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Road vehicles — In-vehicle Ethernet —

Part 1: General information and definitions

Véhicules routiers — Ethernet embarqué —

Partie 1: Information générale et définitions

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Foreword

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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).

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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.

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 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[2].

This document 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 and the amendments, the document structure, type of physical entities, in-vehicle Ethernet specific functionalities and so on.

ISO 21111-2[10] specifies the interface between reconciliation sublayer and physical entity including reduced gigabit media independent interface (RGMII), and the common physical entity wake-up and synchronised link sleep functionalities, independent from physical media and bit rate.

ISO 21111-3[11] 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[12] specifies the optical components requirements and test methods for 1-Gbit/s optical in-vehicle Ethernet.

ISO 21111-5[13] 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[14] 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[15] specifies the implementation for ISO/IEC/IEEE 8802-3, 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.

ISO 21111-8[16] specifies the transmission media, the channel performance and the tests for an ISO/IEC/IEEE 8802-3 in-vehicle Ethernet.

ISO 21111-9[17] 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[18] 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.

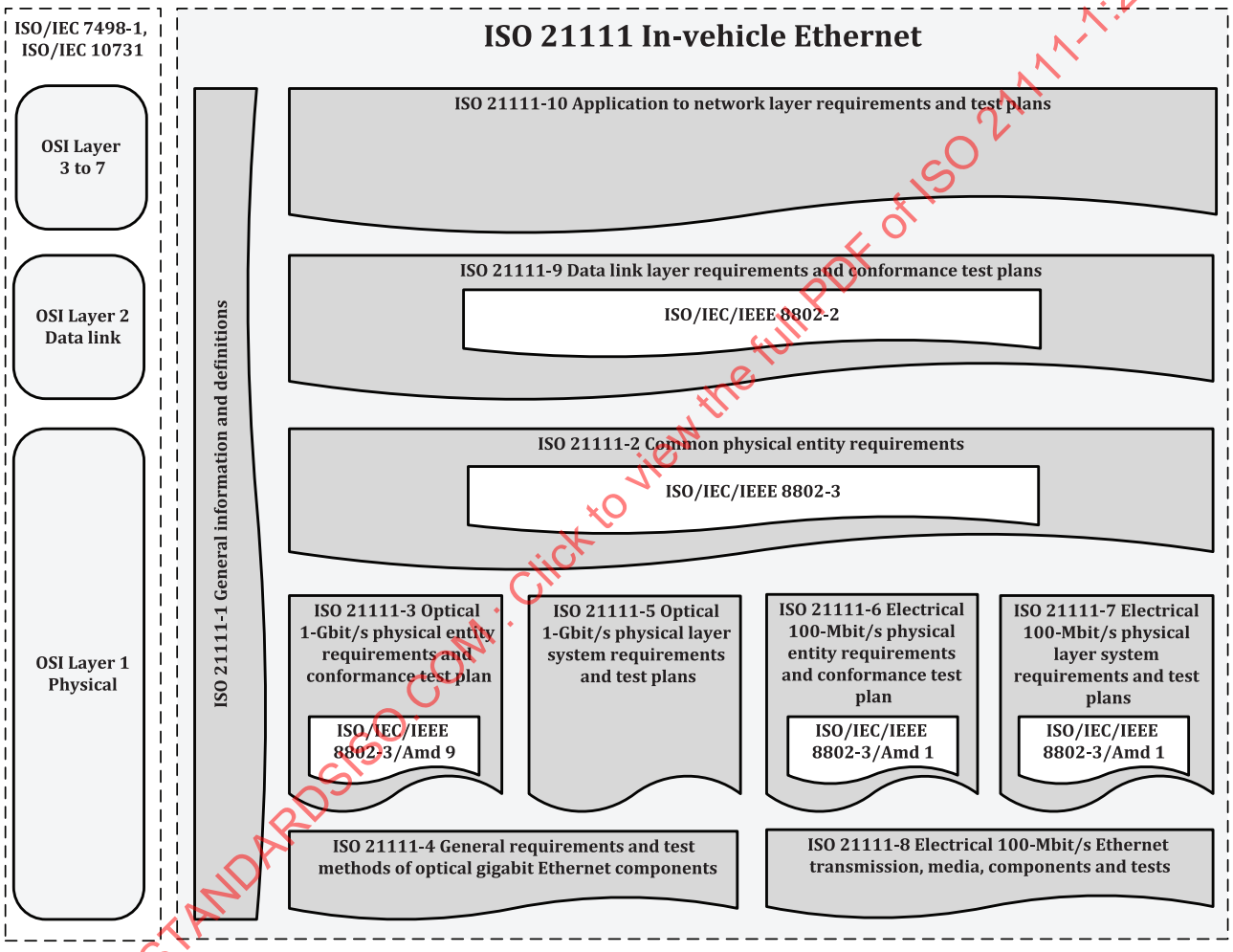


Figure 1 — In-vehicle Ethernet document reference according to OSI model

Road vehicles — In-vehicle Ethernet —

Part 1:
General information and definitions

1 Scope

This document defines the terms which are used in the ISO 21111 series and provides an overview of the standards for in-vehicle Ethernet including the complementary relations to ISO/IEC/IEEE 8802-3:2017[7] and its amendments, the document structure in accordance with OSI reference model specified in ISO/IEC 7498-1[1] and ISO/IEC 10731:1994,[2] type of physical entities, in-vehicle Ethernet specific functionalities, and so on.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions 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
100BASE-T1
physical layer for 100-Mbit/s electrical Ethernet over single balanced twisted pair

Note 1 to entry: 100BASE-T1 is specified in ISO/IEC/IEEE 8802-3:2017/Amd 1[8].

3.2
1000BASE-RHC
physical layer for 1-Gbit/s Ethernet over plastic optical fibre tailored for automotive application requirements

Note 1 to entry: 1000BASE-RHC is specified in ISO/IEC/IEEE 8802-3:2017/Amd 9[9].

3.3
balanced twisted pair
twisted pair of 100-Ω wire, which consist of copper core and dielectric jacket

3.4
bridge
layer 2 interconnection *device* (3.5)

[SOURCE: ISO/IEC/IEEE 8802-3:2017, 1.4]

3.5
device
functioning electric/electronic system

3.6
gigabit Ethernet over plastic optical fibre entity
GEPOF entity
physical layer for 1-Gbit/s Ethernet over *plastic optical fibre* (3.19) tailored for automotive application requirements

Note 1 to entry: GEPOF is specified in specified in ISO/IEC/IEEE 8802-3:2017/Amd 9.

3.7
gigabit media independent interface
GMII
interface between *physical entity* (3.15) and data link layer

Note 1 to entry: GMII is specified in ISO/IEC/IEEE 8802-3:2017, Clause 35.

3.8
in-vehicle Ethernet
Ethernet network system optimized for in-vehicle implementation

3.9
link partners
two physical entities connected bi-directionally through a *physical media* (3.16)

3.10
media dependent interface
MDI
optical or electrical interface between physical layer entity and physical media

Note 1 to entry: MDI is specified in ISO/IEC/IEEE 8802-3.

3.11
media independent interface
MII
interface between physical layer and data link layer

Note 1 to entry: MII is specified in ISO/IEC/IEEE 8802-3:2017, Clause 22.

3.12
neighbour physical entities
two or more physical entities embedded in the same *device* (3.5)

3.13
OSI reference model
model to divide the communication function into seven different layers

Note 1 to entry: OSI reference model is specified in ISO/IEC 7498-1 [1] and ISO/IEC 10731 [2].

3.14
physical coding sublayer
PCS
sublayer in which transmission data bits are encoded

Note 1 to entry: PCS is specified in ISO/IEC/IEEE 8802-3.

3.15
physical entity
in-vehicle Ethernet (3.8) physical layer for certain bit rates and physical media

3.16
physical media
media that transfers signals between physical entities

3.17
physical medium attachment
PMA
sublayer interfacing with *PCS* (3.14) and *PMD* (3.18)

Note 1 to entry: PMA is specified in ISO/IEC/IEEE 8802-3[7].

3.18
physical medium dependent
PMD
sublayer interfacing to the *physical media* (3.16)

Note 1 to entry: PMD is specified in ISO/IEC/IEEE 8802-3.

3.19
plastic optical fibre
POF
optically transparent wave guide fibre made from polymer material

Note 1 to entry: POF is specified in IEC 60793-2-40[6].

3.20
reduced gigabit media independent interface
RGMII
modified gigabit *media independent interface* (3.11) between physical entity and data link layer to reduce pin counts

3.21
test set-up
arrangement of test hardware and/or software and the IUT that is used to implement a test method

3.22
wake-up and synchronised link sleep
functionality devoted to manage physical entities' power consumption in a network system

4 Abbreviated terms

IUT implementation under test

MAC media access control

OSI open systems interconnections

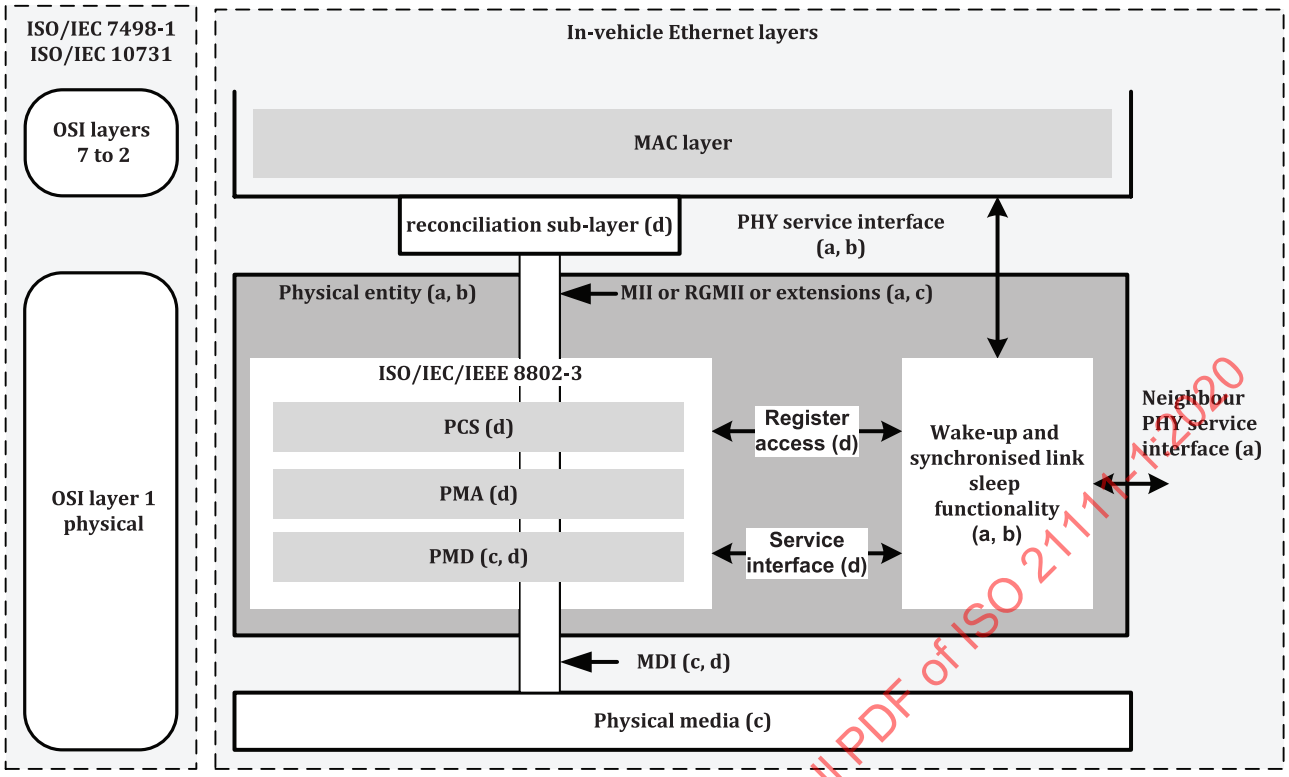
5 In-vehicle Ethernet

5.1 Relationship of in-vehicle Ethernet physical entity to OSI reference model

5.1.1 General

The relationship of in-vehicle Ethernet physical entity to OSI reference model is shown in Figure 2.

Bridge functionality is performed in the higher layers of the in-vehicle Ethernet stack.



Key

(a) scope of ISO 21111-2 (all physical media)

(b) scope of ISO 21111-3 (optical 1-Gbit/s physical layer), ISO 21111-6 (electrical 100- Mbit/s physical layer)

(c) scope of ISO 21111-4 (optical 1-Gbit/s physical layer), ISO 21111-8 (electrical 100- Mbit/s physical layer),

(d) scope of ISO/IEC/IEEE 8802-3

Figure 2 — In-vehicle Ethernet physical entity relationship to the OSI reference model

5.1.2 Interface of in-vehicle Ethernet physical entity to data link layer

ISO/IEC/IEEE 8802-3:2017[7], Clause 22 specifies the MII and Clause 35 specifies the GMII. The RGMII for 1-Gbit/s transmission is specified in ISO 21111-2[10].

5.1.3 Interface of in-vehicle Ethernet physical entity to neighbour physical entities

An in-vehicle Ethernet physical entity is able to communicate to other physical entities in the same device by using the neighbour PHY service interface. This service interface communicates with a forwarding glue logic that can also communicate with other physical entities in the same device.

The neighbour PHY service interface jointly with the forwarding glue logic enables the propagation of wake-up and sleep information among neighbour physical entities.

Neighbour PHY service interface is specified in ISO 21111-2 and is common to all physical media and transmission bit rate.

Forwarding glue logic functionality is out of the scope of the ISO 21111 series.

5.1.4 Wake-up and synchronised link sleep

Common wake-up and synchronised link sleep functionality independent from physical media and transmission bit rate is specified in ISO 21111-2.

Wake-up and synchronised link sleep functionality dependent upon physical media and transmission bit rate is specified:

— ISO 21111-3[11]: 1-Gbit/s optical physical entity; and

— ISO 21111-6[14]: 100-Mbit/s electrical physical entity.

The PHY service interface is specified in ISO 21111-2. More specifications on this service interface that are specific to each physical media are in ISO 21111-3 and ISO 21111-6.

5.1.5 PCS, PMA and PMD sub-layer

The PCS provides the interfaces to the MAC layer as shown in Figure 2.

Depending on the implemented PCS, PMA and PMD sublayer, the physical entity implementation is named differently. For example, the 1-Gbit/s optical physical layer entity is named GEPOF entity, and the 100-Mbit/s electrical physical layer entity is named 100BASE-T1 entity.

The service interface that communicates the wake-up and synchronised link sleep functionality with the implemented PCS, PMA and PMD sublayer depends on the physical layer implementation and it is specified in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018[9] for the GEPOF entity and in ISO/IEC/IEEE 8802-3:2017/Amd 1:2017[8] for the 100BASE-T1 entity.

The register access that communicates the wake-up and synchronised link sleep functionality with the implemented PCS, PMA and PMD sublayer depends on the physical layer implementation and it is specified in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018 for the GEPOF entity and in ISO/IEC/IEEE 8802-3:2017/Amd 1:2017 for the 100BASE-T1 entity.

The MDI depends on the physical layer implementation and it is specified in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018 for the GEPOF entity and in ISO/IEC/IEEE 8802-3:2017/Amd 1:2017 for the 100BASE-T1 entity.

5.2 In-vehicle Ethernet physical entity options

OSI layers of Ethernet are specified in ISO/IEC/IEEE 8802-3:2017, with specific amendments that add physical layer specifications for specific physical medium and data transmission bit rate.

ISO/IEC/IEEE 8802-3:2017/Amd 9:2018 and ISO/IEC/IEEE 8802-3:2017/Amd 1:2017 are applicable for in-vehicle Ethernet:

— ISO/IEC/IEEE 8802-3:2017/Amd 9:2018, adds a family of three point-to-point 1-Gbit/s physical layer specifications and management parameters for operation on a physical media consisting on duplex plastic optical fibre (POF). From the three options, the one defined as 1000BASE-RHC is suitable for in-vehicle Ethernet.

— ISO/IEC/IEEE 8802-3:2017/Amd 1:2017, adds 100-Mbit/s physical layer specifications and management parameters for operation on a physical media consisting on a single balanced twisted-pair copper cable.

Figure 3 shows the ISO 21111 series document relationship for in-vehicle Ethernet physical layer, except for the physical layer components.

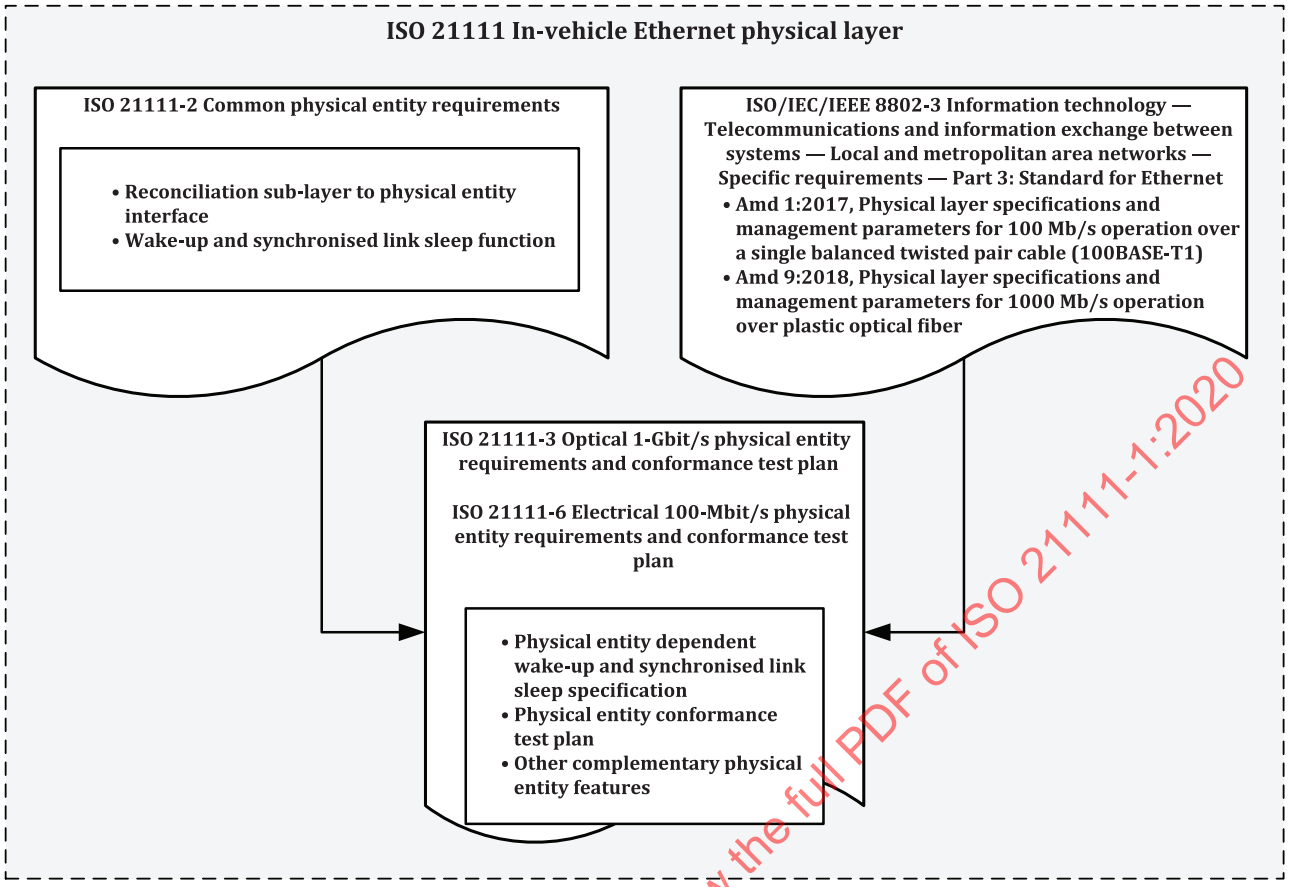


Figure 3 — ISO 21111 series relationship for in-vehicle Ethernet physical layer

There are common requirements for all physical entities, regardless of the physical media and data transmission bit rate used. They are specified in ISO 21111-2.

1000BASE-RHC entity and 100BASE-T1 entity are specified in:

— ISO 21111-3, ISO 21111-4[12], and ISO 21111-5[13] for 1-Gbit/s optical transmission, that includes the requirements specified in ISO/IEC/IEEE 8802-3:2017/Amd 9:2018.

— ISO 21111-6, ISO 21111-7[15], and ISO 21111-8[16] for 100-Mbit/s electrical transmission, that includes the requirements specified in ISO/IEC/IEEE 8802-3:2017/Amd 1:2017.

5.3 Component, physical entity, device, and network system requirements

There are requirements for several components such as the connector and the cable. Additionally, the physical layer designer shall meet some physical layer and device-level requirements and recommendations. In the ISO 21111 series, these different requirement levels are clearly referenced. This means, component, physical entity, device, and network system designer are guided clearly to the relevant requirements and recommendations for them.

An in-vehicle Ethernet network system is composed by at least two devices connected by means of a physical media. An example of network system is shown in Figure 4.

