paire symétrique unique de conducteurs

Reference number
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IEEE Std 802.3cg™-2019
(Amendment to IEEE Std 802.3™-2018
as amended by IEEE Std 802.3cb™-2018,
IEEE Std 802.3bt™-2018, IEEE Std 802.3cd™-2018,
and IEEE Std 802.3cn™-2019)

IEEE Standard for Ethernet

Amendment 5: Physical Layer Specifications and Management Parameters for 10 Mb/s Operation and Associated Power Delivery over a Single Balanced Pair of Conductors

Developed by the

LAN/MAN Standards Committee
of the
IEEE Computer Society

Approved 7 November 2019

IEEE SA Standards Board

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Abstract: This amendment to IEEE Std 802.3-2018 specifies additions and appropriate modifications to add 10 Mb/s Physical Layer (PHY) specifications and management parameters for operation, and associated optional provision of power, over a single balanced pair of conductors.

Keywords: 10BASE-T1L, 10BASE-T1S, amendment, copper, Ethernet, IEEE 802.3™, IEEE 802.3cg™, MASTER-SLAVE, medium dependent interface, physical coding sublayer, Physical Layer, Physical Layer Collision Avoidance, PLCA, physical medium attachment

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Introduction

This introduction is not part of IEEE Std 802.3cg-2019, IEEE Standard for Ethernet—Amendment 5: Physical Layer Specifications and Management Parameters for 10 Mb/s Operation and Associated Power Delivery over a Single Balanced Pair of Conductors.

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. Ethernet at 10 Mb/s 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 was added in 1997.

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 802.3-2018 and are not maintained as separate documents.

At the date of publication for IEEE Std 802.3cg-2019, IEEE Std 802.3 was composed of the following documents:

IEEE Std 802.3-2018

Section One—Includes Clause 1 through Clause 20 and Annex A through Annex H 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 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.

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

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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 the 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 126 and Annex 119A through Annex 120E. Clause 116 through Clause 124 and associated annexes include general information on 200 Gb/s and 400 Gb/s operation as well the 200 Gb/s and 400 Gb/s Physical Layer specifications. Clause 125 and Clause 126 include general information on 2.5 Gb/s and 5 Gb/s operation as well as 2.5 Gb/s and 5 Gb/s Physical Layer specifications.

IEEE Std 802.3cb™-2018

Amendment 1—This amendment includes changes to IEEE Std 802.3-2018 and its amendments and adds Clause 127 through Clause 130, Annex 127A, Annex 128A, Annex 128B, and Annex 130A. This amendment adds new Physical Layers for operation at 2.5 Gb/s and 5 Gb/s over electrical backplanes.

IEEE Std 802.3bt™-2018

Amendment 2—This amendment includes changes to IEEE Std 802.3-2018 and its amendments and adds Clause 145, Annex 145A, Annex 145B, and Annex 145C. This amendment adds power delivery using all four pairs in the structured wiring plant, resulting in greater power being available to end devices. This amendment also allows for lower standby power consumption in end devices and adds a mechanism to better manage the available power budget.

IEEE Std 802.3cd™-2018

Amendment 3—This amendment includes changes to IEEE Std 802.3-2018 and its amendments and adds Clause 131 through Clause 140 and Annex 135A through Annex 136D. This amendment adds MAC parameters, Physical Layers, and management parameters for the transfer of IEEE 802.3 format frames at 50 Gb/s, 100 Gb/s, and 200 Gb/s.

IEEE Std 802.3cn™-2019

Amendment 4—This amendment includes changes to IEEE Std 802.3-2018 and its amendments and adds 50 Gb/s, 200 Gb/s, and 400 Gb/s Physical Layer specifications and management parameters for operation over single-mode fiber with reaches of at least 40 km.

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IEEE Std 802.3cg™-2019

> Amendment 5—This amendment includes changes to IEEE Std 802.3-2018 and its amendments and adds Clause 146 through Clause 148 and Annex 146A and Annex 146B. This amendment adds 10 Mb/s Physical Layer specifications and management parameters for operation on a single balanced pair of conductors.

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.

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IEEE Standard for Ethernet

Amendment 5: Physical Layer Specifications and Management Parameters for 10 Mb/s Operation and Associated Power Delivery over a Single Balanced Pair of Conductors

(This amendment is based on IEEE Std 802.3™-2018 as amended by IEEE Std 802.3cb™-2018, IEEE Std 802.3bt™-2018, IEEE Std 802.3cd™-2018, and IEEE Std 802.3cn™-2019.)

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 ~~strikethrough~~ (to remove old material) and underscore (to add new material). ***Delete*** removes existing material. ***Insert*** adds new material without disturbing the existing material. Deletions and 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. Editing instructions, change markings, and this NOTE will not be carried over into future editions because the changes will be incorporated into the base standard.

Cross references that refer to clauses, tables, equations, or figures not covered by this amendment are highlighted in green.[1]

[1] Notes in text, tables, and figures are given for information only and do not contain requirements needed to implement the standard.

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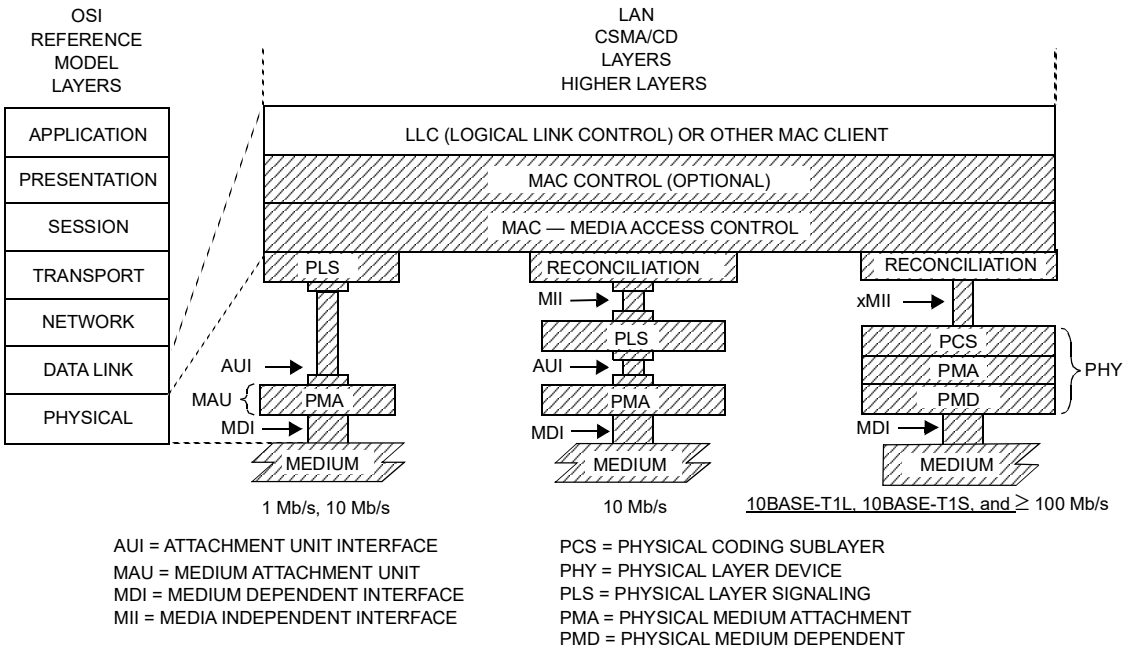
1. Introduction

1.1 Overview

1.1.3 Architectural perspectives

Change Figure 1–1 as follows (see changes at the bottom of the right column and in the note):



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

1.3 Normative references

Insert the following references in alphanumeric order:

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

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

[2]IEC publications are available from the International Electrotechnical Commission (http://www.iec.ch/). IEC publications are also available in the United States from the American National Standards Institute (http://www.ansi.org).

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

IEC 61000-4-4:2012, Electromagnetic compatibility (EMC)—Part 4-4: Testing and measurement techniques—Electrical fast transient/burst immunity test.

IEC 61000-4-5:2017, Electromagnetic compatibility (EMC)—Part 4-5: Testing and measurement techniques—Surge immunity test.

IEC 61000-4-6:2013, Electromagnetic compatibility (EMC)—Part 4-6: Testing and measurement techniques—Immunity to conducted disturbances, induced by radio-frequency fields.

IEC 61000-6-4:2018, Electromagnetic compatibility (EMC)—Part 6-4: Generic standards—Emission standard for industrial environments.

IEC 61010-1:2017, Safety requirements for electrical equipment for measurement, control, and laboratory use—Part 1: General requirements.

IEC 61326-1:2012, Electrical equipment for measurement, control and laboratory use—EMC requirements—Part 1: General requirements.

IEC 62368-1:2014, Audio/video, information and communication technology equipment—Part 1: Safety requirements.

ISO 4892:1982, Plastics—Methods of exposure to laboratory light.[3]

NAMUR NE 021:2017, Electromagnetic Compatibility of Equipment for Industrial Processes and Laboratory.[4]

1.4 Definitions

Insert the following new definitions after 1.4.50 "10BASE-T":

1.4.50a 10BASE-T1L: IEEE 802.3 Physical Layer specification for a 10 Mb/s Ethernet local area network over a single balanced pair of conductors up to at least 1000 m reach. (See IEEE Std 802.3, Clause 146.)

1.4.50b 10BASE-T1S: IEEE 802.3 Physical Layer specification for a 10 Mb/s Ethernet local area network over a single balanced pair of conductors up to at least 15 m reach. (See IEEE Std 802.3, Clause 147.)

Change 1.4.151 as follows:

1.4.151 BASE-T1: PHYs that belong to the set of specific Ethernet PCS/PMA/PMDs that operate on a single twisted-pair copper cable, including 10BASE-T1L, 10BASE-T1S, 100BASE-T1, and 1000BASE-T1. (See IEEE Std 802.3, Clause 96, ~~and~~ Clause 97, Clause 146, and Clause 147.)

[3]ISO publications are available from the International Organization for Standardization (http://www.iso.ch/). ISO publications are also available in the United States from the American National Standards Institute (http://www.ansi.org/).

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

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Change 1.4.198 as follows:

1.4.198 code-group: For IEEE 802.3, a set of encoded symbols representing encoded data or control information. For 100BASE-T4, a set of six ternary symbols that, when representing data, conveys an octet. For 100BASE-TX and 100BASE-FX, a set of five code-bits that, when representing data, conveys a nibble. For 100BASE-T2, a pair of PAM5×5 symbols that, when representing data, conveys a nibble. For 1000BASE-X, a set of ten bits that, when representing data, conveys an octet. For 1000BASE-T, a vector of four 8B1Q4 coded quinary symbols that, when representing data, conveys an octet. For 100BASE-T1, a set of ternary symbols that, when representing data, conveys three bits, as defined in 96.3. For 10BASE-T1L, a set of three ternary symbols that, when representing data, conveys a nibble, as defined in 146.3. (See IEEE Std 802.3, Clause 23, Clause 24, Clause 32, Clause 36, Clause 40, ~~and~~ Clause 96, and Clause 146.)

Change 1.4.319 as follows:

1.4.319 master Physical Layer (PHY): Within IEEE 802.3, in a 100BASE-T2~~—or,~~ 1000BASE-T, 10BASE-T1L, 100BASE-T1, 1000BASE-T1, or any MultiGBASE-T link containing a pair of PHYs, the PHY that uses an external clock for generating its clock signals to determine the timing of transmitter and receiver operations. It also uses the master transmit scrambler generator polynomial for side-stream scrambling. Master and slave PHY status is determined during the Auto-Negotiation process that takes place prior to establishing the transmission link, or in the case of a PHY where Auto-Negotiation is optional and not used, master and slave PHY status is determined by management or hardware configuration. *See also:* **slave Physical Layer (PHY)**.

Insert the following new definition after 1.4.390 "physical header subframe (PHS)":

1.4.390a Physical Layer Collision Avoidance (PLCA): A method for generating transmit opportunities for 10BASE-T1S operating on mixing segments. (See IEEE Std 802.3, Clause 148.)

Change 1.4.456 as follows:

1.4.456 slave Physical Layer (PHY): Within IEEE 802.3, in a 100BASE-T2~~—or,~~ 1000BASE-T, 10BASE-T1L, 100BASE-T1, 1000BASE-T1, or any MultiGBASE-T link containing a pair of PHYs, the PHY that recovers its clock from the received signal and uses it to determine the timing of transmitter operations. It also uses the slave transmit scrambler generator polynomial for side-stream scrambling. Master and slave PHY status is determined during the Auto-Negotiation process that takes place prior to establishing the transmission link, or in the case of a PHY where Auto-Negotiation is optional and not used, master and slave PHY status is determined by management or hardware configuration. *See also:* **master Physical Layer (PHY)**.

Change 1.4.471 as follows:

1.4.471 ternary symbol: In 10BASE-T1L, 100BASE-T4, and 100BASE-T1, a ternary data element. A ternary symbol can have one of three values: –1, 0, or +1. (See IEEE Std 802.3, Clause 23 ~~and~~, Clause 96, and Clause 146.)

Insert the following new definition after 1.4.495 "Type D PoDL System":

1.4.495a Type E PoDL System: A system comprising a PoDL PSE, link section, and PD that are compatible with 10BASE-T1L PHYs.

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1.5 Abbreviations

Insert the following new abbreviations into the list, in alphanumeric order:

DCR	direct current resistance
FSM	Finite State Machine
PLCA	Physical Layer Collision Avoidance

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9. Repeater unit for 10 Mb/s baseband networks

9.1 Overview

Change the first paragraph of 9.1 as follows:

This clause specifies a repeater for use with IEEE 802.3 10 Mb/s baseband networks, with the exceptions of 10BASE-T1L (Clause 146) and 10BASE-T1S (Clause 147). A repeater for any other IEEE 802.3 network type is beyond the scope of this clause.

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22. Reconciliation Sublayer (RS) and Media Independent Interface (MII)

22.1 Overview

Change Figure 22-1 as follows (see changes at the bottom of the right column):

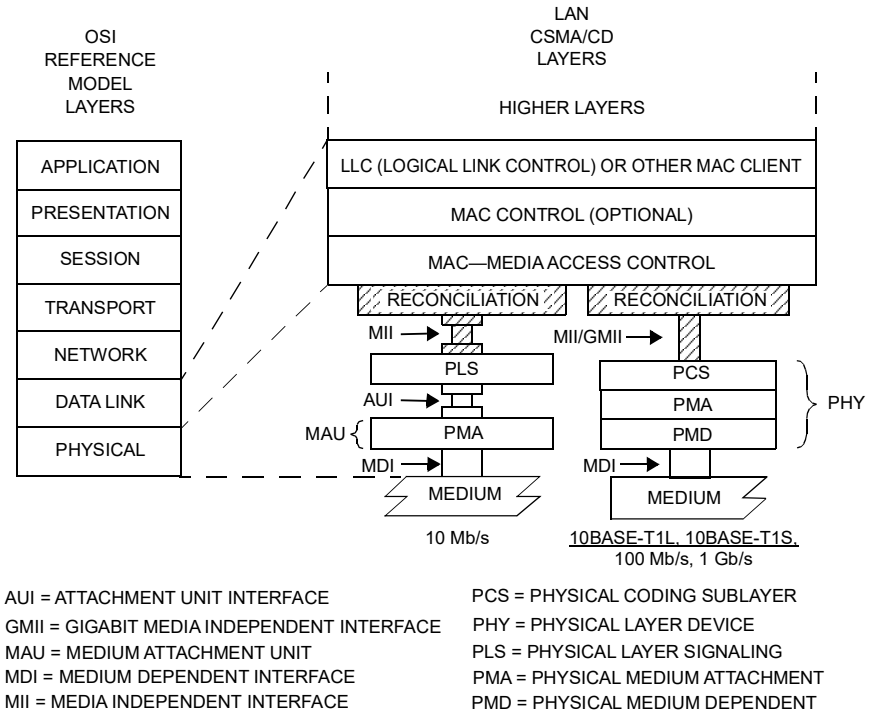

Figure 22–1—MII relationship to the ISO/IEC Open Systems Interconnection (OSI) reference model and the IEEE 802.3 CSMA/CD LAN model

22.2 Functional specifications

22.2.2 MII signal functional specifications

22.2.2.4 TXD (transmit data)

Change the second paragraph in 22.2.2.4 as follows:

For EEE capability, the RS shall use the combination of TX_EN deasserted, TX_ER asserted, and TXD<3:0> equal to 0001 as shown in Table 22–1 as a request to enter, or remain in a low power state. ~~Other values of TXD<3:0> with this combination of TX_EN and TX_ER shall have no effect upon the PHY.~~

Insert the following new paragraphs after the second paragraph in 22.2.2.4:

When PLCA capability is supported and enabled (see 30.16.1.1.1), the RS shall use the combination of TX_EN deasserted, TX_ER asserted, and TXD<3:0> equal to 0010 or 0011 as shown in Table 22–1 to send respectively a BEACON request or a COMMIT request as defined in 148.4.4.1.

When TX_EN is deasserted and TX_ER is asserted, values of TXD<3:0> other than 0001, 0010, and 0011 shall have no effect upon the PHY.

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Change Table 22-1 as follows (unchanged rows not shown):

Table 22–1—Permissible encodings of TXD<3:0>, TX_EN, and TX_ER

TX_EN	TX_ER	TXD<3:0>	Indication
…			
0	1	0010	PLCA BEACON request
0	1	0011	PLCA COMMIT request
0	1	~~0010~~0100 through 1111	Reserved
…			

22.2.2.5 TX_ER (transmit coding error)

Change the second paragraph in 22.2.2.5 as follows:

Assertion of the TX_ER signal shall not affect the transmission of data when TX_EN is deasserted. Additionally, the assertion of TX_ER signal shall not affect the transmission of data when a PHY is operating at 10 Mb/s, ~~or when TX_EN is deasserted.~~ with the exception of 10BASE-T1L (see 146.3.3.1) and 10BASE-T1S (see 147.3.2.1, Figure 147–4).

22.2.2.8 RXD (receive data)

Insert the following new paragraph into 22.2.2.8 after the third paragraph ("For EEE capability, the PHY ...."):

When PLCA capability is supported and enabled, the PHY indicates that it is receiving a BEACON or COMMIT by asserting the RX_ER signal and driving respectively the values 0010 or 0011 onto RXD<3:0> while RX_DV is deasserted. See 148.4.4.1 for the definition and usage of PLCA BEACON and COMMIT.

Change Table 22-2 as follows (unchanged rows not shown):

Table 22–2—Permissible encoding of RXD<3:0>, RX_ER, and RX_DV

RX_DV	RX_ER	RXD<3:0>	Indication
…			
0	1	0010	PLCA BEACON indication
0	1	0011	PLCA COMMIT indication
0	1	~~0010~~0100 through 1101	Reserved
…			

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22.8 Protocol implementation conformance statement (PICS) proforma for Clause 22, Reconciliation Sublayer (RS) and Media Independent Interface (MII)[5]

22.8.2 Identification

22.8.2.3 Major capabilities/options

Insert the following new row at the end of the table in 22.8.2.3:

Item	Feature	Subclause	Status	Support	Value/Comment
*PLCA	Implementation of PLCA	22.2.2.4	O		

22.8.3 PICS proforma tables for reconciliation sublayer and media independent interface

22.8.3.2 MII signal functional specifications

Change the table in 22.8.3.2 as follows (unchanged rows not shown):

Item	Feature	Subclause	Status	Support	Value/Comment
…					
~~SF15~~	~~TXD<3:0> effect on PHY while TX_EN is de-asserted~~	~~22.2.2.4~~	~~M~~		~~No effect~~
…					
SF18	TX_ER effect on PHY while operating at 10 Mb/s (with the exception of 10BASE-T1S and 10BASE-T1L), or when TX_EN is deasserted	22.2.2.5	M		No effect on PHY
…					
SF39	Effect on PHY while TXD<3:0> is 0010, and TX_EN is deasserted, and TX_ER is asserted	22.2.2.4	PLCA: M		RS sends BEACON request
SF40	Effect on PHY while TXD<3:0> is 0011, and TX_EN is deasserted, and TX_ER is asserted	22.2.2.4	PLCA: M		RS sends COMMIT request
SF41	Effect on PHY while TXD<3:0> is any value other than 0010 or 0011, and TX_EN is deasserted, and TX_ER is asserted	22.2.2.4	PLCA: M		No effect

[5] *Copyright release for PICS proformas:* Users of this standard may freely reproduce the PICS proforma in this subclause so that it can be used for its intended purpose and may further publish the completed PICS.

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30. Management

30.2 Managed objects

30.2.2 Overview of managed objects

30.2.2.1 Text description of managed objects

Change the description for oPHYEntity in 30.2.2.1 as follows:

oPHYEntity	If oOMPEmulation is implemented, oPHYEntity is contained within oOMPEmulation. If oMACMergeEntity is implemented, oPHYEntity is contained within oMACMergeEntity. Otherwise oPHYEntity is contained within oMACEntity. Many instances of oPHYEntity may coexist within one instance of oMACEntity or oMACMergeEntity; however, only one PHY may be active for data transfer to and from the MAC at any one time. oPHYEntity is the managed object that contains the MAU, PAF, PLCA, PSE, and PoDLPSE managed objects in a DTE.

Insert the following description for oPLCA into 30.2.2.1 (as amended by IEEE Std 802.3bt-2018) after the description for oPAF:

oPLCA	If implemented, oPLCA is contained within oPHYEntity. The oPLCA managed object class provides the management controls necessary to allow an instance of a PLCA RS to be managed.

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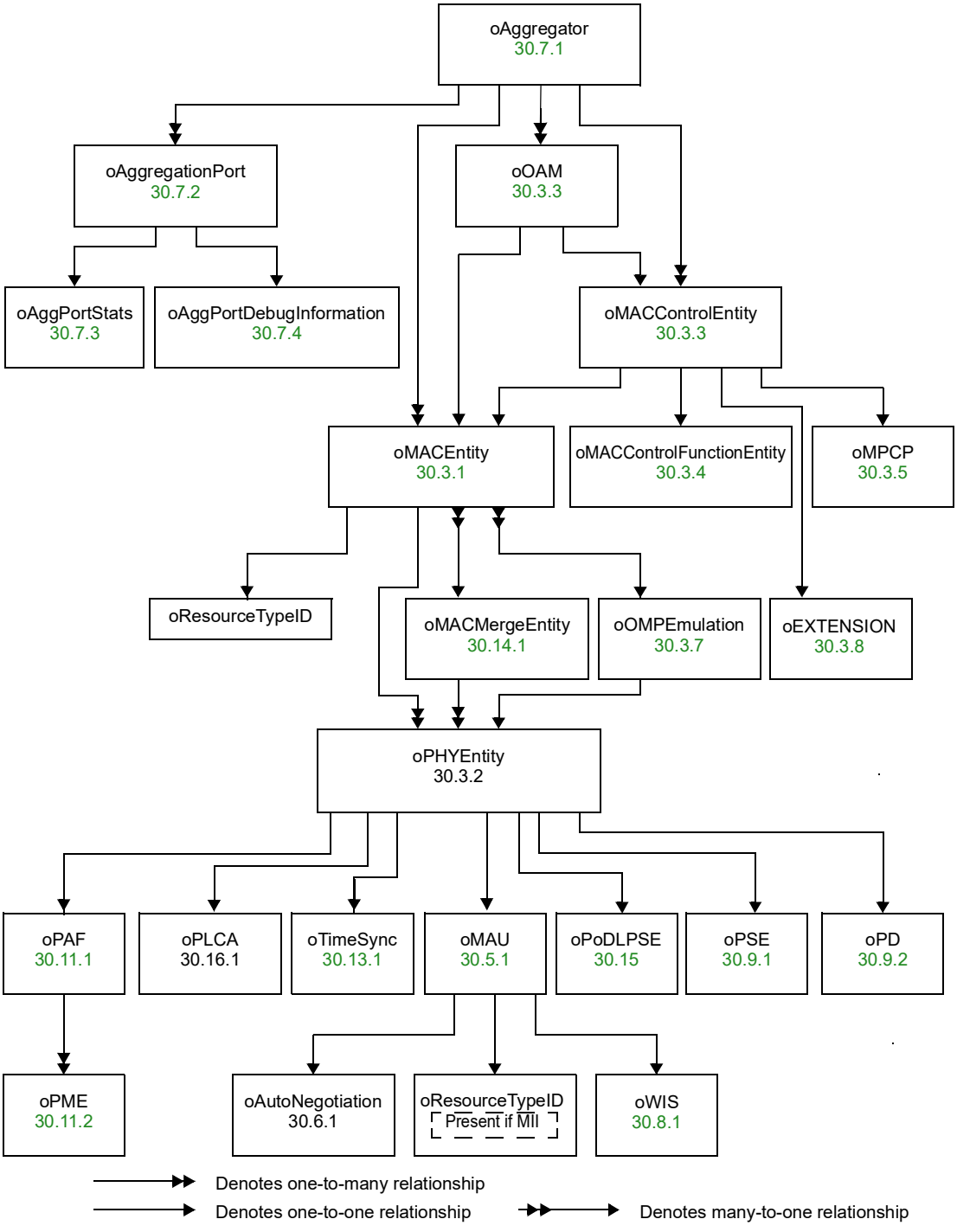
30.2.3 Containment

Replace Figure 30-3 with the following figure (which includes oPLCA):



NOTE—The objects oAggregator, oAggregationPort, oAggPortStats, and oAggPortDebugInformation are deprecated by IEEE Std 802.1AX™-2008.

Figure 30–3—DTE System entity relationship diagram

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30.2.5 Capabilities

Change the last sentence of the first paragraph of 30.2.5 as follows:

The capabilities and packages for IEEE 802.3 Management are specified in Table 30-1a through ~~Table 30-10~~Table 30–11.

Insert the following new table (Table 30–11) after Table 30-10:

Table 30–11—PLCA capabilities

				PLCA capability (optional)
oPLCA managed object class (30.16.1)				
	aPLCAAdminState	ATTRIBUTE	GET	X
	aPLCAStatus	ATTRIBUTE	GET	X
	aPLCABurstTimer	ATTRIBUTE	GET-SET	X
	aPLCALocalNodeID	ATTRIBUTE	GET-SET	X
	aPLCAMaxBurstCount	ATTRIBUTE	GET-SET	X
	aPLCANodeCount	ATTRIBUTE	GET-SET	X
	aPLCATransmitOpportunityTimer	ATTRIBUTE	GET-SET	X
	acPLCAAdminControl	ACTION		X
	acPLCAReset	ACTION		X

30.3 Layer management for DTEs

30.3.2 PHY device managed object class

30.3.2.1 PHY device attributes

30.3.2.1.2 aPhyType

Insert the following new entries in the APPROPRIATE SYNTAX section of 30.3.2.1.2 after the entry for "10 Mb/s":

10BASE-T1L Clause 146 10 Mb/s PAM3
10BASE-T1S Clause 147 10 Mb/s DME

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30.3.2.1.3 aPhyTypeList

Insert the following new entries in the APPROPRIATE SYNTAX section of 30.3.2.1.3 after the entry for "10 Mb/s":

10BASE-T1L Clause 146 10 Mb/s PAM3
10BASE-T1S Clause 147 10 Mb/s DME

30.5 Layer management for medium attachment units (MAUs)

30.5.1 MAU managed object class

30.5.1.1 MAU attributes

30.5.1.1.2 aMAUType

Insert the following new entries in the APPROPRIATE SYNTAX section of 30.5.1.1.2 after the entry for "10BASE-FLFD":

10BASE-T1L	Single balanced pair PHY as specified in Clause 146
10BASE-T1SHD	Single balanced pair PHY as specified in Clause 147, half duplex mode
10BASE-T1SMD	Single balanced pair PHY as specified in Clause 147, multidrop mode
10BASE-T1SFD	Single balanced pair PHY as specified in Clause 147, full duplex mode

30.5.1.1.4 aMediaAvailable

Change the fourth sentence of the third paragraph of the BEHAVIOUR DEFINED AS section of 30.5.1.1.4 as follows:

For 10BASE-T1L and 100BASE-T1, a link_status of OK maps to the enumeration "available".

30.6 Management for link Auto-Negotiation

30.6.1 Auto-Negotiation managed object class

30.6.1.1 Auto-Negotiation attributes

30.6.1.1.5 aAutoNegLocalTechnologyAbility

Insert the following new entries in APPROPRIATE SYNTAX section of 30.6.1.1.5 after the entry for "10BASE-T":

10BASE-T1L	10BASE-T1L as specified in Clause 146
10BASE-T1S	10BASE-T1S as specified in Clause 147

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30.15 Layer management for Power over Data Lines (PoDL) of Single Balanced Twisted-Pair Ethernet

30.15.1 PoDL PSE managed object class

30.15.1.1 PoDL PSE attributes

30.15.1.1.4 aPoDLPSEType

Insert the following new entry in the APPROPRIATE SYNTAX section of 30.15.1.1.4 after the entry for "typeD":

typeE	Type E PoDL PSE

30.15.1.1.5 aPoDLPSEDetectedPDType

Insert the following new entry in the APPROPRIATE SYNTAX section of 30.15.1.1.5 after the entry for "typeD":

typeE	Type E PoDL PD

30.15.1.1.6 aPoDLPSEDetectedPDPowerClass

Insert the following new entries in the APPROPRIATE SYNTAX section of 30.15.1.1.6 after the entry for "class 9":

class10	Class 10 PoDL PD
class11	Class 11 PoDL PD
class12	Class 12 PoDL PD
class13	Class 13 PoDL PD
class14	Class 14 PoDL PD
class15	Class 15 PoDL PD

Change text of BEHAVIOUR DEFINED AS section of 30.15.1.1.6 as shown:

BEHAVIOUR DEFINED AS:

A read-only value that indicates the class of the detected PoDL PD as specified in Table 104-1 and Table 104–1a. This value is only valid while a PD is being powered, that is the attribute aPoDLPSEPowerDetectionStatus is reporting the enumeration "deliveringPower".

If a Clause 45 MDIO Interface to the PoDL PSE function is present, then this attribute may be derived from the PD Class and PD Extended Class bits specified in 45.2.9.2.8 and 45.2.9.3.1a.;

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Insert the following new subclauses (30.16 through 30.16.1.2.2) after 30.15 (and its subclauses):

30.16 Management for PLCA Reconciliation Sublayer

30.16.1 PLCA managed object class

This subclause formally defines the behaviours for the oPLCA managed object class attributes and actions.

30.16.1.1 PLCA attributes

30.16.1.1.1 aPLCAAdminState

ATTRIBUTE

APPROPRIATE SYNTAX:
An ENUMERATED VALUE that has the following entries:
disabled
enabled

BEHAVIOUR DEFINED AS:
A read-only value that indicates the mode of operation of the Reconciliation Sublayer for PLCA operation. When PLCA is enabled, the Reconciliation Sublayer functions in PLCA mode, whose operation is defined by Clause 148. When PLCA functions are not supported or are disabled by the management interface (plca_en = FALSE), RS operation shall conform to the RS definition in Clause 22. By default, PLCA is disabled.;

30.16.1.1.2 aPLCAStatus

ATTRIBUTE

APPROPRIATE SYNTAX:
An ENUMERATED VALUE that has the following entries:
TRUE
FALSE

BEHAVIOUR DEFINED AS:
A read-only value that indicates whether PLCA Control state diagram is receiving BEACON indication or transmitting BEACON request. This parameter maps to the plca_status variable in 148.4.6.2.;

30.16.1.1.3 aPLCANodeCount

ATTRIBUTE

APPROPRIATE SYNTAX:
INTEGER

BEHAVIOUR DEFINED AS:
This value is assigned to define the number of nodes getting a transmit opportunity before a new BEACON is generated. Valid range is 0 to 255, inclusive. The default value is 8.;

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30.16.1.1.4 aPLCALocalNodeID

ATTRIBUTE

APPROPRIATE SYNTAX:
INTEGER

BEHAVIOUR DEFINED AS:
This value is assigned to define the ID of the local node on the PLCA network. The default value is 255. Value range is 0 to 255, inclusive.;

30.16.1.1.5 aPLCATransmitOpportunityTimer

ATTRIBUTE

APPROPRIATE SYNTAX:
INTEGER

BEHAVIOUR DEFINED AS:
This value is assigned to define the time between PLCA transmit opportunities for the node. aPLCATransmitOpportunityTimer maps to the duration of the timer to_timer. The value of aPLCATransmitOpportunityTimer represents the duration of to_timer in bit times. Valid range is 1 to 255, inclusive. The default value is 32. See 148.4.4.4.;

30.16.1.1.6 aPLCAMaxBurstCount

ATTRIBUTE

APPROPRIATE SYNTAX:
INTEGER

BEHAVIOUR DEFINED AS:
Maximum number of additional packets the node is allowed to transmit in a single transmit opportunity as specified in 148.4.4.1 and 148.4.4.2. Valid range is 0 to 255, inclusive. The default value is 0.;

30.16.1.1.7 aPLCABurstTimer

ATTRIBUTE

APPROPRIATE SYNTAX:
INTEGER

BEHAVIOUR DEFINED AS:
This value sets the maximum number of bit-times PLCA waits for the MAC to send a new packet before yielding the transmit opportunity. See definition in 148.4.4.1 and 148.4.4.2. Valid range is 0 to 255, inclusive. The default value is 128.;

30.16.1.2 PLCA device actions

30.16.1.2.1 acPLCAAdminControl

ACTION

APPROPRIATE SYNTAX:
An ENUMERATED VALUE that has the following entries:
disabled
enabled

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BEHAVIOUR DEFINED AS:

This action provides a means to alter aPLCAAdminState. Setting acPLCAAdminControl to the disabled state sets the variable plca_en to FALSE and disables the PLCA functionality specified in Clause 148. Setting acPLCAAdminControl to the enabled state sets the variable plca_en to TRUE in Figure 148–3, Figure 148–4, Figure 148–5, Figure 148–6, and Figure 148–7.;

30.16.1.2.2 acPLCAReset

ACTION

APPROPRIATE SYNTAX:

An ENUMERATED VALUE that has the following entries:
reset
normal

BEHAVIOUR DEFINED AS:

This action provides a means to reset the PLCA Reconciliation Sublayer functions. See 148.4.4.2.;

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45. Management Data Input/Output (MDIO) Interface

45.2 MDIO Interface Registers

45.2.1 PMA/PMD registers

Change Table 45–3 as follows (unchanged rows not shown):

Table 45–3—PMA/PMD registers

Register address	Register name	Subclause
…		
1.2103 through 1.2293~~303~~	Reserved	
1.2294	10BASE-T1L PMA control	45.2.1.186a
1.2295	10BASE-T1L PMA status	45.2.1.186b
1.2296	10BASE-T1L test mode control	45.2.1.186c
1.2297	10BASE-T1S PMA control	45.2.1.186d
1.2298	10BASE-T1S PMA status	45.2.1.186e
1.2299	10BASE-T1S test mode control	45.2.1.186f
1.2300 through 1.2303	Reserved	
…		

45.2.1.7 PMA/PMD status 2 register (Register 1.8)

45.2.1.7.4 Transmit fault (1.8.11)

Insert the following new row at the beginning of Table 45–9:

Table 45–9—Transmit fault description location

PMA/PMD	Description location
10BASE-T1L	146.4.2

45.2.1.7.5 Receive fault (1.8.10)

Insert the following new row at the beginning of Table 45–10:

Table 45–10—Receive fault description location

PMA/PMD	Description location
10BASE-T1L	146.4.3

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45.2.1.16 BASE-T1 PMA/PMD extended ability register (1.18)

Change Table 45-19 as follows (unchanged rows not shown):

Table 45–19—BASE-T1 PMA/PMD extended ability register bit definitions

Bit(s)	Name	Description	R/W[a]
1.18.15:~~2~~4	Reserved	Value always 0	RO
1.18.3	10BASE-T1S ability	1 = PMA/PMD is able to perform 10BASE-T1S 0 = PMA/PMD is not able to perform 10BASE-T1S	RO
1.18.2	10BASE-T1L ability	1 = PMA/PMD is able to perform 10BASE-T1L 0 = PMA/PMD is not able to perform 10BASE-T1L	RO
…			

[a]RO = Read only

45.2.1.185 BASE-T1 PMA/PMD control register (Register 1.2100)

Change Table 45-149 as follows (unchanged rows not shown):

Table 45–149—BASE-T1 PMA/PMD control register bit definitions

Bit(s)	Name	Description	R/W[a]
…			
1.2100.3:0	Type Selection	3 2 1 0 1 x x x = Reserved 0 1 x x = Reserved 0 0 1 1 = 10BASE-T1S 0 0 1 ~~x~~0 = ~~Reserved~~10BASE-T1L 0 0 0 1 = 1000BASE-T1 0 0 0 0 = 100BASE-T1	R/W

[a]RO = Read only, R/W = Read/Write

45.2.1.185.2 Type selection (1.2100.3:0)

Change 45.1.185.2 as follows:

Bits 1.2100.3:0 are used to set the mode of operation when Auto-Negotiation enable bit 7.512.12 is set to zero, or if Auto-Negotiation is not implemented. When these bits are set to 0000, the mode of operation is 100BASE-T1. When these bits are set to 0001, the mode of operation is 1000BASE-T1. When these bits are set to 0010, the mode of operation is 10BASE-T1L. When these bits are set to 0011, the mode of operation is 10BASE-T1S. These bits shall be ignored when the Auto-Negotiation enable bit 7.512.12 is set to one.

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Insert the following new subclauses (45.2.1.186a through 45.2.1.186f.1, including Table 45-150a through Table 45-150f) after 45.2.1.186.1:

45.2.1.186a 10BASE-T1L PMA control register (Register 1.2294)

The assignment of bits in the 10BASE-T1L PMA control register is shown in Table 45–150a.

Table 45–150a—10BASE-T1L PMA control register bit definitions

Bit(s)	Name	Description	R/W[a]
1.2294.15	PMA reset	1 = PMA reset 0 = Normal operation	R/W, SC
1.2294.14	Transmit disable	1 = Transmit disable 0 = Normal operation	R/W
1.2294.13	Reserved	Value always zero	RO
1.2294.12	Transmit voltage amplitude control	1 = Enable 2.4 Vpp operating mode 0 = Enable 1.0 Vpp operating mode	R/W
1.2294.11	Low-power	1 = Low-power mode 0 = Normal operation	R/W
1.2294.10	EEE enable	1 = Enable EEE mode 0 = Disable EEE mode	R/W
1.2294.9:1	Reserved	Value always 0	RO
1.2294.0	Loopback	1 = Enable loopback mode 0 = Disable loopback mode	R/W

[a]RO = Read only, R/W = Read/Write, SC = Self-clearing

45.2.1.186a.1 PMA reset (1.2294.15)

Resetting the 10BASE-T1L PMA is accomplished by setting bit 1.2294.15 to one. This action shall set all 10BASE-T1L PMA registers to their default states. As a consequence, this action may change the internal state of the 10BASE-T1L PMA and the state of the physical link. This action may also initiate a reset in any other MMDs that are instantiated in the same package. This bit is self-clearing, and the 10BASE-T1L PMA shall return a value of one in bit 1.2294.15 when a reset is in progress; otherwise, it shall return a value of zero. The 10BASE-T1L PMA is not required to accept a write transaction to any of its registers until the reset process is completed. The control and management interface shall be restored to operation within 0.5 s from the setting of bit 1.2294.15.

During a reset, the 10BASE-T1L PMA shall respond to reads from bits 1.2294.15, 1.8.15:14, and 1.0.15. Reads for all other bits are indeterminate, and the values are invalid.

NOTE—This operation may interrupt data communication.

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Bit 1.2294.15 is a copy of bit 1.0.15, and setting or clearing either bit shall set or clear the other bit. Setting either bit shall reset the 10BASE-T1L PMA.

45.2.1.186a.2 Transmit disable (1.2294.14)

When bit 1.2294.14 is set to one, the PMA shall disable output on the transmit path. When bit 1.2294.14 is set to zero, the PMA shall enable output on the transmit path.

Bit 1.2294.14 is a copy of bit 1.9.0, and setting or clearing either bit shall set or clear the other bit. Setting either bit shall disable the transmitter.

45.2.1.186a.3 Transmit voltage amplitude control (1.2294.12)

Bit 1.2294.12 is used to set the 2.4 Vpp operating mode when Auto-Negotiation enable bit 7.512.12 is set to zero or if Auto-Negotiation is not implemented. If bit 1.2294.12 is set to one, the PHY shall operate in 2.4 Vpp operating mode according to 146.5.4.1. If bit 1.2294.12 is set to zero, the PHY shall operate in 1.0 Vpp operating mode according to 146.5.4.1. The default value of bit 1.2294.12 is zero. This bit shall be ignored when the Auto-Negotiation enable bit 7.512.12 is set to one.

45.2.1.186a.4 Low-power (1.2294.11)

When the low-power ability is supported, the 10BASE-T1L PMA may be placed into a low-power mode by setting bit 1.2294.11 to one. This action may also initiate a low-power mode in any other MMDs that are instantiated in the same package. The low-power mode is exited by resetting the 10BASE-T1L PMA. The behavior of the 10BASE-T1L PMA in transition to and from the low-power mode is implementation specific, and any interface signals should not be relied upon. While in the low-power mode, the device shall, as a minimum, respond to management transactions necessary to exit the low-power mode. The default value of bit 1.2294.11 is zero.

NOTE—This operation may interrupt data communication. The data path of the 10BASE-T1L PMA, depending on implementation, may take many seconds to run at optimum error ratio after exiting from reset or low-power mode.

Bit 1.2294.11 is a copy of bit 1.0.11, and setting or clearing either bit shall set or clear the other bit. Setting either bit shall put the 10BASE-T1L PMA in low-power mode.

45.2.1.186a.5 EEE enable (1.2294.10)

Bit 1.2294.10 is used to enable EEE functionality when Auto-Negotiation enable bit 7.512.12 is set to zero or if Auto-Negotiation is not implemented. If bit 1.2294.10 is set to one, the PHY shall operate with EEE enabled. If bit 1.2294.10 is set to zero, the PHY shall operate with EEE disabled. This bit shall be ignored when the Auto-Negotiation enable bit 7.512.12 is set to one. The default value of bit 1.2294.10 is zero.

45.2.1.186a.6 Loopback (1.2294.0)

The 10BASE-T1L PMA shall be placed in near-end loopback mode of operation when bit 1.2294.0 is set to one. When in loopback mode, the 10BASE-T1L PMA shall accept data on the transmit path and return it on the receive path. The default value of bit 1.2294.0 is zero. Bit 1.2294.0 is a copy of 1.0.0, and setting or clearing either bit shall set or clear the other bit. Setting either bit shall enable loopback.

45.2.1.186b 10BASE-T1L PMA status register (Register 1.2295)

The assignment of bits in the 10BASE-T1L PMA status register is shown in Table 45–150b.

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Table 45–150b—10BASE-T1L PMA status register bit definitions

Bit(s)	Name	Description	R/W[a]
1.2295.15:14	Reserved	Value always 0	RO
1.2295.13	Loopback ability	1 = PHY has loopback ability 0 = PHY has no loopback ability	RO
1.2295.12	2.4 Vpp operating mode ability	1 = PHY has 2.4 Vpp operating mode ability 0 = PHY does not have 2.4 Vpp operating mode ability	RO
1.2295.11	Low-power ability	1 = PMA has low-power ability 0 = PMA does not have low-power ability	RO
1.2295.10	EEE ability	1 = PHY has EEE ability 0 = PHY does not have EEE ability	RO
1.2295.9	Receive fault ability	1 = PMA has the ability to detect a fault condition on the receive path 0 = PMA does not have the ability to detect a fault condition on the receive path	RO
1.2295.8:3	Reserved	Value always 0	RO
1.2295.2	Receive polarity	1 = Receive polarity is reversed 0 = Receive polarity is not reversed	RO
1.2295.1	Receive fault	1 = Fault condition detected 0 = Fault condition not detected	RO/LH
1.2295.0	Receive link status	1 = PMA receive link up 0 = PMA receive link down	RO/LL

[a]RO = Read only, LL = Latching low, LH = Latching high

45.2.1.186b.1 Loopback ability (1.2295.13)

When read as a one, this bit indicates that the 10BASE-T1L PHY supports PMA loopback. When read as a zero, this bit indicates that the 10BASE-T1L PHY does not support PMA loopback.

45.2.1.186b.2 2.4 Vpp operating mode ability (1.2295.12)

When read as a one, this bit indicates that the 10BASE-T1L PHY supports a transmit level of 2.4 Vpp. When read as a zero, this bit indicates that the 10BASE-T1L PHY does not support a transmit level of 2.4 Vpp.

45.2.1.186b.3 Low-power ability (1.2295.11)

When read as a one, bit 1.2295.11 indicates that the 10BASE-T1L PMA supports the low-power ability. When read as a zero, bit 1.2295.11 indicates that the 10BASE-T1L PMA does not support the low-power ability. If the 10BASE-T1L PMA supports the low-power ability, then it is controlled using either bit 1.2294.11 or bit 1.0.11.

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