INTERNATIONAL STANDARD

ISO 21111-8

First edition
2022-08

Road vehicles — In-vehicle Ethernet —

Part 8: Electrical 100-Mbit/s Ethernet transmission media, components and tests

Véhicules routiers — Ethernet embarqué —

Partie 8: Tests, composants et supports de transmission ethernet électriques à 100 Mbit/s

Reference number
ISO 21111-8:2022(E)

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Contents

Page

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 32, *Electrical and electronic components and general system aspects*.

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 the specifications given in the ISO 21111 series conforms with the Open Systems Interconnection (OSI) reference model specified in ISO/IEC 7498-1[1] and ISO/IEC 10731[2].

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

ISO 21111-2[4] 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.

ISO 21111-3[5] 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[6] specifies the optical components requirements and test methods for 1-Gbit/s optical in-vehicle Ethernet.

ISO 21111-5[7] 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[8] 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 sublayer requirements and conformance test plan.

ISO 21111-7 [9] 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.

This document specifies the transmission media, the channel performance and the tests for an 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[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.

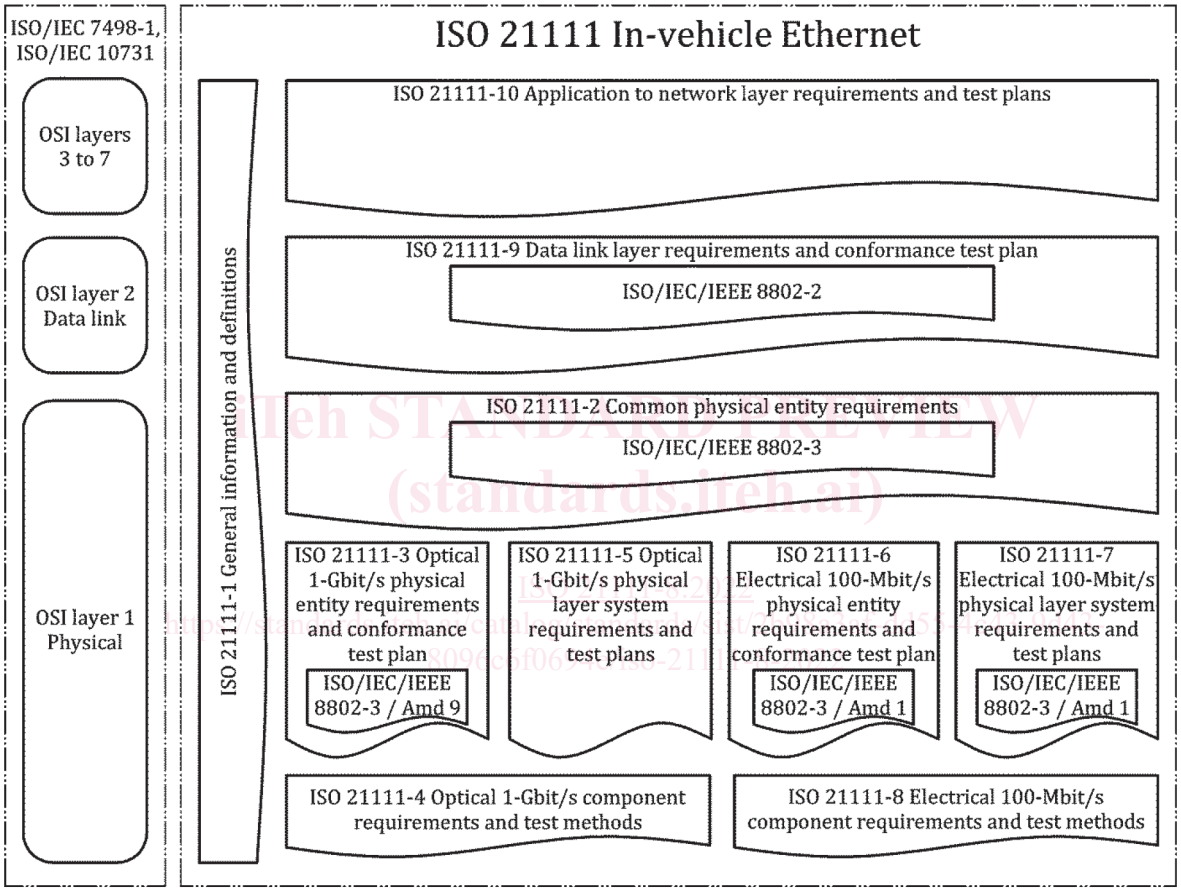


Figure 1 — In-vehicle Ethernet document reference according to the OSI model

Road vehicles — In-vehicle Ethernet —

Part 8:
Electrical 100-Mbit/s Ethernet transmission media, components and tests

1 Scope

This document defines various parameters to be tested for the communication channel between two Ethernet devices (e.g. ECUs for automotive application) and also for the transmission media including cables and connectors as a single component of which the communication channel consists. This document also specifies the general RF requirements for a physical layer communication channel for ISO/IEC/IEEE 8802-3. These requirements are related to signal integrity of the communication channel.

Test methods for electrical performances of the communication channel/link and cables and connectors are also specified in 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/IEC/IEEE 8802-3, *Telecommunications and exchange between information technology systems — Requirements for local and metropolitan area networks — Part 3: Standard for Ethernet*

ISO 19642-2, *Road vehicles — Automotive cables— Part 2: Test methods*

ISO 21111-1, *Road vehicles – In-vehicle Ethernet – Part 1: General information and definitionsIEC 60512-25(all parts), Connectors for electronic equipment – Tests and measurements*

IEC 60603-7-7:2010, *Connectors for electronic equipment - Part 7-7: Detail specification for 8-way, shielded, free and fixed connectors for data transmission with frequencies up to 600 MHz*

IEC 60512-25 (all parts), *Connectors for electronic equipment - Tests and measurements*

IEC 61935-1 (all parts), *Specification for the testing of balanced and coaxial information technology cabling - Part 1: Installed balanced cabling as specified in ISO/IEC 11801-1 and related standards*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 21111-1 and the following apply.

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

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

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

3.1
Ethernet data cable
single twisted pair cable that can transmit 100BASE-T1 Ethernet signals

Note 1 to entry: This is specified in Reference [11].

3.2
power sum alien near end crosstalk loss
PSANEXT

$$PSANEXT(f)_N = -10\log_{10}\sum_{j=1}^{m} 10^{\frac{-ANEXT(f)_{N_j}}{10}}$$

where

$PSANEXT$ is the PSANEXT;

f is the frequency;

j is the disturbing signals;

N is the disturbed signal;

m is the number of disturbing pairs.

α_{ANEXT} is the ANEXT.

Note 1 to entry: Power sum alien near end crosstalk loss is expressed in dB.

3.3
power sum attenuation to alien crosstalk ratio far end
PSAACRF

$$PSAACRF(f)_N = -10\log_{10}\sum_{j=1}^{m} 10^{\frac{-AACRF(f)_{N_j}}{10}}$$

$$AACRF(f)_{Nj} = AFEXT(f)_{Nj} - IL(f)_N$$

where

$PSAACRF$ is the PSAACRF;

f is the frequency;

j is the disturbing signals;

N is the disturbed signal;

m is the number of disturbing pairs;

$AACRF$ is the AACRF;

$AFEXT$ is the AFEXT

IL is the IL

Note 1 to entry: power sum attenuation to alien crosstalk ratio far end is expressed in dB.

4 Abbreviated terms

AACRF	alien attenuation to crosstalk ratio far-end
AFEXT	alien far end crosstalk loss
AFEXTDC	alien far end cross conversion loss common to differential
AFEXTDS	alien far end cross conversion loss single ended to differential
ANEXT	alien near end crosstalk loss
ANEXTDC	alien near end cross conversion loss common to differential
ANEXTDS	alien near end cross conversion loss single ended to differential
CC	communication channel
CIDM	characteristic impedance differential mode
CUT	cable under test
DUT	device under test
ECU	electronic control unit
ES	environment system
GND	ground
IL	insertion loss
LCL	longitudinal conversion loss
LCTL	longitudinal conversion transmission loss
MDI	media dependent interface
PCB	printed circuit board
PSANEXT	power sum alien far end crosstalk loss
PSAACRF	power sum power-sum alien attenuation to crosstalk ratio far-end
RL	return loss
RT	room temperature
SMA	sub miniature type A
SCC	standalone communication channel
S-Parameter	scattering parameter
TDR	time domain reflectometry
VNA	vector network analyser
WCC	whole communication channel

5 Communication channel/link

5.1 General

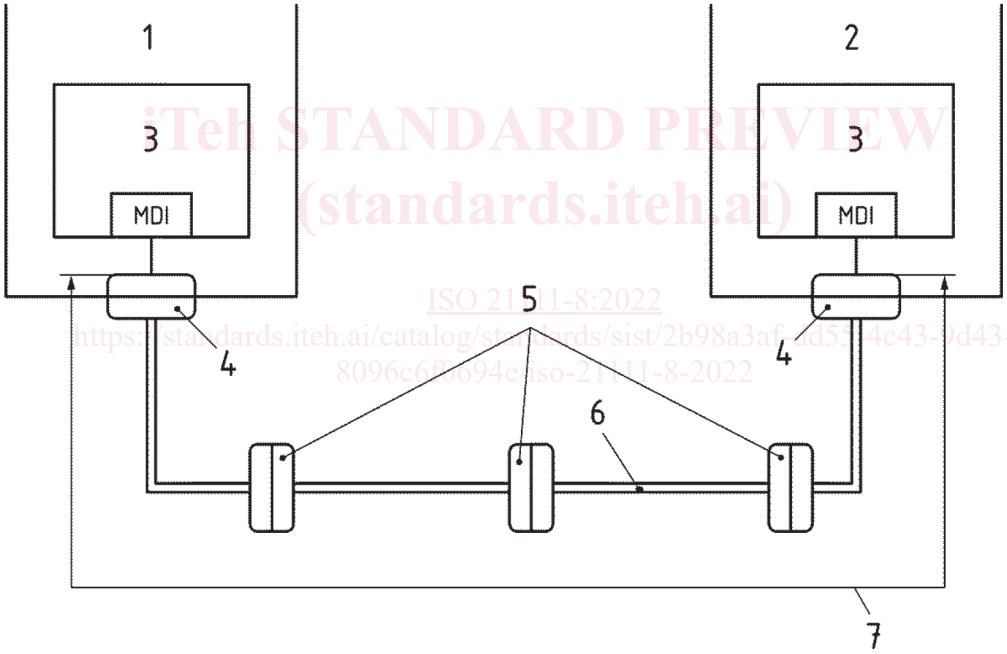
5.1.1 Definition of communication channel

This clause specifies the general RF requirements for a physical layer communication channel according to Figure 2, which shall conform with ISO/IEC/IEEE 8802-3 (100BASE-T1) for in-vehicle Ethernet applications.

The maximum length of WCC is not defined. It depends on the characteristics of each single component. These components should be chosen to achieve a typical length of 15 m and in maximum 4 inline connectors for car applications.

The combination of channel length and maximum inline connections shall be decided in accordance with the compliance with the channel RF performance specification specified in this document.

Connectors and cables which are applied to the communication channel shall fulfil at least electrical requirements (e.g. Open Alliance TC2 100 baseT1 specification[11]).



Key

1 device 1
2 device 2
3 physical entity
4 device connector
5 inline connector
6 cable
7 communication channel

Figure 2 — Definition of communication channel

NOTE The number of inline connections in Figure 2 is an example.

5.1.2 Operating temperature

The communication channel requirements are valid within the temperature range of the intended application. In general, the communication channel is used in between -40 °C and 105 °C. In some applications, an operating temperature of 85 °C, 100 °C, or 125 °C is required.

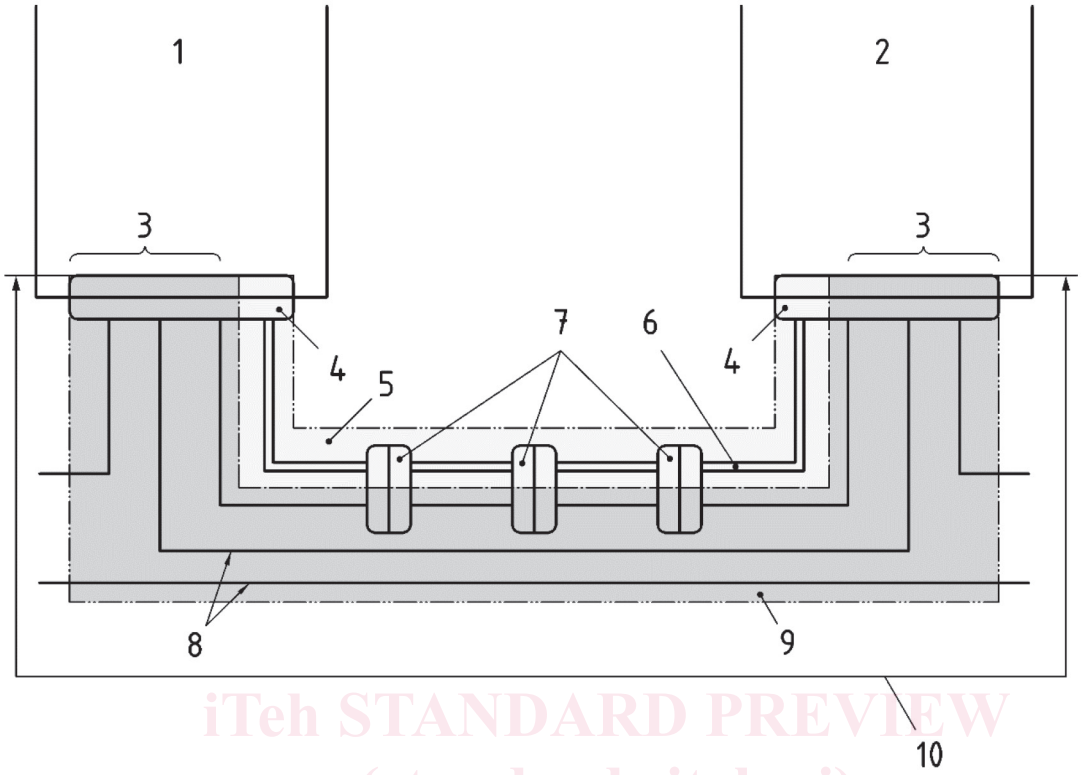
5.1.3 RF parameters

For all parts of the communication channel, the RF requirements are defined in terms of the following RF and S-parameter (see Table 1).

Table 1 — Definitions for RF and S - parameter

Item	Parameter
Impedance	
CIDM	Z_{RF}
Single channel characteristics (port 1, 2)	
RL	S_{dd11}, S_{dd22}
IL	S_{dd21}
LCL	S_{dc11}, S_{dc22}
LCTL	S_{dc12} , S_{dc21}
Cross talk single channel and other signals (channels/port 3 to port x)	
ANEXT	S_{dd31}, S_{ddx1}
AFEXT	S_{dd32}, S_{ddx2}
PSANEXT[a]	N/A
PSAACRF[b]	N/A
ANEXTDC	S_{dc31}, S_{dcx1}
ANEXTDS	S_{ds31}, S_{dsx1}
AFEXTDC	S_{dc32}, S_{dcx2}
AFEXTDS	S_{ds32}, S_{dsx2}
Note In principle, the limits for S-parameter are valid in the frequency range 1 MHz ≤ f ≤ 66 MHz. For LCL, LCTL, AFEXTDC, AFEXTDS, ANEXTDC, and ANEXTDS limits are valid up to f = 200 MHz. [a] See 3.2. [b] See 3.3.	

5.1.4 Definition of whole communication channel



Key

1 device 1
2 device 2
3 power, signals, and other system
4 device connector
5 SCC
6 ethernet data cable
7 inline connector
8 cable other system
9 ES
10 WCC

Figure 3 — Definition of whole communication channel

In a practical system, the communication channel which transmits Ethernet signals is not discrete, but coexists with power lines and control signal lines other than Ethernet signals in the wiring harness bundle. Considering this condition, the whole communication channel (WCC) is defined in Figure 3. Therefore, the communication channel is always subjected to electromagnetic interaction. Hereafter, the communication channel, which is dedicated to transmit Ethernet signals, is defined as standalone communication channel (SCC) and a cabling system which is not for Ethernet signals is defined as an environmental system (ES).

5.1.5 Definition of coupling zone

Electromagnetic interaction between ES and SCC are separated into four different zones (Figure 4).