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Road vehicles — Clock extension peripheral interface (CXPI) —

Part 5: Application layer conformance test plan

Véhicules routiers — Interface périphérique d'extension d'horloge (CXPI) —
Partie 5: Plan de test de conformité de la couche application

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Foreword

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A list of all parts in the ISO 20794 series can be found on the ISO website.

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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);

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— 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 this document;

— 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[10];

— lower OSI layers framework, which is composed of ISO 20794-3[6], ISO 20794-4[7], ISO 20794-6[8] and ISO 20794-7[9].

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.

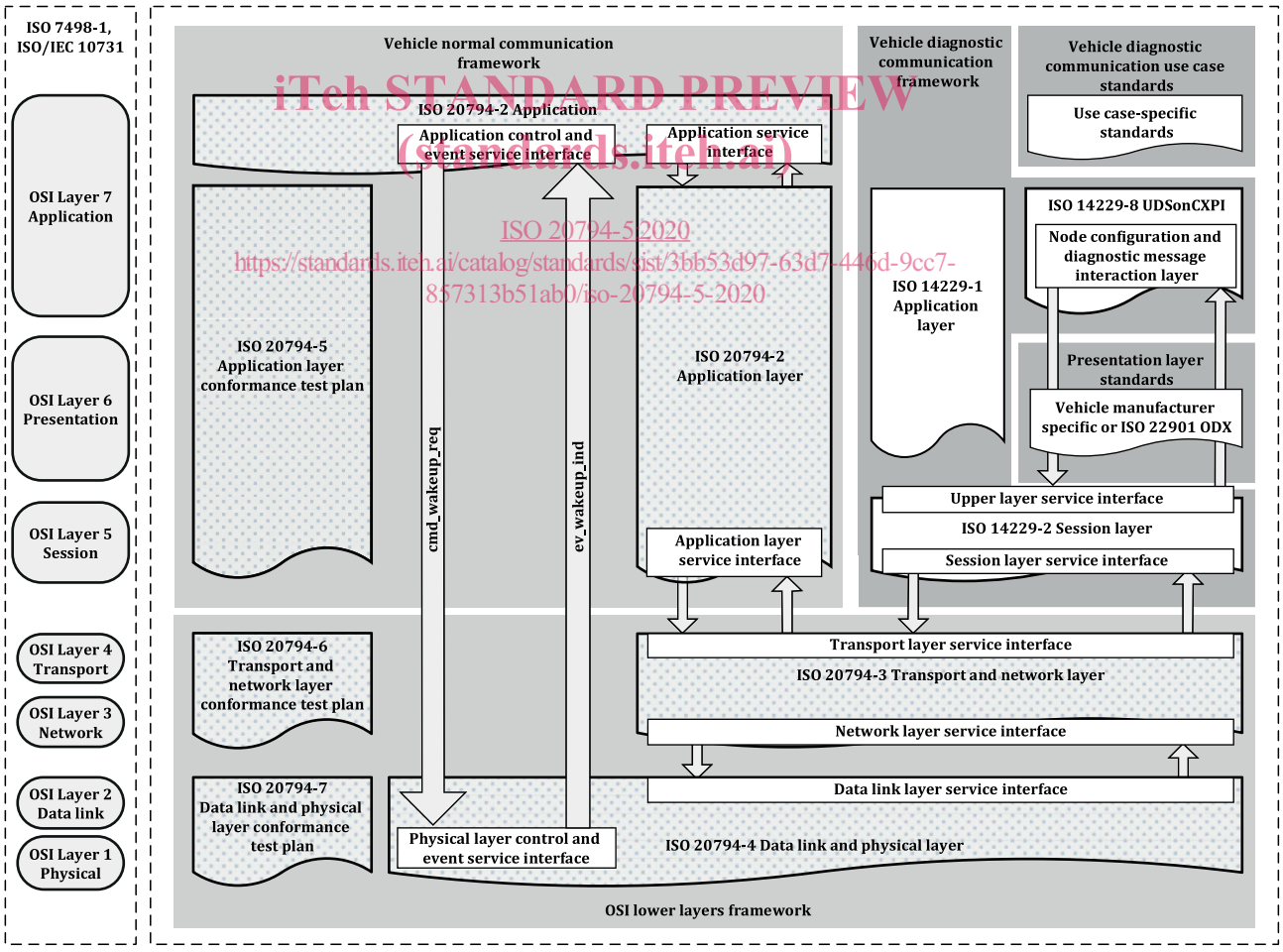

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Figure 1 — ISO 20794 documents reference according to OSI model

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Road vehicles — Clock extension peripheral interface (CXPI) —

Part 5: Application layer conformance test plan

1 Scope

This document specifies the conformance test plan for ISO 20794-2:2020 implementations.

It specifies conformance test cases related to:

— concept of operation;

— network management;

— transfer management; and

— error management.

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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.

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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*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 20794-2, 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
clock master
node that transmits *clock* (3.4) to the *lower OSI layers* (3.2)

3.2
lower OSI layer
OSI layer lower than application layer

3.3
master node
node that provides the *schedule* (3.10) master management (include ReqTypeId transmission), the *primary clock* (3.7) and optionally the sleep message transmission management

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3.4
clock
function that synchronises all nodes on the CXPI network

3.5
initiator
node that transmits messages

3.6
passive
node that receives messages

3.7
primary clock
clock (3.4) that is provided by the *master node* (3.3)

3.8
REPEAT
pseudo code command for an iteration

3.9
REPEAT END
pseudo code command for ending an iteration

3.10
schedule
origin of periodic frame transmission

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3.11
secondary clock
clock (3.4) that is provided by one dedicated *slave node* (3.13)

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3.12
sequence
transmission and reception procedure of messages among two or more nodes

3.13
slave node
node other than *master node* (3.3) connected to the CXPI network

3.14
slave initiator node
node that is woken up by its own *slave node* (3.13)

3.15
slave passive node
node that is woken up by another *slave node* (3.13)

3.16
wake-up pulse
stimulus initiated by a node used for wake-up of other nodes on the CXPI network

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4 Symbols and abbreviated terms

4.1 Symbols

---	empty cell/undefined
kbit/s	kilobit per second
$t_{clock\_start\_m}$	master node clock start time
$t_{clock\_stop\_m}$	master node clock stop time
t_{sleep_s}	slave node sleep state transition time
t_{wakeup_m}	master node wake-up time
$t_{wakeup\_recovery\_s}$	slave node wake-up recovery time
t_{wakeup_s}	slave node wake-up time
$t_{wakeup\_schedule\_m}$	master node wake-up schedule time

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4.2 Abbreviated terms

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ASP	abstract service primitive
AL	application layer
APP	application
CRC	cyclic redundancy check
DLC	data length code
ECU	electronic control unit
EMI	electro-magnetic interference
ErrDet	error detection
ETS	enhanced testability service
IUT	implementation under test
OSI	open systems interconnection
PDU	protocol data unit
PID	protected identifier
PCO	point of control and observation
ReqId	request identifier

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ReqTypeId	request type identifier
SCT	sequence count
SUT	system under 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 20794-2 application layer document.

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.

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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 test case respectively.

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6.4 CTC definition

The definition of each test case specifies, whether the IUT is a master or 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. 8.CTC_1.4 – State machine – Slave node – Sleep permission
Purpose	This CTC shall verify … E.g. This CTC verifies the test for the slave node to transit into the sleep state with sleep permission. This CTC is applicable only to an IUT, which supports the wake-up/sleep feature.
Reference	REQ document, REQ number – REQ name E.g. ISO 20794-2:2020, REQ 8.3 APP – NM – Normal, standby, and sleep states;
Prerequisite	The test system set-up shall be in accordance with Figure 2. The clock master is implemented in the LT of the test system.
Set-up	— The IUT shall be configured as a slave node. — The IUT shall be configured to default (see 6.6) and in addition support W/S_RdySleep configurations (see 6.6.6). — The bit rate shall be set to the default value (see 6.6). — The SUT shall be initialised to the sleep state (see 6.7.3).

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Table 1 *(continued)*

Item	Content
Step	1. A short description of the test step e.g. LT shall transmit the wake-up pulse. 2. A short description of the test step e.g. LT shall observe any messages on the CXPI network and shall report to the UT.
Iteration	Definition of repetitions of test procedure steps. Example: REPEAT step 1 to step 2, 5 times; …; REPEAT END.
Expected response	Define the expected behaviour of IUT by checking on the CXPI network when the test step is executed. Example: After step 1: the IUT shall receive a wake-up notification pulse, waits $t_{cxpi\_network\_error}$ time from the wake-up pulse. After step 2: the LT shall report the observation on the CXPI network to the UT.
Remark	E.g. either "---" if no remark or "Observation of $t_{wakeup\_schedule\_m}$ time and t_{wakeup_m} time starts from second rising edge of clock."

6.5 Test system set-up

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The test system set-up follows ISO/IEC 9646-1 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.

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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 layer 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 ensures the precision of the bit time and bit synchronisation of the master node as specified in ISO 20794-4:2020, 9.3.7.

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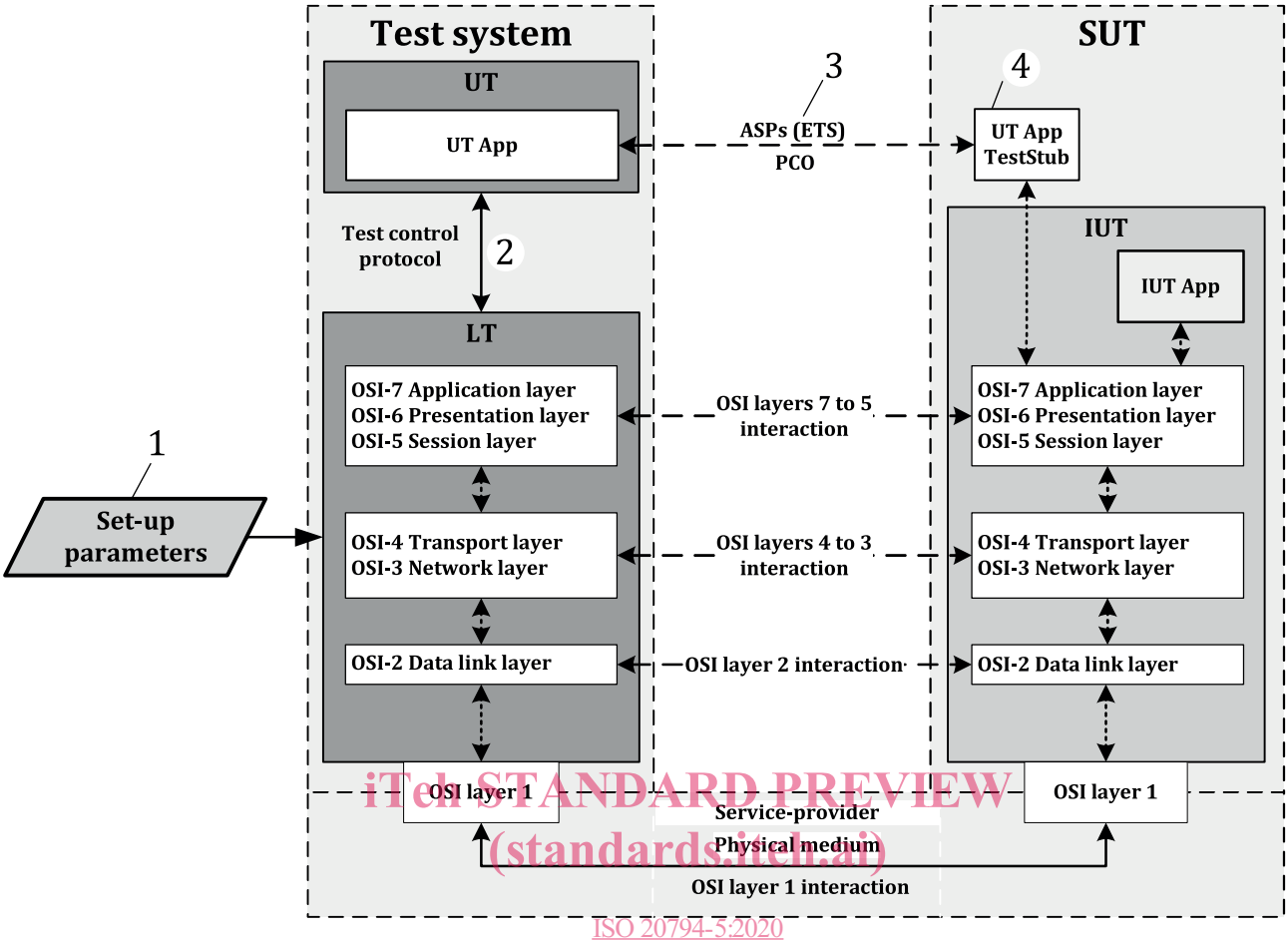

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Key

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 test stub

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 layer properties of the IUT. The IUT-specific data sheet (see Figure 2 key 1) includes set-up parameters, which the test system requires for the conformance test cases.

Table 2 defines the configurations of the test system and the IUT.

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Table 2 — Configuration of test system and IUT

Configuration item	Configuration of test system and IUT								
	W/S _Init	W/S _passive	W/S _Rdy Sleep	W/S _ Not Rdy Sleep	A_WSSup	Non W/S	ErrDet	Event	Polling
Internal condition of wake-up	1_2	0_2	1_2	1_2	---	---	---	---	---
Transmission method	---	---	---	---	---	---	---	event	polling
Wake-up/sleep	1_2	1_2	1_2	1_2	0_2	---	---	---	---
TST_FRM_05_REQ_PID_ERRBIT	---	---	---	---	supported by IUT	---	supported by IUT	---	---
Condition of sleep permission (sleep_ind)	1_2	1_2	1_2	0_2	---	0_2	0_2	---	---

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 'Definition' 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 master node including a ReqTypeId value (00_{16}) of A_ReqId.
TST_MSG_01_REQ_PID	Test message 01_{16} of master or slave node including an A_PID value (01_{16} to $7F_{16}$) of A_ReqId.
TST_MSG_02_REQ_PID_SLEEP	Test message 02_{16} for master node including an A_PID value ($1F_{16}$) of A_ReqId for diagnostic and node configuration requests or sleep message.
TST_MSG_03_REQ_PID_UNKNOWN	Test message 03_{16} for master or slave node including a not defined A_PID value of A_ReqId (not defined for reception/transmission by IUT).
TST_MSG_04_REQ_PID_INVALID	Test message 04_{16} for master or slave node including an A_PID value of A_ReqId (not defined for reception/transmission by IUT with an incorrect parity bit) determined by A_Length = 01_{16}.
TST_MSG_05_REQ_PID_ERRBIT	Test message 05_{16} of master or slave node including an error bit A_PID value (01_{16} to $7F_{16}$) of L_ReqId. The value of this PID can use a supplier-specific ReqId.
TST_MSG_10_RESP_0-12	Test message 10_{16} for master or slave node including FI field, DATA field and CRC field determined by 00_{16} ≤ A_Lenght ≤ $0C_{16}$.
TST_MSG_11_RESP_12	Test message 11_{16} for master or slave node including FI field, DATA field and CRC field determined by A_Length = $0C_{16}$.
TST_MSG_14_RESP_LONG_0-255	Test message 14_{16} of master or slave node including FI field, DATA field and CRC field determined by 00_{16} ≤ A_Length ≤ FF_{16}.
TST_MSG_17_RESP_SLEEP_8	Test message 17_{16} of 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 A_Length = 08_{16}.
TST_MSG_18_RESP_ERRBIT_0-12	Test message 18_{16} of master node including FI field, DATA field with an error bit and CRC field determined by 00_{16} ≤ A_Length ≤ $0C_{16}$.

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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} in the request protected type identifier field.

— The CXPI node wake-up uses a wake-up trigger based on the parameter wakeup_ind value 0_2 or 1_2.

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