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Road vehicles — Unified diagnostic services (UDS) —

Part 7: UDS on local interconnect network (UDSonLIN)

Véhicules routiers — Services de diagnostic unifiés (SDU) — Partie 7: SDU sur l'implémentation LIN (SDUsurLIN)

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ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

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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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The committee responsible for this document is ISO/TC 22, *Road vehicles*, Subcommittee SC 3, *Electrical and electronic equipment*.

ISO 14229 consists of the following parts, under the general title *Road vehicles — Unified diagnostic services (UDS)*:

— *Part 1: Specification and requirements*

— *Part 2: Session layer services*

— *Part 3: Unified diagnostic services on CAN implementation (UDSonCAN)*

— *Part 4: Unified diagnostic services on FlexRay implementation (UDSonFR)*

— *Part 5: Unified diagnostic services on Internet Protocol implementation (UDSonIP)*

— *Part 6: Unified diagnostic services on K-Line implementation (UDSonK-Line)*

— *Part 7: Unified diagnostic services on Local Interconnect Network implementation (UDSonLIN)*

Introduction

This part of ISO 14229 has been established in order to enable the implementation of unified diagnostic services, as specified in ISO 14229-1, on UART-based local interconnect networks (UDSonLIN).

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. When mapped on this model, the services specified by ISO 14229 are divided into the following.

— Application layer (layer 7), unified diagnostic services specified in ISO 14229-1, ISO 14229-3 UDSonCAN, ISO 14229-4 UDSonFR, ISO 14229-5 UDSonIP, ISO 14229-6 UDSonK-Line, ISO 14229-7 UDSonLIN, further standards, and ISO 27145-3 WWH-OBD.

— Presentation layer (layer 6), vehicle manufacturer specific, ISO°27145-2 WWH-OBD.

— Session layer services (layer 5) specified in ISO 14229-2.

— Transport layer services (layer 4), specified in ISO 15765-2 DoCAN, ISO 10681-2 Communication on FlexRay, ISO 13400-2 DoIP, ISO 17987-2 LIN, ISO 27145-4 WWH-OBD.

— Network layer services (layer 3), specified in ISO 15765-2 DoCAN, ISO 10681-2 Communication on FlexRay, ISO 13400-2 DoIP, ISO 17987-2 LIN, ISO 27145-4 WWH-OBD.

— Data link layer (layer 2), specified in ISO 11898-1, ISO 11898-2, ISO 17458-2, ISO 13400-3, IEEE 802.3, ISO 14230-2, ISO 17987-3 LIN and further standards, ISO 27145-4 WWH-OBD.

— Physical layer (layer 1), specified in ISO 11898-1, ISO 11898-2, ISO 17458-4, ISO 13400-3, IEEE 802.3, ISO 14230-1, ISO 17987-4 LIN and further standards, ISO 27145-4 WWH-OBD.

These services should be in accordance with Table 1.

Table 1 — LIN enhanced diagnostics, legislated OBD and WWH-OBD specification reference applicable to the OSI layers

<table>
<tr><th>Applicability</th><th>OSI seven layer</th><th colspan="7">Enhanced diagnostics services</th><th>WWH-OBD</th></tr>
<tr><td rowspan="8">Seven layer according to ISO/IEC 7498-1 and ISO/IEC 10731</td><td>Application (layer 7)</td><td colspan="7">ISO 14229-1, ISO 14229-3 UDSonCAN, ISO 14229-4 UDSonFR, ISO 14229-5 UDSonIP, ISO 14229-6 UDSonK-Line, ISO 14229-7 UDSonLIN, further standards</td><td>ISO 27145-3</td></tr>
<tr><td>Presentation (layer 6)</td><td colspan="7">Vehicle manufacturer specific</td><td>ISO 27145-2</td></tr>
<tr><td>Session (layer 5)</td><td colspan="8">ISO 14229-2</td></tr>
<tr><td>Transport (layer 4)</td><td rowspan="2">ISO 15765-2</td><td rowspan="2">ISO 10681-2</td><td rowspan="2">ISO 13400-2</td><td rowspan="2">Not applicable</td><td rowspan="2">ISO 17987-2</td><td>Further standards</td><td rowspan="4">ISO 27145-4</td></tr>
<tr><td>Network (layer 3)</td><td>Further standards</td></tr>
<tr><td>Data link (layer 2)</td><td rowspan="2">ISO 11898-1, ISO 11898-2</td><td>ISO 17458-2</td><td rowspan="2">ISO 13400-3, IEEE 802.3</td><td>ISO 14230-2</td><td>ISO 17987-3</td><td>Further standards</td></tr>
<tr><td>Physical (layer 1)</td><td>ISO 17458-4</td><td>ISO 14230-1</td><td>ISO 17987-4</td><td>Further standards</td></tr>
</table>

The titles of future parts will be drafted as follows:

— *Part n: Unified diagnostic services on … implementation (UDSon…)*

Road vehicles — Unified diagnostic services (UDS) —

Part 7: UDS on local interconnect network (UDSonLIN)

1 Scope

This part of ISO 14229 specifies the implementation of a common set of unified diagnostic services (UDS) on UART-based local interconnect networks in road vehicles. The UDSonLIN diagnostics defines methods to implement diagnostic data transfer between a client and the LIN slave nodes through the LIN master node.

LIN slave nodes support three different diagnostic classes as defined in ISO 17987.

UDSonLIN references ISO 14229-1 and ISO 14229-2 and specifies implementation requirements of the following:

— diagnostic services to be used for diagnostic communication over LIN,

— server memory programming for in-vehicle LIN servers with an external test equipment, and

— configuration of a LIN slave node as specified in ISO 17987.

NOTE UDSonLIN does not specify any requirement for the in-vehicle LIN bus architecture.

This part of ISO 14229 makes reference to information contained in the following:

— ISO 14229-1,

— ISO 14229-2, and

— ISO 17987 (all parts).

This part of ISO 14229 does not include any redundant information of the above mentioned documents. It focuses on the following:

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

— specific restrictions in the implementation of UDSonLIN network.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 14229-1, *Road vehicles — Unified diagnostic services (UDS) — Part 1: Specification and requirements*

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

ISO 17987-3, *Road vehicles — Local Interconnect Network (LIN) — Part 3: Protocol specification*

3 Terms, definitions, symbols, and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 14229-1, ISO 14229-2, and ISO 17987 (all parts) apply.

3.2 Symbols and abbreviated terms

AE	address extension
CF	consecutive frame
DA	destination address
FC	flow control
FF	first frame
ID	identifier
Mtype	message type
NAD	node address
NCF	node configuration file
P2	server response time
SA	source address
SF	single frame
SFID	sub-function identifier
ST_{min}	separation time
TA	target address
UART	universal asynchronous receiver transmitter

4 Conventions

This part of ISO 14229 is based on the conventions discussed in the OSI Service Conventions (ISO/IEC 10731) as they apply for diagnostic services.

5 Document overview

Figure 1 illustrates the document references from ISO 14229-1, ISO 14229-2, and ISO 17987 (all parts). ISO 14229-7 uses only a subset of the diagnostic services defined in ISO 14229-1 (see Table 3).

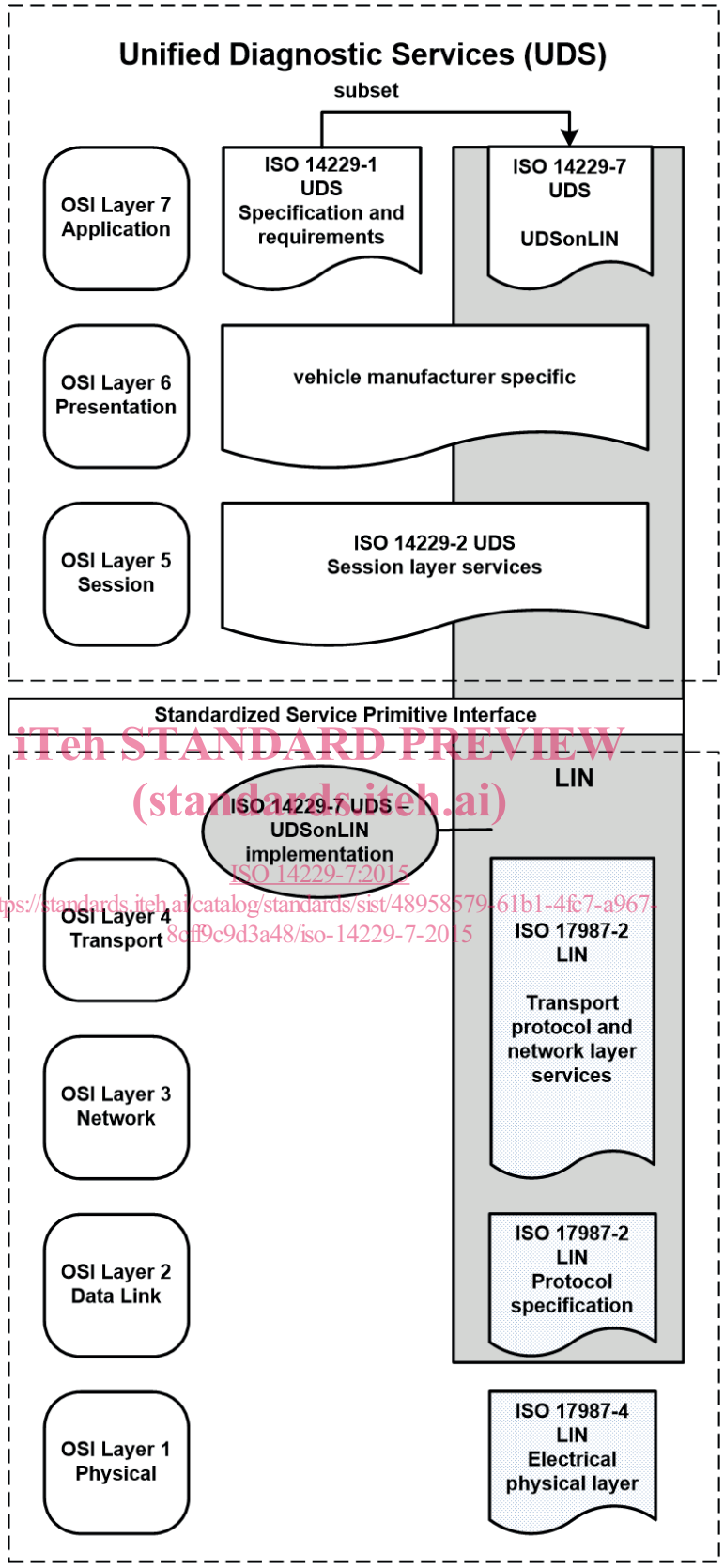

Figure 1 — UDSonLIN document reference according to OSI model

6 UDSonLIN implementation requirements

6.1 General

This clause defines how the diagnostic services, as defined in ISO 14229-1, apply to LIN.

To allow a common implementation of application layer and session layer for ISO 17987 and other communications, this part of ISO 14229 uses the session layer protocol as defined in ISO 14229-2 and focuses on necessary modifications and interfaces to adopt it to ISO 17987- series.

The subfunction parameter definitions take into account 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 LIN master and slave nodes to exchange UDSonLIN information according to ISO 17987- series.

6.2 Definition of diagnostic classes

6.2.1 Overview

Architectural, diagnostic communication performance, and transport protocol needs of slave nodes are accommodated by dividing 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.

6.2.2 Diagnostic class I

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 signal carrying frames. Therefore, specific diagnostic support for these tasks is not required. Fault indication is always signal-based.

6.2.3 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. Testers 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 signal carrying frames. Therefore, specific diagnostic support for these tasks is not required. Fault indication is always signal-based.

6.2.4 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 are often not exchanged with the master node and, therefore, not included in signal carrying frames. 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 initiate downloads and transfer data, etc.

The primary difference between diagnostic class II and diagnostic class III is the distribution of diagnostic capabilities between the LIN master node and the LIN slave node for diagnostic class II while

for a diagnostic class III LIN slave node, no diagnostic application features of the LIN slave node are implemented in the LIN master node.

6.3 LIN node requirements

6.3.1 Master node requirements

6.3.1.1 Master message routing

The master node usually is a high performance ECU and, in most implementations, supports the ISO 14229-1 diagnostic services. The master node and the external test equipment are connected through a backbone bus (e.g. ISO 11898). The master node shall receive all diagnostic requests addressed to the slave nodes from the backbone bus and route them to the appropriate LIN cluster(s). Responses from the slave nodes shall be routed back to the backbone bus through the master node.

All diagnostic request and response messages addressed to the slave nodes can be routed in the network layer (i.e. no application layer routing). The master node shall implement the LIN transport protocol (see ISO 17987-2) as well as the transport protocols used on the backbone busses (e.g. ISO 15765-2).

6.3.1.2 Master node fault management, sensor reading, I/O control

Diagnostic class I and diagnostic class II slave nodes (see ISO 17987-3) provide signal-based fault information and sensor, I/O access through signal carrying frames. The LIN master node is responsible to handle the slave nodes signal based faults and handle the associated DTCs. The LIN master node serves UDS requests directly to the client/tester and acts as a diagnostic application layer gateway. UDS services provide access to the sensor/actuator signals on the LIN bus.

Diagnostic class III slave nodes (see ISO 17987-3) are independent diagnostic entities. The LIN master node does not implement diagnostic services for the diagnostic capabilities of its diagnostic class III slave nodes.

6.3.2 Slave node requirements

Slave nodes are typically electronic devices that are not involved in a complex data communication. Also, their need of distributing diagnostic data is low. However, most slave nodes shall transmit simple diagnostic information such as error indications in signal carrying frames.

Although diagnostics and node configuration services use the same frame IDs, i.e. 0x3C (master request frame) and 0x3D (slave response frame), different services are used for configuration and diagnostics. Node configuration can be performed by the master node independently while diagnostic services are always routed on request from external or internal test equipment. Both cases use the same node address (NAD) and transport protocol with the exception that configuration is always performed through SingleFrames (SF). Only slave nodes have an NAD. The NAD is also used as the source address in a diagnostic slave response frame.

NOTE There is a one-to-many mapping between a physical node and a logical node and it is addressed using the NAD.

6.4 Signal-based diagnostics

6.4.1 Slave implementation

Signal-based 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.