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Road vehicles — Clock extension peripheral interface (CXPI) —

Part 6:
Transport and network layer conformance test plan

Véhicules routiers — Interface périphérique d'extension d'horloge (CXPI) —

Partie 6: Plan de test de conformité des couches transport et réseau

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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 20794 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

ISO 20794 (all parts) specifies the application (partly), application layer, transport layer, network layer, data link layer and physical layer requirements of an in-vehicle network called "clock extension peripheral interface (CXPI)".

CXPI is an automotive low-speed single wire network. It is an enabler for reducing vehicle weight and fuel consumption by reducing wire counts to simple devices like switches and sensors.

CXPI serves as and is designed for automotive control applications, for example door control group, light switch and HVAC (Heating Ventilation and Air Condition) systems.

The CXPI services, protocols and their key characteristics are specified in different parts according to the OSI layers.

— Application and application layer:

— application measurement and control data communication to exchange information between applications in different nodes based on message communication;

— wake-up and sleep functionality;

— two kinds of communication methods can be selected at system design by each node:

   i) the event-triggered method, which supports application measurement- and control-based (event-driven) slave node communication; and

   ii) the polling method, which supports slave node communication based on a periodic master schedule;

— performs error detection and reports the result to the application;

— application error management.

— Transport layer and network layer:

— transforms a message into a single packet;

— adds protocol control information for diagnostic and node configuration into each packet;

— adds packet identifier for diagnostic and node configuration into each packet;

— performs error detection and reports the result to higher OSI layers.

— Data link layer and physical layer:

— provides long and short data frames;

— adds a frame identifier into the frame;

— adds frame information into the frame;

— adds a cyclic redundancy check into the frame;

— performs byte-wise arbitration and reports the arbitration result to higher OSI layers;

— performs frame type detection in reception function;

— performs error detection and reports the result to higher OSI layers;

— performs Carrier Sense Multiple Access (CSMA);

— performs Collision Resolution (CR);

— generates a clock, which is transmitted with each bit to synchronise the connected nodes on the CXPI network;

— supports bit rates up to 20 kbit/s.

To achieve this, it is based on the Open Systems Interconnection (OSI) Basic Reference Model specified in ISO/IEC 7498-1 and ISO/IEC 10731[2], which structures communication systems into seven layers.

Figure 1 illustrates an overview of communication frameworks beyond the scope of this document including related standards:

— vehicle normal communication framework, which is composed of ISO 20794-2 and ISO 20794-5[6];

— vehicle diagnostic communication framework, which is composed of ISO 14229-1[3], ISO 14229-2[4] and ISO 14229-8[5];

— presentation layer standards, e.g. vehicle manufacturer specific or ISO 22901-1 ODX[8];

— lower OSI layers framework, which is composed of ISO 20794-3, ISO 20794-4, this document and ISO 20794-7[7].

ISO 20794 (all parts) and ISO 14229-8[5] are based on the conventions specified in the OSI Service Conventions (ISO/IEC 10731[2]) as they apply for all layers and the diagnostic services.
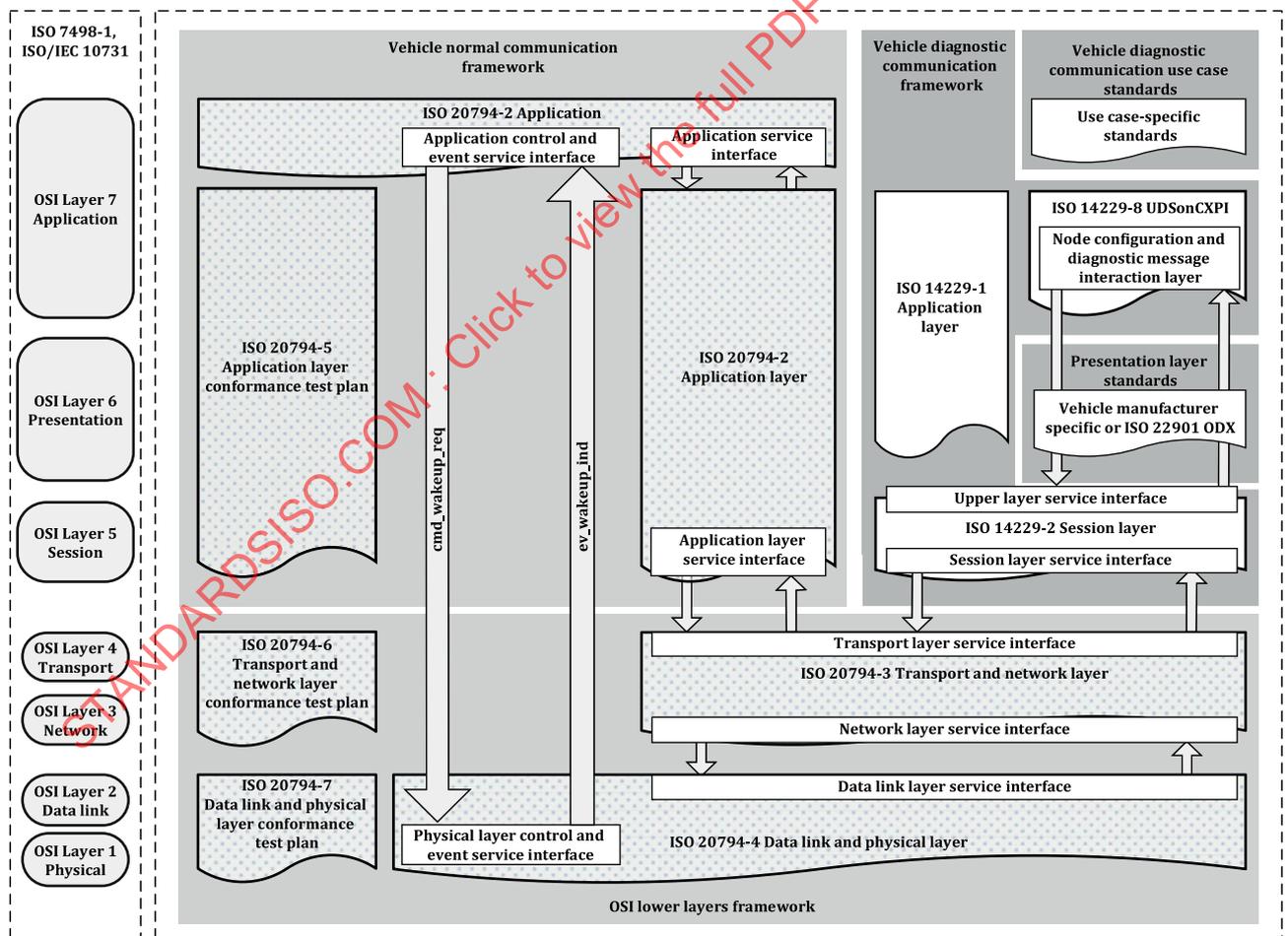
Figure 1 — ISO 20794 document reference according to OSI model

Road vehicles — Clock extension peripheral interface (CXPI) —

Part 6:
Transport and network layer conformance test plan

1 Scope

This document specifies the transport and network layer conformance test plan, which tests the transportation of diagnostic communication, node configuration data and network layer services using the service interface parameters reported by the lower OSI layers and submitted to the higher OSI layers.

The transport layer and network layer conformance test plan contain the following descriptions:

— concept of operation conformance test plan;

— transport layer protocol conformance test plan;

— network layer services conformance test plan; and

— error detection conformance test plan.

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 7498-1, *Information processing systems — Open systems interconnection — Basic reference model*

ISO 20794-2:2020, *Road vehicles — Clock extension peripheral interface (CXPI) — Part 2: Application layer*

ISO 20794-3:2020, *Road vehicles — Clock extension peripheral interface (CXPI) — Part 3: Transport and network layer*

ISO 20794-4:2020, *Road vehicles — Clock extension peripheral interface (CXPI) — Part 4: Data link layer and physical layer*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 20794-3, ISO/IEC 7498-1 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
lower OSI layer
OSI layer lower than transport layer and network layer

3.2
master node
node that provides the schedule master management (include ReqTypeId transmission), the primary clock and optionally the sleep message transmission management

3.3
slave node
node other than *master node* (3.2) connected to the CXPI network

3.4
protocol data unit
data byte array that contains data and the other information to establish communication

3.5
protocol control information
information that contains message type and data length

3.6
protocol control information type
information that identifies the message type

3.7
REPEAT
pseudo code command for an iteration

3.8
REPEAT END
pseudo code command for ending an iteration

3.9
single message data length
information that identifies the data length

3.10
node address
address information that identifies target node

3.11
result
transmission or reception status to report to the higher OSI layers

3.12
status report message
message which enable to observe any error occurrence and internal state on the CXPI network

Note 1 to entry: This message consists with the TST_MSG_05_REQ_PID_ERRBIT and the TST_MSG_16_RESP_ERRBIT_0–12.

4   Symbols and abbreviated terms

4.1   Symbols

---   empty cell/undefined

kbit/s   kilobit per second

4.2 Abbreviated terms

ASP	abstract service primitive
CRC	cyclic redundancy check
CTC	conformance test case
Err	error
ETS	enhanced testability service
IUT	implementation under test
MSG	message
N_NAD	network layer node address
N_PDU	network layer protocol data unit
NL	network layer
OSI	open systems interconnection
PDU	protocol data unit
PID	protected identifier
PCO	point of control and observation
ReqId	request identifier
ReqTypeId	request type identifier
SUT	system under test
T_PCI	transport layer protocol control information
T_PCItype	transport layer protocol control information type
T_PCI_DL	transport layer protocol control information single message data length
T_PDU	transport layer protocol data unit
TL	transport layer
TST	test

5 Conventions

This document is based on OSI service conventions as specified in ISO/IEC 10731[2] and ISO/IEC 9646-1[1] for conformance test system setup.

6 General test specification considerations

6.1 General

This document covers the conformance test cases (CTC) to verify the requirements described in ISO 20794-3.

6.2   Test conditions

Tests can be performed at room temperature, if the temperature is in the range of 15° C to 35° C. Also, the tests shall be performed under room EMI (electro-magnetic interference) conditions.

6.3   IUT requirements

The occurrence of the error specified in ISO 20794-2:2020, 9.6.8 shall be notified to the application.

The IUT shall be initialised in the CTC respectively.

6.4   CTC definition

The definition of each test case specifies, whether the IUT is a master or a slave node. Each CTC is defined in the structure as defined in Table 1.

Table 1 — CTC definition example

Item	Content
CTC # – Title	[OSI layer #].CTC_[number_name]
	E.g. 3.CTC_4.1 – Master node – NL error detection (N_As timeout)
Purpose	E.g. This CTC verifies the master node to detect the error of an N_As timeout.
	E.g. This CTC verifies that timeout error detection shall be performed correctly.
Reference	REQ document, REQ number – REQ name
	E.g. ISO 20794-2:2020, REQ 3.13 NL – Timing definition – NL – Timing parameters;
Prerequisite	The test system set-up shall be in accordance with Figure 2.
Set-up	— The IUT shall be configured as a master node or a slave node.
	— The IUT shall be configured to support N_ErrDet2 (see 6.6.7), TST_MSG_01_REQ_PID, TST_MSG_10_RESP_0–12, TST_MSG_05_REQ_PID_ERRBIT and TST_MSG_16_RESP_ERRBIT_0–12.
	— The bit rate shall be set to the default value (see 6.6.2).
	— The SUT shall be initialised to the default state (see 6.7).
Step	1. The IUT shall transmit the TST_MSG_01_REQ_PID and the TST_MSG_10_RESP_0–12.
	2. The LT shall transmit the TST_MSG_01_REQ_PID as the higher priority than the IUT and the TST_MSG_10_RESP_0–12 to generate arbitration lost on the IUT.
	3. The LT shall transmit the TST_MSG_05_REQ_PID_ERRBIT.
Iteration	Definition of repetitions of test procedure steps.
	EXAMPLE
	REPEAT step 1 to step 2, 1 000 times;
	…
	REPEAT END
Expected response	Define the expected behaviour of the IUT by checking on the CXPI network when the test step is executed.
	EXAMPLE
	After step 3: The IUT shall transmit the TST_MSG_16_RESP_ERRBIT_0–12 with Err_NL_TIMEOUT_A = TRUE.
	The LT shall receive the TST_MSG_16_RESP_ERRBIT_0–12 with Err_NL_TIMEOUT_A = TRUE and report to the UT.
Remark	E.g. "---" if no remark

6.5 Test system set-up

The test system set-up follows the ISO/IEC 9646-1[1] and consists of a test system and a system under test (SUT) connected via the physical medium. The test system implements an upper tester (UT) and a lower tester (LT). The test system uses set-up parameters (see Figure 2, key 1) for testing the communication with the IUT.

The UT uses the test control protocol (see Figure 2, key 2) to control the LT.

The point of control and observation (PCO) functionality between the UT of the test system and the UT App test stub in the SUT is provided by direct logical access to the abstract service primitive interface (ASPs (ETSs), PCO, see dashed line in Figure 2, key 3) and the associated parameters of the OSI layers as specified in the ISO 20794 series.

The UT App test stub in the SUT (see Figure 2, key 4) supports an equivalent part of the ASP (see Figure 2, key 3) and the associated parameters to control and measure the state(s) of the IUT.

The UT App in the test system, which represents the conformance test controller, manipulates the service primitive interface parameters in the IUT App test stub via the ASPs (ETSs) and PCO of the OSI layers to fulfil the purpose of each CTC.

If the IUT is a master node then the LT functions as a slave node. If the IUT is a slave node then the LT functions as a master node. The test system shall ensure the precision of the bit time and bit synchronisation of the master node as specified in ISO 20794-4:2020, 9.3.7.
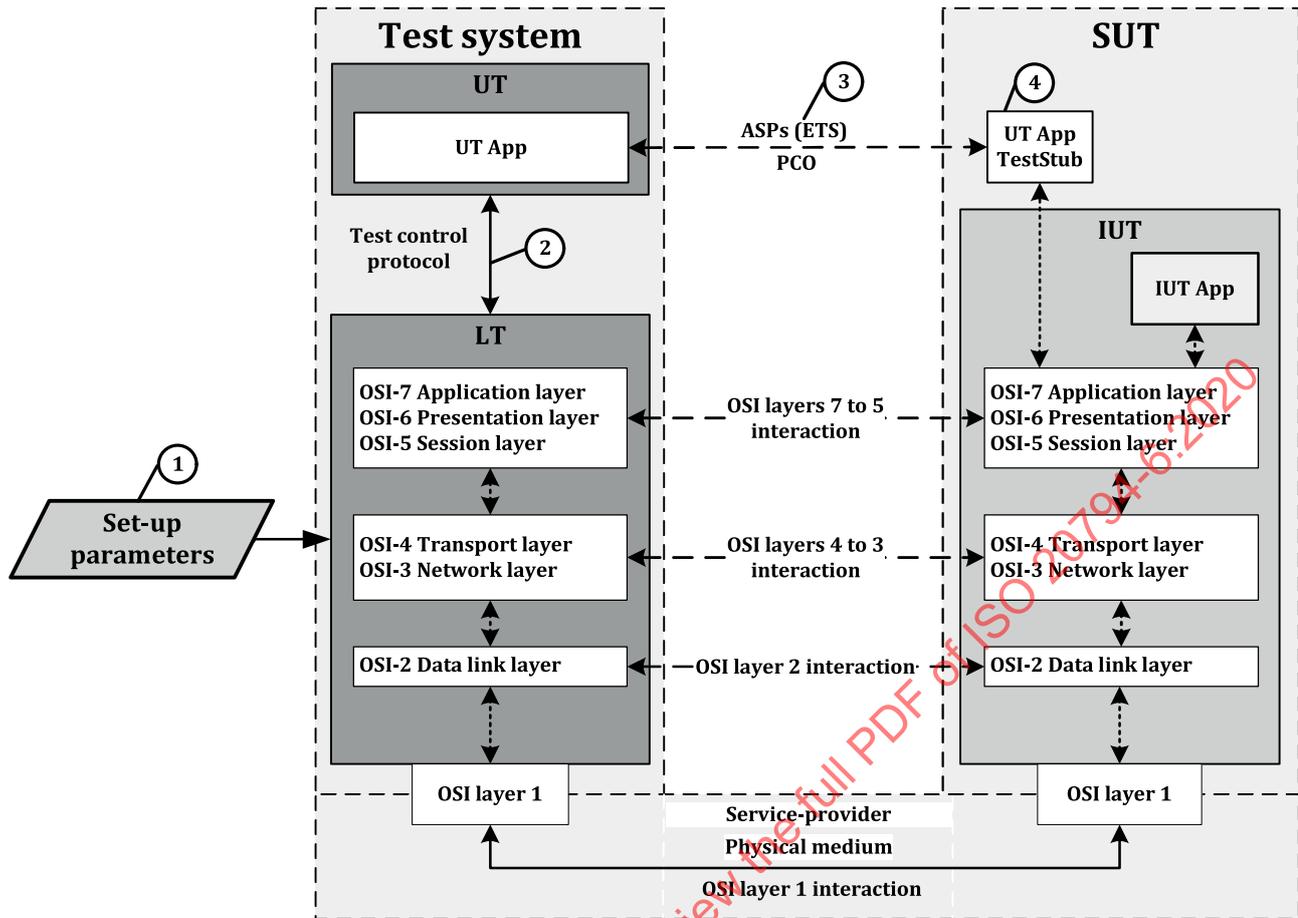
Key

1   set-up parameters (CXPI node's electronic data sheet)

2   test control protocol

3   abstract service primitives (ASPs) based on enhanced testability services (ETS) and points of control and observation (PCO)

4   upper tester application TestStub

Figure 2 — Test system set-up

6.6   Configuration of test system and IUT

6.6.1   General

The test system requires set-up parameters (see Figure 2, key 1), which specify OSI-4 and 3-layer properties of the IUT. The IUT-specific data sheet (see Figure 2, key 1) includes set-up parameters which the test system requires to perform the CTCs.

Table 2 specifies the configuration of test system and the IUT in the CTCs. In each CTC description, configuration is specified in the 'configuration' column.

Table 2 — Configuration of test system and IUT

Configuration item	Configuration of test system and IUT					
	User_Specific	T_FltMng1	T_FltMng2	N_ErrDet1	N_ErrDet2	W/S
Wake-up/sleep	not supported	not supported	not supported	not supported	not supported	supported
T_PCItype	0000_2	any invalid	0000_2	0000_2	0000_2	0000_2
T_PCI_DL/T_PCI_DLext	any valid	any valid	any invalid	any valid	any valid	any valid
N_NAD	any valid	any valid	any valid	any invalid	any valid	any valid
Status report message	not applicable	not applicable	not applicable	not applicable	supported by IUT	not applicable

Table 3 specifies test message names which are used by the IUT and the test system in the CTCs. In each CTC description, the message setting is specified in the 'configuration' column. If there is no reference to Table 3, the settings are specified in the CTC.

Table 3 — Configuration of test messages used by IUT and test system

Name	Definition
TST_MSG_00_REQ_PTYPE	Test message 00_{16} of a master node including a ReqTypeId value (00_{16}) of T_ReqId.
TST_MSG_01_REQ_PID	Test message 01_{16} of a master node or a slave node including a T_PID/N_PID value (01_{16} to $7F_{16}$) of T_ReqId/N_ReqId.
TST_MSG_02_REQ_PID_SLEEP	Test message 02_{16} of a master node including a T_PID/N_PID value ($1F_{16}$) of T_ReqId/N_ReqId for diagnostic and node configuration requests or sleep message.
TST_MSG_03_REQ_PID_UNKNOWN	Test message 03_{16} of a master node or a slave node including a not defined T_PID value of T_ReqId (not defined for reception/transmission by the IUT).
TST_MSG_04_REQ_PID_INVALID	Test message 04_{16} of a master node or a slave node including a T_PID value of T_ReqId (not defined for reception/transmission by the IUT with an incorrect parity bit) determined by T_Length = 01_{16}.
TST_MSG_05_REQ_PID_ERRBIT	Test message 05_{16} of a master node or a slave node including an error bit T_PID/N_PID value (01_{16} to $7F_{16}$) of T_ReqId/N_ReqId. The value of this PID can use supplier-specific ReqId($3F_{16}$).
TST_MSG_10_RESP_0–12	Test message 10_{16} of a master node or a slave node including FI field, DATA field and CRC field determined by $00_{16} \leq$ T_Lenght $\leq 0C_{16}$.
TST_MSG_11_RESP_LONG_0–12	Test message 11_{16} of a master node or a slave node including FI field, DATA field and CRC field determined by $00_{16} \leq$ T_Length $\leq 0C_{16}$.
TST_MSG_12_RESP_LONG_13–255	Test message 12_{16} of a master node or a slave node including FI field, DATA field and CRC field determined by $0D_{16} \leq$ T_Length = FF_{16}.
TST_MSG_13_RESP_UNKOWN_0–12	Test message 13_{16} of a master node or a slave node including FI field, DATA field and CRC field (not defined for reception/transmission by the IUT) with a correct parity bit determined by $00_{16} \leq$ T_Length $\leq 0C_{16}$.
TST_MSG_14_RESP_INVALID_0–12	Test message 14_{16} of a master node or a slave node including FI field, DATA field and CRC field (not defined for reception/transmission by the IUT with an incorrect parity bit) determined by $00_{16} \leq$ T_Length $\leq 0C_{16}$.
TST_MSG_15_RESP_SLEEP_8	Test message 15_{16} of a master node including FI field, fixed byte pattern of DATA field and CRC field fixed byte pattern is (00_{16}, FF_{16}, FF_{16}, FF_{16}, FF_{16}, FF_{16}, FF_{16}, FF_{16}) determined by T_Length/N_Length = 08_{16}.

Name	Definition
TST_MSG_16_RESP_ERRBIT_0–12	Test message 16_{16} of a master node or a slave node including FI field, DATA field with an error bit and CRC field determined by $00_{16} \leq$ T_Length/N_Length $\leq 0C_{16}$.

6.6.2 IUT-specific set-up parameters

The set-up parameters include at least the following information:

— the request identifier uses 01_{16} to $7F_{16}$ and uses 00_{16} by the request protected type identifier field and other values are invalid;

— the T_PCItype uses 0000_2 as single packet, other values are invalid;

— the T_PCI_DL uses 0001_2 to 1010_2, other values are invalid;

— the T_PCI_DLext uses $0B_{16}$ to FC_{16}, other values are invalid;

— the N_NAD uses 01_{16} to $7F_{16}$, other values are invalid;

— the bit rate is set to the default value of 20 kbit/s if not otherwise specified;

— the message with request identifier $3F_{16}$ and the associated response field is reserved for supplier specific maintenance, enhanced testability services and error bit status reporting.

6.6.3 User_Specific configurations

The User_Specific parameters include at least the following information:

— wake-up sleep: not supported;

— T_PCItype: set to 0000_2;

— T_PCI_DL (also T_PCI_DLext): set to any valid value supported by the IUT;

— N_NAD: set to any valid value supported by the IUT.

6.6.4 T_FltMng1 configurations

The T_FltMng1 parameters include at least the following information:

— wake-up sleep: not supported;

— T_PCItype: set to any invalid value;

— T_PCI_DL (also T_PCI_DLext): set to any valid value supported by the IUT;

— N_NAD: set to any valid value supported by the IUT.

6.6.5 T_FltMng2 configurations

The T_FltMng2 parameters include at least the following information:

— wake-up sleep: not supported;

— T_PCItype: set to 0000_2;

— T_PCI_DL (also T_PCI_DLext): set to any invalid value;

— N_NAD: set to any valid value supported by the IUT.

6.6.6 N_ErrDet1 configurations

The N_ErrDet1 parameters include at least the following information:

— wake-up sleep: not supported;

— T_PCItype: set to 0000_2;

— T_PCI_DL (also T_PCI_DLext): set to any valid value supported by the IUT;

— N_NAD: set to any invalid value.

6.6.7 N_ErrDet2 configurations

The N_ErrDet2 parameters include at least the following information:

— wake-up sleep: not supported;

— T_PCItype: set to 0000_2;

— T_PCI_DL (also T_PCI_DLext): set to any valid value supported by the IUT;

— N_NAD: set to any valid value supported by the IUT;

— status report message: supported by the IUT.

6.6.8 W/S configurations

The W/S parameters include at least the following information:

— wake-up sleep: supported;

— T_PCItype: set to 0000_2;

— T_PCI_DL (also T_PCI_DLext): set to any valid value supported by the IUT;

— N_NAD: set to any valid value supported by the IUT.

6.7 SUT initialisation

6.7.1 General

An initialisation of the IUT shall be performed before each CTC.

6.7.2 Default initialisation

The IUT shall be reset so that the transmission/reception of a T_ReqIds/N_ReqIds is configured and the error counter value is reset (0). If the IUT is a master node, it shall be ready to transmit the request field to the lower OSI layers. If the IUT is a slave node, it shall be ready to transmit response PDUs upon the reception of a T_ReqIds/N_ReqIds from the master node.

7 Transport layer conformance test plan

7.1 General

The transport layer conformance test evaluates the operation of response field (T_PDU), whether those are transmitted and received in the correct order according to ISO 20794-3:2020, 8.5 TL — T_PDU.

7.2 4.CTC_1.1 – Master node – T_PDU and T_PCI data handling – T_PCItype and T_PCI_DL

Table 4 specifies the CTC that verifies the operation of the T_PCI data handling into the T_PDU on the transport layer as a master node.

Table 4 — 4.CTC_1.1 – Master node – T_PDU and T_PCI data handling – T_PCItype and T_PCI_DL

Item	Content
CTC # – Title	4.CTC_1.1 – Master node – T_PDU and T_PCI data handling – T_PCItype and T_PCI_DL
Purpose	This CTC verifies the test for the master node to set T_PCItype and T_PCI_DL in the T_PDU. This test is for the diagnostic messages; hence the master node transmits a request and the slave node transmits a response.
Reference	ISO 20794-3:2020: — REQ 4.5 TL – Internal operation; — REQ 4.7 TL – T_PDU – TL – T_PCItype definition; — REQ 4.8 TL – T_PDU – TL – T_PCI_DL and T_PCI_DLext definition; — REQ 4.9 TL – Function models – TL – Transmission logic.
Prerequisite	The test system set-up shall be in accordance with Figure 2. The UT shall be connected to the backbone network of the IUT (CXPI master node). The LT shall be a CXPI slave node on the CXPI network.
Set-up	— The IUT shall be configured as a master node. — The IUT shall be configured to support User_Specific configurations (see 6.6.3), TST_MSG_01_REQ_PID and TST_MSG_10_RESP_0–12. — The bit rate shall be set to the default value (see 6.6.2). — The SUT shall be initialised to the default state (see 6.7).
Step	1. The UT shall control the IUT to transmit the TST_MSG_01_REQ_PID and the TST_MSG_10_RESP_0–12.
Iteration	TST_MSG_10_RESP_0–12(T_PCI_DL) = 1; REPEAT step 1, 10 times; TST_MSG_10_RESP_0–12(T_PCI_DL) = TST_MSG_10_RESP_0–12(T_PCI_DL) + 1; REPEAT END.
Expected response	After step 1: The IUT shall transmit the TST_MSG_10_RESP_0–12 with T_PCItype = 0000_2 and T_PCI_DL according to the data length of the packet. The LT shall receive the TST_MSG_10_RESP_0–12 with T_PCItype = 0000_2 and T_PCI_DL according to the data length of the TST_MSG_10_RESP_0–12 and shall report to the UT.
Remark	---

7.3 4.CTC_1.2 – Slave node – T_PDU and T_PCI data handling – T_PCItype and T_PCI_DL

Table 5 specifies the CTC that verifies the operation of the T_PCI data handling into the T_PDU on the transport layer as a slave node.

Table 5 — 4.CTC_1.2 – Slave node – T_PDU and T_PCI data handling – T_PCItype and T_PCI_DL

Item	Content
CTC # – Title	4.CTC_1.2 – Slave node – T_PDU and T_PCI data handling – T_PCItype and T_PCI_DL
Purpose	This CTC verifies the test for the slave node to set T_PCItype and T_PCI_DL in the T_PDU. This test is for the diagnostic messages; hence the master node transmits a request and the slave node transmits a response.
Reference	ISO 20794-3:2020: — REQ 4.5 TL – Internal operation; — REQ 4.7 TL – T_PDU – TL – T_PCItype definition; — REQ 4.8 TL – T_PDU – TL – T_PCI_DL and T_PCI_DLext definition; — REQ 4.9 TL – Function models – TL – Transmission logic.
Prerequisite	The test system set-up shall be in accordance with Figure 2.
Set-up	— The IUT shall be configured as a slave node. — The IUT shall be configured to support User-Specific configurations (see 6.6.3), TST_MSG_01_REQ_PID and TST_MSG_10_RESP_0–12. — The bit rate shall be set to the default value (see 6.6.2). — The SUT shall be initialised to the default state (see 6.7).
Step	1. The LT shall transmit the TST_MSG_01_REQ_PID and TST_MSG_10_RESP_0–12.
Iteration	TST_MSG_10_RESP_0–12(T_PCI_DL) = 1; REPEAT step 1, 10 times; TST_MSG_10_RESP_0–12(T_PCI_DL) = TST_MSG_10_RESP_0–12(T_PCI_DL) + 1; REPEAT END.
Expected response	After step 1: The IUT shall transmit the TST_MSG_10_RESP_0–12 with T_PCItype = 0000_2 and T_PCI_DL according to the data length of the TST_MSG_10_RESP_0–12. The LT shall receive the TST_MSG_10_RESP_0–12 with T_PCItype = 0000_2 and T_PCI_DL.
Remark	---

7.4   4.CTC_1.3 – Master node – T_PDU and T_PCI data handling (T_PCItype and T_PCI_DLext)

Table 6 specifies the CTC that verifies the operation of the T_PCI data handling into the T_PDU on the transport layer as a master node.

Table 6 — 4.CTC_1.3 – Master node – T_PDU and T_PCI data handling (T_PCItype and T_PCI_DLext)

Item	Content
CTC # – Title	4.CTC_1.3 – Master node – T_PDU and T_PCI data handling (T_PCItype and T_PCI_DLext)
Purpose	This CTC verifies the test for the master node to set T_PCItype, T_PCI_DL and T_PCI_DLext in the T_PDU. This test is for the diagnostic messages; hence the master node transmits a request and the slave node transmits a response.
Reference	ISO 20794-3:2020: — REQ 4.5 TL – Internal operation; — REQ 4.7 TL – T_PDU – TL – T_PCItype definition; — REQ 4.8 TL – T_PDU – TL – T_PCI_DL and T_PCI_DLext definition; — REQ 4.9 TL – Function models – TL – Transmission logic.
Prerequisite	The test system set-up shall be in accordance with Figure 2. The UT shall be connected to the backbone network of the IUT (CXPI master node). The LT shall be a CXPI slave node on the CXPI network.
Set-up	— The IUT shall be configured as a master node. — The IUT shall be configured to support User_Specific configurations (see 6.6.3), TST_MSG_01_REQ_PID and TST_MSG_12_RESP_LONG_13–255. — The bit rate shall be set to the default value (see 6.6.2). — The SUT shall be initialised to the default state (see 6.7).
Step	1. The UT shall control the IUT to transmit the TST_MSG_01_REQ_PID and the TST_MSG_12_RESP_LONG_13–255.
Iteration	TST_MSG_12_RESP_LONG_13–255(T_PCI_DLext) = 11; REPEAT step 1, 241 times; TST_MSG_12_RESP_LONG_13–255(T_PCI_DLext) = TST_MSG_12_RESP_LONG_13–255(T_PCI_DLext) + 1; REPEAT END.
Expected response	After step 1: The IUT shall transmit the TST_MSG_12_RESP_LONG_13–255 with T_PCItype = 0000_2, T_PCI_DL = 0000_2 and T_PCI_DLext according to the data length of the TST_MSG_12_RESP_LONG_13–255. The LT shall receive the TST_MSG_12_RESP_LONG_13–255 with T_PCItype = 0000_2, T_PCI_DL = 0000_2 and T_PCI_DLext according to the data length of the TST_MSG_12_RESP_LONG_13–255 and shall report to the UT.
Remark	---

7.5   4.CTC_1.4 – Slave node – T_PDU and T_PCI data handling (T_PCItype and T_PCI_DLext)

Table 7 specifies the CTC that verifies the operation of the T_PCI data handling into the T_PDU on the transport layer as a slave node.

Table 7 — 4.CTC_1.4 – Slave node – T_PDU and T_PCI data handling (T_PCItype and T_PCI_DLext)

Item	Content
CTC # – Title	**4.CTC_1.4 – Slave node – T_PDU and T_PCI data handling (T_PCItype and T_PCI_DLext)**
Purpose	This CTC verifies the test for the slave node to set T_PCItype, T_PCI_DL and T_PCI_DLext in the T_PDU. This test is for the diagnostic messages; hence the master node transmits a request and the slave node transmits a response.
Reference	ISO 20794-3:2020: — REQ 4.5 TL – Internal operation; — REQ 4.7 TL – T_PDU – TL – T_PCItype definition; — REQ 4.8 TL – T_PDU – TL – T_PCI_DL and T_PCI_DLext definition; — REQ 4.9 TL – Function models – TL – Transmission logic.
Prerequisite	The test system set-up shall be in accordance with Figure 2.
Set-up	— The IUT shall be configured as a slave node. — The IUT shall be configured to support User_Specific configurations (see 6.6.3), TST_MSG_01_REQ_PID and TST_MSG_12_RESP_LONG_13–255. — The bit rate shall be set to the default value (see 6.6.2). — The SUT shall be initialised to the default state (see 6.7).
Step	1. The LT shall transmit the TST_MSG_01_REQ_PID and the TST_MSG_12_RESP_LONG_13–255.
Iteration	TST_MSG_12_RESP_LONG_13–255(T_PCI_DLext) = 11; REPEAT step 1, 41 times; TST_MSG_12_RESP_LONG_13–255(T_PCI_DLext) = TST_MSG_12_RESP_LONG_13–255(T_PCI_DLext) + 1; REPEAT END.
Expected response	After step 1: The IUT shall transmit the TST_MSG_12_RESP_LONG_13–255 with T_PCItype = 0000_2, T_PCI_DL = 0000_2 and T_PCI_DLext according to the data length of the TST_MSG_12_RESP_LONG_13–255. The LT shall receive the TST_MSG_12_RESP_LONG_13–255 with T_PCItype = 0000_2, T_PCI_DL = 0000_2 and T_PCI_DLext according to the data length of the TST_MSG_12_RESP_LONG_13–255 and shall report to the UT.
Remark	---

7.6 4.CTC_1.5 – Master node – T_PDU and T_PCI data handling (T_PCItype and T_PCI_DLext with short data field)

Table 8 specifies the CTC that verifies the operation of the T_PCI data handling into the T_PDU on the transport layer as a master node.

Table 8 — 4.CTC_1.5 – Master node – T_PDU and T_PCI data handling (T_PCItype and T_PCI_DLext with short data field)

Item	Content
CTC # – Title	4.CTC_1.5 – Master node – T_PDU and T_PCI data handling (T_PCItype and T_PCI_DLext with short data field)
Purpose	This CTC verifies the test for the master node to set T_PCItype, T_PCI_DL and T_PCI_DLext in the T_PDU. This test is for the diagnostic messages; hence the master node transmits a request and the slave node transmits a response.
Reference	ISO 20794-3:2020: — REQ 4.5 TL – Internal operation; — REQ 4.7 TL – T_PDU – TL – T_PCItype definition; — REQ 4.8 TL – T_PDU – TL – T_PCI_DL and T_PCI_DLext definition; — REQ 4.9 TL – Function models – TL – Transmission logic.
Prerequisite	The test system set-up shall be in accordance with Figure 2. The UT shall be connected to the backbone network of the IUT (CXPI master node). The LT shall be a CXPI slave node on the CXPI network.
Set-up	— The IUT shall be configured as a master node. — The IUT shall be configured to support User_Specific configurations (see 6.6.3), TST_MSG_01_REQ_PID and TST_MSG_11_RESP_LONG_0–12. — The bit rate shall be set to the default value (see 6.6.2). — The SUT shall be initialised to the default state (see 6.7).
Step	1. The UT shall control the IUT to transmit the TST_MSG_01_REQ_PID and the TST_MSG_11_RESP_LONG_0–12.
Iteration	TST_MSG_11_RESP_LONG_0–12(T_PCI_DLext) = 1; REPEAT step 1, 10 times; 　TST_MSG_11_RESP_LONG_0–12(T_PCI_DLext) = TST_MSG_11_RESP_LONG_0–12(T_PCI_DLext) + 1; REPEAT END.
Expected response	After step 1: The IUT shall transmit the TST_MSG_11_RESP_LONG_0–12 with T_PCItype = 0000_2, T_PCI_DL = 0000_2 and T_PCI_DLext according to the data length of the TST_MSG_11_RESP_LONG_0–12. 　The LT shall receive the TST_MSG_11_RESP_LONG_0–12 with T_PCItype = 0000_2, T_PCI_DL = 0000_2 and T_PCI_DL according to the data length of the TST_MSG_11_RESP_LONG_0–12 and shall report to the UT.
Remark	---

7.7　4.CTC_1.6 – Slave node – T_PDU and T_PCI data handling (T_PCItype and T_PCI_DLext with short data field)

Table 9 specifies the CTC that verifies the operation of the T_PCI data handling into the T_PDU on the transport layer as a slave node.

Table 9 — 4.CTC_1.6 – Slave node – T_PDU and T_PCI data handling (T_PCItype and T_PCI_DLext with short data field)

Item	Content
CTC # – Title	4.CTC_1.6 – Slave node – T_PDU and T_PCI data handling (T_PCItype and T_PCI_DLext with short data field)
Purpose	This CTC verifies the test for the slave node to set T_PCItype, T_PCI_DL and T_PCI_Dlext, in the T_PDU. This test is for the diagnostic messages; hence the master node transmits a request and the slave node transmits a response.
Reference	ISO 20794-3:2020: — REQ 4.5 TL – Internal operation; — REQ 4.7 TL – T_PDU – TL – T_PCItype definition; — REQ 4.8 TL – T_PDU – TL – T_PCI_DL and T_PCI_DLext definition; — REQ 4.9 TL – Function models – TL – Transmission logic.
Prerequisite	The test system set-up shall be in accordance with Figure 2.
Set-up	— The IUT shall be configured as a slave node. — The IUT shall be configured to support User_Specific configurations (see 6.6.3), TST_MSG_01_REQ_PID and TST_MSG_11_RESP_LONG_0–12. — The bit rate shall be set to the default value (see 6.6.2). — The SUT shall be initialised to the default state (see 6.7).
Step	1. The LT shall transmit the TST_MSG_01_REQ_PID and the TST_MSG_11_RESP_LONG_0–12.
Iteration	TST_MSG_11_RESP_LONG_0–12(T_PCI_DLext) = 1; REPEAT step 1, 10 times; TST_MSG_11_RESP_LONG_0–12(T_PCI_DLext) = TST_MSG_11_RESP_LONG_0–12(T_PCI_DLext) + 1; REPEAT END.
Expected response	After step 1: The IUT shall transmit the TST_MSG_11_RESP_LONG_0–12 with T_PCItype = 0000_2, T_PCI_DL = 0000_2 and T_PCI_DLext according to the data length of the TST_MSG_11_RESP_LONG_0–12. The LT shall receive the TST_MSG_11_RESP_LONG_0–12 with T_PCItype = 0000_2, T_PCI_DL = 0000_2 and T_PCI_DL according to the data length of the TST_MSG_11_RESP_LONG_0–12 and shall report to the UT.
Remark	---

7.8 4.CTC_2.1 – Master node – TL Error detection test (T_PCItype)

Table 10 specifies the CTC that verifies the operation of fault management on the transport layer as a master node.

Table 10 — CTC_2.1 – Master node – TL Error detection test (T_PCItype)

Item	Content
CTC # – Title	CTC_2.1 – Master node – TL Error detection test (T_PCItype)
Purpose	This CTC verifies the test for the master node to detect the error of an invalid value of the T_PCItype. This test is for the diagnostic messages; hence the master node transmits a request and the slave node transmits a response.
Reference	ISO 20794-3:2020:
	— REQ 4.5 TL – Internal operation; — REQ 4.10 TL – Function models – TL – Reception logic; — REQ 4.11 TL – Error detection – T_Data.ind and T_Data.conf with T_PCItype ≠ 0000_2.
Prerequisite	The test system set-up shall be in accordance with Figure 2. The UT shall be connected to the backbone network of the IUT (CXPI master node). The LT shall be a CXPI slave node on the CXPI network.
Set-up	— The IUT shall be configured as a master node. — The IUT shall be configured to support T_FltMng1 configurations (see 6.6.4), TST_MSG_01_REQ_PID and TST_MSG_10_RESP_0–12. — The bit rate shall be set to the default value (see 6.6.2). — The SUT shall be initialised to the default state (see 6.7).
Step	1. The LT shall transmit the TST_MSG_01_REQ_PID and the TST_MSG_10_RESP_0–12 with the invalid value of T_PCItype ≠ 0000_2.
Iteration	Not applicable
Expected response	After step 1: The IUT shall not transmit any packet to the LT. The IUT shall not transmit any packet to the backbone network.
Remark	---

7.9 4.CTC_2.2 – Slave node – TL Error detection test (T_PCItype)

Table 11 specifies the CTC that verifies the operation of fault management on the transport layer as a slave node.

Table 11 — 4.CTC_2.2 – Slave node – TL Error detection test (T_PCItype)

Item	Content
CTC # – Title	
Purpose	This CTC verifies the test for the slave node to detect the error of an invalid value of the T_PCItype. This test is for the diagnostic messages; hence the master node transmits a request and the slave node transmits a response.
Reference	ISO 20794-3:2020: — REQ 4.5 TL – Internal operation; — REQ 4.10 TL – Function models – TL – Reception logic; — REQ 4.11 TL – Error detection – T_Data.ind and T_Data.conf with T_PCItype ≠ 0000_2.
Prerequisite	The test system set-up shall be in accordance with Figure 2.
Set-up	— The IUT shall be configured as a slave node. — The IUT shall be configured to support T_FltMng1 configurations (see 6.6.4), TST_MSG_01_REQ_PID and TST_MSG_10_RESP_0–12. — The bit rate shall be set to the default value (see 6.6.2). — The SUT shall be initialised to the default state (see 6.7).
Step	1. The LT shall transmit the TST_MSG_01_REQ_PID and the TST_MSG_10_RESP_0–12 with the invalid value of T_PCItype ≠ 0000_2.
Iteration	Not applicable
Expected response	After step 1: The IUT shall not transmit any packet to the LT. The LT shall report no packet to the UT.
Remark	---

7.10 4.CTC_2.3 – TL Error detection test (T_PCItype) using error bit

Table 12 specifies the CTC that verifies the operation of fault management using the error bit on the transport layer.

Table 12 — 4.CTC_2.3 – TL Error detection test (T_PCItype) using error bit

Item	Content
CTC # – Title	4.CTC_2.3 – TL Error detection test (T_PCItype) using error bit
Purpose	This CTC verifies the test for the IUT to detect the error of an invalid value of the T_PCItype. This test is for the diagnostic messages; hence the master node transmits a request and the slave node transmits a response.
Reference	ISO 20794-3:2020: — REQ 4.5 TL – Internal operation; — REQ 4.10 TL – Function models – TL – Reception logic; — REQ 4.11 TL – Error detection – T_Data.ind and T_Data.conf with T_PCItype ≠ 0000_2.
Prerequisite	The test system set-up shall be in accordance with Figure 2.
Set-up	— The IUT shall be configured as a master node or a slave node. — The IUT shall be configured to support N_ErrDet2 configurations (see 6.6.7), TST_MSG_01_REQ_PID, TST_MSG_10_RESP_0–12, TST_MSG_05_REQ_PID_ERRBIT, and TST_MSG_16_RESP_ERRBIT_0–12. — The bit rate shall be set to the default value (see 6.6.2). — The SUT shall be initialised to the default state (see 6.7).
Step	1. The LT shall transmit the TST_MSG_01_REQ_PID and the TST_MSG_10_RESP_0–12 with the invalid value of T_PCItype ≠ 0000_2. 2. The LT shall transmit the TST_MSG_05_REQ_PID_ERRBIT.
Iteration	Not applicable
Expected response	After step 1: The IUT shall not transmit any packet to the LT. The LT shall report no packet to the UT. After step 2: The IUT shall transmit the TST_MSG_16_RESP_ERRBIT_0–12 with Err_TL_Ptype = TRUE to the LT. The LT shall receive the TST_MSG_16_RESP_ERRBIT_0–12 with Err_TL_Ptype = TRUE and shall report to the UT.
Remark	---

7.11 4.CTC_2.4 – Master node – TL Error detection test (T_PCI_DL)

Table 13 specifies the CTC that verifies the operation of fault management on the transport layer as a master node.

Table 13 — 4.CTC_2.4 – Master node – TL Error detection test (T_PCI_DL)

Item	Content
CTC # – Title	4.CTC_2.4 – Master node – TL Error detection test (T_PCI_DL)
Purpose	This CTC verifies the test for the master node to detect the error of an invalid value in the T_PCI_DL. This test is for the diagnostic messages; hence the master node transmits a request and the slave node transmits a response.
Reference	ISO 20794-3:2020: — REQ 4.10 TL – Function models – TL – Reception logic; — REQ 4.12 TL – Error detection – T_Data.conf frame reception with T_PCI_DL = $[0_{16}, B_{16}$ to $F_{16}]$.
Prerequisite	The test system set-up shall be in accordance with Figure 2. The UT shall be connected to the backbone network of the IUT (CXPI master node). The LT shall be a CXPI slave node on the CXPI network.
Set-up	— The IUT shall be configured as a master node. — The IUT shall be configured to support T_FltMng2 configurations (see 6.6.5), TST_MSG_01_REQ_PID and TST_MSG_10_RESP_0–12. — The bit rate shall be set to the default value (see 6.6.2). — The SUT shall be initialised to the default state (see 6.7).
Step	1. The LT shall transmit the TST_MSG_01_REQ_PID and the TST_MSG_10_RESP_0–12 with the invalid value of T_PCI_DL.
Iteration	Not applicable
Expected response	After step 1: The IUT shall not transmit any packet to the LT. The IUT shall not transmit any packet to the backbone network.
Remark	---

7.12 4.CTC_2.5 – Slave node – TL Error detection test (T_PCI_DL)

Table 14 specifies the CTC that verifies the operation of fault management on the transport layer as a slave node.

Table 14 — 4.CTC_2.5 – Slave node – TL Error detection test (T_PCI_DL)

Item	Content
CTC # – Title	**4.CTC_2.5 – Slave node – TL Error detection test (T_PCI_DL)**
Purpose	This CTC verifies the test for the slave node to detect an error of an invalid value in the T_PCI_DL. This test is for the diagnostic messages; hence the master node transmits a request and the slave node transmits a response.
Reference	ISO 20794-3:2020: — REQ 4.10 TL – Function models – TL – Reception logic; — REQ 4.12 TL – Error detection – T_Data.conf frame reception with $T\_PCI\_DL = [0_{16}, B_{16}$ to $F_{16}]$.
Prerequisite	The test system set-up shall be in accordance with Figure 2.
Set-up	— The IUT shall be configured as a slave node. — The IUT shall be configured to support T_FltMng2 configurations (see 6.6.5), TST_MSG_01_REQ_PID and TST_MSG_10_RESP_0–12. — The bit rate shall be set to the default value (see 6.6.2). — The SUT shall be initialised to the default state (see 6.7).
Step	1. The LT shall transmit the TST_MSG_01_REQ_PID and the TST_MSG_10_RESP_0–12 with an invalid value of T_PCI_DL.
Iteration	Not applicable
Expected response	After step 1: The IUT shall not transmit any packet to the LT. The LT shall report no packet to the UT.
Remark	---

7.13 4.CTC_2.6 – TL Error detection test (T_PCI_DL) using error bit

Table 15 specifies the CTC that verifies the operation of fault management using the error bit on the transport layer.

Table 15 — 4.CTC_2.6 – TL Error detection test (T_PCI_DL) using error bit

Item	Content
CTC # – Title	4.CTC_2.6 – TL Error detection test (T_PCI_DL) using error bit
Purpose	This CTC verifies the test for the IUT to detect the error of an invalid value in the T_PCI_DL. This test is for the diagnostic messages; hence the master node transmits a request and the slave node transmits a response.
Reference	ISO 20794-3:2020: — REQ 4.10 TL – Function models – TL – Reception logic; — REQ 4.12 TL – Error detection – T_Data.conf frame reception with T_PCI_DL = $[0_{16}, B_{16}$ to $F_{16}]$.
Prerequisite	The test system set-up shall be in accordance with Figure 2.
Set-up	— The IUT shall be configured as a master node or a slave node. — The IUT shall be configured to support N_ErrDet2 configurations (see 6.6.7), TST_MSG_01_REQ_PID, TST_MSG_10_RESP_0–12, TST_MSG_05_REQ_PID_ERRBIT, and TST_MSG_16_RESP_ERRBIT_0–12. — The bit rate shall be set to the default value (see 6.6.2). — The SUT shall be initialised to the default state (see 6.7).
Step	1. The LT shall transmit the TST_MSG_01_REQ_PID and the TST_MSG_10_RESP_0–12 with the invalid value of T_PCI_DL. 2. The LT shall transmit the TST_MSG_05_REQ_PID_ERRBIT.
Iteration	Not applicable
Expected response	After step 1: The IUT shall not transmit any packet to the LT. The LT shall report no packet to the UT. After step 2: The IUT shall transmit the TST_MSG_16_RESP_ERRBIT_0–12 with Err_TL_PCI_DL_Value = TRUE to the LT. The LT shall receive the TST_MSG_16_RESP_ERRBIT_0–12 with Err_TL_PCI_DL_Value = TRUE and shall report to the UT.
Remark	---

7.14 4.CTC_2.7 – Master node – TL Error detection test (T_PCI_DLext)

Table 16 specifies the CTC that verifies the operation of fault management on the transport layer as a master node.

Table 16 — 4.CTC_2.7 – Master node – TL Error detection test (T_PCI_DLext)

Item	Content
CTC # – Title	4.CTC_2.7 – Master node – TL Error detection test (T_PCI_DLext)
Purpose	This CTC verifies the test for the master node to detect the error of an invalid value in the T_PCI_DLext. This test is for the diagnostic messages; hence the master node transmits a request and the slave node transmits a response.
Reference	ISO 20794-3:2020: — REQ 4.10 TL – Function models – TL – Reception logic; — REQ 4.13 TL – Error detection – T_Data.conf frame reception with T_PCI_DLext = $[01_{16}$ to A_{16}, FD_{16} to $FF_{16}]$.
Prerequisite	The test system set-up shall be in accordance with Figure 2. The UT shall be connected to the backbone network of the IUT (CXPI master node). The LT shall be a CXPI slave node on the CXPI network.
Set-up	— The IUT shall be configured as a master node. — The IUT shall be configured to support T_FltMng2 configurations (see 6.6.5), TST_MSG_01_REQ_PID, TST_MSG_11_RESP_LONG_0–12 and TST_MSG_12_RESP_LONG_13–255. — The bit rate shall be set to the default value (see 6.6.2). — The SUT shall be initialised to the default state (see 6.7).
Step	1. The LT shall transmit the TST_MSG_01_REQ_PID and the TST_MSG_11_ RESP_LONG_0–12 or the TST_MSG_12_RESP_LONG_13–255 with the invalid value of T_PCI_DLext.
Iteration	Not applicable
Expected response	After step 1: The IUT shall not transmit any packet to the LT. The IUT shall not transmit any packet to the backbone network.
Remark	---

7.15 4.CTC_2.8 – Slave node – TL Error detection test (T_PCI_DLext)

Table 17 specifies the CTC that verifies the operation of fault management on the transport layer as a slave node.

Table 17 — 4.CTC_2.8 – Slave node – TL Error detection test (T_PCI_DLext)

Item	Content
CTC # – Title	**4.CTC_2.8 – Slave node – TL Error detection test (T_PCI_DLext)**
Purpose	This CTC verifies the test for the master node to detect the error of an invalid value in the T_PCI_DLext. This test is for the diagnostic messages; hence the master node transmits a request and the slave node transmits a response.
Reference	ISO 20794-3:2020: — REQ 4.10 TL – Function models – TL – Reception logic; — REQ 4.13 TL – Error detection – T_Data.conf frame reception with T_PCI_DLext = [01_{16} to A_{16}, FD_{16} to FF_{16}].
Prerequisite	The test system set-up shall be in accordance with Figure 2.
Set-up	— The IUT shall be configured as a slave node. — The IUT shall be configured to support T_FltMng2 configurations (see 6.6.5), TST_MSG_01_REQ_PID, TST_MSG_11_RESP_LONG_0–12 and TST_MSG_12_RESP_LONG_13–255. — The bit rate shall be set to the default value (see 6.6.2). — The SUT shall be initialised to the default state (see 6.7).
Step	1. The LT shall transmit the TST_MSG_01_REQ_PID and the TST_MSG_11_RESP_LONG_0–12 or the TST_MSG_12_RESP_LONG_13–255 with the invalid value of T_PCI_DLext.
Iteration	Not applicable
Expected response	After step 1: The IUT shall not transmit any packet to the LT. The LT shall report no packet to the UT.
Remark	---

7.16 4.CTC_2.9 – TL Error detection test (T_PCI_DLext) using error bit

Table 18 specifies the CTC that verifies the operation of fault management using the error bit on the transport layer.

Table 18 — 4.CTC_2.9 – TL Error detection test (T_PCI_DLext) using error bit

Item	Content
CTC # – Title	4.CTC_2.9 – TL Error detection test (T_PCI_DLext) using error bit
Purpose	This CTC verifies the test for the IUT to detect the error of an invalid value in the T_PCI_DLext. This test is for the diagnostic messages; hence the master node transmits a request and the slave node transmits a response.
Reference	ISO 20794-3:2020: — REQ 4.10 TL – Function models – TL – Reception logic; — REQ 4.13 TL – Error detection – T_Data.conf frame reception with T_PCI_DLext = $[01_{16}$ to A_{16}, FD_{16} to $FF_{16}]$.
Prerequisite	The test system set-up shall be in accordance with Figure 2.
Set-up	— The IUT shall be configured as a master node or a slave node. — The IUT shall be configured to support N_ErrDet2 configurations (see 6.6.7), TST_MSG_01_REQ_PID, TST_MSG_11_ RESP_LONG_0–12, TST_MSG_12_RESP_LONG_13–255, TST_MSG_05_REQ_PID_ERRBIT and TST_MSG_16_RESP_ERRBIR_0–12. — The bit rate shall be set to the default value (see 6.6.2). — The SUT shall be initialised to the default state (see 6.7).
Step	1. The LT shall transmit the TST_MSG_01_REQ_PID and the TST_MSG_11_ RESP_LONG_0–12 or the TST_MSG_12_RESP_LONG_13–255 with the invalid value of T_PCI_DLext. 2. The LT shall transmit the TST_MSG_05_REQ_PID_ERRBIT.
Iteration	Not applicable
Expected response	After step 1: The IUT shall not transmit any packet to the LT. The LT shall report no packet to the UT. After step 2: The IUT shall transmit the TST_MSG_16_RESP_ERRBIT_0–12 with Err_TL_PCI_DLext_Value = TRUE to the LT. The LT shall receive the TST_MSG_16_RESP_ERRBIT_0–12 with Err_TL_PCI_DLext_Value = TRUE and shall report to the UT.
Remark	---

8 Network layer conformance test

8.1 General

The network layer conformance test evaluates the operation of the response field (N_PDU) whether the information is received in the correct order according to the network layer specification (ISO 20794-3:2020). The network layer conformance tests do not evaluate the exact time or field contents which is tested by other parts of the conformance test plan (e.g. ISO 20794-5, ISO 20794-7).