INTERNATIONAL STANDARD

ISO 21111-2

First edition
2020-10

Road vehicles — In-vehicle Ethernet —

Part 2: Common physical entity requirements

Véhicules routiers — Ethernet embarqué —

Partie 2: Exigences de l'entité physique commune

Reference number
ISO 21111-2:2020(E)

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Published in Switzerland

Contents

Page

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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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.

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 synchronised 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.

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.

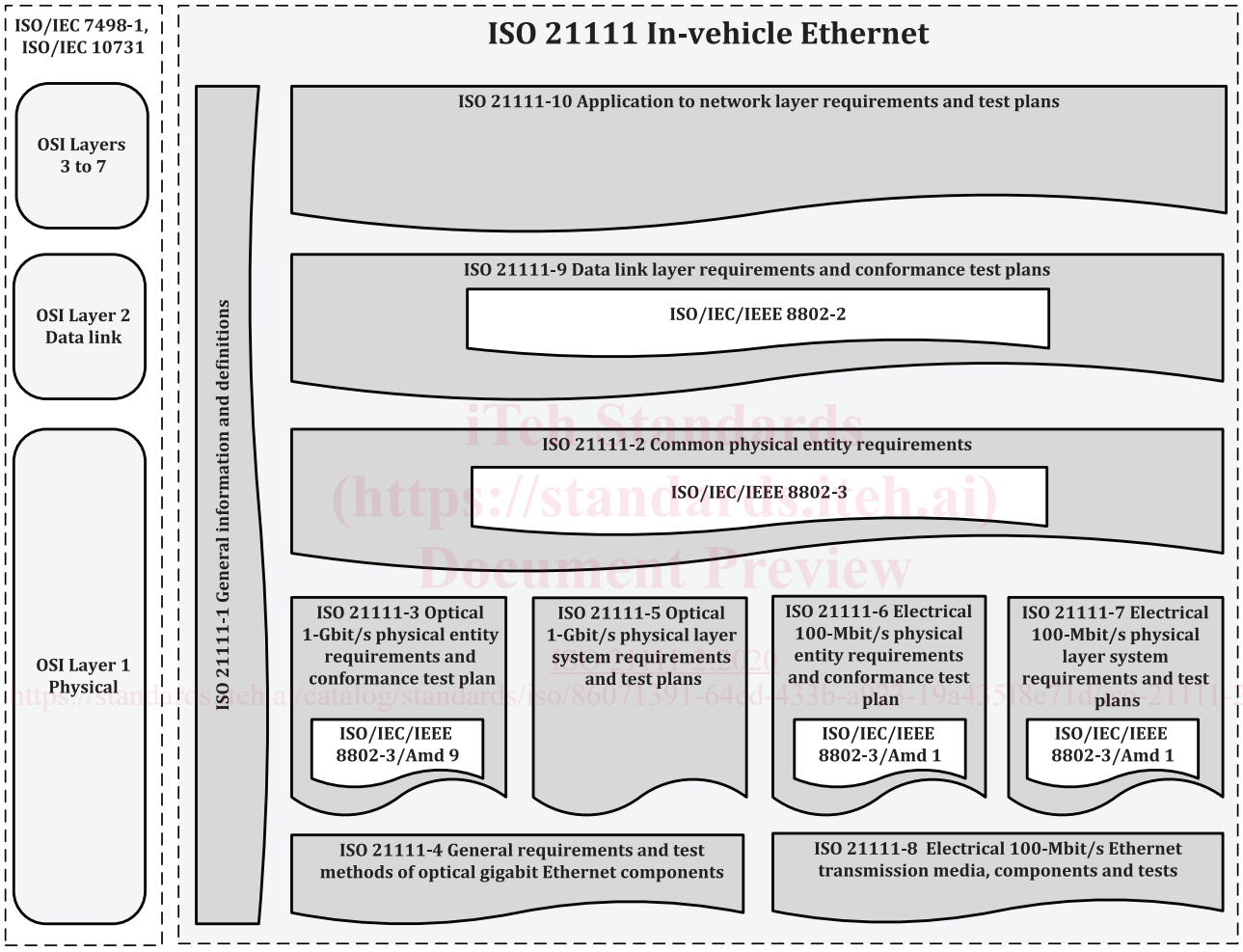

Figure 1 — In-vehicle Ethernet document reference according to the OSI model

Road vehicles — In-vehicle Ethernet —

Part 2:
Common physical entity requirements

1 Scope

This document specifies the following items to complement ISO/IEC /IEEE 8802-3:

— interface between reconciliation sublayer and physical entity including reduced gigabit media independent interface (RGMII);

— common physical entity wake-up and synchronised link sleep functionalities independent from physical media and transmission bit rate.

The optical and electrical component requirements and test methods for optical and electrical transmission of in-vehicle Ethernet are not in 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, *Road vehicles — In-vehicle Ethernet — Part 1: General information and definitions*

JEDEC – JESD8C.01:2006, *Interface Standard for Nominal 3 V/3.3 V Supply Digital Integrated Circuits*

JEDEC – JESD8-5A:2006, *2.5 V ± 0.2 V (Normal Range) and 1.8 V – 2.7 V (Wide Range) Power Supply Voltage and Interface Standard for Nonterminated Digital Integrated Circuits*

JEDEC – JESD8-7A:1997, *1.8 V ± 0.15 V (Normal Range) and 1.2 V – 1.95 V (Wide Range) Power Supply Voltage and Interface Standard for Nonterminated Digital Integrated Circuits*

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 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
double data rate
DDR
data transmission scheme, in which the data is transferred on both the rising and falling edges of the clock signal

3.2
event
piece of management information exchanged between a calling physical entity and a called physical entity

4 Abbreviated terms

DoD delay on destination

DoS delay on source

GMII gigabit media independent interface

I/O input and output

MAC media access control

MDC management data clock

MDIO management data input/output

MII media independent interface

N/A not applicable

PHY physical layer

RGMII reduced gigabit media independent interface

RTBI reduced ten-bit interface

RX receiver

TX transmitter

5 Media independent interfaces

5.1 General

ISO/IEC/IEEE 8802-3 specifies several speed-specific interfaces which are recommended for the communication between the reconciliation sub-layer and the PCS sub-layer. Two of the recommended interfaces are MII, used for10-Mbit/s and 100-Mbit/s capable physical entities, and GMII for 1-Gbit/s capable physical entities.

ISO/IEC/IEEE 8802-3:2017, Clause 22 specifies MII and ISO/IEC/IEEE 8802-3:2017, Clause 35 specifies GMII.

GMII signals, TXD and RXD, as specified in ISO/IEC/IEEE 8802-3:2017, Clause 35 are 8-bits wide. A direct mapping of the TXD or RXD 8-bits wide signals of the GMII interface into eight electrical lines is a drawback for some implementations. A mapping from GMII signals to a reduced set of electrical lines is specified in 5.2.

5.2 RGMII

5.2.1 General

The RGMII architecture (see Figure 2) is composed by the mapping of the GMII interface into a reduced set of signal lines, the reduced set of signal lines, and the de-mapping from the reduced set of signal lines into the GMII interface. In this subclause RGMII signal lines are the reduced set of signal lines in Figure 2.

The RGMII transmitter side adapter shall adapt the GMII signals to the RGMII signal lines in the reconciliation sub-layer side. The RGMII receiver side adapter shall adapt the RGMII signal lines to the GMII signals in the PCS sub-layer side.

5.2.2 specifies the RGMII signal lines. Each RGMII signal line is able to transmit an electrical signal. 5.2.3 specifies the RGMII electrical signal voltage levels and 5.2.4 specifies the RGMII electrical signal timing. 5.2.5 specifies how the GMII signals shall be mapped to the RGMII signal lines and vice versa.

All signals transmitted in an electrical signal line shall be conveyed with positive logic except if it is specified differently.

An electrical signal line shall be at logic high when it is at a voltage level greater than certain threshold. This threshold depends on the RGMII signal line nominal voltage.

An electrical signal line shall be at logic low when it is at a voltage level lower than certain threshold. This threshold depends on the RGMII signal line nominal voltage.

JEDEC - JESD8C.01:2006 shall be used for the thresholds for RGMII signal line voltage of 3,3 V.

JEDEC - JESD8-5A:2006 shall be used for the thresholds for RGMII signal line voltage of 2,5 V.

JEDEC - JESD8-7A:1997 shall be used for the thresholds for RGMII signal line voltage of 1,8 V.

5.2.2 RGMII signals

Figure 2 shows the architecture of the RGMII interface.

The RGMII is a full-duplex bidirectional interface and transfers data simultaneously in both directions. The RGMII connects the upper GMII and the lower GMII interfaces by means of adapters, which convert GMII signals to RGMII signals and vice versa.

The signals of each of the interfaces are grouped by the signal flow direction. The signals going in a downward direction in Figure 2 compose the transmit path, and the signals going in an upward direction compose the receive path. The transmitter side adapter is the signal source in the RGMII transmit path and the receiver side adapter is the signal source in the RGMII receive path.

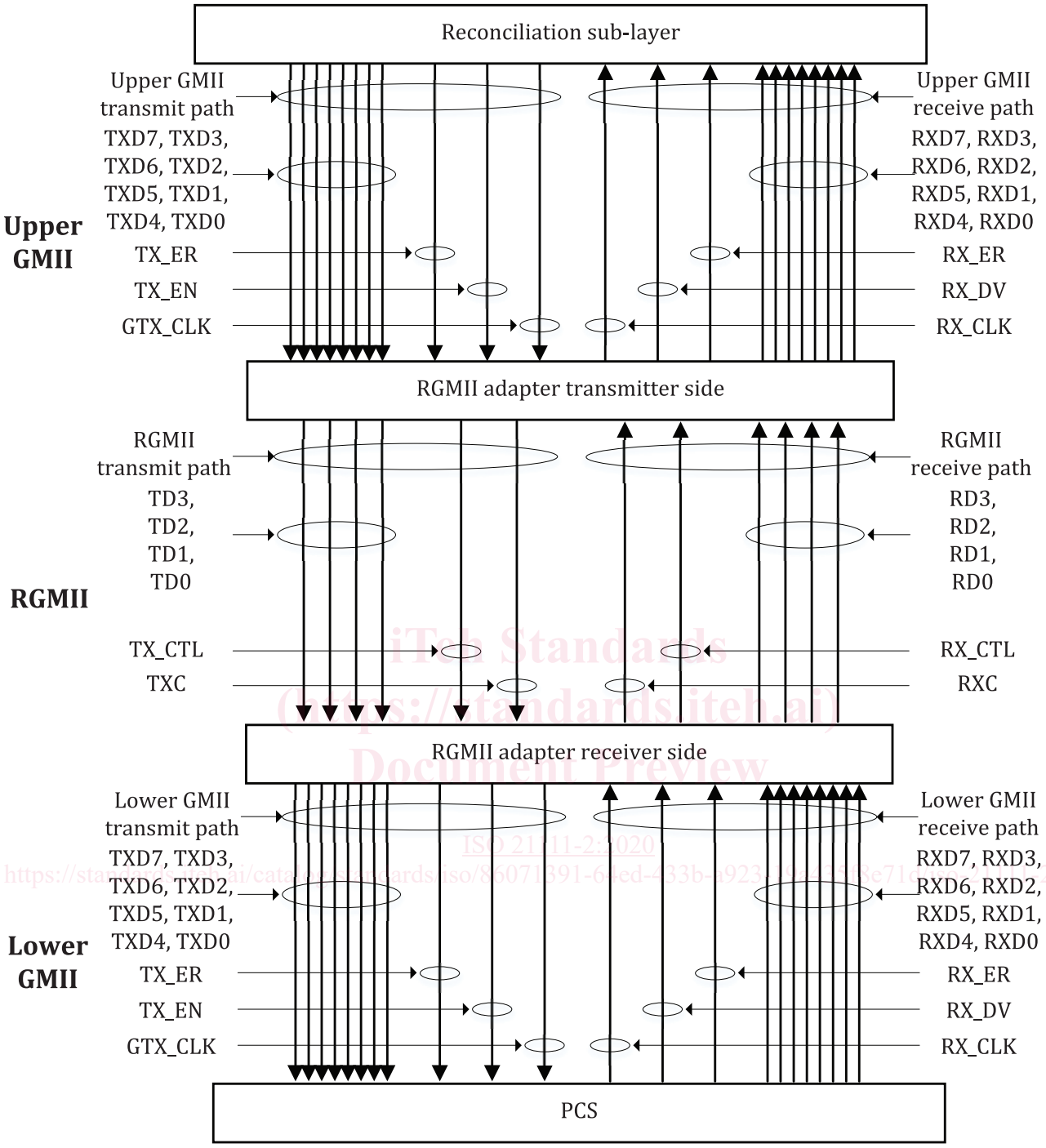

Figure 2 — RGMII architecture

Table 1 specifies the conversion of the GMII signals to the RGMII signals in the transmit path at the transmit side. The signals in the column "RGMII adapter internal signals" are only available inside the adapter and are used to convert the GMII signals. All GMII electrical signals are only valid during the rising edge of the GTX_CLK signal, whereas the RGMII adapter internal signals are valid during both edges of the A_TXC signal.

Table 1 — Conversion table for adapter at transmit side in transmit path

GMII signal	RGMII adapter internal signal		RGMII signal	Remark
	TXC rising edge	TXC falling edge		
GTX_CLK	A_TXC		TXC	N/A
TX_EN	A_TXEN	N/A	TX_CTL	A_TXEN=TX_EN
TX_ER	N/A	A_TXERR		A_TXERR=TX_EN xor TX_ER
TXD7	N/A	A_TD7	TD3	N/A
TXD6	N/A	A_TD6	TD2	N/A
TXD5	N/A	A_TD5	TD1	N/A
TXD4	N/A	A_TD4	TD0	N/A
TXD3	A_TD3	N/A	TD3	N/A
TXD2	A_TD2	N/A	TD2	N/A
TXD1	A_TD1	N/A	TD1	N/A
TXD0	A_TD0	N/A	TD0	N/A

Table 2 specifies the conversion of the RGMII signals to GMII signals in the transmit path at the receiver side. The signals in the column "RGMII adapter internal signal" are only available inside the adapter.

Table 2 — Conversion table for adapter at receiver side in transmit path

RGMII signal	RGMII adapter internal signal		GMII signal	Remark
	TXC rising edge	TXC falling edge		
TXC	A_TXC		GTX_CLK	N/A
TX_CTL	A_TXEN	N/A	TX_EN	TX_EN=A_TXEN
	N/A	A_TXERR	TX_ER	TX_ER=A_TXEN xor A_TXERR
TD3	A_TD3	N/A	TXD3	N/A
	N/A	A_TD7	TXD7	N/A
TD2	A_TD2	N/A	TXD2	N/A
	N/A	A_TD6	TXD6	N/A
TD1	A_TD1	N/A	TXD1	N/A
	N/A	A_TD5	TXD5	N/A
TD0	A_TD0	N/A	TXD0	N/A
	N/A	A_TD4	TXD4	N/A

Table 3 specifies the conversion of the GMII signals to RGMII signals in the receive path at the receiver side. The signals in the column "RGMII adapter internal signal" are only available inside the adapter.

Table 3 — Conversion table for adapter at receiver side in receive path

GMII signal	RGMII adapter internal signal		RGMII signal	Remark
	TXC rising edge	TXC falling edge		
RX_CLK	A_RXC		RX_CLK	N/A
RX_DV	A_RXDV	N/A	TX_CTL	A_RXDV=RX_DV
RX_ER	N/A	A_RXERR		A_RXERR=RX_DV xor RX_ER
RXD7	N/A	A_RD7	RD3	N/A
RXD6	N/A	A_RD6	RD2	N/A
RXD5	N/A	A_RD5	RD1	N/A
RXD4	N/A	A_RD4	RD0	N/A
RXD3	A_RD3	N/A	RD3	N/A