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Road vehicles — In-vehicle Ethernet —

Part 3: Optical 1-Gbit/s physical entity requirements and conformance test plan

Véhicules routiers — Ethernet embarqué —

Partie 3: Exigences et plan d'essais de conformité de la couche physique optique à 1-Gbit/s

Reference number
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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 31, *Data communication*.

A list of all parts in the ISO 21111 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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Introduction

The ISO 21111 series includes in-vehicle Ethernet requirements and test plans that are disseminated in other International Standards and complements them with additional test methods and requirements. The resulting requirement and test plans are structured in different documents following the Open Systems Interconnection (OSI) reference model and grouping the documents that depend on the physical media and bit rate used.

In general, the Ethernet requirements are specified in ISO/IEC/IEEE 8802-3. The ISO 21111 series provides supplemental specifications (e.g. wake-up, I/O functionality), which are required for in-vehicle Ethernet applications. In road vehicles, Ethernet networks are used for different purposes requiring different bit-rates. Currently, the ISO 21111 series specifies the 1-Gbit/s optical and 100-Mbit/s electrical physical layer.

The ISO 21111 series contains requirement specifications and test methods related to the in-vehicle Ethernet. This includes requirement specifications for physical layer entity (e.g. connectors, physical layer implementations) providers, device (e.g. electronic control units, gateway units) suppliers, and system (e.g. network systems) designers. Additionally, there are test methods specified for conformance testing and for interoperability testing.

Safety (electrical safety, protection, fire, etc.) and electromagnetic compatibility (EMC) requirements are out of the scope of the ISO 21111 series.

The structure of the specifications given in the ISO 21111 series complies with the Open Systems Interconnection (OSI) reference model specified in ISO/IEC 7498-1[1] and ISO/IEC 10731[5].

ISO 21111-1 defines the terms which are used in this series of standards and provides an overview of the standards for in-vehicle Ethernet including the complementary relations to ISO/IEC/IEEE 8802-3, the document structure, type of physical entities, in-vehicle Ethernet specific functionalities and so on.

ISO 21111-2 specifies the interface between reconciliation sublayer and physical entity including reduced gigabit media independent interface (RGMII), and the common physical entity wake-up and synchronized link sleep functionalities, independent from physical media and bit rate.

This document specifies supplemental requirements to a physical layer capable of transmitting 1-Gbit/s over plastic optical fibre compliant with ISO/IEC/IEEE 8802-3, with specific application to communications inside road vehicles, and a test plan for physical entity conformance testing.

ISO 21111-4 specifies the optical components requirements and test methods for 1-Gbit/s optical in-vehicle Ethernet.

ISO 21111-5 specifies, for 1-Gbit/s optical in-vehicle Ethernet, requirements on the physical layer at system level, requirements on the interoperability test set-ups, the interoperability test plan that checks the requirements for the physical layer at system level, requirements on the device-level physical layer conformance test set-ups, and device-level physical layer conformance test plan that checks a set of requirements for the OSI physical layer that are relevant for device vendors.

ISO 21111-6 specifies advanced features of an ISO/IEC/IEEE 8802-3 in-vehicle Ethernet physical layer (often also called transceiver), e.g. for diagnostic purposes for in-vehicle Ethernet physical layers. It specifies advanced physical layer features, wake-up and sleep features, physical layer test suite, physical layer control requirements and conformance test plan, physical sublayers test suite and physical sublayers requirements and conformance test plan.

ISO 21111-7 specifies the implementation for ISO/IEC/IEEE 8802-3:2017/Amd 1:2017, which defines the interface implementation for automotive applications together with requirements on components used to realize this Bus Interface Network (BIN). ISO 21111-7 also defines further testing and system requirements for systems implemented according to the system specification. In addition, ISO 21111-7 defines the channels for tests of transceivers with a test wiring harness that simulates various electrical communication channels.

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ISO 21111-8 specifies the transmission media, the channel performance and the tests for ISO/IEC/IEEE 8802-3 in-vehicle Ethernet.

ISO 21111-9 specifies the data link layer requirements and conformance test plan. It specifies the requirements and test plan for devices and systems with bridge functionality.

ISO 21111-10 specifies the application to network layer requirements and test plan. It specifies the requirements and test plan for devices and systems that include functionality related with OSI layers from 3 to 7.

Figure 1 shows the parts of the ISO 21111 series and the document structure.

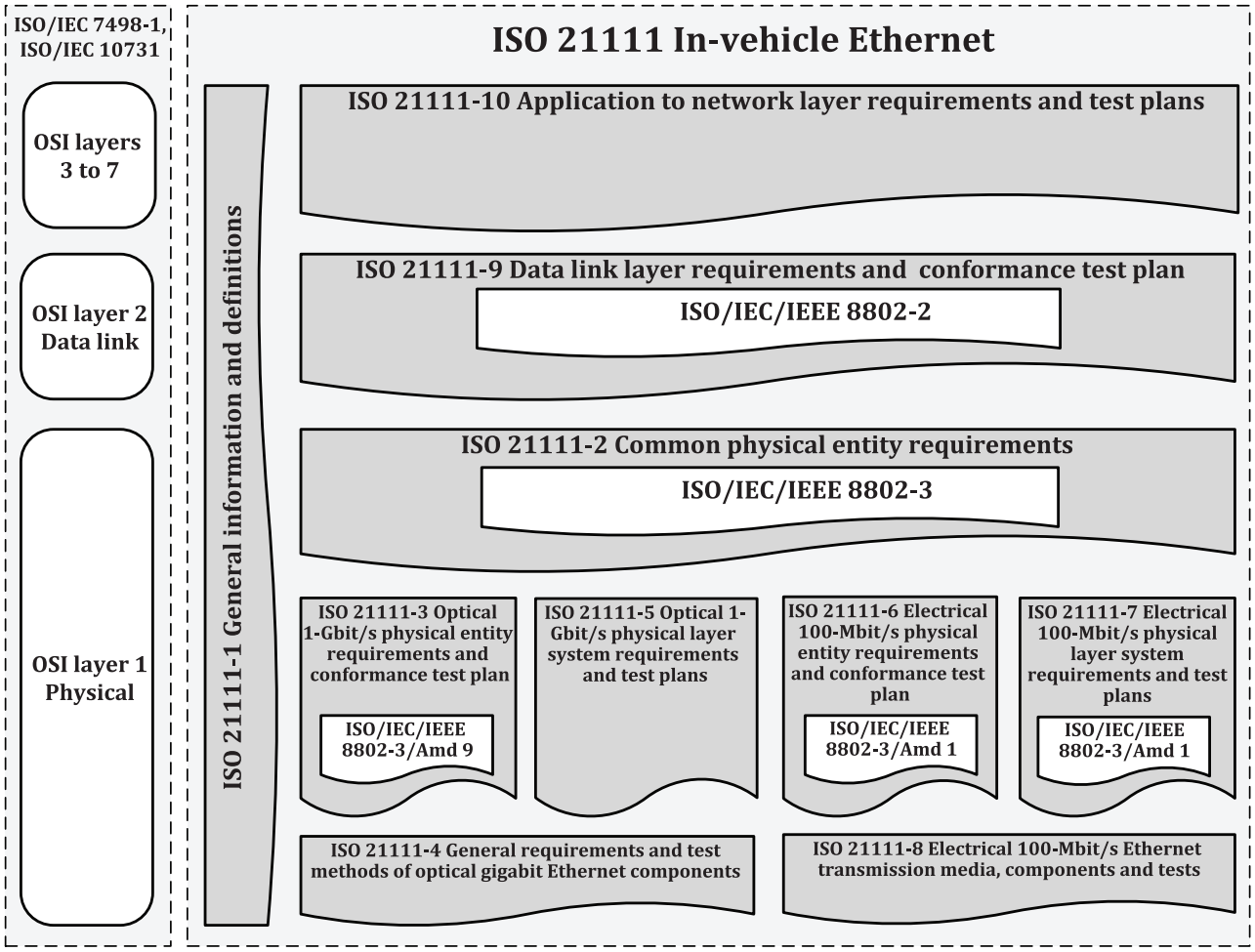


Figure 1 — In-vehicle Ethernet document reference according to the OSI model

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Road vehicles — In-vehicle Ethernet —

Part 3: Optical 1-Gbit/s physical entity requirements and conformance test plan

1 Scope

This document provides supplemental specifications to a physical layer capable of transmitting 1 Gbit/s over plastic optical fibre compliant with ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, with specific application to communications inside road vehicles.

Additionally, there is a test plan specified for conformance testing. The test plan includes test cases to assure compliance of an IUT with the functionality specified in this document.

ISO/IEC/IEEE 8802-3:2017/Amd 9:2018 is considered indispensable for the application of this document.

The supplemental specifications include wake-up and synchronised link sleep functionality. The specification includes the sublayers, service interfaces, and state diagrams that support the functionality. The supplemental specifications are collected in protocol implementation conformance statement (PICS).

The requirements specified in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018 and in this document constitute the complete PICS that specifies the GEPOF physical entity functionality.

The optical component requirements and test methods for optical 1-Gbit/s transmission of in-vehicle Ethernet are not within the scope of this document.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 21111-1[1)], *Road vehicle — In-vehicle Ethernet — Part 1: General information and definitions*

ISO 21111-2:—[2)], *Road vehicles — In-vehicle Ethernet — Part 2: Common medium-independent interface specifications*

ISO/IEC/IEEE 8802-3:2017, *Information technology — Telecommunications and information exchange between systems — Local and metropolitan area networks — Specific requirements — Part 3: Standard for Ethernet*

ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, *Physical layer specifications and management parameters for 1000 Mb/s operation over plastic optical fiber*

1) Under preparation. Stage at the time of publication: ISO/DIS 21111-1:2020.

2) Under preparation. Stage at the time of publication: ISO/DIS 21111-2:2020.

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3 Terms and definitions

For the purposes of this document, the terms and definitions in ISO/IEC/IEEE 8802-3, ISO 21111-1 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
neighbour GEPOF entities
two or more GEPOF entities embedded in the same device

3.2
GEPOF link partners
two GEPOF entities connected bi-directionally through POF

3.3
IEEE 802.3bv physical layer
physical layer compliant with 1000BASE-RHC

Note 1 to entry: 1000BASE-RHC is specified in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, 1.4.26c.

3.4
symbol
smallest unit of data transmission on the medium

Note 1 to entry: Symbols are specified in ISO/IEC/IEEE 8802-3:2017, 1.4.393 and in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, 115.2.

3.5
transmit block
sequence of a fixed number of *symbols* (3.4) that encodes data from MAC layer and control information

Note 1 to entry: The transmit block is specified in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, 115.2.1.

3.6
transmit block generator
instrument that transmits and generates a *transmit block* (3.5) with controlled content

3.7
transmit block analyser
instrument that receives a *transmit block* (3.5) and processes the information contained in it

3.8
payload data sub-block
part of a *transmit block* (3.5) that encodes data from MAC layer

Note 1 to entry: The payload data sub-block is specified in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, 115.2.1.

4 Abbreviated terms

ACK	acknowledgement
AOP	average optical power
BCH	Bose, Ray-Chaudhuri, Hocquenghem
BER	bit error rate

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CID	company identifier
CRC	cyclic check redundancy
EEE	energy-efficient Ethernet
ER	extinction ratio
FFME	fast forward management entity
GEPOF	gigabit Ethernet over plastic optical fibre
GMII	gigabit media independent interface
IUT	implementation under test
LPI	low power idle
LSB	least significant bit
LT	lower tester
MAC	medium access control
MDI	medium dependent interface
MDIO	management data input/output
MSB	most significant bit
OAM	operations, administration, and maintenance
OAMPDU	OAM protocol data unit
PCS	physical coding sublayer
PHD	physical header data
PHS	physical header sub-frame
PICS	protocol implementation conformance statement
PMA	physical medium attachment
PMD	physical medium dependent
POF	plastic optical fibre
RIN	reference input noise
RX	receiver
TX	transmitter
UT	upper tester
WUSME	wake-up and synchronised link sleep management entity

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5 Wake-up and synchronised link sleep functionality

5.1 General

Figure 2 shows the functional block diagram of the GEPOF entity.

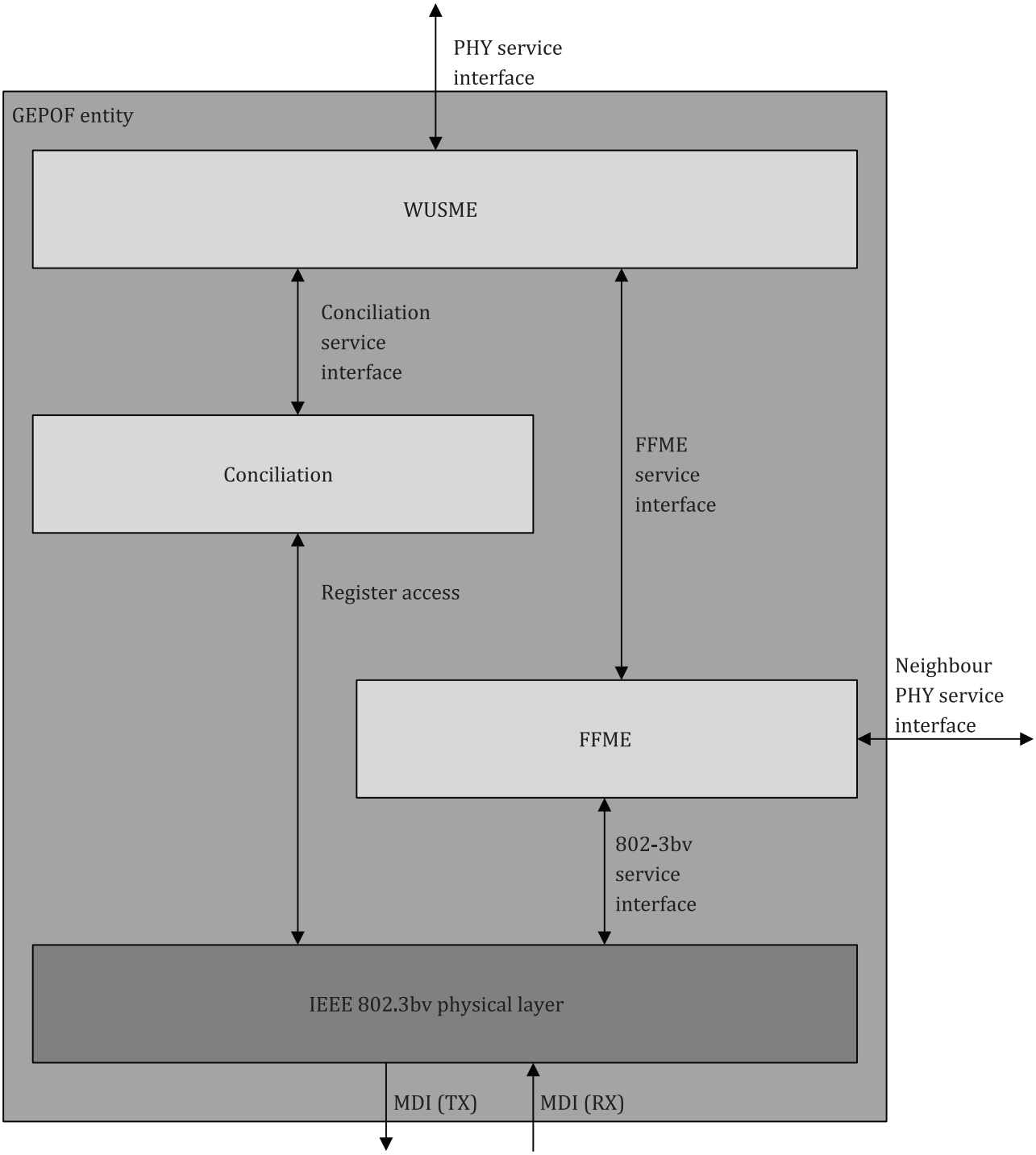


Figure 2 — GEPOF entity functional block diagram

WUSME sublayer shall communicate with the MAC layer over the PHY service interface specified in 5.2 and in ISO 21111-2:—, 6.8.

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WUSME sublayer shall contain wake-up and synchronised link sleep algorithms as specified in ISO 21111-2:—, 6.4 and 6.5. This specification includes exchange of events that shall be encoded by using message exchange over the 1000BASE-H OAM channel specified in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, 115.9 and the state diagrams specified in 5.7.

WUSME sublayer shall communicate with the conciliation sublayer over the conciliation service interface specified in 5.2.

WUSME sublayer shall communicate with FFME sublayer over the FFME service interface specified in 5.5.

FFME sublayer shall behave as the state diagram that controls the power state of the GEPOF entity specified in 5.8 and ISO 21111-2:—, 6.2.

FFME shall communicate with another FFME located inside neighbour GEPOF entity over the neighbour PHY service interface specified in 5.3 and in ISO 21111-2:—, 6.9.

FFME shall communicate with the IEEE 802.3bv physical layer over the 802-3bv service interface specified in 5.6.

The conciliation sublayer shall include the functions described in 5.9 that translate each of the conciliation service primitives into transactions over MDIO registers.

Bit naming and MDIO register numbering are specified in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, Clause 45. CID is specified in ISO/IEC/IEEE 8802-A:2015, 1.4.162.

The high logic level and low logic level for the MDIO registers are specified in ISO/IEC/IEEE 8802-3:2017, 22.4.

The value of the service primitive parameters follows a positive logic. TRUE corresponds to a high logic level and FALSE corresponds to a low logic level.

State diagrams in this document follow the notation specified in ISO/IEC/IEEE 8802-3:2017, 1.2.

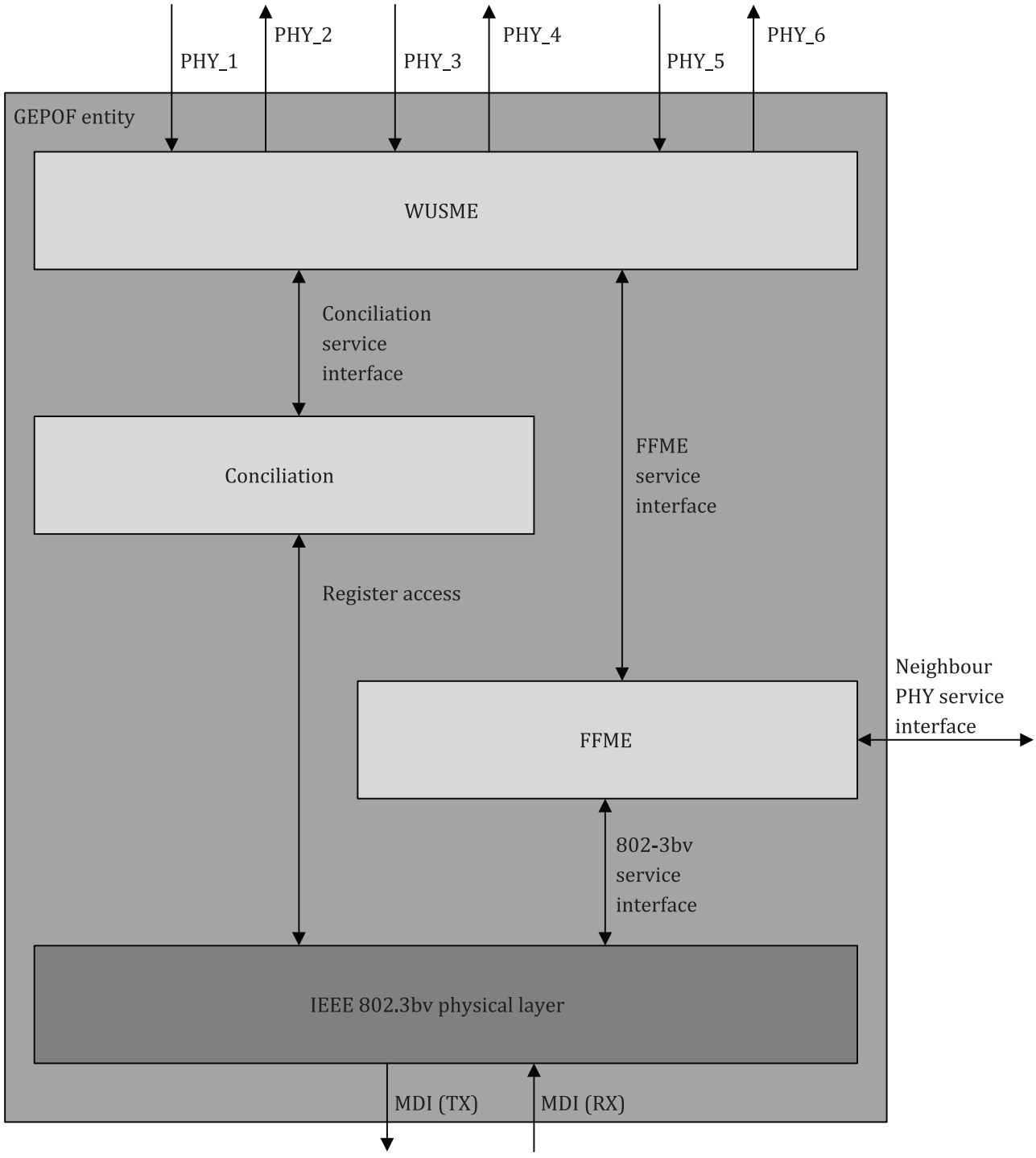
5.2 PHY service interface for a GEPOF entity

The following specifies the mandatory service primitives of the PHY service interface as given in ISO 21111-2 that are required by a GEPOF entity.

Figure 3 shows the service primitives of the PHY service interface and the relationship with the GEPOF entity sublayers.

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Key

PHY service interface

PHY_1: PHY_LinkSleep.request
PHY_2: PHY_LinkSleep.indication
PHY_3: PHY_WakeUp.request
PHY_4: PHY_WakeUp.indication
PHY_5: PHY_ConfigSleepReject.request
PHY_6: PHY_SleepStatus.indication

Figure 3 — PHY service interface

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The PHY service interface comprises the following service primitives:

— PHY_LinkSleep.request (see ISO 21111-2:—, 6.8.1);

— PHY_LinkSleep.indication (see ISO 21111-2:—, 6.8.2);

— PHY_WakeUp.request (see ISO 21111-2:—, 6.8.3);

— PHY_WakeUp.indication (see ISO 21111-2:—, 6.8.4);

— PHY_ConfigSleepReject.request (see ISO 21111-2:—, 6.8.5);

— PHY_SleepStatus.indication (see ISO 21111-2:—, 6.8.6).

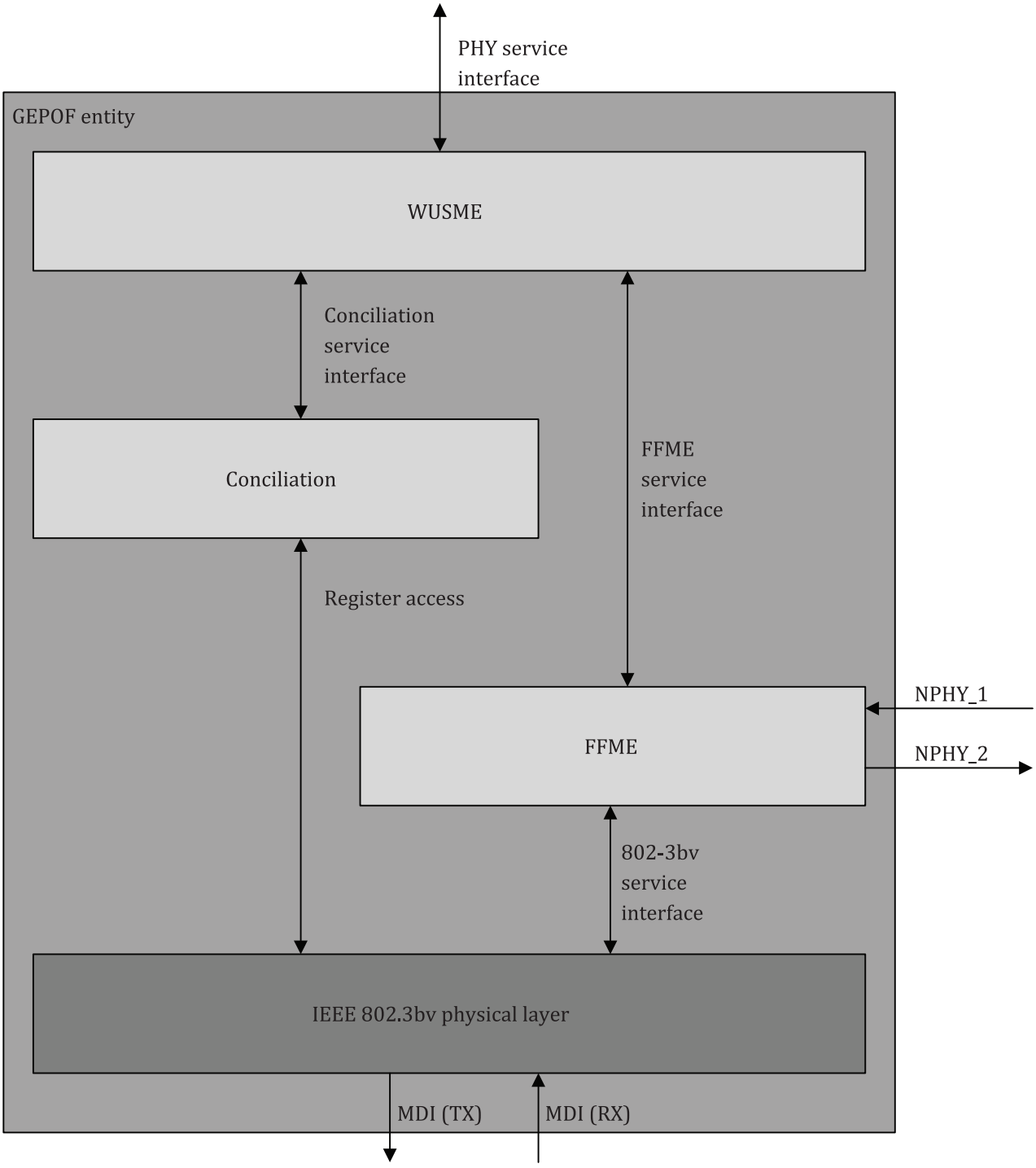
5.3 Neighbour PHY service interface for a GEPOF entity

The following specifies the mandatory service primitives of the neighbour PHY service interface as given in ISO 21111-2 that are required by a GEPOF entity.

Figure 4 shows the service primitives of the neighbour PHY service interface and the relationship with the GEPOF entity sublayers.

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Key

Neigbour PHY service interface

NPHY_1: PHY_WakeUpForward.request

NPHY_2: PHY_WakeUpForward.indication

Figure 4 — Neighbour PHY service interface

The neighbour PHY service interface comprises the following service primitives:

— NPHY_WakeUpForward.request (see ISO 21111-2:— , 6.9.1);

— NPHY_WakeUpForward.indication (see ISO 21111-2:— , 6.9.2).

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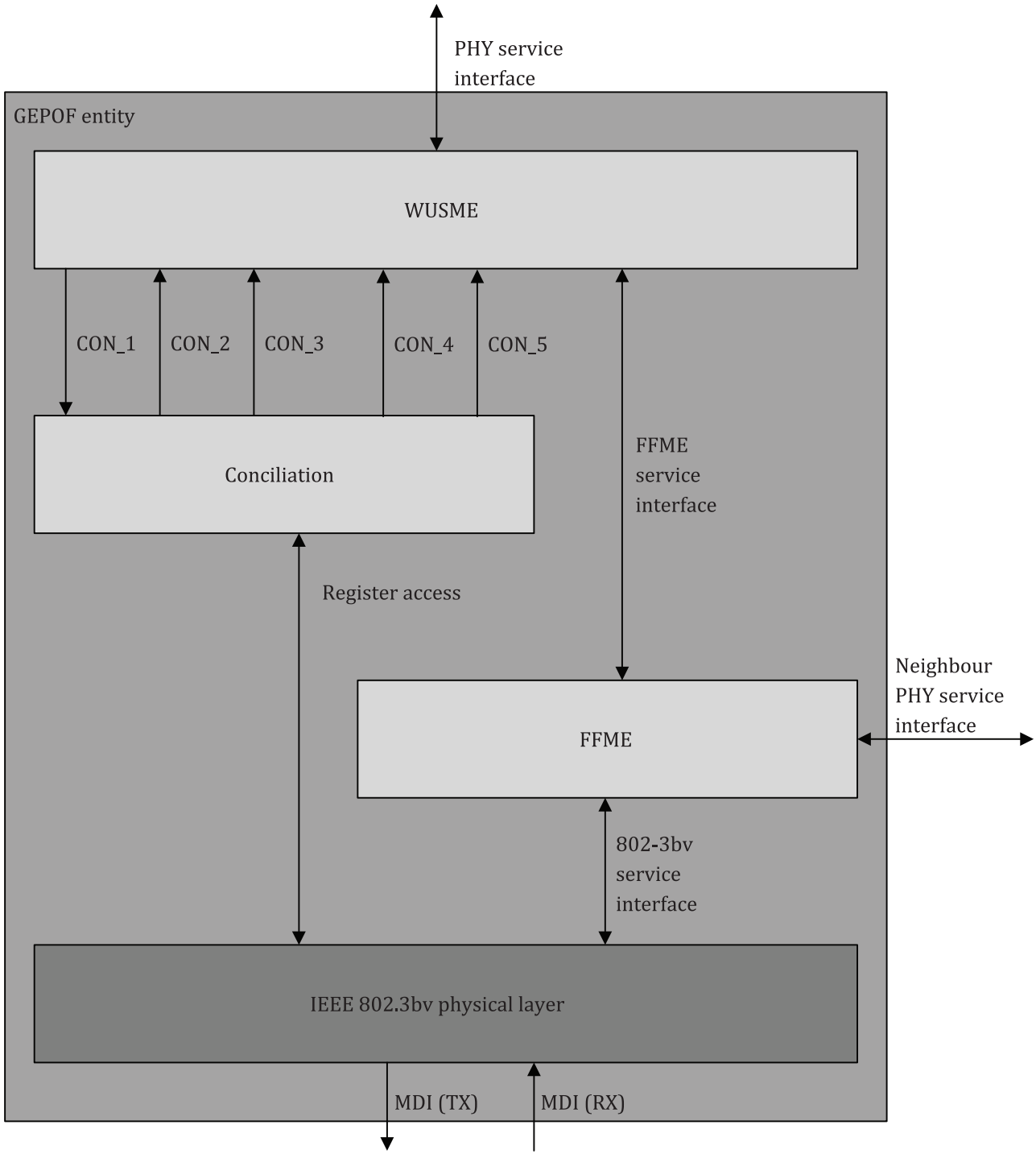
5.4 Conciliation service interface

5.4.1 General

The following specifies the service primitives provided by the conciliation sublayer to the WUSME sublayer. Figure 5 shows the service primitives of the conciliation service interface and the relationship with the GEPOF entity sublayers.

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Key

Conciliation service interface

CON_1: CON_WakeUpSleepPacket.request
CON_2: CON_WakeUpSleepPacket.indication
CON_3: CON_WakeUpSleepPacketACK.indication
CON_4: CON_SignalDetected.indication
CON_5: CON_OAMActive.indication

Figure 5 — Conciliation service interface

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The conciliation service interface comprises the following service primitives:

— CON_WakeUpSleepPacket.request (see 5.4.2);

— CON_WakeUpSleepPacket.indication (see 5.4.3);

— CON_WakeUpSleepPacketACK.indication (see 5.4.4);

— CON_SignalDetected.indication (see 5.4.5);

— CON_OAMActive.indication (see 5.4.6).

5.4.2 CON_WakeUpSleepPacket.request

This service primitive is used to request to send a synchronised link sleep or wake-up event as specified in ISO 21111-2.

Table 1 specifies CON_WakeUpSleepPacket.request.

Table 1 — Specification of CON_WakeUpSleepPacket.request

Item	Description
Semantic	CON_WakeUpSleepPacket.request(c45_wu_sleep_pkt)
Parameters	The c45_wu_sleep_pkt parameter shall have one of the following values: — SLEEP; — SLEEP_ACK; — NO_SLEEP; — WAKE_UP.
Generation	CON_WakeUpSleepPacket.request shall be generated when the wu_sleep_pkt (see Table 10) variable is assigned to a value in the state diagram of Figure 8 or Figure 9. The value of the wu_sleep_pkt variable shall be copied to the c45_wu_sleep_pkt parameter.
Effect of receipt	A sequence of transactions over the IEEE 802.3bv physical layer registers depending on the c45_wu_sleep_pkt value shall be performed as described in 5.9.4.

5.4.3 CON_WakeUpSleepPacket.indication

This service primitive is used to indicate the reception of a synchronised link sleep or wake-up event as specified in ISO 21111-2.

Table 2 specifies CON_WakeUpSleepPacket.indication.

Table 2 — Specification of CON_WakeUpSleepPacket.indication

Item	Description
Semantic	CON_WakeUpSleepPacket.indication(wu_sleep_pkt_remote)
Parameters	The wu_sleep_pkt_remote parameter shall have one of the following values: — SLEEP; — SLEEP_ACK; — NO_SLEEP; — WAKE_UP.
Generation	CON_WakeUpSleepPacket.indication shall be generated when the conciliation sublayer receives a synchronised link sleep or wake-up packet (see 5.9.5).

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Table 2 *(continued)*

Item	Description
Effect of receipt	The parameter wu_sleep_pkt_remote shall be copied to the WUSME variable wu_sleep_pkt_ind (see Table 10).

5.4.4 CON_WakeUpSleepPacketACK.indication

This service primitive is used to indicate the reception of an ACK of a previously sent synchronised link sleep or wake-up event from the IEEE 802.3bv physical layer.

Table 3 specifies CON_WakeUpSleepPacketACK.indication.

Table 3 — Specification of CON_WakeUpSleepPacketACK.indication

Item	Description
Semantic	CON_WakeUpSleepPacketACK.indication (void)
Parameters	None
Generation	CON_WakeUpSleepPacketACK.indication shall be generated when the transmission of a synchronised link sleep or wake-up event is acknowledged (see 5.9.6).
Effect of receipt	The variable wu_sleep_ack_ind (see Table 10) of WUSME sublayer (see 5.7.3.1) shall be set to TRUE.

5.4.5 CON_SignalDetected.indication

This service primitive is used to indicate the change in the content of the MDIO register 1.10.0 specified in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, Table 115-18.

Table 4 specifies CON_SignalDetected.indication.

Table 4 — Specification of CON_SignalDetected.indication

Item	Description
Semantic	CON_SignalDetected.indication (signal_detect_reg)
Parameters	The signal_detect_reg parameter shall have one of the following values: — TRUE: the MDIO register 1.10.0 specified in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, Table 115-18 of the IEEE 802.3bv physical layer is set to 1_2; — FALSE: the MDIO register 1.10.0 specified in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, Table 115-18 of the IEEE 802.3bv physical layer is set to 0_2.
Generation	CON_SignalDetected.indication shall be generated by the conciliation sublayer when the MDIO register 1.10.0 specified in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, Table 115-18 of the IEEE 802.3bv physical layer changes its value.
Effect of receipt	The parameter signal_detect_reg shall be copied to the WUSME variable signal_detect_reg (see Table 11).

5.4.6 CON_OAMActive.indication

This service primitive is used to indicate the change in the content of the MDIO register 3.519.13 specified in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, 45.2.3.47d.3 when the MDIO register 3.518.1 specified in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, 45.2.3.47c.3 is set to 1_2.

Table 5 specifies CON_OAMActive.indication.

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Table 5 — Specification of CON_OAMActive.indication

Item	Description
Semantic	CON_OAMActive.indication (oam_ch_active)
Parameters	The oam_ch_active parameter shall have one of the following values: — TRUE: the MDIO registers 3.518.1, 3.519.1, 3.519.3 and 3.519.10 specified in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, 45.2.3.47c.3 and 45.2.3.47d are set to 1_2; — FALSE: any of the MDIO registers 3.518.1, 3.519.1, 3.519.3 and 3.519.10 specified in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, 45.2.3.47c.3 and 45.2.3.47d is set to 0_2.
Generation	CON_OAMActive.indication shall be generated by the conciliation sublayer when the content of the MDIO register 3.519.10 specified in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, 45.2.3.47d.6 changes its value and the MDIO register 3.518.1 specified in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, 45.2.3.47c.3 is set to 1_2.
Effect of receipt	The parameter oam_ch_active shall be copied to the WUSME variable oam_ch_active (see Table 10).

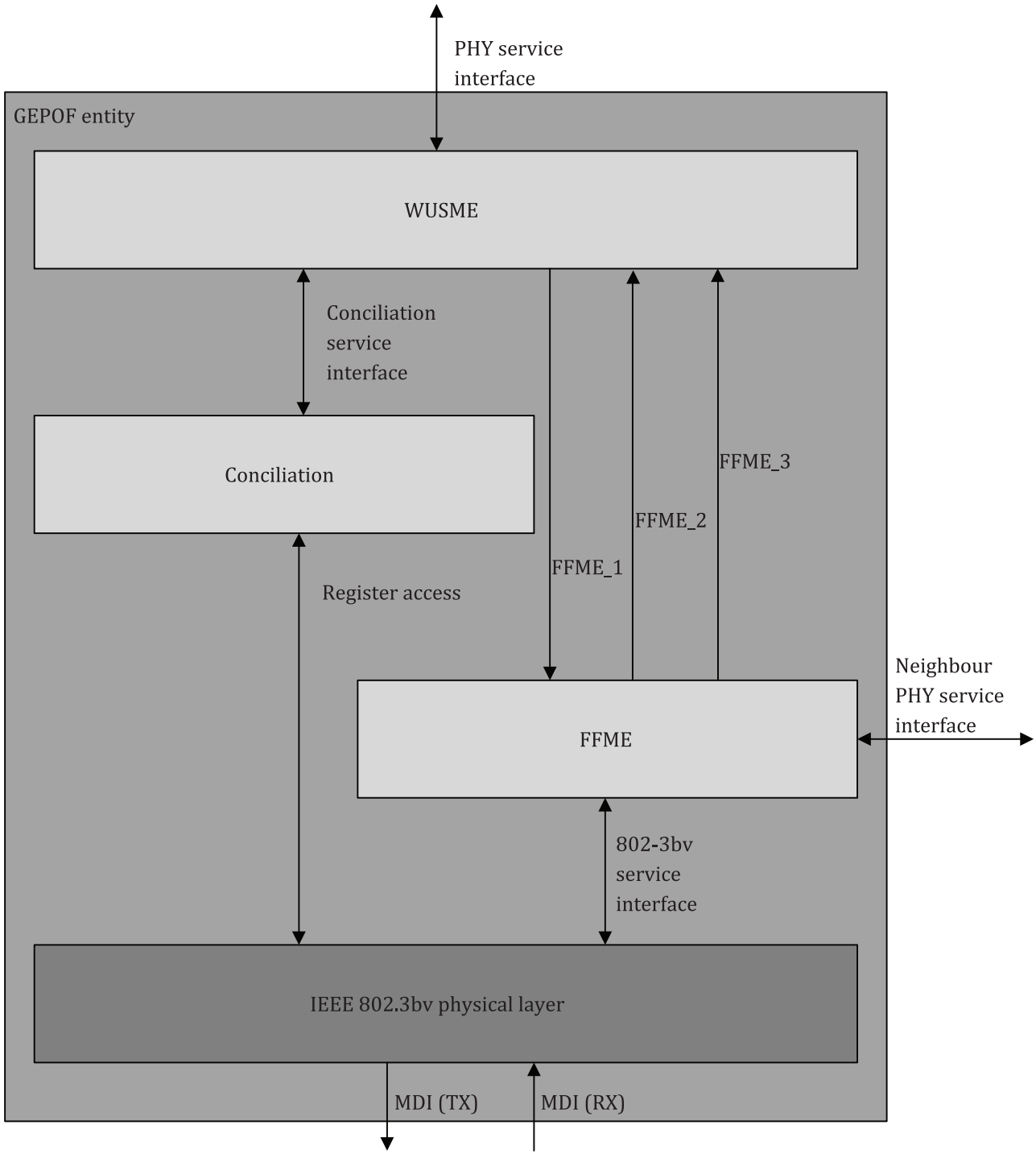
5.5 FFME service interface

5.5.1 General

The following subclauses specify the service primitives provided by the FFME sublayer connected to the WUSME. Figure 6 shows the service primitives of the FFME service interface and the relationship with the GEPOF entity sublayers.

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Key

FFME service interface

FFME_1: FFME_PowerDownStatus.request

FFME_2: FFME_PowerDownStatus.indication

FFME_3: FFME_WakeUp.indication

Figure 6 — FFME service interface

The FFME service interface comprises the following service primitives:

— FFME_PowerDownStatus.request (see 5.5.2);

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— FFME_PowerDownStatus.indication (see 5.5.3);

— FFME_WakeUp.indication (see 5.5.4).

5.5.2 FFME_PowerDownStatus.request

This service primitive is used to request to the IEEE 802.3bv physical layer to enter or to leave the power-down state as specified in ISO/IEC/IEEE 8802-3:2017, 22.2.4.1.5.

Table 6 specifies FFME_PowerDownStatus.request.

Table 6 — Specification of FFME_PowerDownStatus.request

Item	Description
Semantic	FFME_PowerDownStatus.request (ffme_pd_status)
Parameters	The ffme_pd_status parameter shall have one of the following values: — TRUE: the WUSME sublayer requests to the IEEE 802.3bv physical layer to enter into the power-down state; — FALSE: the WUSME sublayer requests to the IEEE 802.3bv physical layer to leave the power-down state.
Generation	FFME_PowerDownStatus.request shall be generated when set_phy_pd_status (see Table 11) variable is assigned to a value as performed, for example in state diagram of Figure 9. The value of the set_phy_pd_status variable shall be copied to the ffme_pd_status parameter.
Effect of receipt	A transition in the FFME state diagram may be performed as described in Figure 10.

5.5.3 FFME_PowerDownStatus.indication

This service primitive is used to indicate if the FFME state diagram is in the Normal power state or not.

Table 7 specifies FFME_PowerDownStatus.indication.

Table 7 — Specification of FFME_PowerDownStatus.indication

Item	Description
Semantic	FFME_PowerDownStatus.indication (pd_status)
Parameters	The pd_status parameter shall have one of the two values: — TRUE: the FFME state diagram is not in the Normal power state; — FALSE: the FFME state diagram is in the Normal power state.
Generation	FFME_PowerDownStatus.indication shall be generated when a transition occurs from or to the Normal power state in the FFME state diagram (see Figure 10). The value of the pd_status variable (see Table 13) of the state diagram shall be copied to the pd_status parameter.
Effect of receipt	A transition in one of the WUSME state diagrams may be performed as specified in Figure 8 or Figure 9.

5.5.4 FFME_WakeUp.indication

This service primitive is used to indicate an assignation to TRUE of the ffme_wu_ind_gen variable of the FFME power state diagram (see Figure 10).

Table 8 specifies FFME_WakeUp.indication.

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Table 8 — Specification of FFME_WakeUp.indication

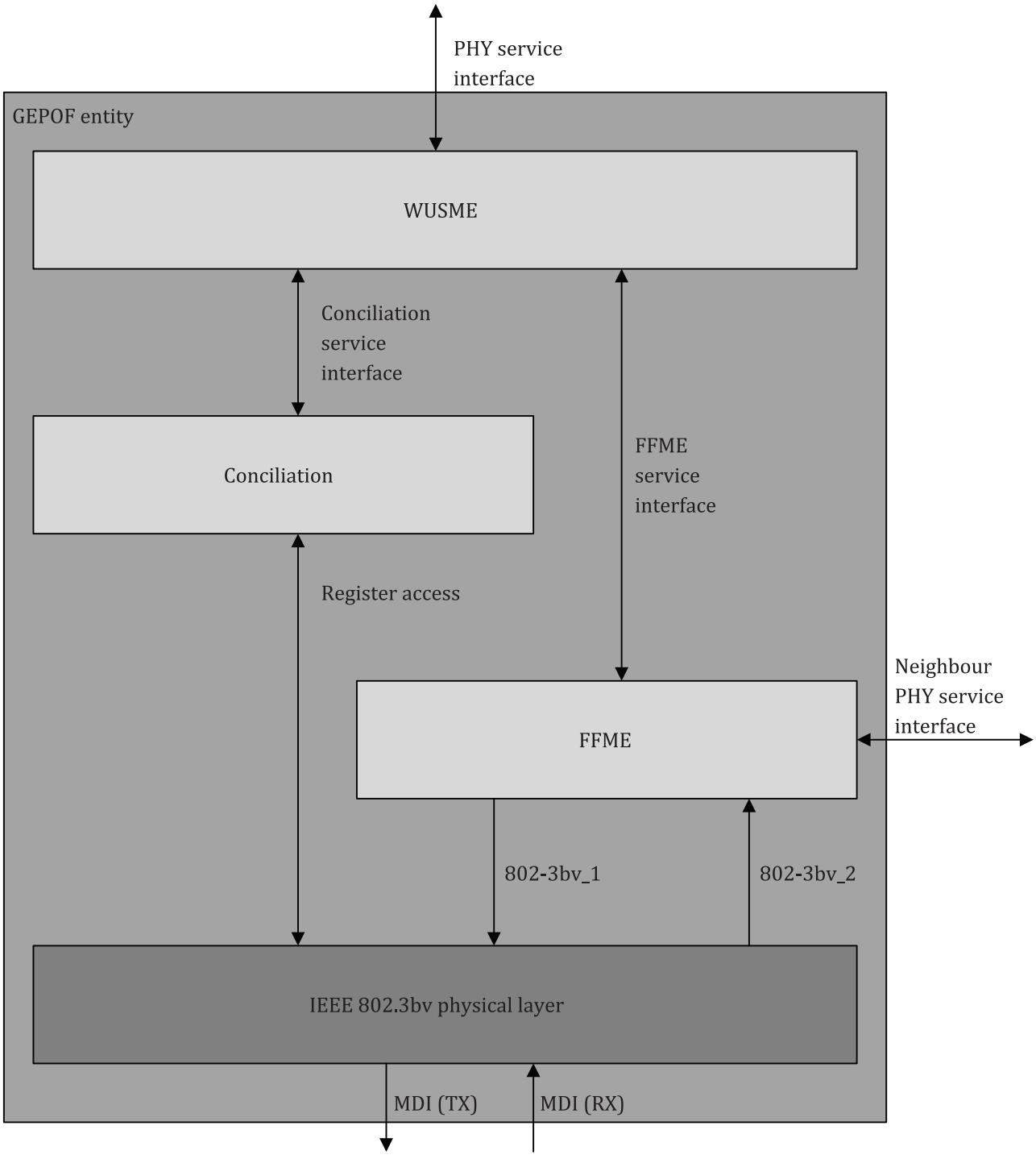
Item	Description
Semantic	FFME_WakeUp.indication (void)
Parameters	None
Generation	FFME_WakeUp.indication shall be generated when ffme_wu_ind_gen variable is assigned to a TRUE value in the FFME state diagram (see Figure 10).
Effect of receipt	A transition in one of the WUSME state diagrams may be performed as specified in Figure 8 or Figure 9.

5.6 802-3bv service interface

5.6.1 General

The following specifies the service primitives provided by the IEEE 802.3bv physical layer and used by the FFME sublayer. Figure 7 shows the service primitives of the 802-3bv service interface and the relationship with the GEPOF entity sublayers.

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Key

802-3bv service interface

802-3bv_1: 802-3bv_PowerDownStatus.request

802-3bv_2: 802-3bv_RXDETECT.indication

Figure 7 — 802-3bv service interface

The 802-3bv service interface comprises the following service primitives:

— 802-3bv_PowerDownStatus.request (see 5.6.2);

— 802-3bv_RXDETECT.indication (see 5.6.3).

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5.6.2 802-3bv_PowerDownStatus.request

This service primitive is used to request a write operation in the MDIO register 1.0.11 specified in ISO/IEC/IEEE 8802-3:2017, 45.2.1.1.2 with the value defined by its parameter 802-3bv_pd_status.

Table 9 specifies 802-3bv_PowerDownStatus.request.

Table 9 — Specification of 802-3bv_PowerDownStatus.request

Item	Description
Semantic	802-3bv_PowerDownStatus.request (802-3bv_pd_status)
Parameters	The 802-3bv_pd_status parameter shall have one of the following values: — TRUE: the value to be written into the MDIO register 1.0.11 specified in ISO/IEC/IEEE 8802-3:2017, 45.2.1.1.2 is equal to 1_2; — FALSE: the value to be written into the MDIO register 1.0.11 specified in ISO/IEC/IEEE 8802-3:2017, 45.2.1.1.2 is equal to 0_2.
Generation	802-3bv_PowerDownStatus.request shall be generated when pd_status variable (see Table 13) is assigned to a value in the FFME state diagram (see Figure 10). The value of the pd_status variable shall be copied to the 802-3bv_pd_status.
Effect of receipt	A write operation in the MDIO register 1.0.11 specified in ISO/IEC/IEEE 8802-3:2017, 45.2.1.1.2 of the IEEE 802.3bv physical layer shall be performed with the value specified in the 802-3bv_pd_status parameter.

5.6.3 802-3bv_RXDETECT.indication

This service primitive is the same as PMD_RXDETECT.indication specified in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, 115.6.1.5.

5.7 WUSME Sublayer

5.7.1 General

WUSME sublayer shall transit between the states shown in the state diagram specified in 5.7.2.2 and 5.7.3.2.

WUSME sublayer shall generate the PHY_SleepStatus.indication service primitive as specified in 5.7.4.

5.7.2 WUSME wake-up functionality

The WUSME wake-up functionality shall perform the event exchange between the GEPOF entity and its link partner for the wake-up algorithm specified in ISO 21111-2.

The WUSME wake-up functionality shall comply with the state diagram of Figure 8, and the associate state diagram variables specified in 5.7.2.1.

5.7.2.1 WUSME wake-up state diagram variables

Table 10 specifies the WUSME wake-up state diagram variables.

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Table 10 — WUSME wake-up state diagram variables

Variable	Associated action	Value	Specification
wu_req	This variable reports the reception of a PHY_WakeUp.request service primitive (see ISO 21111-2:—, 6.8.3).	TRUE	A PHY_WakeUp.request is received and the wu_req variable shall be set to TRUE.
		FALSE	A PHY_WakeUp.request is not received and the wu_req variable shall be set to FALSE.
wu_ind	When this variable is assigned to TRUE, the WUSME sublayer generates a PHY_WakeUp.indication service primitive (see ISO 21111-2:—, 6.8.4).	TRUE	A PHY_WakeUp.indication shall be generated.
		FALSE	A PHY_WakeUp.indication shall not be generated.
wu_sleep_pkt	When this variable is assigned to a value, such value is copied into the parameter c45_wu_sleep_pkt of CON_WakeUpSleepPacket.request and the WUSME sublayer generates a CON_WakeUpSleepPacket.request service primitive (see 5.4.2).	SLEEP	The packet specified in the synchronised link sleep algorithm requested to be sent shall be of type SLEEP.
		SLEEP_ACK	The packet specified in the synchronised link sleep algorithm requested to be sent shall be of type SLEEP_ACK.
		NO_SLEEP	The packet specified in the synchronised link sleep algorithm requested to be sent shall be of type NO_SLEEP.
		WAKE_UP	The packet specified in the synchronised link sleep algorithm requested to be sent shall be of type WAKE_UP.
wu_sleep_ack_ind	This variable reports the reception of a CON_WakeUpSleepPacketACK.indication service primitive (see 5.4.4).	TRUE	A CON_WakeUpSleepPacketACK.indication is received and the variable WU_sleep_ack_ind shall be set to TRUE.
		FALSE	A CON_WakeUpSleepPacketACK.indication is not received and the variable wu_sleep_ack_ind shall be set to FALSE.
ffme_wu_ind	This variable reports the reception and presence of an FFME_WakeUp.indication service primitive (see 5.5.4).	TRUE	A FFME_WakeUp.indication is received and and the variable ffme_wu_ind shall be set to TRUE.
		FALSE	A FFME_WakeUp.indication is not received and the variable ffme_wu_ind shall be set to FALSE.
oam_ch_active	This variable stores the value of the oam_ch_active parameter of the last received CON_OAMActive.indication service primitive (see 5.4.6).	TRUE	The value of the oam_ch_active parameter of the last received CON_OAMActive.indication service primitive is TRUE and the variable oam_ch_active shall be set to TRUE.
		FALSE	The value of the oam_ch_active parameter of the last received CON_OAMActive.indication service primitive is FALSE and the variable oam_ch_active shall be set to FALSE.

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Table 10 *(continued)*

Variable	Associated action	Value	Specification
wu_sleep_pkt_ind	This variable reports the value of the parameter wu_sleep_pkt_remote of a received CON_WakeUpSleepPacket.indication service primitive. Otherwise, the variable is set to FALSE (see 5.4.3).	SLEEP	A CON_WakeUpSleepPacket.indication service primitive is received and the parameter wu_sleep_pkt_remote is equal to SLEEP. Then the variable wu_sleep_pkt_ind shall be set to SLEEP.
		SLEEP_ACK	A CON_WakeUpSleepPacket.indication service primitive is received and the parameter wu_sleep_pkt_remote is equal to SLEEP_ACK. Then the variable wu_sleep_pkt_ind shall be set to SLEEP_ACK.
		NO_SLEEP	A CON_WakeUpSleepPacket.indication service primitive is received and the parameter wu_sleep_pkt_remote is equal to NO_SLEEP. Then the variable wu_sleep_pkt_ind shall be set to NO_SLEEP.
		WAKE_UP	A CON_WakeUpSleepPacket.indication service primitive is received and the parameter wu_sleep_pkt_remote is equal to WAKE_UP. Then the variable wu_sleep_pkt_ind shall be set to WAKE_UP.
		FALSE	A CON_WakeUpSleepPacket.indication service primitive is not received.

5.7.2.2 WUSME wake-up state diagram

WUSME wake-up functionality shall comply with the WUSME wake-up state diagram in Figure 8.

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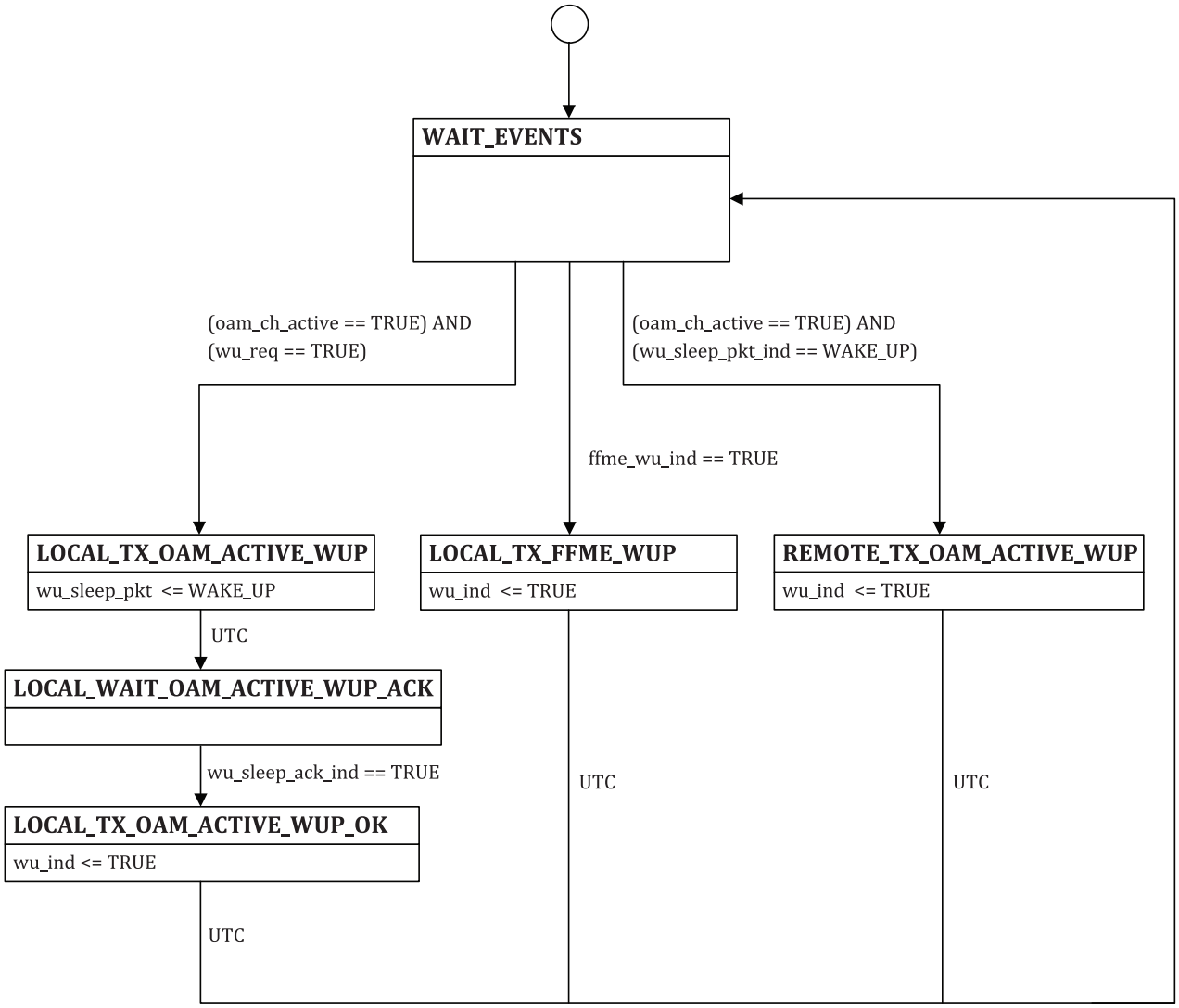


Figure 8 — WUSME wake-up state diagram

5.7.3 WUSME synchronised link sleep functionality

The WUSME synchronised link sleep functionality shall perform the event exchange between the GEPOF entity and its link partner for the synchronised link sleep algorithm specified in ISO 21111-2:—, 6.4.

The WUSME synchronised link sleep functionality shall comply with the synchronised link sleep state diagram in Figure 9, and the associate state diagram variables specified in 5.7.3.1.

5.7.3.1 WUSME synchronised link sleep state diagram variables

Table 11 specifies the WUSME synchronised link sleep state diagram variables not already specified in Table 10.

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Table 11 — WUSME synchronised link sleep state diagram variables

Variable	Associated action	Value	Specification
sleep_reject	This variable stores the value of the mng_sleep_reject parameter of the last received PHY_ConfigSleepReject.request service primitive (see ISO 21111-2:—, 6.8.5).	TRUE	The value of the mng_sleep_reject parameter of the last received PHY_ConfigSleepReject.request service primitive is TRUE. Then the variable sleep_reject shall be set to TRUE.
		FALSE	The value of the mng_sleep_reject parameter of the last received PHY_ConfigSleepReject.request service primitive is FALSE. Then the variable sleep_reject shall be set to FALSE.
set_phy_pd_status	When this variable is assigned to a value, such value is copied into the parameter ffme_pd_status of FFME_PowerDownStatus.request and the WUSME sublayer generates an FFME_PowerDownStatus.request service primitive (see 5.5.2).	TRUE	The state diagram requests to the GEPOF entity to go to the sleep power state. An FFME_PowerDownStatus.request service primitive shall be generated.
		FALSE	The state diagram requests to the GEPOF entity to go to the Normal power state. An FFME_PowerDownStatus.request service primitive shall be generated.
link_sleep_success	When this variable is assigned to a value, such value is copied into the parameter link_sleep_success of PHY_LinkSleep.indication and the WUSME sublayer generates a PHY_LinkSleep.indication service primitive (see ISO 21111-2:—, 6.8.2).	TRUE	Synchronised link sleep algorithm is successful. A PHY_LinkSleep.indication service primitive shall be generated.
		FALSE	Synchronised link sleep algorithm is failed. A PHY_LinkSleep.indication service primitive shall be generated.
link_sleep_req	This variable reports the reception of a PHY_LinkSleep.request (see ISO 21111-2:—, 6.8.1).	TRUE	A PHY_LinkSleep.request is received and the variable link_sleep _req shall be set to TRUE.
		FALSE	A PHY_LinkSleep.request is not received and the variable link_sleep _req shall be set to FALSE.
signal_detect_reg	This variable stores the value of the signal_detect_reg parameter of the last received CON_SignalDetected.indication (see 5.4.5).	TRUE	The value of the signal_detect_reg parameter of the last received CON_SignalDetected.indication service primitive is TRUE. Then, the variable signal_detect_reg shall be set to TRUE.
		FALSE	The value of the signal_detect_reg parameter of the last received CON_SignalDetected.indication service primitive is FALSE. Then, the variable signal_detect_reg shall be set to FALSE.

5.7.3.2 WUSME synchronised link sleep state diagram

WUSME synchronised link sleep functionality shall comply with the WUSME synchronised link sleep state diagram in Figure 9.

NOTE The WAIT_EVENTS state is the same as the one specified in Figure 8.

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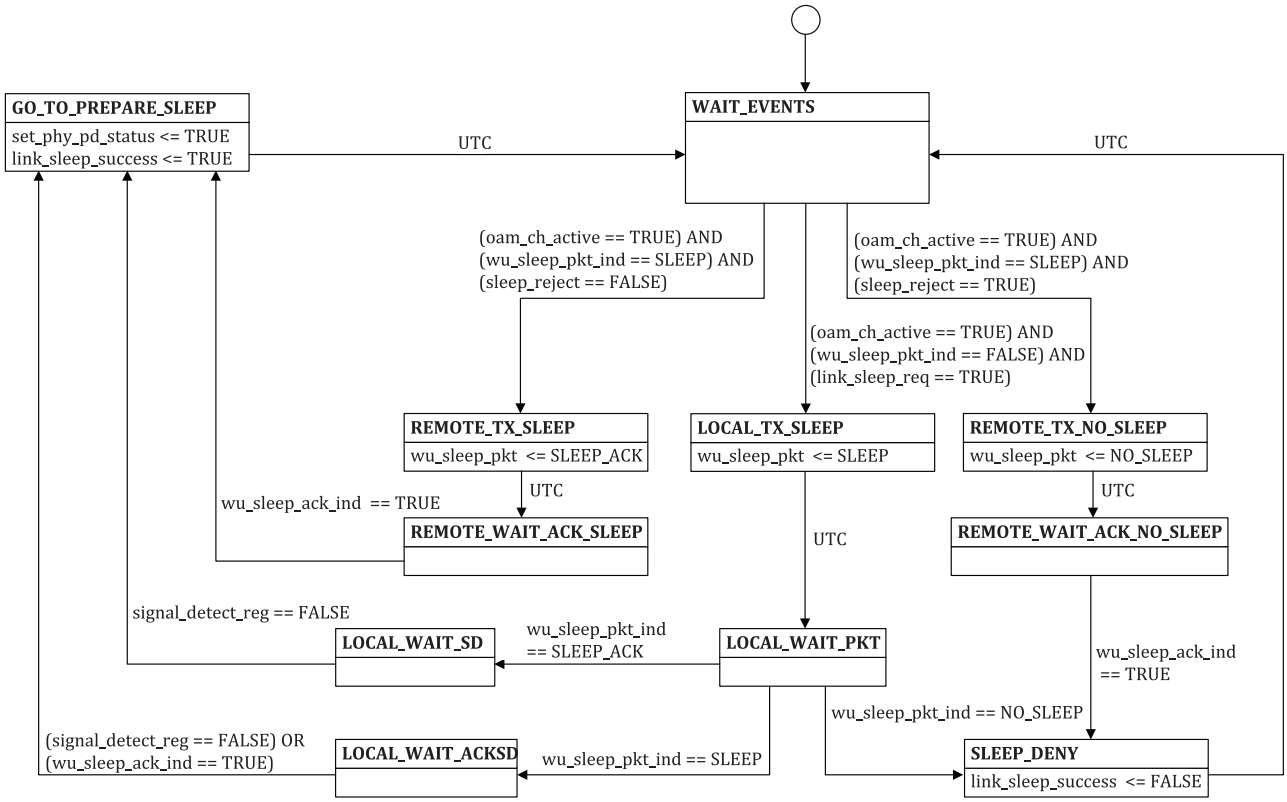


Figure 9 — WUSME synchronised link sleep state diagram

5.7.4 PHY_SleepStatus.indication generation

WUSME sublayer shall generate a PHY_SleepStatus.indication (see ISO 21111-2:—, 6.8.6) when it receives a FFME_PowerDownStatus.indication (see 5.5.3) or the variable power_off_entity changes its value (see Table 13).

The sleep_status parameter of PHY_SleepStatus.indication shall be determined from the pd_status parameter of FFME_PowerDownStatus.indication in accordance to Table 12.

Table 12 — PHY_SleepStatus.indication sleep_status parameter determination

pd_status parameter value	sleep_status parameter value
FALSE	NORMAL
TRUE	SLEEP

5.8 FFME sublayer

5.8.1 General

FFME sublayer shall transit between the states shown in the state diagram specified in 5.8.2.

5.8.2 FFME power state functionality

The FFME power state functionality shall perform the transitions between the power states specified in ISO 21111-2:—, 6.2.

The FFME power state functionality shall comply with the state diagram of Figure 10, and the associate state diagram variables specified in 5.8.2.1.

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Sleep power state specified in ISO 21111-2:—, 6.2 is split in two FFME_power states: Prepare_sleep and Deep_sleep. Normal power state specified in ISO 21111-2:—, 6.2 is mapped into FFME_power state Normal.

5.8.2.1 FFME power state diagram variables

Table 13 specifies the FFME power state diagram variables.

Table 13 — FFME power state diagram variables

Variable	Associated action	Value	Specification
pd_status	When this variable is assigned to a value, such value is copied into the parameter pd_status of FFME_PowerDownStatus.indication and the FFME sublayer generates an FFME_PowerDownStatus.indication service primitive (see 5.5.3). Additionally, the value of this variable is also copied into the parameter 802-3bv_pd_status of 802-3bv_PowerDownStatus.request and the FFME sublayer generates an 802-3bv_PowerDownStatus.request service primitive (see 5.6.2).	TRUE	The IEEE 802.3bv physical layer is in power-down state. An FFME_PowerDownStatus.indication service primitive and an 802-3bv_PowerDownStatus.request service primitive shall be generated.
		FALSE	The IEEE 802.3bv physical layer is not in power-down state. An FFME_PowerDownStatus.indication service primitive and an 802-3bv_PowerDownStatus.request service primitive shall be generated.
power_off_entity	This variable changes when the power supply connected to the GEPOF entity goes to or from power off mode as specified in ISO 21111-2.	TRUE	The power supply connected to the GEPOF entity is in power-off mode. Then, the variable power_off_entity shall be set to TRUE.
		FALSE	The power supply connected to the GEPOF entity is not in power-off mode. Then, the variable power_off_entity shall be set to FALSE.
nphy_inh_sleep_req	This variable stores the value of the nphy_inh_sleep_req parameter of the last received NPHY_WakeUpForward.request (see ISO 21111-2:—, 6.9.1).	TRUE	The value of the nphy_inh_sleep_req parameter of the last received NPHY_WakeUpForward.request service primitive is TRUE. Then, the variable nphy_inh_sleep_req shall be set to TRUE.
		FALSE	The value of the nphy_inh_sleep_req parameter of the last received NPHY_WakeUpForward.request service primitive is FALSE. Then, the variable nphy_inh_sleep_req shall be set to FALSE.
power_state_is_normal	When the GEPOF entity enters or exits the Normal power status, the value of this variable is copied into the parameter power_state_is_normal of NPHY_WakeUpForward.indication and an NPHY_WakeUpForward.indication service primitive is generated (see ISO 21111-2:—, 6.9.2).	TRUE	The GEPOF entity is in the Normal power state. An NPHY_WakeUpForward.indication service primitive shall be generated.
		FALSE	The GEPOF entity is not in the Normal power state. An NPHY_WakeUpForward.indication service primitive shall be generated.
ffme_wu_ind_gen	When this variable is assigned to TRUE, the FFME sublayer generates an FFME_WakeUp.indication service primitive (see 5.4.2).	TRUE	An FFME_WakeUp.indication shall be generated.
		FALSE	An FFME_WakeUp.indication shall not be generated.

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Table 13 *(continued)*

Variable	Associated action	Value	Specification
ffme_sd_ind	This variable stores the value of the signal_detect parameter of the last received 802-3bv_RXDETECT.indication (see 5.6.3).	TRUE	The value of the signal_detect parameter of the last received 802-3bv_RXDETECT.indication service primitive is OK. The meaning of OK for this parameter of the service primitive is specified in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, 115.6.1.5. Then, the variable ffme_sd_ind shall be set to TRUE.
		FALSE	The value of the signal_detect parameter of the last received 802-3bv_RXDETECT.indication is FAIL. The meaning of FAIL for this parameter of the service primitive is specified in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, 115.6.1.5. Then, the variable ffme_sd_ind shall be set to FALSE.
ffme_pd_status	This variable stores the value of the ffme_pd_status parameter of the last received FFME_PowerDownStatus.request (see 5.5.2).	TRUE	The value of the ffme_pd_status parameter of the last received FFME_PowerDownStatus.request was TRUE. Then, the variable ffme_pd_status shall be set to TRUE.
		FALSE	The value of the ffme_pd_status parameter of the last received FFME_PowerDownStatus.request was FALSE. Then, the variable ffme_pd_status shall be set to FALSE.

5.8.2.2 FFME power state diagram

FFME power state functionality shall comply with the FFME power state diagram in Figure 10.

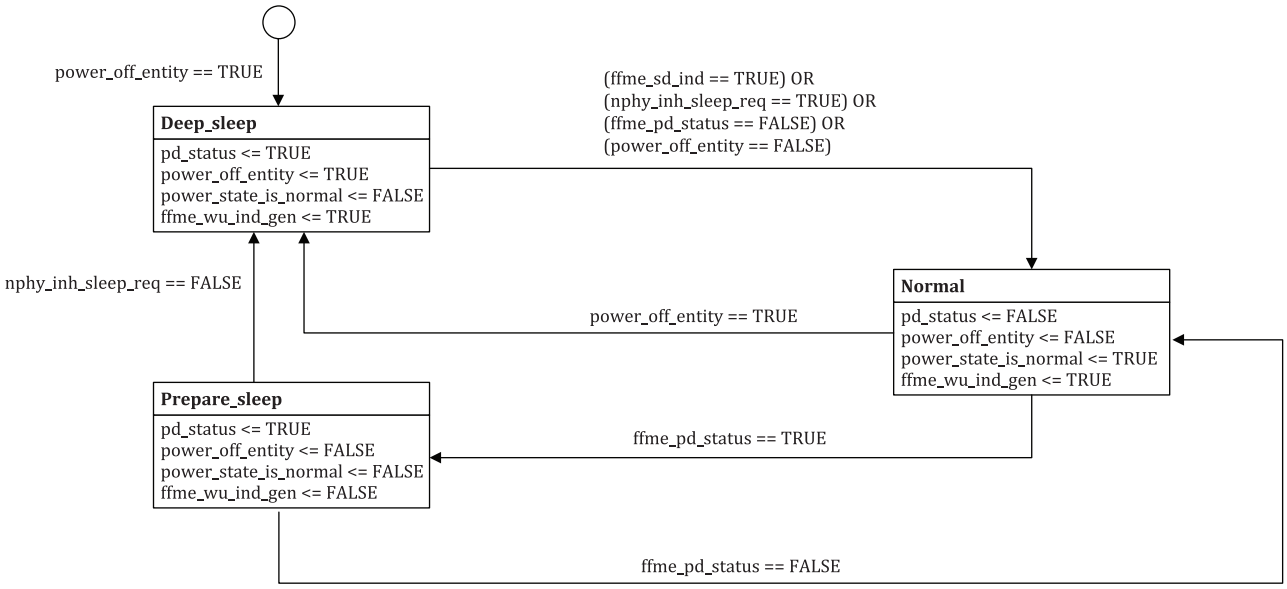


Figure 10 — FFME power state diagram

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5.9 Conciliation sublayer

5.9.1 General

The conciliation sublayer shall implement the functions that generate the following conciliation service primitives:

— CON_WakeUpSleepPacket.indication (see 5.4.3);

— CON_WakeUpSleepPacketACK.indication (see 5.4.4);

— CON_SignalDetected.indication (see 5.4.5).

The information used to generate the service primitives shall be extracted from the MDIO registers specified in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, Clause 45.

The conciliation sublayer shall also implement the functions that write the MDIO registers specified in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, Clause 45 when receiving the following conciliation service primitive:

— CON_WakeUpSleepPacket.request (see 5.4.2).

The conciliation sublayer and its service primitives use certain bits of the MDIO register 3.500. TXO_MSGT bit is the bit 12 of the MDIO register 3.500. TXO_MERT bit is the bit 13 of the MDIO register 3.500. TXO_REQ bit is the bit 15 of the MDIO register 3.500.

The conciliation sublayer implements also the CRC16 computation.

5.9.2 Conciliation sublayer variables

Table 14 specifies the conciliation sublayer variables.

Table 14 — Conciliation sublayer variables

Variable	Associated action	Value	Description
pkt_id	This variable stores the OAMPDU identifier (see ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, Table 45-160a).	TRUE	The TXO_MSGT bit is equal to TXO_REQ when a CON_ WakeUpSleepPacket.request service primitive is received. Then, the variable pkt_id shall be set to TRUE.
		FALSE	The TXO_MSGT bit is different from TXO_REQ when a CON_ WakeUpSleepPacket.request service primitive is received. Then, the variable pkt_id shall be set to FALSE.

5.9.3 CRC16 computation

The OAMPDU is composed of a total of 140 bit. These 140 bit are the concatenation, from the LSB to the MSB, of the set of bits TXO_DATA0 to TXO_DATA8 in this order, as specified in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, 45.2.3.47a.5, 115.3.4, and 115.9.

This subclause specifies how to compute a set of 16 bit for extra error detection capability from the 124 least significant bits of the OAMPDU. The computed set of 16 bit is called CRC16.

The generator polynomial is $(x + 1)\cdot(x^{15} + x^{14} + x^{13} + x^{11} + x^{9} + x^{8} + x^{5} + x + 1)$.

The CRC16 shall be computed from the 124 least significant bits of the OAMPDU and shall produce the same result as the implementation shown in Figure 11 and the procedure specified in this subclause. Each shift register element from S0 to S15 in Figure 11 stores one bit. The adders shall be one bit wide and module 2 (XOR).

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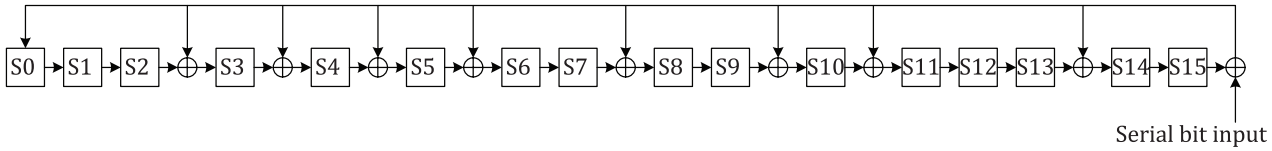


Figure 11 — CRC16 computation

The procedure to obtain CRC16 from the 124 least significant bits of the OAMPDU is the following:

1) The shift register elements from S0 to S15 shall be initialised with the value of 0000_{16} before the 124 least significant bits of the OAMPDU are introduced in the implementation of Figure 11.

2) The 124 least significant bits of the OAMPDU, starting with the LSB, are then used to compute the CRC16. The serial bit input of Figure 11 is set sequentially to each of the bit used to compute the CRC16. For each different bit in the serial bit input, a partial result of the computation is stored in each shift register element. For S0 the computation is always the feedback bit, computed as the XOR of the serial bit input and the bit stored in S15. For the rest of shift register elements, the partial result of the computation is one of the two possibilities:

   — the XOR of the bit stored in the left side shift register element and the feedback bit, or

   — the bit stored in the left side shift register.

3) After the 124 bit are serially processed, the 16 bit stored in the shift register elements from S15 to S0 in Figure 11 are the CRC16. The MSB of CRC16 is equal to the bit stored in S15 and the LSB of CRC16 is equal to the bit stored in S0.

5.9.4 Generating ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, Clause 45 stimuli from CON_WakeUpSleepPacket.request

The request to send a synchronised link sleep or wake-up event service primitive (CON_WakeUpSleepPacket.request) shall be implemented by performing the transmission of an OAMPDU following the steps specified in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, 115.9.1.

The first 12 bit of the OAMPDU shall be the 12 most significant bits of the CID.

The following 128 user data bits of the OAMPDU shall be:

1) the 12 least significant bits of the CID, as specified in Table 15,

2) 4 bit set to zero,

4) the 16 bit of the protocol identifier for synchronised link sleep and wake-up protocol, as specified in Table 15,

5) the 16 bit of the packet type to transmit, as specified in Table 15, depending on the parameter c45_wu_sleep_pkt (see 5.4.2),

6) 64 bit set to zero, and

7) CRC16 computed using this OAMPDU as specified in 5.9.3.

5.9.5 Generating CON_WakeUpSleepPacket.indication from ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, Clause 45 stimuli

The conciliation sublayer shall generate a CON_WakeUpSleepPacket.indication service primitive after the reception of a packet specified in the synchronised link sleep algorithm.

The reception of a packet consists on the reception of an OAMPDU with a fixed content.

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The sequence of ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, Clause 45 stimuli from IEEE 802.3bv physical layer that leads to the reception of an OAMPDU is specified in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, 115.9.3.

To generate a CON_WakeUpSleepPacket.indication service primitive the content of the received OAMPDU shall fulfil all the following requirements:

— the composed CID shall be the one specified in Table 15,

— the protocol identifier shall be equal to the one specified for synchronised link sleep and wake-up protocol (see Table 15),

— the packet type shall be one of the valid values specified in Table 15, and

— the CRC16 computed for this OAMPDU as specified in 5.9.3 matches with the CRC16 field of this OAMPDU.

When CON_WakeUpSleepPacket.indication is generated, its parameter wu_sleep_pkt_remote shall be set according to the received packet type of Table 15.

5.9.6 Generating CON_WakeUpSleepPacketACK.indication from ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, Clause 45 stimuli

The necessary sequence of ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, Clause 45 stimuli from an IEEE 802.3bv physical layer to generate CON_WakeUpSleepPacketACK.indication shall be the following:

1) wait until the value of TXO_MERT bit of MDIO register 3.500 and the value of the conciliation sublayer variable pkt_id are equal, and

2) then, CON_WakeUpSleepPacketACK.indication shall be generated.

CON_WakeUpSleepPacketACK.indication shall be present the time necessary to make a transition in any of the state diagrams specified in Figure 8 or Figure 9, or when TXO_MERT bit and the value of the conciliation sublayer pkt_id are the same.

5.9.7 Generating CON_SignalDetected.indication from ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, Clause 45 stimuli

The sequence of ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, Clause 45 stimuli from an IEEE 802.3bv physical layer to generate CON_SignalDetected.indication shall be the following:

1) wait until the MDIO register 1.10.0 changes, and

2) then, CON_SignalDetected.indication shall be generated with its parameter signal_detect_reg equal to the value of the MDIO register 1.10.0.

CON_SignalDetected.indication shall be present the time necessary to make a transition in the state diagram specified in Figure 9.

5.9.8 Conciliation sublayer constants

Table 15 specifies the value of conciliation sublayer constants and the relationship with CON_WakeUpSleepPacket.indication parameter wu_sleep_pkt_remote.

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Table 15 — Conciliation sublayer constants

Constant	Description	Value	Associated parameter	Associated parameter value
ISO TC22/SC31 CID	CID corresponding to ISO TC22/SC31	$BAF21C_{16}$	None	None
Protocol identifier for synchronised link sleep and wake-up	Value to identify a synchronised link sleep or wake-up packet specified in the synchronised link sleep algorithm	0001_{16}	None	None
SLEEP packet type	Value to identify a SLEEP packet specified in the synchronised link sleep algorithm	0000_{16}	wu_sleep_pkt_remote	SLEEP
NO_SLEEP packet type	Value to identify a NO_SLEEP packet specified in the synchronised link sleep algorithm	0001_{16}	wu_sleep_pkt_remote	NO_SLEEP
SLEEP_ACK packet type	Value to identify a SLEEP_ACK packet specified in the synchronised link sleep algorithm	0002_{16}	wu_sleep_pkt_remote	SLEEP_ACK
WAKE_UP packet type	Value to identify a WAKE_UP packet specified in the wake-up functionality (see 5.7.2)	0003_{16}	wu_sleep_pkt_remote	WAKE_UP

6 PICS proforma

6.1 General

The supplier of a protocol implementation that claims to conform to this document shall complete the following PICS proforma in addition to the one specified in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, 115.14.

The convention used in the PICS proforma and the instructions for completing it are specified in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, Clause 21.

6.2 Major capabilities/options

Table 16 speficies the major capabilities/options.

Table 16 — Wake-up and synchronised link sleep PICS. Major capabilities/options

Item	Feature	Clause	Value/Comment	Status	Support
*WUS	Wake-up and synchronised link sleep algorithms	Clause 5	Wake-up and synchronised link sleep algorithms comply with Clause 5.	O	Yes [ ] No [ ]

6.3 Wake-up and synchronised link sleep PICS items

Table 17 specifies the wake-up and synchronised link sleep PICS items

Table 17 — Wake-up and synchronised link sleep functionality PICS items

Item	Feature	Subclause	Value/Comment	Status	Support
WUS1	WUSME wake-up functionality	5.7.2	WUSME wake-up state diagram complies with Figure 8.	WUS:M	Yes [ ]
WUS2	WUSME synchronised link sleep functionality	5.7.3	WUSME synchronised link sleep state diagram complies with Figure 9.	WUS:M	Yes [ ]
WUS3	FFME power state functionality	5.8.2	FFME power state diagram complies with Figure 10.	WUS:M	Yes [ ]

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Table 17 *(continued)*

Item	Feature	Subclause	Value/Comment	Status	Support
WUS4	Time to complete synchronised link sleep algorithm	ISO 21111-2:—, 6.10.1	Time to complete synchronised link sleep algorithm shall be less than 50 ms.	WUS:M	Yes [ ]
WUS5	Time to complete wake-up algorithm when the physical entities involved in the algorithm are in the Normal power state	ISO 21111-2:—, 6.10.2	Time to complete wake-up algorithm shall be less than 2 ms.	WUS:M	Yes [ ]
WUS6	tWU_Link_Active	ISO 21111-2:—, 6.10.2.2	tWU_Link_Active shall be less than 2 ms.	WUS:M	Yes [ ]
WUS7	tWU_Link_Passive	ISO 21111-2:—, 6.10.2.3	tWU_Link_Passive shall be less than 2 ms.	WUS:M	Yes [ ]
WUS8	t_Powersupply_Stable	ISO 21111-2:—, 6.10.2.4	t_Powersupply_Stable shall be less than 5 ms.	WUS:M	Yes [ ]
WUS9	t_Initialisation	ISO 21111-2:—, 6.10.2.4	t_Initialisation shall be less than 10 ms.	WUS:M	Yes [ ]
WUS10	tWU_WakeIO	ISO 21111-2:—, 6.10.2.5	tWU_WakeIO shall be less than 1 ms.	WUS:M	Yes [ ]
WUS11	tWU_Forwarding	ISO 21111-2:—, 6.10.2.6	tWU_Forwarding shall be less than 1 ms.	WUS:M	Yes [ ]

7 Test plan

7.1 Test plan scope

The test plan specified in Clause 7 is designed to determine if a certain implementation of the GEPOF physical entity complies with the requirements specified in this document and in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018.

The complete list of the requirements is the collection of PICS in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, 115.14 and in Clause 6 of this document.

All requirements in the complete list belong to the physical layer as specified in ISO 7498-1.

Bit naming and MDIO register numbering are specified in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, Clause 45. CID is specified in ISO/IEC/IEEE 8802-A:2015, 1.4.162.

The high logic level and low logic level for the MDIO registers are specified in ISO/IEC/IEEE 8802-3:2017, 22.4.

The valid values of the service primitive parameters specified in this document follow a positive logic. A value equal to TRUE corresponds to a high logic level and a value equal to FALSE corresponds to a low logic level.

The valid values of the header fields in the PHD follow a positive logic and are specified in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, Table 115-6. A value equal to OK corresponds to a high logic level and a value equal to NOT_OK corresponds to a low logic level.

Clause 7 specifies test cases that contain checks inside. The result of a check shall be OK only if the expected result for this concrete check is obtained. Otherwise, the result of the check shall be fail. The expected result is specified in each test case.

7.2 Test plan architecture

The ISO/IEC 9646 series specifies the methodology to check the conformance of protocol implementations to certain PICS. This methodology does not apply fully to physical layer protocols.

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However, the test plan follows when possible the "OSI conformance testing general concepts" ISO/IEC 9646-1.

The test plan is restricted to the single party testing mode as specified in ISO/IEC 9646-1. The IUT is a GEPOF entity implementation for this test plan.

The generic test environment is described in Figure 12.

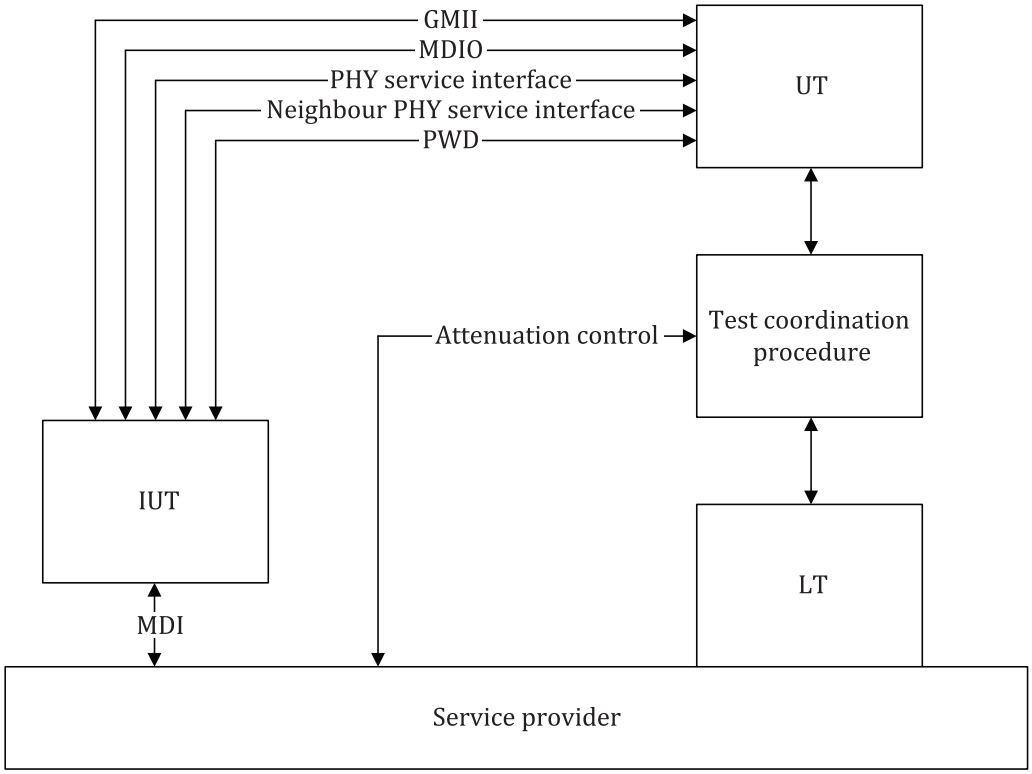


Figure 12 — Generic test environment

There are four interfaces that communicate the IUT with the UT:

— GMII as specified in ISO/IEC/IEEE 8802-3. The implementation of this interface for automotive Ethernet is specified in ISO 21111-2

— MDIO as specified in ISO/IEC/IEEE 8802-3:2017, Clauses 22, 35, and 45,

— PHY service interface, as specified in ISO 21111-2, and

— Neighbour PHY service interface, as specified in ISO 21111-2.

Additionally, the power source line PWD is also used as interface in this test plan.

The MDI standardized interface communicates the IUT with the physical medium. The MDI optical specifications are specified in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018. The MDI is not an OSI protocol standard; therefore, the direct application of the ISO/IEC 9646 series' methodology is not possible.

Some PICS items require the measurement of several physical quantities such as AOP, frequency response or signal jitter.

The test environment used for the implementation of the test case involves four test functions:

— an LT operating as link partner of the IUT,

— an UT acting as user of the IUT,

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— a test coordination procedure, running test case and granting test verdict, and

— a service provider that models the physical medium.

Each test case requires a particular implementation of the test environment defined as test setup. 7.6 specifies the test setups required by the test cases of this document.

Before test execution, the test coordination procedure configures IUT by means of the UT. The test coordination procedure configures also the service provider by selecting the optical attenuation required by the test case if needed by the test setup.

During test execution, a number of checks are performed by the test coordination procedure using the information obtained from the UT and LT. In some test cases these checks are required to be performed as measurements of physical quantities at test points inside the service provider. See ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, Figure 115-34 for test point specifications.

After test execution, the test coordination procedure grants the test verdict. The test verdict shall be "pass" only if all requirements listed in the observable results section of the test case are fulfilled. Otherwise, the test verdict shall be "failed".

The test case sections are specified in 7.4.

7.3 Test plan organization

The test cases are organized in groups of tests. Tests methods in the same group cover similar PICS.

The groups of tests are organized in blocks. Groups of tests in the same block share the same requirement level.

There are three blocks of groups of tests:

Block 1 contains all groups of tests that cover the GEPOF entity testing and loopback PICS items. The list of test cases in block 1 is specified in 7.5.1.

Block 2 contains all groups of tests that cover all the other mandatory GEPOF entity PICS items. The list of test cases in block 2 is specified in 7.5.2.

Block 3 contains all groups of tests that cover the optional GEPOF entity PICS items. The list of test cases in block 3 is specified in 7.5.3.

The order of execution of the test cases is strongly recommended to follow the same order as presented in this document.

The test case name is composed of the group of tests name in capital letters followed by a correlative test case number inside the group.

7.4 Test case sections

The test case specification consists of the following sections:

— purpose,

— test case references,

— test setup,

— discussion,

— test configuration,

— test procedure steps,

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— observable results, and

— remarks.

The purpose is a brief statement outlining what the test case attempts to achieve.

The test case reference section specifies source material external to the test plan, including specific subsections pertinent to the test case definition, or any other references that might be helpful in understanding the test methodology and/or test results.

The test setup section specifies the instruments needed to perform the test case and how they are connected. The different test setups used in this document are specified in 7.6.

The discussion section covers the assumptions made in the design or implementation of the test case, as well as known limitations. Other items specific to the test case are covered here.

The test configuration section describes the initial configuration of the test environment. Small changes in the configuration shall not be included here and are generally covered in the test procedure steps section described in the paragraph below.

The test procedure steps section of the test case contains the systematic instructions in steps for carrying out the test. It provides a cookbook approach to testing and may be interspersed with observable results. The steps may consist of getting information from the IUT through the UT, set the instruments that compose the LT to perform some action or perform checks using the information obtained from the UT and LT among others. The test coordination procedure runs the test procedure steps and performs the checks that lead to the test verdict.

The observable results section lists the specific observables that shall be examined by the test coordination procedure in order to verify that the IUT is operating properly. When multiple values for an observable are possible, this section provides a short discussion on how to interpret them. The determination of a pass or fail verdict for a particular test case is based on the successful (or unsuccessful) detection of a specific observable result. The test coordination procedure shall determine that the test case verdict is equal to "pass" only if all requirements listed in the observable results section are fulfilled.

The remarks section contains a description of known issues with the test case, which can affect test results in certain situations.

7.5 Test case reference tables

7.5.1 Block 1: test mode and loopback test cases

Table 18 specifies block 1 test cases.

Table 18 — Block 1: test modes and loopbacks test cases

Group	Test	Name	Description
Loopbacks	LBT_1	Loopback control	Verifies that the loopback mode selection is possible by using MDIO registers.
	LBT_2	GMII loopback	Verifies that the GMII loopback mode fulfils functionality specified in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018.
	LBT_3	PMD loopback	Verifies that the PMD service interface loopback mode fulfils functionality specified in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018.
	LBT_4	Line loopback	Verifies that the line loopback mode fulfils functionality specified in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018.

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Table 18 *(continued)*

Group	Test	Name	Description
Test modes	TMT_1	Test mode configuration general	Verifies that the configuration and general properties of test modes fulfil functionality specified in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018.
	TMT_2	Test mode 1 transmission	Verifies that the test mode 1 fulfils functionality specified in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018.
	TMT_3	Test mode 1 reception	Verifies that the test mode 1 fulfils functionality specified in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018.
	TMT_4	Test mode 2 transmission	Verifies that the pattern generated fulfils functionality specified in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018.
	TMT_5	Test mode 3 transmission	Verifies that the pattern generated fulfils functionality specified in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018.
	TMT_6	Test mode 4 transmission	Verifies that the pattern generated fulfils functionality specified in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018.
	TMT_7	Test mode 5 transmission	Verifies that the pattern generated fulfils functionality specified in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018.
	TMT_8	Test mode 6 transmission	Verifies that the pattern generated fulfils functionality specified in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018.

7.5.2 Block 2: PCS, PMA, PMD and MDI test cases

Table 19 specifies block 2 test cases.

Table 19 — Block 2: PCS, PMA, PMD and MDI test cases

Group	Test	Name	Description
PCS	PCST_1	PCS transmission signalling	Verifies that the IUT transmits a compliant transmit block structure as specified in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018.
	PCST_2	PCS transmission PHD	Verifies that the IUT transmits properly the PHD contents with the correct modulation, encoding, and position inside the transmit block as specified in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018.
	PCST_3	PCS transmission payload data	Verifies that the IUT transmits a compliant transmit block containing a fixed and known payload data.
	PCST_4	PCS reception header and payload data	Verifies that the IUT receives properly the PHD and payload data contents with the correct modulation, encoding, and position inside the transmit block.
	PCST_5	PCS transmission alignment	Verifies that the IUT sends properly using the PHD.TX.NEXT.PDB.OFFSET field in the PHD the information about the offset of the PCS measured from the beginning of the transmit block.
	PCST_6	PCS reception alignment	Verifies that the IUT receives properly using the PHD.TX.NEXT.PDB.OFFSET field in the PHD the information about the offset of the PCS measured from the beginning of the transmit block.

[a] Specification in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, 115.13 is 6 500 bit-times not including delay in the POF cable and in the in-line connectors. A consideration of 1 ns per bit-time without taking additional channel delay is taken into account to reach the 6,5 µs requirement.

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Table 19 *(continued)*

Group	Test	Name	Description
PMA	PMAT_1	Transmission PMA power scaling	Verifies that the IUT transmits a compliant transmit block and that each of the sub-blocks that compose it (pilot S1, pilot $S2_x$, and PHS_x) are correctly power scaled to generate symbols at the output of the PMA in such way that $-1 \leq x(t) < 1$.
	PMAT_2	THP transmission	Verifies that the payload data transmitted by the IUT is properly precoded using the Tomlinson-Harashima precoding and reset at the times specified in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, 115.3.1.1.
	PMAT_3	State diagrams – Transmit PHD commit point	Verifies that a change in the internal variable in the IUT that shall change the value of its associated PHD field is effectively reflected in the PHD transmitted over the first complete transmit block started after the internal variable change.
	PMAT_4	State diagrams – Receive PHD commit point	Verifies that a change in the internal variable in the IUT that shall change after receiving the value of its associated PHD field is effectively performed after PHS decoding of the received transmit block.
	PMAT_5	State diagrams – TX control	Verifies that the IUT performs correctly the transitions of the state diagram specified in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, 115.3.5.2 and Figure 115-22.
	PMAT_6	State diagrams – RX control	Verifies that the IUT performs correctly the transitions of the state diagram specified in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, 115.3.5.3 and Figure 115-23.
	PMAT_7	State diagrams – Link monitor	Verifies that the IUT performs correctly the transitions of the state diagram specified in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, 115.3.5.4 and Figure 115-24.
	PMAT_8	State diagrams – PHD monitor	Verifies that the IUT performs correctly the transitions of the state diagram specified in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, 115.3.5.5 and Figures 115-25, 115-26 and 115-27.
	PMAT_9	State diagrams – Adaptive THP TX	Verifies that the IUT performs correctly the transitions of the state diagram specified in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, 115.3.6.2 and Figure 115-28.
	PMAT_10	State diagrams – Adaptive THP request	Verifies that the IUT performs correctly the transitions of the state diagram specified in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, 115.3.6.3 and Figure 115-29.
	PMAT_11	State diagrams – Quality monitor state diagram	Verifies that the IUT performs correctly the transitions of the state diagram specified in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, 115.3.7.4 and Figure 115-30.

[a] Specification in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, 115.13 is 6 500 bit-times not including delay in the POF cable and in the in-line connectors. A consideration of 1 ns per bit-time without taking additional channel delay is taken into account to reach the 6,5 µs requirement.

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Table 19 *(continued)*

Group	Test	Name	Description
	PMAT_12	Synchronisation	Verifies that the IUT performs correctly the coarse and fine-tuning synchronisation with a transmitter that complies with the maximum clock deviation specified in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, 115.6.3.2.
	PMAT_13	Equalization and BER measurement	Verifies that the IUT performs correctly the equalization algorithm that allows reaching the BER specified in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, 115.6.3.3 when the system is designed for certain channel type specified in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, 115.7.
PMD	PMDT_1	PMD transmit function – Electrical to optical	Verifies that the IUT performs correctly the PMD transmit function defined as the translation of electrical signals to optical signals. The test setup is already specified in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, 115.6.4.3.
	PMDT_2	PMD transmit function – Power control	Verifies that the IUT turns on and off the optical power output in transmission by using the PMD_TXPWR.request as specified in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018.
	PMDT_3	PMD reception function – Optical to electrical	Verifies that the IUT converts the received optical power into electrical signal.
	PMDT_4	PMD reception function – Signal detection	Verifies that the IUT detects the presence of the optical signal at its input following the values given in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, 115.6.2.4 and Table 115-7.
PMD/MDI	PMD_MDIT_1	Transmitter optical specifications – AOP	Verifies that the IUT fulfils the AOP required in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, 115.6.3.1 and Table 115-8 measured in TP2.
	PMD_MDIT_2	Transmitter optical specifications – ER	Verifies that the IUT fulfils the ER required in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, 115.6.3.1 and Table 115-8 measured in TP2.
	PMD_MDIT_3	Transmitter optical specifications – Centre wavelength	Verifies that the IUT fulfils the centre wavelength required in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, 115.6.3.1 and Table 115-8 measured in TP2.
	PMD_MDIT_4	Transmitter optical specifications – Spectral width	Verifies that the IUT fulfils the spectral width required in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, 115.6.3.1 and Table 115-8 measured in TP2.
	PMD_MDIT_5	Transmitter optical specifications – Rise time	Verifies that the IUT fulfils the rise time required in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, 115.6.3.1 and Table 115-8 measured in TP2.
	PMD_MDIT_6	Transmitter optical specifications – Fall time	Verifies that the IUT fulfils the fall time required in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, 115.6.3.1 and Table 115-8 measured in TP2.
	PMD_MDIT_7	Transmitter optical specifications – Signal overshoot	Verifies that the IUT fulfils the signal overshoot required in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, 115.6.3.1 and Table 115-8 measured in TP2.
	PMD_MDIT_8	Transmitter optical specifications – Positive output droop	Verifies that the IUT fulfils the positive output droop required in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, 115.6.3.1 and Table 115-8 measured in TP2.

[a] Specification in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, 115.13 is 6 500 bit-times not including delay in the POF cable and in the in-line connectors. A consideration of 1 ns per bit-time without taking additional channel delay is taken into account to reach the 6,5 µs requirement.

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Table 19 *(continued)*

Group	Test	Name	Description
	PMD_MDIT_9	Transmitter optical specifications – Negative output droop	Verifies that the IUT fulfils the negative output droop required in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, 115.6.3.1 and Table 115-8 measured in TP2
	PMD_MDIT_10	Transmitter optical specifications – Signal distortion	Verifies that the IUT fulfils the signal distortion (2nd, 3rd and 4th order harmonic and residual distortion), required in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, 115.6.3.1 and Table 115-8 measured in TP2.
	PMD_MDIT_11	Transmitter optical specifications – Relative intensity noise	Verifies that the IUT fulfils the relative intensity noise required in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, 115.6.3.1 and Table 115-8 measured in TP2.
	PMD_MDIT_12	Transmitter optical specifications – Transmitter off transition time	Verifies that the IUT reaches the AOP in transmission to be considered in transmission quiet mode in less than the off-transition time t_{OFF} specified in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, Table 115-8.
	PMD_MDIT_13	Transmitter optical specifications – Transmitter on transition time	Verifies that the IUT reaches the AOP in transmission to be considered in transmission active operation in less than the on-transition time t_{ON} specified in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, Table 115-8.
	PMD_MDIT_14	Transmitter optical specifications – Modal power distribution	Verifies that the IUT fulfils the modal power distribution required in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, 115.6.3.1 and Table 115-8 measured in TP2.
	PMD_MDIT_15	Transmitter optical specifications – Timing jitter	Verifies that the IUT fulfils the timing jitter required in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, 115.6.3.1 and Table 115-8 measured in TP2.
	PMD_MDIT_16	Receiver optical specifications – AOP for a minimum BER	Verifies that the IUT fulfils the minimum and maximum AOP required in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, 115.6.3.3 and Table 115-10 measured in TP3 for all channel types specified for 1000BASE-RHC.
	PMD_MDIT_17	Receiver optical specifications – Damage threshold power	Verifies that the IUT fulfils the damage threshold power required in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, Table 115-10 Note a.
Delay	DLYT_1	Transmission plus reception delay	Verifies that the delay measured from the time when an bit pattern sequence sent over the IUT GMII transmission interface (GTX_CLK, TXD<7:0>, TX_EN and TX_ER in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, Figure 115-3) to the time when the same bit pattern sequence is received, is lower than 6,5 µs, as specified[a] in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, 115.13.

[a] Specification in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, 115.13 is 6 500 bit-times not including delay in the POF cable and in the in-line connectors. A consideration of 1 ns per bit-time without taking additional channel delay is taken into account to reach the 6,5 µs requirement.

7.5.3 Block 3. EEE, OAM and wake-up and synchronised link sleep test cases

Table 20 specifies block 3 test cases.

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Table 20 — Block 3. EEE, OAM and wake-up and synchronised link sleep test cases

Group	Test	Name	Description
EEE	EEET_1	Enter to LPI mode transmit operation	Verifies that the IUT enters properly into LPI mode as specified in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, 115.4 and that the structure of the transmit block when entering the LPI mode matches the structure specified in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, Figure 115-31.
	EEET_2	EEE capability exchange	Verifies that the IUT enters into LPI mode as specified in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, 115.4 only when both, the link partner and the IUT, have the EEE capability activated, and it is properly announced in the IUT header.
	EEET_3	Loop test for LPI mode	Verifies that the IUT that enters into LPI mode continues the normal reception of GMII transactions when normal operation is resumed.
	EEET_4	Resume from LPI mode transmit operation	Verifies that the IUT resumes properly from LPI mode as specified in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, 115.4 and that normal communication is possible after the resume from LPI mode.
OAM	OAMT_1	State diagrams – OAM transmit control	Verifies that the IUT performs correctly the transitions of the state diagram specified in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, 115.9.4.2 and Figure 115-42.
	OAMT_2	State diagrams – OAM receive control	Verifies that the IUT performs correctly the transitions of the state diagram specified in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, 115.9.4.3 and Figure 115-43.
	OAMT_3	Loop test for OAMPDU transmission and reception	Verifies that the IUT transmits and receives OAMPDUs.
Wake-up functionality and synchronised link sleep algorithm	WUST_1	WUSME synchronised link sleep state diagram – Synchronised link sleep ACK	Verifies that the IUT responds with a SLEEP_ACK packet to a synchronised link sleep requirement from its link partner.
	WUST_2	WUSME synchronised link sleep state diagram – SLEEP_ACK packet reception	Verifies that the IUT generates a synchronised link sleep requirement to its link partner and the response is a SLEEP_ACK packet.
	WUST_3	WUSME synchronised link sleep state diagram – SLEEP packet reception	Verifies that the IUT generates a synchronised link sleep requirement to its link partner and the response is a SLEEP packet.
	WUST_4	WUSME synchronised link sleep state diagram – Sleep rejection	Verifies that the IUT rejects a synchronised link sleep requirement from its link partner.
	WUST_5	WUSME wake-up state diagram	Verifies that the IUT transmits or receives packet specified in the synchronised link sleep algorithm with a request to perform a wake-up.

7.6 Test setups

7.6.1 General

A list of test setups and their description is specified in Table 21.

The name of each test setup is composed of the letters TS_ followed by a descriptive short name of the test setup.

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Some of the test setups are already specified in the ISO/IEC/IEEE 8802-3:2017/Amd 9:2018 specifications. In this case, a comment in the description field of Table 21 and a column in Table 22 are included.

Table 21 — Test setups and description

Test setup number	Test setup name	Description
1	TS_BASE	The IUT is connected over the GMII interface with a GMII station, and over MDIO interface with an MDIO station. Both stations are controlled by a test coordination procedure. The optical RX connector (MDI RX) of the IUT is connected with a transmit block generator (see 7.6.2). The optical TX connector (MDI TX) of the IUT is connected with a transmit block analyser. Both instruments are controlled by a test coordination procedure. Additionally, in each of the POF cables, an optical attenuator is introduced and programmed remotely by the test coordination procedure. POF cables fulfil the POF channel type II as specified in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, Figure 115-38.
2	TS_EXTEND	This setup is the same as TS_BASE but adding two more measurement instruments. The first one is devoted to control using the exact time when the power supply is connected or disconnected to the IUT. The second one controls the wake I/O and detects and generates electrical signals as specified in ISO 21111-2.
3	TS_SIGPOW	The IUT is excited using a test mode with a known pattern. The optical signal power is physically analysed, without decodification of symbols. This test setup is already specified in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, 115.6.4.3.
4	TS_AOPTX	The IUT is excited using a test mode with a known pattern. The optical signal AOP is analysed, without decodification of symbols. This test setup is already specified in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, 115.6.4.3.
5	TS_ER	The IUT is excited using a test mode with a known pattern. The optical signal ER is analysed, without decodification of symbols. This test setup is already specified in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, 115.6.4.5.
6	TS_CW	The IUT is excited using a test mode with a known pattern. The optical signal centre wavelength is analysed, without decodification of symbols. This test setup is already specified in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, 115.6.4.1 and IEC 61280-1-3.
7	TS_SW	The IUT is excited using a test mode with a known pattern. The optical signal spectral width is analysed, without decodification of symbols. This test setup is already specified in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, 115.6.4.2 and IEC 61280-1-3.
8	TS_RT _FT	The IUT is excited using a test mode with a known pattern. The optical signal rise and falling time is analysed, without decodification of symbols. This test setup is already specified in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, 115.6.4.4.
9	TS_OS	The IUT is excited using a test mode with a known pattern. The optical signal overshoot (OS) is analysed, without decodification of symbols. This test setup is already specified in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, 115.6.4.6.
10	TS_NOD_POD	The IUT is excited using a test mode with a known pattern. The optical negative and positive output droop is analysed, without decodification of symbols. This test setup is already specified in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, 115.6.4.7.
11	TS_DIST	The IUT is excited using a test mode with a known pattern. The optical signal distortion 2nd, 3rd, 4rd and residual harmonic distortion is analysed, without decodification of symbols. This test setup is already specified in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, 115.6.4.8.
12	TS_RIN	The IUT is excited using a test mode with a known pattern. The optical transmitter relative intensity noise is analysed, without decodification of symbols. This test setup is already specified in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, 115.6.4.10.
13	TS_MPD	The IUT is excited using a test mode with a known pattern. The modal power distribution is analysed, without decodification of symbols. This test setup is already specified in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, 115.6.4.11.

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Table 21 *(continued)*

Test setup number	Test setup name	Description
14	TS_TJ	The IUT is excited using a test mode with a known pattern. The timing jitter is analysed, without decodification of symbols. This test setup is already specified in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, 115.6.4.9.
15	TS_2LP	Two optically linked IUTs (a system composed of two link partners linked by an optical channel). One of them (transmitter) is set in a test mode. An instrument that sets a variable optical attenuation is inserted. Resulting optical signal with certain AOP is analysed and inserted in the link partner (reception) IUT. This test setup is already specified in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, 115.6.3.3 and 115.6.3.4.
16	TS_AOPRX	Equivalent to TS_EXTEND adding a controlled POF transfer function block in each of the links.
17	TS_LOOP	An IUT with MDI TX and MDI RX interfaces linked by a 1-m POF cable. The transfer function of this cable fulfils the POF channel type II as specified in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, Figure 115-38.

Table 22 specifies the test cases associated with each test setup. The test cases are grouped by blocks.

Table 22 — Test setups and related test cases grouped to blocks

Test setup number	Test setup name	Block 1	Block 2	Block 3	Document where test setup is specified
1	TS_BASE	LBT_1	PCST_1	EEET_1	This document
		LBT_2	PCST_2	EEET_2	
		LBT_3	PCST_3	EEET_4	
		LBT_4	PCST_4	OAMT_1	
		TMT_1	PCST_5	OAMT_2	
		TMT_2	PCST_6		
		TMT_3	PMAT_1		
		TMT_4	PMAT_2		
		TMT_5	PMAT_3		
		TMT_6	PMAT_4		
		TMT_7	PMAT_5		
		TMT_8	PMAT_6		
			PMAT_7		
			PMAT_8		
			PMAT_9		
			PMAT_10		
			PMAT_11		
			PMAT_12		
			PMDT_3		
			PMDT_4		

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Table 22 *(continued)*

Test setup number	Test setup name	Block 1	Block 2	Block 3	Document where test setup is specified
2	TS_EXTEND	None	None	WUST_1 WUST_2 WUST_3 WUST_4 WUST_5 PMD_MDIT_12 PMD_MDIT_13	This document
3	TS_SIGPOW	None	PMDT_1 PMDT_2	None	ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, 115.6.4.3
4	TS_AOPTX	None	PMD_MDIT_1	None	ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, 115.6.4.3
5	TS_ER	None	PMD_MDIT_2	None	ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, 115.6.4.5
6	TS_CW	None	PMD_MDIT_3	None	ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, 115.6.4.1
7	TS_SW	None	PMD_MDIT_4	None	ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, 115.6.4.2
8	TS_RT_FT	None	PMD_MDIT_5 PMD_MDIT_6	None	ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, 115.6.4.4
9	TS_OS	None	PMD_MDIT_7	None	ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, 115.6.4.6
10	TS_NOD_POD	None	PMD_MDIT_8 PMD_MDIT_9	None	ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, 115.6.4.7
11	TS_DIST	None	PMD_MDIT_10	None	ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, 115.6.4.8
12	TS_RIN	None	PMD_MDIT_11	None	ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, 115.6.4.10
13	TS_MPD	None	PMD_MDIT_14	None	ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, 115.6.4.11
14	TS_TJ	None	PMD_MDIT_15	None	ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, 115.6.4.9
15	TS_2LP	None	PMD_MDIT_16 PMD_MDIT_17	None	ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, 115.6.3.3 and 115.6.3.4
16	TS_AOPRX	None	PMAT_13	None	This document

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Table 22 *(continued)*

Test setup number	Test setup name	Block 1	Block 2	Block 3	Document where test setup is specified
17	TS_LOOP	None	DLYT_1	EEET_3 OAMT_3	This document

7.6.2 Test setup 1: TS_BASE

The elements that compose the test setup 1 are the following:

— The UT is composed of the following elements:

  — GMII station: instrument that transmits a bit pattern sequence with controlled content over a GMII interface.

  — MDIO station: instrument that translates test coordination procedure write or read operations on IUT registers into MDIO transactions.

— The LT is composed of the following elements:

  — Transmit block generator: instrument that transmits optically a transmit block with controlled content, both for control information and payload data. It shall use a reference light emitter that complies with ISO/IEC/IEEE 8802-3:2017/Amd 9:2018 requirements. It shall precode the data payload contents using the coefficients stored in a local variable to perform the equations in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, 115.3.1.1. The time when the transmit block is generated shall be controllable from the test coordination procedure.

  — Transmit block analyser: instrument that receives optically a transmit block and process it. That includes synchronisation, equalization and linearization of the communication channel. It also detects the presence of optical signal beyond the limits established in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018. It shall use a reference light receiver that complies with ISO/IEC/IEEE 8802-3:2017/Amd 9:2018 requirements.

— The service provider that models the physical medium is composed of the following elements:

  — Optical attenuator: instrument that adds a controlled amount of attenuation to the optical channel. It is controlled by the test coordination procedure.

  — POF cables: four 1-m POF cables that shall fulfil the fibre optic channel type II as specified in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, Figure 115-38.

— The test coordination procedure runs the test case and grants the test verdict.

The service provider frequency response up to 160 MHz when the optical attenuator is set to 0 dB shall be higher than −3 dB.

The service provider frequency response up to 160 MHz shall be flat with an allowed deviation of 0,5 dB around the mean.

The MDIO station of the UT shall perform at least two successful reads of MDIO registers within 100 µs.

The MDI RX port of the IUT is connected to the transmit block generator through a programmable optical attenuator that is controlled by the test coordination procedure. The transmit block generator is also controlled by the test coordination procedure that shall load the data to be transmitted and the time when the transmission shall start.

The MDI TX port of the IUT is connected to the transmit block analyser through a programmable optical attenuator that is controlled by the test coordination procedure. The transmit block analyser is also

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