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Road vehicles — Unified diagnostic services (UDS) —

Part 8: UDS on Clock eXtension Peripheral Interface (UDSonCXPI)

Véhicules routiers — Services de diagnostic unifiés (SDU) —

Partie 8: Partie 8: SDU sur l'interface périphérique d'extension d'horloge (UDSonCXPI)

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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 14229 series can be found on the ISO website.

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Introduction

This document has been created in order to enable the implementation of unified diagnostic services, as specified in ISO 14229-1, on the clock extension peripheral interface (CXPI) networks (UDSonCXPI).

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, which structures communication systems into seven layers.

Figure 1 illustrates the document references from ISO 14229-1, ISO 14229-2 and ISO 20794 (all parts). This document uses only a subset of the diagnostic services defined in ISO 14229-1 (see Table 2).

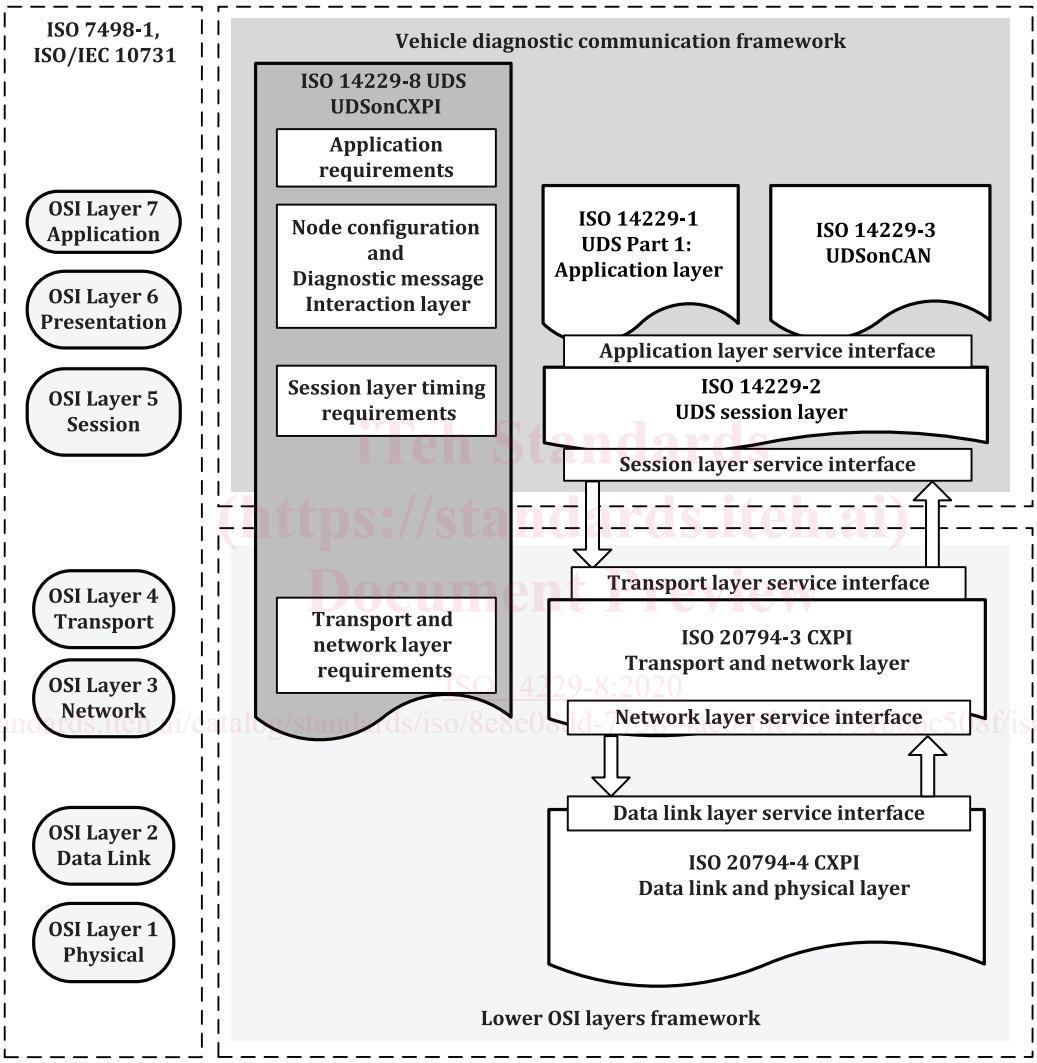

Figure 1 — UDSonCXPI documents reference according to OSI model

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Road vehicles — Unified diagnostic services (UDS) —

Part 8: UDS on Clock eXtension Peripheral Interface (UDSonCXPI)

1 Scope

This document specifies the implementation of a common set of unified diagnostic services (UDS) on clock extension peripheral interface networks in road vehicles. The UDSonCXPI diagnostics defines methods to implement diagnostic data transfer between a client and the CXPI slave nodes via the CXPI master node.

This document specifies support of three different diagnostic classes for CXPI slave nodes.

This document references ISO 14229-1 and ISO 14229-2 and specifies implementation requirements of the UDSonCXPI communication protocol for mainly HMI (Human Machine Interface), but not limited to, electric/electronic systems of road vehicles. UDSonCXPI defines how to implement the diagnostic data transfer between a client and CXPI slave nodes via CXPI master node.

NOTE UDSonCXPI does not specify any requirement for the in-vehicle CXPI bus architecture.

This document refers to information contained in ISO 14229-1, ISO 14229-2 and ISO 20794 (all parts).

This document does not include any redundant information of the above-mentioned documents.

It focuses on

— additional requirements specific to the implementation of UDSonCXPI network, and

— specific restrictions in the implementation of UDSonCXPI network.

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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.

ISO 7498-1, *Information technology — Open Systems Interconnection — Basic Reference Model: The Basic Model*

ISO 14229-1, *Road vehicles — Unified diagnostic services (UDS) — Part 1: Application layer*

ISO 14229-2, *Road vehicles — Unified diagnostic services (UDS) — Part 2: Session layer services*

ISO 14229-3, *Road vehicles — Unified diagnostic services (UDS) — Part 3: Unified diagnostic services on CAN implementation (UDSonCAN)*

ISO 20794 (all parts), *Road vehicles — Clock extension peripheral interface (CXPI)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 14229-1, ISO 14229-2, ISO 20794 (all parts), ISO/IEC 7498-1 apply.

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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/

4 Abbreviated terms

AE	address extension
APP	application
C	conditional
Cvt	convention
GW	gateway
M	mandatory
ID	identifier
N/A	not applicable
NAD	node address for slave nodes
P2	server response time
SA	source address
SF	single frame
TA	target address
U	user optional

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5 Conventions

This document is based on the conventions discussed in the OSI Service Conventions (ISO/IEC 10731:1994) as they apply for diagnostic services.

6 SIP – Service interface parameters

6.1 SIP – General

The following subclauses specify the service interface parameters and data types, which are used by the application and application layer services.

6.2 SIP — Data type definitions

This requirement specifies the data type definitions of the UDSonCXPI service interface parameters.

REQ	0.1 SIP – Data type definitions
The data types shall be in accordance to:	

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REQ	0.1 SIP – Data type definitions
—	`Enum` = 8-bit enumeration
—	`Unsigned Byte` = 8-bit unsigned numeric value
—	`Unsigned Word` = 16-bit unsigned numeric value
—	`Byte Array` = sequence of 8-bit aligned data
—	`2-bit Bit String` = 2-bit binary coded
—	`8-bit Bit String` = 8-bit binary coded
—	`16-bit Bit String` = 16-bit binary coded

6.3 SIP — A_Mtype, message type

This requirement specifies the message type parameter values of the CXPI service interface.

REQ	0.2 SIP – A_Mtype, message type
The `A_Mtype` parameter shall be of data type `Enum` and shall be used to identify the message type and range of address information included in a service call. Range: [`NormalCom, DiagNodeCfg`]	

6.4 SIP — A_TAtype, target address type

This requirement specifies the target address type parameter values of the CXPI service interface.

REQ	0.3 SIP – A_TAtype, target address type
The `A_TAtype` parameter shall be of data type `Enum` and shall be used to encode the communication model used by the communicating peer entities. Two communication models are specified: '1 to 1' communication, called physical addressing, and '1 to n' communication, called functional addressing. Range: [`physical, functional`]	

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6.5 SIP — A_TA, target address

This requirement specifies the target address parameter values of the CXPI service interface.

REQ	0.4 SIP – A_TA, target address
The `A_TA` parameter shall be of data type `Unsigned Byte` and shall be used to identify the target address of the information to be transmitted. Range: [`0116 to FF16`]	

6.6 SIP — A_SA, source address

This requirement specifies the source address parameter values of the CXPI service interface.

REQ	0.5 SIP – A_SA, source address
The `A_SA` parameter shall be of data type `Unsigned Byte` and shall be used to identify the source address of the received information. Mtype = DiagNodeCfg: Range = [00_{16} to FC_{16}]	

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6.7 SIP — A_Length, length of A_PDU

This requirement specifies the length of PDU parameter value of the CXPI service interface.

REQ	0.7 SIP – A_Length, length of PDU
The `A_Length` parameter shall be of data type `Unsigned Byte` and shall contain the length of the A_PDU to be requested transmission/notified reception.	

6.8 SIP — A_Data, protocol data unit

This requirement specifies the protocol data unit parameter values of the CXPI service interface.

REQ	0.8 SIP – A_Data, protocol data unit
The `A_Data` parameter shall be of data type `Byte Array` and shall contain the packet data (A_Data) content of the request or response packet to be transmitted/received. Range: [00_{16} to FF_{16}]	

6.9 SIP — A_SCT, sequence count

This requirement specifies the sequence count parameter values of the CXPI service interface.

REQ	0.9 SIP – A_SCT, sequence count
The `A_SCT` parameter shall be of data type `2-bit Numeric` and shall contain the sequence count information in the response field to be transmitted/received. Range: [0_{02} to 1_{12}]	

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6.10 SIP — A_Result, result

This requirement specifies the result parameter values of the CXPI service interface.

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REQ	0.10 SIP – A_Result, result
The `A_Result` parameter shall be of data type `16-bit Bit String` and shall contain the status relating to the outcome of a service execution. If two or more errors are discovered at the same time, then the transport or network layer entity shall set the appropriate error bit in the Result parameter. Range: [`OK, DLL_Arb_Lost, Err_DLL_Byte, Err_DLL_CRC, Err_DLL_DLC, Err_DLL_DLCext, Err_DLL_Parity, Err_DLL_Framing, Err_NL_TIMEOUT_A, Err_TL_Ptype, Err_TL_PCI_DL_Value, Err_APP_SCT`] Range: [0_2 to 1_2] (1-bit per result)	

6.11 SIP — ev_wakeup_ind, event wake-up indication (optional)

This requirement specifies the event wake-up indication parameter values of the CXPI service interface.

REQ	0.11 SIP – ev_wakeup_ind, event wake-up indication (optional)
The `ev_wakeup_ind` parameter shall be of data type `Enum` and shall include the event wake-up indication information. Table 1 describes the network management values. Range: [`ev_wakeup_pulse_detect, ev_dominant_pulse_detect, ev_clk_detect, ev_clk_loss`]	

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Table 1 — ev_wakeup_ind, event wake-up indication (optional)

Enum values	Description
ev_wakeup_pulse_detect	This service interface parameter value indicates the reception of the wake-up pulse event from the lower OSI layers. This parameter is optional if cmd_wake-up_pulse_on in Table 2 is (optional).
ev_dominant_pulse_detect	This service interface parameter value indicates the reception of the dominant pulse event from the lower OSI layers. This parameter is optional if cmd_wakeup_pulse_on in Table 2 is (optional).
ev_clk_detect	This service interface parameter value indicates the reception of the clock detection event from the lower OSI layers.
ev_clk_loss	This service interface parameter value indicates the reception of the clock loss event from the lower OSI layers.

6.12 SIP — cmd_wakeup_req, command wake-up request

This requirement specifies the command wake-up request parameter values of the CXPI service interface.

REQ	0.12 SIP – cmd_wakeup_req, command wake-up request
The cmd_wakeup_req parameter shall be of data type Enum and shall include the wake-up request command information to wake-up a CXPI node. Table 2 specifies the cmd_wakeup_req values. Range: [cmd_clk_generator_on, cmd_clk_generator_off, cmd_wakeup_pulse_on]	

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Table 2 — cmd_wakeup_req values

Enum values	Description
cmd_clk_generator_on	This service interface parameter value commands the clock generator to turn on the clock transmission to the lower OSI layers.
cmd_clk_generator_off	This service interface parameter value commands the clock generator to turn off the clock transmission to the lower OSI layers.
cmd_wakeup_pulse_on (optional)	This service interface parameter value commands the transmission of the wake-up pulse to the lower OSI layers.

6.13 SIP — NMInfo, network management information

This requirement specifies the network management information parameter values of the CXPI service interface.

REQ	0.13 SIP – NMInfo, network management information
The NMInfo parameter shall be of data type 2-bit Bit String and shall contain the NetMngt information in the response field. 00_2 = [no request for wakeup_ind, sleep_ind prohibition] 01_2 = [no request for wakeup_ind, sleep_ind permission] 10_2 = [request for wakeup_ind, sleep_ind prohibition] 11_2 = [request for wakeup_ind, sleep_ind permission]	

7 APP – Application

7.1 APP – General

The subclauses define how the diagnostic services, as defined in ISO 14229-1, apply to CXPI.

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To allow a common implementation of application layer and session layer for the ISO 20794 series and other communications, this document uses the session layer protocol as defined in ISO 14229-2 and focuses on necessary modifications and interfaces to adopt it to the ISO 20794 series.

The subfunction parameter definitions consider that the most significant bit is used for the suppressPosRspMsgIndicationBit parameter as defined in ISO 14229-1.

It is the vehicle manufacturer's responsibility to setup the CXPI master and slave nodes to exchange UDSonCXPI information according to the ISO 20794 series documents.

7.2 APP – Definition of diagnostic classes

7.2.1 APP – Overview

Architectural, diagnostic communication performance and transport protocol requirements of slave nodes are accommodated by classifying diagnostic services functionality into three diagnostic classes.

Therefore, a diagnostic class is assigned to each slave node according to its level of diagnostic functionality and complexity. See Table 4 for further detail.

7.2.2 APP – Diagnostic class I

Diagnostic class I slave nodes are smart and simple devices like intelligent sensors and actuators, requiring none or very low amount of diagnostic functionality. Actuator control, sensor reading and fault memory handling is done by the master node, using measurement and control data carrying messages. Therefore, specific diagnostic support for these tasks is not required. Fault indication is always measurement and control data based.

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7.2.3 APP – Diagnostic class II

A diagnostic class II slave node is similar to a diagnostic class I slave node, but it provides node identification support. The extended node identification is normally required by vehicle manufacturers. Test equipment or master nodes use ISO 14229-1 diagnostic services to request the extended node identification information. Actuator control, sensor reading and fault memory handling is done by the master node, using measurement and control data carrying messages. Therefore, specific diagnostic support for these tasks is not required. Fault indication is always measurement and control data based.

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7.2.4 APP – Diagnostic class III

Diagnostic class III slave nodes are devices with enhanced application functions, typically performing their own local information processing (e.g. function controllers, local sensor/actuator loops). The slave nodes execute tasks beyond the basic sensor/actuator functionality, and therefore require extended diagnostic support. Direct actuator control and raw sensor data is often not exchanged with the master node, and therefore not included in measurement and control data carrying messages. ISO 14229-1 diagnostic services for I/O control, sensor value reading and parameter configuration (beyond node configuration) are required.

Diagnostic class III slave nodes have internal fault memory, along with associated reading and clearing services. Optionally, reprogramming (flash/NVRAM reprogramming) of the slave node is possible. This requires an implementation of a boot loader and necessary diagnostic services to unlock the device to initiate downloads and transfer data, etc.

The primary difference between diagnostic class II and diagnostic class III is the distribution of diagnostic capabilities to both, CXPI master node and the CXPI slave node, while for a diagnostic class III CXPI slave node no diagnostic application features of the CXPI slave node are implemented in the CXPI master node.

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7.3 APP – CXPI master node requirements – Master node fault management, sensor reading, I/O control

Diagnostic class I and diagnostic class II slave nodes provide measurement and control data-based fault information and sensor, I/O access via measurement and control data carrying messages. The CXPI master node is responsible to handle the slave nodes measurement and control data faults and handle the associated DTCs. The CXPI master node serves UDS requests directly to the client/tester and acts as a diagnostic application layer gateway. UDS services provide access to the measurement and control data on the CXPI bus.

Diagnostic class III slave nodes are independent diagnostic entities. The CXPI master node does not implement diagnostic services for the diagnostic capabilities of its diagnostic class III slave nodes.

7.4 APP – CXPI slave node requirements

7.4.1 APP – General

Slave nodes are typically electronic devices that are not involved in a complex data communication. Also, their need of distributing diagnostic data is low.

7.4.2 APP – Error indications

REQ	8.1 APP – Error indications
Slave nodes shall transmit diagnostic information such as error indications in measurement and control data carrying messages.	

Node configuration services use frame ID $1F_{16}$ (same as the ID of master request field) and $5F_{16}$ (same as the ID of slave response field). Node configuration can be performed by the master node. The NAD is used as the target address in a diagnostic request message and as the source address in a diagnostic response message.

Slave nodes are only accessable by the external test equipment via the CXPI master node network connected to the diagnostic connector.

There is a one-to-many mapping between a physical slave node and a logical slave node and it is addressed using the target address (NAD) value. This means that one physical slave node may be composed of several logical slave nodes.

7.5 APP – CXPI measurement and control data diagnostics

7.5.1 APP – Master handling of slave failure status measurement and control data

REQ	8.2 APP – Master handling of slave failure status measurement and control data
A failure status measurement and control data shall be assigned for each failure that would result in a separate DTC in the master node.	

This information is used to indicate a failure of one of the components to the master node's application, which can then store the associated DTC. There should be one measurement and control data per replaceable component to simplify repair and maintenance of the vehicle.

7.5.2 APP – Slave node current failure status support

Measurement and control data diagnostics are implemented by slave nodes (diagnostic class I and II), which do not implement a fault memory and the diagnostic protocol to directly access this fault memory from an external test tool.

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There are two types of failure transmission via measurement and control data carrying messages:

a) Type 1 failure information is periodically transmitted and encoded into an existing measurement and control data (e.g. upper values of measurement and control data range used to indicate specific failure conditions) by the slave node. A type 1 use case-specific failure defined by vehicle manufacturers is not part of this document.

b) Type 2 failure information is not periodically transmitted for components which do not generate a measurement and control data that is periodically transmitted (e.g. slave node internal failure). Additional measurement and control data-based failure transmission shall be implemented for type 2 failures (i.e. if a slave node is capable of locally detecting faults which are not transmitted via the associated measurement and control data in carrying messages already).

REQ	8.3 APP – Slave node current failure status support
Each slave node shall transmit the failure status information that is monitored by the slave node to the master node via measurement and control data carrying messages. The status information shall contain the current failure status of the slave nodes' components. The measurement and control data shall support the states as defined in Table 3.	

Table 3 — Measurement and control data fault states

Test result	Description
no test result	No test execution available, default, initialization value
failed	---
passed	---

If a slave node implements more than one independent function, a status measurement and control data can be assigned to each function. In this case only the failing function could be disabled by the application.

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7.6 APP – Network management (optional)

Network management involves wake-up and sleep functionality. The wake-up/sleep function is an optional feature. This function manages the start and stop of transmission and reception of the message by each node.

7.7 APP – CXPI master node gateway application

7.7.1 APP – General

The CXPI master node gateway application supports bidirectional CAN to CXPI communication as well as multiple client backbone network handling on the CXPI subnetwork(s).

7.7.2 APP – CXPI master gateway number of subnets

REQ	8.4 APP – CXPI master gateway number of subnets
A CXPI master node gateway shall have no more than 8 subnets with a maximum of 15 CXPI slave nodes connected to each subnet.	

7.7.3 APP – CXPI master gateway address routing table

Each connected subnet requires an address routing table.

REQ	8.5 APP – Master node – Address routing table
The CXPI master node gateway shall implement an address routing table including CXPI target addresses (NADs) and a supported message size for each CXPI slave node on a subnet.	

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