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ISO/ IEC/IEEE 8802-3

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AMENDMENT 5
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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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Contents

1. Introduction ... 26

1.1 Overview ... 26
1.1.3 Architectural perspectives ... 26
1.3 Normative references ... 26
1.4 Definitions ... 27
1.5 Abbreviations ... 29

9. Repeater unit for 10 Mb/s baseband networks ... 30

9.1 Overview ... 30

22. Reconciliation Sublayer (RS) and Media Independent Interface (MII) ... 31

22.1 Overview ... 31
22.2 Functional specifications ... 31
22.2.2 MII signal functional specifications ... 31
22.2.2.4 TXD (transmit data) ... 31
22.2.2.5 TX_ER (transmit coding error) ... 32
22.2.2.8 RXD (receive data) ... 32
22.8 Protocol implementation conformance statement (PICS) proforma for Clause 22, Reconciliation Sublayer (RS) and Media Independent Interface (MII) ... 33
22.8.2 Identification ... 33
22.8.2.3 Major capabilities/options ... 33
22.8.3 PICS proforma tables for reconciliation sublayer and media independent interface 33
22.8.3.2 MII signal functional specifications ... 33

30. Management ... 34

30.2 Managed objects ... 34
30.2.2 Overview of managed objects ... 34
30.2.2.1 Text description of managed objects ... 34
30.2.3 Containment ... 35
30.2.5 Capabilities ... 36
30.3 Layer management for DTEs ... 36
30.3.2 PHY device managed object class ... 36
30.3.2.1 PHY device attributes ... 36
30.3.2.1.2 aPhyType ... 36
30.3.2.1.3 aPhyTypeList ... 37
30.5 Layer management for medium attachment units (MAUs) ... 37
30.5.1 MAU managed object class ... 37
30.5.1.1 MAU attributes ... 37
30.5.1.1.2 aMAUType ... 37
30.5.1.1.4 aMediaAvailable ... 37
30.6 Management for link Auto-Negotiation ... 37
30.6.1 Auto-Negotiation managed object class ... 37
30.6.1.1 Auto-Negotiation attributes ... 37
30.6.1.1.5 aAutoNegLocalTechnologyAbility ... 37
30.15 Layer management for Power over Data Lines (PoDL) of Single Balanced Twisted-Pair Ethernet ... 38
30.15.1 PoDL PSE managed object class ... 38

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30.15.1.1 PoDL PSE attributes 38
30.15.1.1.4 aPoDLPSEType 38
30.15.1.1.5 aPoDLPSEDetectedPDType 38
30.15.1.1.6 aPoDLPSEDetectedPDPowerClass 38
30.16 Management for PLCA Reconciliation Sublayer 39
30.16.1 PLCA managed object class 39
30.16.1.1 PLCA attributes 39
30.16.1.1.1 aPLCAAdminState 39
30.16.1.1.2 aPLCAStatus 39
30.16.1.1.3 aPLCANodeCount 39
30.16.1.1.4 aPLCALocalNodeID 40
30.16.1.1.5 aPLCATransmitOpportunityTimer 40
30.16.1.1.6 aPLCAMaxBurstCount 40
30.16.1.1.7 aPLCABurstTimer 40
30.16.1.2 PLCA device actions 40
30.16.1.2.1 acPLCAAdminControl 40
30.16.1.2.2 acPLCAReset 41

45. Management Data Input/Output (MDIO) Interface 42

45.2 MDIO Interface Registers 42
45.2.1 PMA/PMD registers 42
45.2.1.7 PMA/PMD status 2 register (Register 1.8) 42
45.2.1.7.4 Transmit fault (1.8.11) 42
45.2.1.7.5 Receive fault (1.8.10) 42
45.2.1.16 BASE-T1 PMA/PMD extended ability register (1.18) 43
45.2.1.185 BASE-T1 PMA/PMD control register (Register 1.2100) 43
45.2.1.185.2 Type selection (1.2100.3:0) 43
45.2.1.186a 10BASE-T1L PMA control register (Register 1.2294) 44
45.2.1.186a.1 PMA reset (1.2294.15) 44
45.2.1.186a.2 Transmit disable (1.2294.14) 45
45.2.1.186a.3 Transmit voltage amplitude control (1.2294.12) 45
45.2.1.186a.4 Low-power (1.2294.11) 45
45.2.1.186a.5 EEE enable (1.2294.10) 45
45.2.1.186a.6 Loopback (1.2294.0) 45
45.2.1.186b 10BASE-T1L PMA status register (Register 1.2295) 45
45.2.1.186b.1 Loopback ability (1.2295.13) 46
45.2.1.186b.2 2.4 Vpp operating mode ability (1.2295.12) 46
45.2.1.186b.3 Low-power ability (1.2295.11) 46
45.2.1.186b.4 EEE ability (1.2295.10) 47
45.2.1.186b.5 Receive fault ability (1.2295.9) 47
45.2.1.186b.6 Receive polarity (1.2295.2) 47
45.2.1.186b.7 Receive fault (1.2295.1) 47
45.2.1.186b.8 Receive link status (1.2295.0) 47
45.2.1.186c 10BASE-T1L test mode control register (Register 1.2296) 47
45.2.1.186c.1 Test mode control (1.2296.15:13) 48
45.2.1.186d 10BASE-T1S PMA control register (Register 1.2297) 48
45.2.1.186d.1 PMA reset (1.2297.15) 48
45.2.1.186d.2 Transmit disable (1.2297.14) 49
45.2.1.186d.3 Low-power (1.2297.11) 49
45.2.1.186d.4 Multidrop mode (1.2297.10) 49
45.2.1.186d.5 Loopback (1.2297.0) 49
45.2.1.186e 10BASE-T1S PMA status register (Register 1.2298) 49
45.2.1.186e.1 10BASE-T1S loopback ability (1.2298.13) 50

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45.2.1.186e.2 Low-power ability (1.2298.11) ... 50
45.2.1.186e.3 Multidrop ability (1.2298.10) ... 50
45.2.1.186e.4 Receive fault ability (1.2298.9) ... 50
45.2.1.186e.5 Receive fault (1.2298.1) ... 51
45.2.1.186f 10BASE-T1S test mode control register (Register 1.2299) ... 51
45.2.1.186f.1 Test mode control (1.2299.15:13) ... 51
45.2.3 PCS registers ... 51
45.2.3.68a 10BASE-T1L PCS control register (Register 3.2278) ... 52
45.2.3.68a.1 PCS reset (3.2278.15) ... 52
45.2.3.68a.2 Loopback (3.2278.14) ... 53
45.2.3.68b 10BASE-T1L PCS status register (Register 3.2279) ... 53
45.2.3.68b.1 Tx LPI received (3.2279.11) ... 54
45.2.3.68b.2 Rx LPI received (3.2279.10) ... 54
45.2.3.68b.3 Tx LPI indication (3.2279.9) ... 54
45.2.3.68b.4 Rx LPI indication (3.2279.8) ... 54
45.2.3.68b.5 Fault (3.2279.7) ... 54
45.2.3.68b.6 PCS receive link status (3.2279.2) ... 54
45.2.3.68c 10BASE-T1S PCS control register (Register 3.2291) ... 54
45.2.3.68c.1 PCS reset (3.2291.15) ... 55
45.2.3.68c.2 Loopback (3.2291.14) ... 55
45.2.3.68c.3 Duplex mode (3.2291.8) ... 55
45.2.3.68d 10BASE-T1S PCS status register (Register 3.2292) ... 56
45.2.3.68d.1 Fault (3.2292.7) ... 56
45.2.3.68e 10BASE-T1S PCS diagnostic 1 (Register 3.2293) ... 56
45.2.3.68e.1 Remote jabber count (3.2293.15:0) ... 56
45.2.3.68f 10BASE-T1S PCS diagnostic 2 (Register 3.2294) ... 57
45.2.3.68f.1 CorruptedTxCnt (3.2294.15:0) ... 57
45.2.7 Auto-Negotiation registers ... 57
45.2.7.25 10BASE-T1 AN control register (Register 7.526) ... 57
45.2.7.25.1 10BASE-T1L capability advertisement (7.526.15) ... 58
45.2.7.25.2 10BASE-T1L EEE ability advertisement (7.526.14) ... 58
45.2.7.25.3 10BASE-T1L increased transmit/receive level ability advertisement (7.526.13) ... 58
45.2.7.25.4 10BASE-T1L increased transmit level request (7.526.12) ... 59
45.2.7.25.5 10BASE-T1S full duplex ability advertisement (7.526.7) ... 59
45.2.7.25.6 10BASE-T1S half duplex capability advertisement (7.526.6) ... 59
45.2.7.26 10BASE-T1 AN status register (Register 7.527) ... 59
45.2.9 Power Unit Registers ... 60
45.2.9.1 PoDL PSE Control register (Register 13.0) ... 60
45.2.9.2 PoDL PSE Status 1 register (Register 13.1) ... 61
45.2.9.2.7 PSE Type (13.1.9:7) ... 61
45.2.9.2.8 PD Class (13.1.6:3) ... 61
45.2.9.3 PoDL PSE Status 2 register (Register 13.2) ... 62
45.2.9.3.1a PD Extended Class (13.2.10:9) ... 62
45.2.9.3.2 PD Type (13.2.2:0) ... 62
45.2.9.4 PoDL PSE Status 3 register (Register 13.3) ... 63
45.2.9.4.1 PD Assigned Power (13.3.11:0) ... 63
45.2.9.5 PoDL PSE Status 4 register (Register 13.4) ... 63
45.2.9.5.1 PD Requested Power (13.4.11:0) ... 63
45.5 Protocol implementation conformance statement (PICS) proforma for Clause 45, Management Data Input/Output (MDIO) interface ... 64
45.5.3 PICS proforma tables for the Management Data Input Output (MDIO) interface ... 64
45.5.3.3 PMA/PMD management functions ... 64

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45.5.3.7 PCS management functions ... 68
45.5.3.9 Auto-Negotiation management functions ... 70

78. Energy-Efficient Ethernet (EEE) ... 71

78.1 Overview ... 71
78.1.4 PHY types optionally supporting EEE ... 71
78.2 LPI mode timing parameters description ... 71
78.5 Communication link access latency ... 71

98. Auto-Negotiation for single differential-pair media ... 72

98.2 Functional specifications ... 72
98.2.1 Transmit function requirements ... 72
98.2.1.1 DME transmission ... 72
98.2.1.1.1 DME page encoding ... 72
98.2.1.1.2 DME page timing ... 72
98.2.1.1.3 DME page Delimiters ... 73
98.5 Detailed functions and state diagrams ... 74
98.5.1 State diagram variables ... 74
98.5.2 State diagram timers ... 74
98.5.5 State diagrams ... 77
98.5.6 High-speed and low-speed Auto-Negotiation modes ... 81
98.5.6.1 Variables ... 81
98.5.6.2 Functions ... 82
98.5.6.3 Timers ... 82
98.6 Protocol implementation conformance statement (PICS) proforma for Clause 98, Auto-Negotiation for Single Differential-Pair Media ... 83
98.6.2a Major capabilities/options ... 83
98.6.3 General ... 83
98.6.4 DME transmission ... 83
98.6.8 State diagram and variable definitions ... 84
98.6.9 High-speed and low-speed Auto-Negotiation modes ... 85

104. Power over Data Lines (PoDL) of Single Balanced Twisted-Pair Ethernet ... 86

104.1 Overview ... 86
104.1.3 PoDL system types ... 86
104.2 Link segment ... 86
104.3 Class power requirements ... 87
104.4 Power Sourcing Equipment (PSE) ... 87
104.4.1 PSE types ... 87
104.4.1a PI pin assignments ... 87
104.4.3 PSE state diagram ... 88
104.4.3.3 Variables ... 88
104.4.3.5 Functions ... 89
104.4.4 PSE detection of a PD ... 89
104.4.4.1 Detection probe requirements ... 89
104.4.6 PSE output requirements ... 90
104.4.6.3 Power feeding ripple and transients ... 91
104.5 Powered Device (PD) ... 91
104.5.1 PD types ... 91
104.5.1a PD PI ... 92
104.5.3 PD state diagram ... 92

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104.5.3.5 Functions ... 92
104.5.6 PD power ... 93
104.5.6.4 PD ripple and transients ... 94
104.6 Additional electrical specifications ... 94
104.6.2 Fault tolerance ... 94
104.7 Serial communication classification protocol (SCCP) ... 95
104.7.1 SCCP signaling ... 95
104.7.1.1 Initialization procedure—reset and presence pulses ... 95
104.7.1.2 Write time slots ... 95
104.7.1.3 Read time slots ... 96
104.7.1.4 Calculations for cable resistance ... 99
104.7.1.5 Calculations for power allocation ... 99
104.7.2 Serial communication classification protocols ... 100
104.7.2.4 Read_Scratchpad function command [0xAA] ... 101
104.7.2.5 CRC8 field ... 101
104.7.2.6 Read_VOLT_INFO command [0xBB] ... 102
104.7.2.7 Read_POWER_INFO command [0x77] ... 103
104.7.2.8 Write_POWER_ASSIGN command [0x99] ... 103
104.7.2.9 Read_POWER_ASSIGN command [0x81] ... 103
104.9 Protocol implementation conformance statement (PICS) proforma for Clause 104, Power over Data Lines (PoDL) of Single Balanced Twisted-Pair Ethernet ... 104
104.9.1 Introduction ... 104
104.9.2 Identification ... 104
104.9.2.2 Protocol summary ... 104
104.9.3 Major capabilities/options ... 105
104.9.4 PICS proforma tables for Clause 104, Power over Data Lines (PoDL) of Single Balanced Twisted-Pair Ethernet ... 105
104.9.4.1 Link Segment ... 105
104.9.4.2 Power Sourcing Equipment (PSE) ... 106
104.9.4.3 Powered Device (PD) ... 106
104.9.4.7 SCCP ... 106

146. Physical Coding Sublayer (PCS), Physical Medium Attachment (PMA) sublayer and baseband medium, type 10BASE-T1L ... 108

146.1 Overview ... 108
146.1.1 Relationship of 10BASE-T1L to other standards ... 108
146.1.2 Operation of 10BASE-T1L ... 108
146.1.2.1 Physical Coding Sublayer (PCS) ... 109
146.1.2.2 Physical Medium Attachment (PMA) sublayer ... 110
146.1.2.3 EEE capability ... 110
146.1.2.4 Signaling ... 110
146.1.3 Conventions in this clause ... 111
146.1.3.1 State diagram notation ... 111
146.1.3.2 State diagram timer specifications ... 111
146.1.3.3 Service specifications ... 111
146.2 Service primitives and interfaces ... 111
146.2.1 PMA_LINK.request ... 112
146.2.1.1 Semantics of the primitive ... 112
146.2.1.2 When generated ... 113
146.2.1.3 Effect of receipt ... 113
146.2.2 PMA_LINK.indication ... 113
146.2.2.1 Semantics of the primitive ... 113
146.2.2.2 When generated ... 113

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146.2.2.3 Effect of receipt ... 113
146.2.3 PMA_TXMODE.indication ... 113
146.2.3.1 Semantics of the primitive ... 113
146.2.3.2 When generated ... 114
146.2.3.3 Effect of receipt ... 114
146.2.4 PMA_UNITDATA.indication ... 114
146.2.4.1 Semantics of the primitive ... 114
146.2.4.2 When generated ... 114
146.2.4.3 Effect of receipt ... 114
146.2.5 PMA_UNITDATA.request ... 114
146.2.5.1 Semantics of the primitive ... 114
146.2.5.2 When generated ... 114
146.2.5.3 Effect of receipt ... 114
146.2.6 PMA_RXSTATUS.indication ... 115
146.2.6.1 Semantics of the primitive ... 115
146.2.6.2 When generated ... 115
146.2.6.3 Effect of receipt ... 115
146.2.7 PMA_REMRXSTATUS.request ... 115
146.2.7.1 Semantics of the primitive ... 115
146.2.7.2 When generated ... 115
146.2.7.3 Effect of receipt ... 115
146.2.8 PMA_SCRSTATUS.request ... 116
146.2.8.1 Semantics of the primitive ... 116
146.2.8.2 When generated ... 116
146.2.8.3 Effect of receipt ... 116
146.2.9 PMA_TXEN.request (tx_enable_mii) ... 116
146.2.9.1 Semantics of the primitive ... 116
146.2.9.2 When generated ... 116
146.2.9.3 Effect of receipt ... 116
146.2.10 PMA_RX_LPI_STATUS.request (rx_lpi_active) ... 117
146.2.10.1 Semantics of the primitive ... 117
146.2.10.2 When generated ... 117
146.2.10.3 Effect of receipt ... 117
146.2.11 PMA_TX_LPI_STATUS.request (tx_lpi_active) ... 117
146.2.11.1 Semantics of the primitive ... 117
146.2.11.2 When generated ... 117
146.2.11.3 Effect of receipt ... 117
146.2.12 PMA_TX_LPI_STATUS.indication ... 118
146.2.12.1 Semantics of the primitive ... 118
146.2.12.2 When generated ... 118
146.2.12.3 Effect of receipt ... 118
146.3 Physical Coding Sublayer (PCS) functions ... 118
146.3.1 PCS Reset function ... 118
146.3.2 PCS Data Transmission Enable ... 120
146.3.2.1 Variables ... 120
146.3.3 PCS Transmit ... 121
146.3.3.1 PCS Transmit state diagram ... 121
146.3.3.1.1 Variables ... 122
146.3.3.1.2 Functions ... 123
146.3.3.1.3 Timers ... 124
146.3.3.1.4 Abbreviations ... 124
146.3.3.1.5 Constants ... 124
146.3.3.1.6 State diagram ... 125
146.3.3.2 PCS Transmit multiplexer state diagram ... 126

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146.3.3.2.1 Variables ... 126
146.3.3.2.2 Timers ... 126
146.3.3.2.3 Abbreviations ... 126
146.3.3.2.4 State diagram ... 127
146.3.3.3 PCS Transmit symbol generation ... 127
146.3.3.4 Data and idle stream scrambling ... 128
146.3.3.4.1 Side-stream scrambler polynomial ... 128
146.3.3.4.2 Generation of Syn[3:0] ... 128
146.3.3.4.3 Generation of scrambled bits Sdn[3:0] ... 129
146.3.3.5 Generation of code-groups ... 129
146.3.3.5.1 Generation of code-groups in mode SEND_N and SEND_I ... 129
146.3.3.5.2 Generation of code-groups in mode SEND_Z ... 131
146.3.4 PCS Receive ... 131
146.3.4.1 PCS Receive overview ... 131
146.3.4.1.1 Variables ... 132
146.3.4.1.2 Functions ... 133
146.3.4.1.3 Timers ... 134
146.3.4.1.4 Constants ... 134
146.3.4.1.5 State diagrams ... 134
146.3.4.2 PCS Receive symbol decoding ... 137
146.3.4.3 PCS Receive descrambler polynomial ... 138
146.3.4.4 PCS Receive automatic polarity detection ... 138
146.3.5 PCS loopback ... 138
146.4 Physical Medium Attachment (PMA) sublayer ... 138
146.4.1 PMA Reset function ... 140
146.4.2 PMA Transmit function ... 140
146.4.3 PMA Receive function ... 140
146.4.4 PHY Control function ... 141
146.4.4.1 Variables ... 142
146.4.4.2 Timers ... 143
146.4.4.3 State diagram ... 145
146.4.5 Link Monitor function ... 148
146.4.5.1 Variables ... 148
146.4.5.2 State diagram ... 148
146.4.6 PMA clock recovery ... 148
146.4.7 LPI quiet-refresh cycling ... 148
146.4.7.1 Variables ... 149
146.4.7.2 Timers ... 149
146.4.7.3 State diagram ... 150
146.5 PMA electrical specifications ... 151
146.5.1 EMC tests ... 151
146.5.1.1 Immunity—DPI test ... 151
146.5.1.2 Emission—Conducted emission test ... 151
146.5.2 Test modes ... 151
146.5.3 Test fixture ... 152
146.5.4 Transmitter electrical specifications ... 152
146.5.4.1 Transmitter output voltage ... 152
146.5.4.2 Transmitter output droop ... 153
146.5.4.3 Transmitter timing jitter ... 153
146.5.4.4 Transmitter Power Spectral Density (PSD) and power level ... 153
146.5.4.5 Transmit clock frequency ... 155
146.5.5 Receiver electrical specifications ... 155
146.5.5.1 Receiver differential input signals ... 155

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146.5.5.2 Receiver frequency tolerance 155
146.5.5.3 Alien crosstalk noise rejection 155
146.5.6 PMA local loopback 156
146.6 Management interface 156
146.6.1 Support for Auto-Negotiation 156
146.6.2 MASTER-SLAVE configuration 156
146.6.3 PHY initialization 157
146.6.4 Increased transmit level configuration 157
146.6.5 EEE configuration 157
146.6.6 PMA and PCS MDIO function mapping 157
146.7 Link segment characteristics 158
146.7.1 Link transmission parameters for 10BASE-T1L 158
146.7.1.1 Insertion loss 159
146.7.1.1.1 Insertion loss for PHYs in the 2.4 Vpp operation mode 159
146.7.1.1.2 Insertion loss supported for PHYs in 1.0 Vpp operation mode 160
146.7.1.2 Return loss 160
146.7.1.3 Maximum link delay 161
146.7.1.4 Differential to common mode conversion 161
146.7.1.5 Coupling attenuation 161
146.7.1.6 Electromagnetic classifications 162
146.7.2 Coupling parameters between 10BASE-T1L link segments 162
146.7.2.1 Multiple disturber power sum alien near-end crosstalk (PSANEXT) loss 162
146.7.2.2 Multiple disturber power sum alien far-end crosstalk (PSAFEXT) loss 163
146.8 MDI specification 163
146.8.1 MDI connectors 163
146.8.2 MDI electrical specification 166
146.8.3 MDI return loss 166
146.8.4 MDI mode conversion loss 166
146.8.5 MDI DC power voltage tolerance 166
146.8.6 MDI fault tolerance 166
146.9 Environmental specifications 167
146.9.1 General safety 167
146.9.2 Network safety 167
146.9.2.1 Environmental safety 167
146.9.2.2 Electromagnetic compatibility 168
146.10 Delay constraints 168
146.11 Protocol implementation conformance statement (PICS) proforma for Clause 146, Physical Coding Sublayer (PCS), Physical Medium Attachment (PMA) sublayer and baseband medium, type 10BASE-T1L 169
146.11.1 Introduction 169
146.11.2 Identification 169
146.11.2.1 Implementation identification 169
146.11.2.2 Protocol summary 169
146.11.3 Major capabilities/options 170
146.11.4 PICS proforma tables for Physical Coding Sublayer (PCS), Physical Medium Attachment (PMA) sublayer and baseband medium, type 10BASE-T1L 170
146.11.4.1 Physical Coding Sublayer (PCS) 170
146.11.4.1.1 PCS Transmit 170
146.11.4.1.2 PCS Receive 171
146.11.4.1.3 PCS loopback 172
146.11.4.2 Physical Medium Attachment (PMA) 172
146.11.4.2.1 PMA function 172

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146.11.4.2.2 PMA electrical specification ... 173
146.11.4.3 Management interface ... 175
146.11.4.4 Link Segment characteristics ... 176
146.11.4.5 MDI specifications ... 176
146.11.4.6 Environmental specifications ... 177
146.11.4.7 Delay constraints ... 177

147. Physical Coding Sublayer (PCS), Physical Medium Attachment (PMA) sublayer and baseband medium, type 10BASE-T1S ... 178

147.1 Overview ... 178
147.1.1 Relationship of 10BASE-T1S to other standards ... 178
147.1.2 Operation of 10BASE-T1S ... 178
147.1.3 Conventions in this clause ... 179
147.1.3.1 State diagram notation ... 179
147.1.3.2 State diagram timer specifications ... 179
147.1.3.3 Service specifications ... 180
147.2 Service primitives and interfaces ... 180
147.2.1 PMA_UNITDATA.indication ... 181
147.2.1.1 Semantics of the primitive ... 181
147.2.1.2 When generated ... 181
147.2.1.3 Effect of receipt ... 181
147.2.2 PMA_UNITDATA.request ... 181
147.2.2.1 Semantics of the primitive ... 181
147.2.2.2 When generated ... 181
147.2.2.3 Effect of receipt ... 181
147.2.3 Mapping of PMA_CARRIER.indication ... 182
147.2.3.1 Function ... 182
147.2.3.2 Semantic of the service primitive ... 182
147.2.3.3 When generated ... 182
147.2.4 PMA_LINK.request ... 182
147.2.4.1 Semantics of the primitive ... 182
147.2.4.2 When generated ... 182
147.2.5 PMA_LINK.indication ... 182
147.2.5.1 Semantics of the primitive ... 182
147.2.5.2 When generated ... 183
147.2.5.3 Effect of receipt ... 183
147.2.6 PCS_STATUS.indication ... 183
147.2.6.1 Semantics of the primitive ... 183
147.2.6.2 When generated ... 183
147.2.6.3 Effect of receipt ... 183
147.3 Physical Coding Sublayer (PCS) functions ... 183
147.3.1 PCS Reset function ... 183
147.3.2 PCS Transmit ... 184
147.3.2.1 PCS Transmit overview ... 184
147.3.2.2 Variables ... 185
147.3.2.3 Constants ... 186
147.3.2.4 Functions ... 187
147.3.2.5 Abbreviations ... 188
147.3.2.6 Timers ... 188
147.3.2.7 State diagram ... 189
147.3.2.8 Self-synchronizing scrambler ... 190
147.3.2.9 Jabber functional requirements ... 191

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147.3.3 PCS Receive ... 191
147.3.3.1 PCS Receive overview ... 191
147.3.3.2 Variables ... 192
147.3.3.3 Constants ... 192
147.3.3.4 Functions ... 193
147.3.3.5 Abbreviations ... 193
147.3.3.6 Timers ... 193
147.3.3.7 State diagrams ... 194
147.3.3.8 Self-synchronizing descrambler ... 196
147.3.3.9 Jabber diagnostics ... 196
147.3.4 PCS loopback ... 196
147.3.5 Collision detection ... 196
147.3.6 Carrier sense ... 197
147.3.7 Support for PCS status generation ... 197
147.3.7.1 Heartbeat transmit overview ... 197
147.3.7.1.1 Variables ... 197
147.3.7.1.2 Timers ... 198
147.3.7.1.3 State diagram ... 199
147.3.7.2 Heartbeat receive overview ... 200
147.3.7.2.1 Variables ... 200
147.3.7.2.2 Constants ... 201
147.3.7.2.3 Timers ... 201
147.3.7.2.4 State diagram ... 201
147.4 Physical Medium Attachment (PMA) sublayer ... 202
147.4.1 PMA Reset function ... 202
147.4.2 PMA Transmit function ... 202
147.4.3 PMA Receive function ... 203
147.4.4 Link Monitor function ... 204
147.4.4.1 Link Monitor overview ... 204
147.4.4.2 Variables ... 204
147.5 PMA electrical specifications ... 205
147.5.1 EMC tests ... 205
147.5.1.1 Immunity—DPI test ... 205
147.5.1.2 Emission—Conducted emission test ... 205
147.5.2 Test modes ... 205
147.5.3 Test fixtures ... 206
147.5.4 Transmitter electrical specification ... 207
147.5.4.1 Transmitter output voltage ... 207
147.5.4.2 Transmitter output droop ... 207
147.5.4.3 Transmitter timing jitter ... 207
147.5.4.4 Transmitter Power Spectral Density (PSD) ... 208
147.5.4.4.1 Upper PSD ... 208
147.5.4.4.2 PSD mask ... 208
147.5.4.5 Transmitter high impedance mode ... 209
147.5.5 Receiver electrical specifications ... 209
147.5.5.1 Receiver differential input signals ... 209
147.5.5.2 Alien crosstalk noise rejection ... 209
147.5.6 PMA local loopback ... 209
147.6 Management interface ... 210
147.6.1 Support for Auto-Negotiation ... 210
147.7 Point-to-point link segment characteristics ... 210
147.7.1 Insertion loss ... 210
147.7.2 Return loss ... 210
147.7.3 Mode conversion loss ... 211

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147.7.4 Power sum alien near-end crosstalk (PSANEXT) ... 211
147.7.5 Power sum alien attenuation to crosstalk ratio far-end (PSAACRF) ... 211
147.8 Mixing segment characteristics ... 211
147.8.1 Insertion loss ... 212
147.8.2 Return loss ... 212
147.8.3 Mode conversion loss ... 212
147.9 MDI specification ... 212
147.9.1 MDI connectors ... 212
147.9.2 MDI electrical specification ... 215
147.9.3 MDI line powering voltage tolerance ... 215
147.9.4 MDI fault tolerance ... 215
147.10 Environmental specifications ... 216
147.10.1 General safety ... 216
147.10.2 Network safety ... 216
147.10.2.1 Environmental safety ... 216
147.10.2.2 Electromagnetic compatibility ... 217
147.11 Delay constraints ... 217
147.12 Protocol implementation conformance statement (PICS) proforma for Clause 147, Physical Coding Sublayer (PCS), Physical Medium Attachment (PMA) sublayer and baseband medium, type 10BASE-T1S ... 218
147.12.1 Introduction ... 218
147.12.2 Identification ... 218
147.12.2.1 Implementation identification ... 218
147.12.2.2 Protocol summary ... 218
147.12.3 Major capabilities/options ... 219
147.12.4 PICS proforma tables for Physical Medium Attachment (PMA) sublayer and baseband medium, type 10BASE-T1S ... 219
147.12.4.1 PCS Transmit ... 219
147.12.4.2 PCS Receive ... 220
147.12.4.3 PCS loopback ... 220
147.12.4.4 Collision detection ... 221
147.12.4.5 Support for PCS status generation ... 221
147.12.4.6 Physical Medium Attachment (PMA) ... 221
147.12.4.6.1 PMA function ... 221
147.12.4.6.2 PMA electrical specification ... 222
147.12.4.7 Point-to-point link Segment characteristics ... 224
147.12.4.8 Mixing Segment characteristics ... 224
147.12.4.9 MDI specification ... 225
147.12.4.10 Delay constraints ... 225

148. PLCA Reconciliation Sublayer (RS) ... 226

148.1 Introduction ... 226
148.1.1 Conventions in this clause ... 226
148.1.1.1 State diagram notation ... 226
148.1.1.2 State diagram timer specifications ... 226
148.1.1.3 Service specifications ... 226
148.2 Overview ... 226
148.3 Relationship with other IEEE standards ... 227
148.4 PLCA Reconciliation Sublayer operation ... 228
148.4.1 General ... 228
148.4.2 Mapping of MII signals to PLS service primitives and PLCA functions ... 228
148.4.2.1 Mapping of PLS_DATA.request ... 228
148.4.2.1.1 Function ... 228

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148.4.2.1.2 Semantic of the service primitive 229
148.4.2.1.3 When generated 229
148.4.2.2 Mapping of PLS_DATA.indication 229
148.4.2.3 Mapping of PLS_CARRIER.indication 229
148.4.2.3.1 Function 229
148.4.2.3.2 Semantic of the service primitive 229
148.4.2.3.3 When generated 229
148.4.2.4 Mapping of PLS_SIGNAL.indication 229
148.4.2.4.1 Function 229
148.4.2.4.2 Semantic of the service primitive 230
148.4.2.4.3 When generated 230
148.4.2.5 Mapping of PLS_DATA_VALID.indication 230
148.4.2.6 Generation of TX_ER 230
148.4.2.7 Response to RX_ER indication 230
148.4.3 Requirements for the PHY 230
148.4.3.1 PHY response to PLCA commands and notifications 230
148.4.3.1.1 BEACON request 230
148.4.3.1.2 COMMIT request 230
148.4.3.2 Mapping of MII signals to PLCA variables 231
148.4.3.2.1 BEACON indication 231
148.4.3.2.2 COMMIT indication 231
148.4.4 PLCA Control 231
148.4.4.1 PLCA Control state diagram 231
148.4.4.2 PLCA Control variables 232
148.4.4.3 Functions 234
148.4.4.4 Timers 234
148.4.4.5 Abbreviations 235
148.4.4.6 State diagram 236
148.4.5 PLCA Data 238
148.4.5.1 PLCA Data state diagram 238
148.4.5.2 Variables 239
148.4.5.3 Functions 240
148.4.5.4 Timers 240
148.4.5.5 Abbreviations 240
148.4.5.6 Constants 240
148.4.5.7 State diagram 241
148.4.6 PLCA Status 243
148.4.6.1 PLCA Status state diagram 243
148.4.6.2 PLCA Status variables 243
148.4.6.3 Functions 243
148.4.6.4 Timers 243
148.4.6.5 State diagram 244
148.5 Protocol implementation conformance statement (PICS) proforma for Clause 148, PLCA Reconciliation Sublayer (RS) 245
148.5.1 Introduction 245
148.5.2 Identification 245
148.5.2.1 Implementation identification 245
148.5.2.2 Protocol summary 245
148.5.3 PICS proforma tables for PLCA Reconciliation Sublayer (RS) 246
148.5.3.1 Reconciliation Sublayer 246
148.5.3.2 Mapping of MII signals to PLS service primitives and PLCA functions 246
148.5.3.3 Specific RS and PHY specification 247
148.5.3.4 PLCA Control 247

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148.5.3.5 PLCA Data 247
148.5.3.6 PLCA Status 247

Annex A (informative) Bibliography 248

Annex 98B (normative) IEEE 802.3 Selector Base Page definition 249

98B.3 Technology Ability Field bit assignments 249
98B.3.1 10BASE-T1L-specific bit assignments 249
98B.4 Priority Resolution 249

Annex 146A (informative) Guidelines for implementation of the 10BASE-T1L PHY in an intrinsically safe application 250

Annex 146B (informative) Optional power distribution 253

146B.1 Overview 253
146B.2 Point-to-point powering topologies 253
146B.3 Powered trunk cable topologies 254

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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.

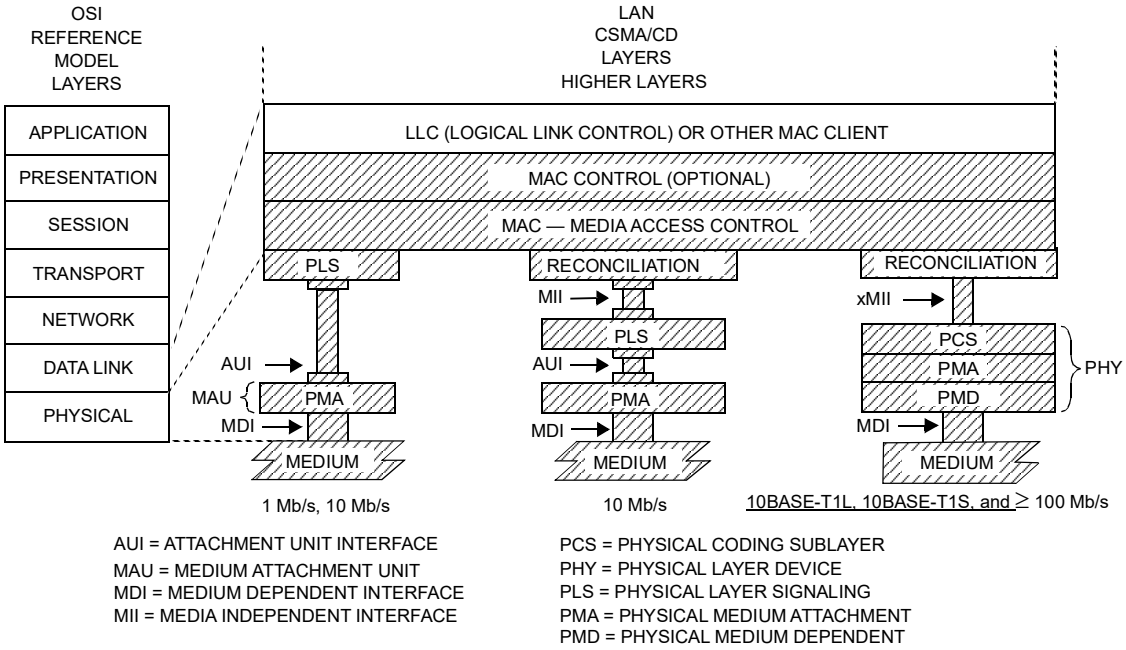
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1. Introduction

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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