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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

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](http://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](http://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](http://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](http://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<sup>[1]</sup> and ISO/IEC 10731<sup>[2]</sup>.

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<sup>[10]</sup> specifies the interface between reconciliation sublayer and physical entity including reduced gigabit media independent interface (RGMI), and the common physical entity wake-up and synchronised link sleep functionalities, independent from physical media and bit rate.

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

ISO 21111-5<sup>[13]</sup> 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<sup>[14]</sup> 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<sup>[15]</sup> 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

# ISO 21111-1:2020(E)

the channels for tests of transceivers with a test wiring harness that simulates various electrical communication channels.

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

ISO 21111-9<sup>[17]</sup> 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<sup>[18]</sup> 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.

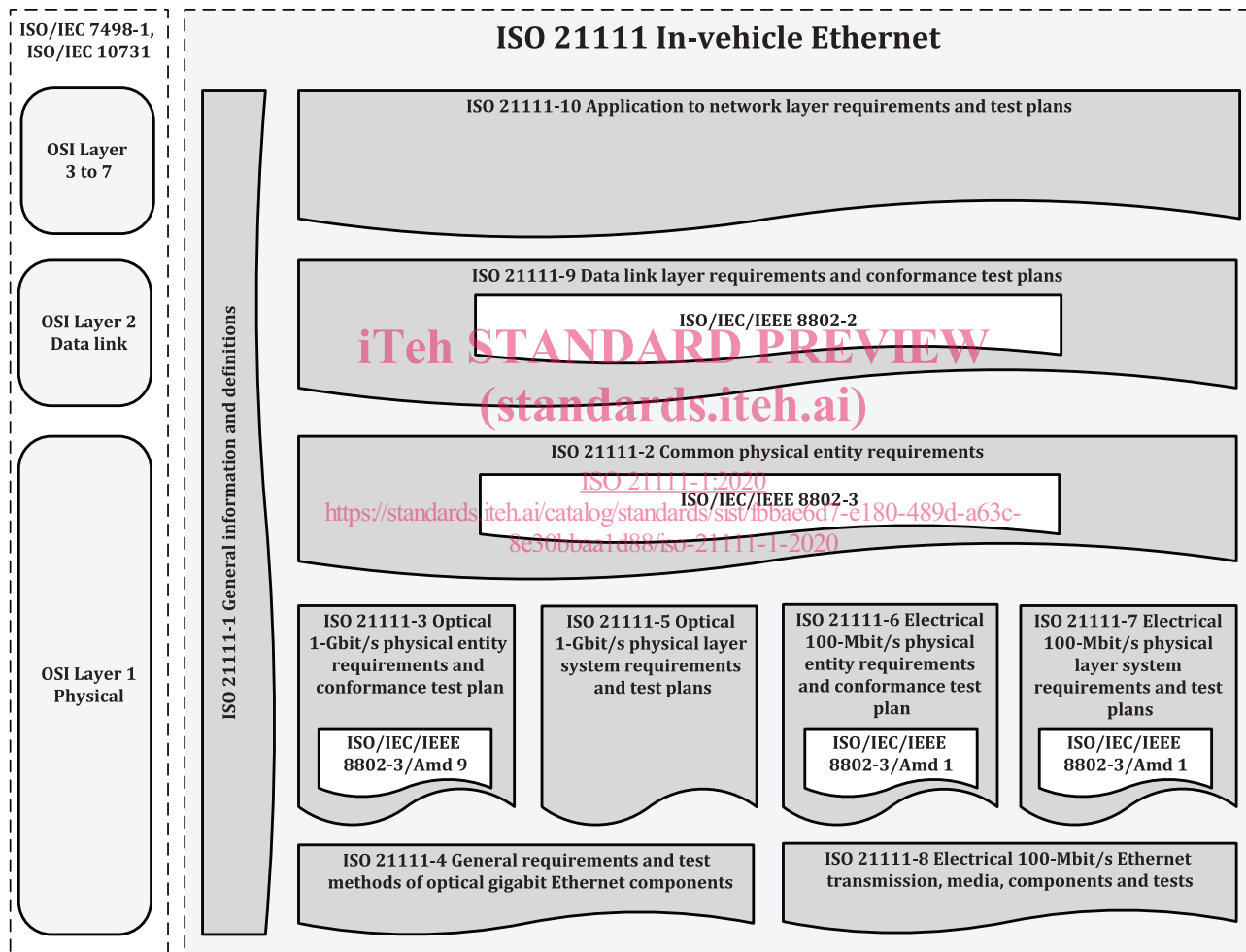


Figure 1 — In-vehicle Ethernet document reference according to OSI model

# 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<sup>[Z]</sup> and its amendments, the document structure in accordance with OSI reference model specified in ISO/IEC 7498-1<sup>[1]</sup> and ISO/IEC 10731:1994,<sup>[2]</sup> 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<sup>[8]</sup>.

#### 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<sup>[9]</sup>.

#### 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<sup>[7]</sup>.

**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<sup>[6]</sup>.

**3.20**  
**reduced gigabit media independent interface**  
**RGMI**

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

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## 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.