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AMENDMENT 6
2021-10

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

Part 3: Standard for Ethernet

AMENDMENT 6: Maintenance #13: Power over ethernet over 2 pairs

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

Partie 3: Norme pour Ethernet

AMENDEMENT 6: Maintenance #13 : Puissance par ethernet sur 2 paires

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

Email: stds.ipr@ieee.org
Website: www.ieee.org

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IEEE Std 802.3cq™-2020
(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,
IEEE Std 802.3cn™-2019,
and IEEE Std 802.3cg™-2019)

IEEE Standard for Ethernet

Amendment 6: Maintenance #13: Power over Ethernet over 2 pairs

Developed by the

LAN/MAN Standards Committee
of the
IEEE Computer Society

Approved 30 January 2020

IEEE SA Standards Board

Abstract: This amendment to IEEE Std 802.3-2018 makes technical and editorial corrections and refinements to Power over Ethernet over 2-pairs in Clause 33.

Keywords: 802.3, 802.3cq, amendment, Ethernet, DTE power via MDI, Power over Ethernet, PoE

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

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

Chad Jones, *IEEE P802.3cq Maintenance #13: Power over Ethernet over 2 pairs Task Force Chair*
Lennart Yseboodt, *IEEE P802.3cq Maintenance #13: Power over Ethernet over 2 pairs Task Force Editor-in-Chief*
David Abramson, *IEEE P802.3cq Maintenance #13: Power over Ethernet over 2 pairs Task Force Comment Editor*

John Abbott
Andrea Agnes
Dale Amason
Hongming An
Jes Asmussen
Richard Baca
Tim Baggett
Amrik Bains
Thananya Baldwin
Steven Baumgartner
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Liav Ben-Artsi
Piergiorgio Beruto
Vipul Bhatt
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Brad Booth
Martin Bouda
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Matthew Brown
Michal Brychta
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Jairo Bustos Heredia
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Xin Chang
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Kamal Dalmia
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Introduction

This introduction is not part of IEEE Std 802.3cq-2020, IEEE Standard for Ethernet. Amendment 6: Maintenance #13: Power over Ethernet over 2 pairs

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 IEEE Std 802.3cq-2020 publication, 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 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 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 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 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.

EEE 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.

IEEE Std 802.3cq™-2020

Amendment 6—This amendment includes editorial and technical corrections, refinements, and clarifications to Clause 33 and related portions of the standard.

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.

Contents

IEEE Standard for Ethernet

Amendment 6: Maintenance #13: Power over Ethernet over 2 pairs

(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, IEEE Std 802.3cn™-2019, and IEEE Std 802.3cg™-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.

1. Introduction

1.4 Definitions

Change 1.4.323 "Medium Dependent Interface (MDI)" (re-numbered from 1.4.324 due to the deletion of 1.4.294 by IEEE Std 802.3bt-2018) as follows:

1.4.323 Medium Dependent Interface (MDI): The mechanical and electrical or optical interface between the transmission medium and the MAU (e.g., 10BASE-T) or the PHY (e.g., 1000BASE-T) and also between the transmission medium and any associated (optional per IEEE Std 802.3, Clause 33, Clause 104, and Clause 145) Powered Device (PD) or Endpoint Power Sourcing Equipment (PSE).

30. Management

30.9 Management for Power over Ethernet

30.9.1 PSE managed object class

30.9.1.1 PSE attributes

Change 30.9.1.1.9 (as modified by IEEE Std 802.3bt-2018) as follows:

30.9.1.1.9 aPSEOverLoadCounter

ATTRIBUTE

APPROPRIATE SYNTAX:

Generalized nonresettable counter. This counter has a maximum increment rate of 2 counts per second.

BEHAVIOUR DEFINED AS:

This counter is incremented when the PSE state diagram (Figure 33–9 and Figure 145–13) enters the state ERROR_DELAY due to the ovld_detected variable being TRUE. For Type 1 or Type 2 PSEs, if a Clause 22 MII or Clause 35 GMII is present, then this will map to the Overload bit specified in 33.5.1.2.8.;

33. Power over Ethernet over 2 Pairs

33.1 Overview

Change the first paragraph of 33.1 as follows:

~~This clause defines the functional and electrical characteristics of two optional power (non-data) entities, a Powered Device (PD) and Power Sourcing Equipment (PSE), for use with the MAU defined in Clause 14 and the PHYs defined in Clause 25 and Clause 40.~~ This clause defines the functional and electrical characteristics for providing a Power over Ethernet (PoE) system. The system consists of two optional power (non-data) entities, a Powered Device (PD) and Power Sourcing Equipment (PSE), for use with the MAU defined in Clause 14 and the PHYs defined in Clause 25, Clause 40, Clause 55, and Clause 126. These entities allow devices to draw/supply power using the same generic cabling as is used for data transmission.

33.1.3 Relationship of Power over Ethernet to the IEEE 802.3 Architecture

Change the third and fourth paragraphs of 33.1.3 as follows:

~~The Power Interface (PI) is the generic term that refers to the mechanical and electrical interface between the PSE or PD and the transmission medium.~~ The Power Interface (PI), as defined in 1.4.405, is the mechanical and electrical interface between the Power Sourcing Equipment (PSE) or Powered Device (PD) and the transmission medium.

~~In an Endpoint PSE and in a PD, the PI is encompassed within the MDI.~~ The PI in both an Endpoint PSE and in a PD is the MDI as defined in 1.4.323.

33.1.4 Type 1 and Type 2 system parameters

Change 33.1.4 as follows:

A power system, consisting of a single PSE, link ~~segment~~ section, and a single PD, defined as either Type 1 or Type 2, has certain basic parameters defined according to Table 33–1. These parameters define not only certain performance characteristics of the system, but are also used in calculating the various electrical characteristics of PSEs and PDs as described in 33.2 and 33.3.

Table 33–1—Type 1 and Type 2 system parameters

Parameter	Symbol	Units	Type 1 value	Type 2 value	Additional information
Nominal highest DC current per pair	I_{Cable}	A	0.350	0.600	
Channel maximum DC pair loop resistance	R_{Ch}	Ω	20.0	12.5	
Minimum cable type			twisted-pair cabling per 14.4 and 14.5[a]	Class D	See 33.1.4.1, 33.1.4.2

[a]Class D recommended.

I_{Cable} is the current on one twisted pair in the multi-twisted pair cable. Two twisted pairs are required to source I_{Cable}—one carrying (+ I_{Cable}) and one carrying (– I_{Cable}), from the perspective of the PI.

It should be noted that the cable references use "DC loop resistance," which refers to a single conductor. This clause uses "DC pair loop resistance," which refers to a pair of conductors in parallel. Therefore, R_{Ch} is related to, but not equivalent to, the "DC loop resistance" called out in the cable references.

I_{Port} is the current on either powered pair.

V_{PD} is the voltage at the PD PI, measured between any positive conductor and any negative conductor of the powered pairs.

V_{PSE} is the voltage at the PSE PI, measured between any positive conductor and any negative conductor of the powered pairs.

33.2 Power sourcing equipment (PSE)

33.2.3 PI pin assignments

Change the last paragraph in 33.2.3 as follows:

A PSE shall implement Alternative A, Alternative B, or both. While a PSE may be capable of both Alternative A and Alternative B, PSEs shall not operate both Alternative A and Alternative B on the same link ~~segment~~ section simultaneously.

33.2.4 PSE state diagrams

33.2.4.4 Variables

Change the definition of variable pd_dll_power_type in 33.2.4.4 as follows:

pd_dll_power_type
: A control variable initially output by the PSE power control state diagram (Figure 33–27), which can be updated by LLDP (see Table 33–23), that indicates the type of PD as advertised through Data Link Layer classification.
Values:1: PD is a Type 1 PD (default)
2: PD is a Type 2 PD

33.2.5 PSE detection of PDs

Change the second paragraph of 33.2.5 as follows:

The PSE probes the link section in order to detect a valid PD detection signature. The PSE PI is connected to a PD through a link ~~segment~~ section. In the following subclauses, the link is not called out to preserve clarity.

33.2.6 PSE classification of PDs and mutual identification

Change the paragraph following Equation (33–3) as follows:

where

V_{PSE}	is the voltage at the PSE PI as defined in ~~1.4.503~~ 33.1.4
R_{Chan}	is the channel DC pair loop resistance
P_{Class_PD}	is the PD's power classification (see Table 33–18)

33.2.7 Power supply output

33.2.7.1 Output voltage in the POWER_ON state

Change the first paragraph of 33.2.7.1 as follows:

The specification for V_{Port_PSE} in Table 33–11 shall be met with a (I_{Hold} max × V_{Port_PSE} min) to P_{Type} min load step at a rate of change of ~~at least~~ up to 15 mA/µs. The voltage transients as a result of load changes up to 35 mA/µs shall be limited to 3.5 V/µs max.

33.2.7.4 Continuous output current capability in the POWER_ON state

Change the paragraph following Equation (33–4) as follows:

where

V_{PSE}	is the voltage at the PSE PI as defined in ~~1.4.503~~ 33.1.4
R_{Chan}	is the channel loop resistance as defined in 33.1.4; this parameter has a worst-case value of R_{Ch}, defined in Table 33–1
P_{Peak_PD}	is the peak power a PD may draw for its class; see Table 33–18

33.2.7.8 Turn off time

Change 33.2.7.8 as follows:

The specification for T_{Off} in Table 33–11 shall apply to the discharge time from V_{Port_PSE} to V_{Off} with a test resistor of 320 kΩ attached to the PI. In addition, it is recommended that the PI be discharged when turned off. T_{Off} starts when V_{PSE} drops 1 V below the steady-state value after the pi_powered variable is cleared (see Figure 33–9). T_{Off} ends when $V_{PSE} \leq V_{Off}$ max. ~~The PSE remains in the IDLE state as long as the average voltage across the PI is V_{Off}.~~ The IDLE state is the state when the PSE is not in detection, classification, or normal powering states.

33.2.8 Power supply allocation

Change the first sentence of 33.2.8 as follows:

A PSE does not initiate power provision to a link if the PSE ~~is unable to provide the maximum power level requested by the PD based on the PD's class~~ has less than Class 3 power available and the connected PD requests more than the available power.

33.2.9 PSE power removal

33.2.9.1 PSE Maintain Power Signature (MPS) requirements

33.2.9.1.2 PSE DC MPS component requirements

Change 33.2.9.1.2 as follows:

A PSE shall consider the DC MPS component to be present if I_{Port} is greater than or equal to I_{Hold} max for a minimum of T_{MPS}. A PSE shall consider the DC MPS component to be absent if I_{Port} is less than or equal to I_{Hold} min. A PSE may consider the DC MPS component to be either present or absent if I_{Port} is in the range of I_{Hold}.

Power shall be removed from the PI when DC MPS has been absent for a duration greater than T_{MPDO}.

The specification for T_{MPS} in Table 33–11 applies only to the DC MPS component. In addition to the requirements on T_{MPS} and T_{MPDO} in Table 33–11, the PSE shall use values for T_{MPS} and T_{MPDO} that meet Equation (33–7a).

$$T_{MPDO} - T_{MPS} \geq 250 \text{ ms} \quad (33–7a)$$

~~The PSE shall not remove power from the port when I_{Port} is greater than or equal to I_{Hold} max continuously for at least T_{MPS} every T_{MPS} + T_{MPDO}, as defined in Table 33–11. This allows a PD to minimize its power consumption.~~ The PSE shall not remove power from the port when less than T_{MPDO} has passed since MPS was last present. This allows a PD to minimize its power consumption.

33.3 Powered devices (PDs)

33.3.3 PD state diagram

33.3.3.3 Variables

Change the definitions of the variables pse_dll_power_type and V_{PD} in 33.3.3.3 as follows:

pse_dll_power_type
: A control variable initially output by the PD power control state diagram (Figure 33–28), which can be updated by LLDP (see Table 33–23), that indicates the type of PSE by which the PD is being powered.
Values:1: The PSE is a Type 1 PSE (default).
2: The PSE is a Type 2 PSE.

V_{PD}
: Voltage at the PD PI as defined in ~~1.4.502~~ 33.1.4.

33.3.3.5 State diagrams

Change Figure 33–16 as follows:

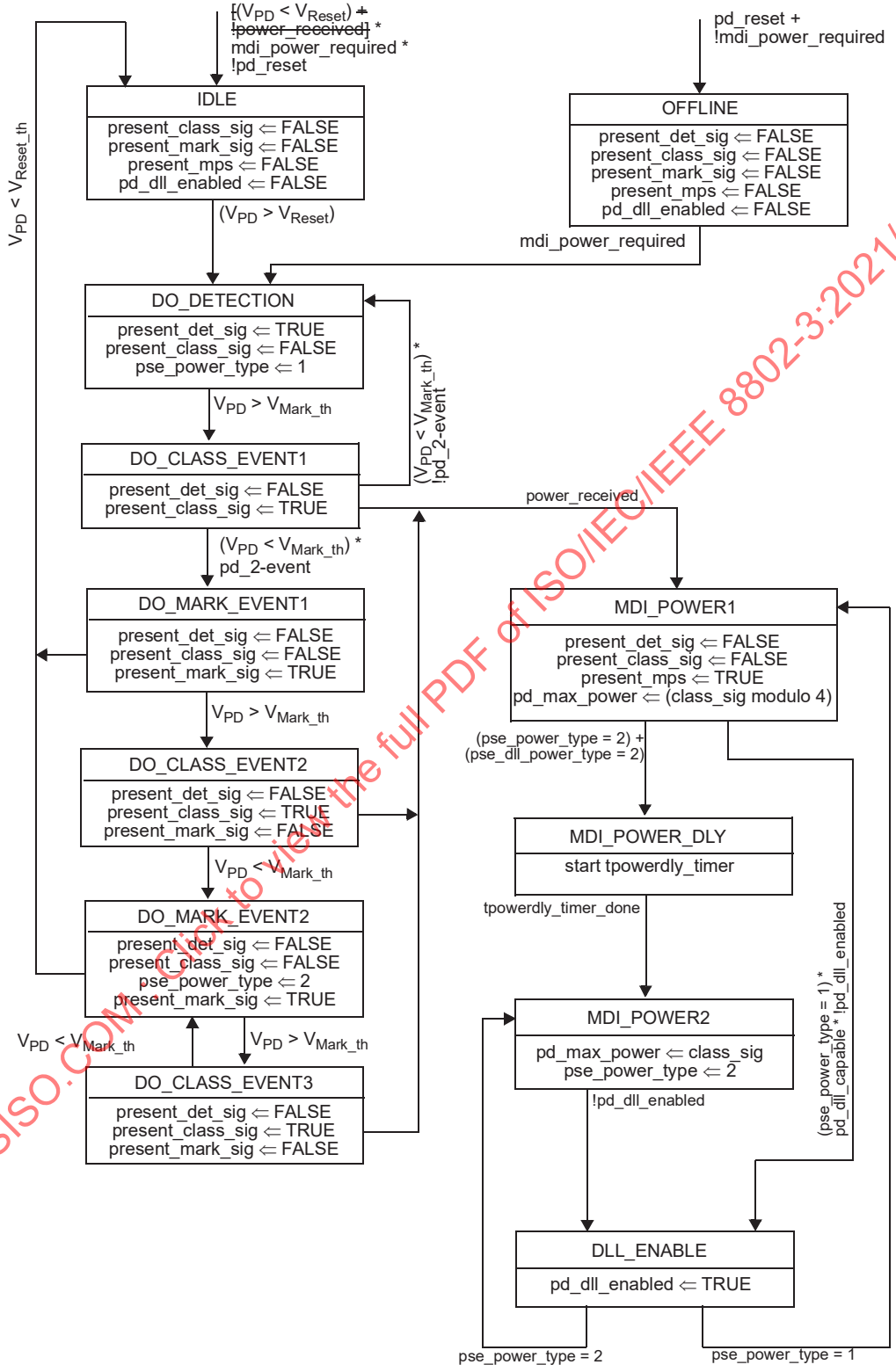

Figure 33–16—PD state diagram