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Road vehicles — Unified diagnostic services (UDS) —

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

Véhicules routiers — Services de diagnostic unifiés (SDU) —

Partie 6: SDU sur l'implémentation de la ligne-K (SDUsurLigne-K)

Reference number
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Foreword

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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)*

The following part is under preparation:

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

The titles of future parts will be drafted as follows:

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

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 K-Line (UART based) networks (UDSonK-Line).

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:

— Application layer (layer 7), specified in:
  — Vehicle manufacturer enhanced diagnostics: ISO 14229-1 / ISO 14229-6,
  — Legislated OBD: ISO°15031-5,
  — Legislated WWH-OBD: ISO 14229-1, ISO 27145-3;
— Presentation layer (layer 6), specified in:
  — Vehicle manufacturer enhanced diagnostics: not applicable,
  — Legislated OBD: SAE J1930-DA, SAE J1979-DA, SAE J2012-DA,
  — Legislated WWH-OBD: ISO 27145-2 with reference to SAE J1930-DA, SAE J1939 Companion Spreadsheet (SPNs), SAE J1939-73:2010, Appendix A (FMIs), SAE J1979-DA and SAE J2012-DA;
— Session layer services (layer 5), specified in:
  — Vehicle manufacturer enhanced diagnostics: ISO 14229-2,
  — Legislated OBD: ISO 14229-2,
  — Legislated WWH-OBD: ISO 14229-2;
— Transport layer services (layer 4), specified in:
  — Vehicle manufacturer enhanced diagnostics: ISO 14230-2,
  — Legislated OBD: ISO 15765-2, ISO 15765-4,
  — Legislated WWH-OBD: ISO 27145-4;
— Network layer services (layer 3), specified in:
  — Vehicle manufacturer enhanced diagnostics: ISO 14230-2,
  — Legislated OBD: ISO 15765-2, ISO 15765-4,
  — Legislated WWH-OBD: ISO 27145-4;
— Data link layer (layer 2), specified in:
  — Vehicle manufacturer enhanced diagnostics: ISO 14230-2,
  — Legislated OBD: ISO 11898-1, ISO 11898-2, ISO 15765-4,
  — Legislated WWH-OBD: ISO 27145-4;
— Physical layer (layer 1), specified in:
  — Vehicle manufacturer enhanced diagnostics: ISO 14230-1,
  — Legislated OBD: ISO 11898-1, ISO 11898-2, ISO 15765-4,

— Legislated WWH-OBD: ISO 27145-4;

in accordance with Table 1.

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

<table>
<tr><th>Applicability</th><th>OSI 7 layers</th><th>Vehicle manufacturer enhanced diagnostics</th><th>Legislated OBD</th><th colspan="3">Legislated WWH-OBD</th></tr>
<tr><td rowspan="7">Seven layer according to ISO/IEC 7498-1
and
ISO/IEC 10731</td><td>Application (layer 7)</td><td>ISO 14229-1 / ISO 14229-6</td><td>ISO 15031-5</td><td colspan="3">ISO 14229-1 / ISO 27145-3</td></tr>
<tr><td>Presentation (layer 6)</td><td>Vehicle manufacturer specific</td><td>SAE J1930-DA / SAE J1979-DA / SAE J2012-DA</td><td colspan="3">ISO 27145-2, SAE J1930-DA, SAE J1939 Companion Spreadsheet (SPNs), SAE J1939-73:2010, Appendix A (FMIs), SAE J1979-DA, SAE J2012-DA</td></tr>
<tr><td>Session (layer 5)</td><td colspan="5">ISO 14229-2</td></tr>
<tr><td>Transport (layer 4)</td><td rowspan="2">ISO 14230-2</td><td rowspan="2">ISO 15765-2, ISO 15765-4</td><td rowspan="2">ISO 15765-2, ISO 15765-4</td><td rowspan="3">ISO 27145-4</td><td>ISO 13400-2</td></tr>
<tr><td>Network (layer 3)</td><td rowspan="2">ISO 13400-3, IEEE 802.3</td></tr>
<tr><td>Data link (layer 2)</td><td rowspan="2">ISO 14230-1</td><td rowspan="2">ISO 11898-1, ISO 11898-2, ISO 15765-4</td><td rowspan="2">ISO 11898-1, ISO 11898-2, ISO 15765-4</td></tr>
<tr><td>Physical (layer 1)</td></tr>
</table>

Road vehicles — Unified diagnostic services (UDS) —

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

1 Scope

This part of ISO 14229 specifies the implementation of a common set of unified diagnostic services (UDS) on K-Line (UART based) in road vehicles (UDSonK-Line).

UDSonK-Line references ISO 14229-1 and ISO 14229-2, and specifies implementation requirements of

— the diagnostic services to be used for diagnostic communication over K-Line,

— the server memory programming for all in-vehicle servers connected to a K-Line network with external test equipment.

NOTE UDSonK-Line does not specify any requirement for the in-vehicle K-Line bus architecture.

This part of ISO°14229 makes reference to information contained in ISO 14229-1, ISO 14229-2, ISO 14230-1, and ISO 14230-2.

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

— additional requirements specific to the implementation of UDSonK-Line network, and

— specific restrictions in the implementation of UDSonK-Line 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 14230-1, *Road vehicles — Diagnostic communication over K-Line (DoK-Line) — Part 1: Physical layer*

ISO 14230-2, *Road vehicles — Diagnostic communication over K-Line (DoK-Line) — Part 2: Data link layer*

ISO 14230-4, *Road vehicles — Diagnostic systems — Keyword Protocol 2000 — Part 4: Requirements for emission-related systems*

3 Terms, definitions 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, ISO 14230-1 and ISO 14230-2 apply.

3.2 Abbreviated terms

Mtype	message type
AE	address extension
DA	destination address
ID	identifier
FB	first byte
SA	source address
TA	target address
SFID	subfunction identifier

4 Conventions

This part of ISO 14229 is based on the conventions discussed in the OSI Service Conventions (ISO/IEC 10731:1994) as they apply for diagnostic services.

5 Document overview

Figure 1 illustrates the document references from ISO 14229-1, ISO 14229-2, ISO 14230-1 and ISO 14230-2. This part of ISO 14229 uses only a subset of the diagnostic services defined in ISO 14229-1 (see Table 2).

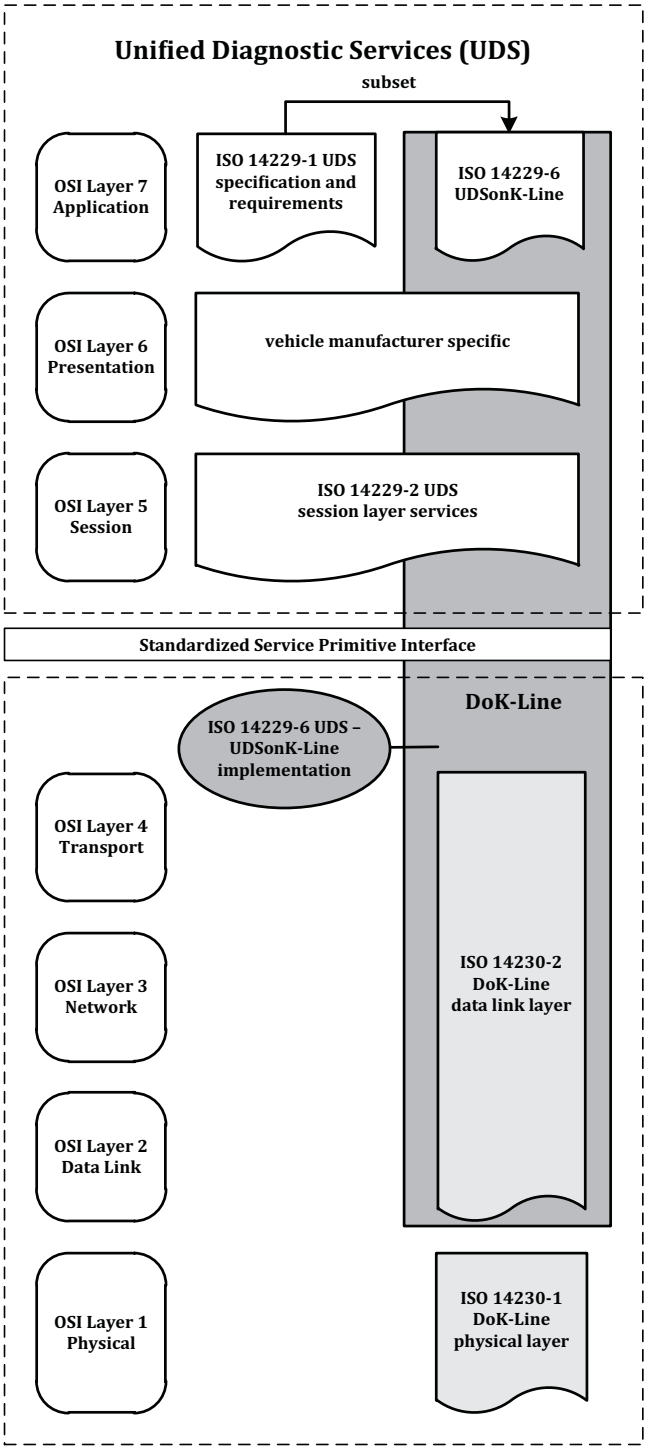

Figure 1 — UDSonK-Line document reference according to OSI model

6 Unified diagnostic services implementation on K-Line

6.1 General

This clause defines how the diagnostic services as defined in ISO 14229-1 apply to DoK-Line. For each applicable service, the applicable subfunction and data parameters are defined.

To allow a common implementation of application layer and session layer for DoK-Line 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 14230-2.

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

NOTE 2 It is the system designer's responsibility to ensure that in case the client does not require a response message (suppressPosRspMsgIndicationBit = TRUE ('1')) and the server might need more than $P2_{Server}$ to process the request message that the client shall insert sufficient time between subsequent requests.

6.2 UDSonK-Line services overview

The purpose of Table 2 is to reference all unified diagnostic services as they are applicable for an implementation of UDSonK-Line. The table contains the sum of all applicable services. Certain applications using this part of ISO 14229 to implement UDSonK-Line may restrict the number of useable services and may categorize them in certain application areas/diagnostic sessions (default session, programming session, etc.).

The restriction of data length for all diagnostic services due to the data link layer applies (see 7.1).

NOTE 1 Certain diagnostic services e.g. ReadDTCInformation (depends on the number of DTCs to be reported) might exceed the message length restriction.

NOTE 2 Services which are not listed in Table 2 are not supported.

Table 2 — Overview of applicable ISO°14229-1 Unified diagnostic services and data ranges

Diagnostic service name (ISO 14229-1)	Comment	Reference in this document
Diagnostic and Communication Management Functional Unit		
DiagnosticSessionControl	No K-Line specific requirements	—
ECUReset	No K-Line specific requirements	—
SecurityAccess	No K-Line specific requirements	—
TesterPresent	No K-Line specific requirements	—
AccessTimingParameter	K-Line specific requirements	see 6.3.1
ControlDTCSetting	No K-Line specific requirements	—
LinkControl	K-Line specific requirements	see 6.3.2
Data Transmission Functional Unit		
ReadDataByIdentifier	No K-Line specific requirements	—
ReadMemoryByAddress	No K-Line specific requirements	—
ReadScalingDataByIdentifier	No K-Line specific requirements	—
DynamicallyDefineDataIdentifier	K-Line specific requirements	see 6.4
WriteDataByIdentifier	No K-Line specific requirements	—
WriteMemoryByAddress	No K-Line specific requirements	—

Table 2 *(continued)*

Diagnostic service name (ISO 14229-1)	Comment	Reference in this document
Stored Data Transmission Functional Unit		
ReadDTCInformation	No K-Line specific requirements	—
ClearDiagnosticInformation	No K-Line specific requirements	—
Input/Output Control Functional Unit		
InputOutputControlByIdentifier	No K-Line specific requirements	—
Remote Activation Of Routine Functional Unit		
RoutineControl	No K-Line specific requirements	—
Upload/Download Functional Unit		
RequestDownload	No K-Line specific requirements	—
RequestUpload	No K-Line specific requirements	—
TransferData	No K-Line specific requirements	—
RequestTransferExit	No K-Line specific requirements	—

6.3 Diagnostic and communication control functional unit

6.3.1 AccessTimingParameter (0x83) service

The service is specified in ISO 14230-2 (DoK-Line). The sub-function parameters, specified in ISO 14229-1, are not applicable.

The usage of the AccessTimingParameter service is restricted to the timing parameters of the data link layer ($P2_{Server\_min}$, $P2_{Server\_max}$, $P3_{Client\_min}$, $P3_{Client\_max}$, $P4_{Sender\_min}$). For the session layer timing parameters $P2_{Server\_max}$ and $S3_{Client}$ of ISO 14229-2 applies.

The parameters $P2_{Client\_max}$ and $P3_{Client\_max}$ in the client request data record, as defined in ISO 14230-2, shall be ignored by the data link layer (see 11.4).

The DoK-Line_ChangeParameter.request service primitive is used to request the change of timing parameter's value on the local protocol entity.

The parameter $S3_{Server}$ and $S3_{Client}$ is not part of the AccessTimingParameter service.

6.3.2 LinkControl (0x87) service

LinkControl is utilized on DoK-Line to adapt data link relevant parameters such that diagnostic communication bandwidth is maximized (e.g. programming event). This results in an adaptation of the DoK-Line cycle design (e.g. change baudrate). However, the detailed implementation is vehicle manufacturer specific and shall be described in an individual implementation specification.

The following requirements shall apply for this service when implemented on DoK-Line:

Step 1: The communication strategy shall follow the requirements as stated in ISO 14229-1.

Step 2: This step shall only be requested if step 1 has been performed successfully. In case of functional communication, there should be no response from a server when the mode transition is performed (suppressPosRspMsgIndicationBit = TRUE), because one server might already have been transitioned to the new mode while others are still in progress.

Table 3 defines the sub-function parameters applicable for the implementation of this service on K-Line.

Table 3 — Sub-function parameter definition

Hex (bit 6-0)	Description	Cvt	Mnemonic
01	**verifyModeTransitionWithFixedParameter** This parameter is used to verify if a transition with a predefined DoK-Line schedule design, which is specified by the linkControlModeIdentifier data parameter, can be performed.	M	VMTWFP
02	**verifyModeTransitionWithSpecificParameter** The format of the linkRecord (used for verifyModeTransitionWithSpecificParameter) is vehicle manufacturer-specific.	M	VMTWSP
03	**transitionMode** The baudrate change is supported only if one single physical point-to-point connection is active. The fixed baudrates, specified in ISO 14229-2, are applicable. This sub-function parameter requests the server(s) to transition the DoK-Line to the schedule design which was requested in the preceding verification message.	M	TM

6.4 Data transmission functional unit

The implementation of PeriodicDataIdentifiers is not supported for this service on K-Line.

7 Application layer requirements

7.1 Application layer services

This part of ISO 14229 uses the application layer services as defined in ISO 14229-1 for client-server based systems to perform functions such as test, inspection, monitoring, diagnosis or programming of on-board vehicle servers.

The message length is restricted to 255 bytes by ISO 14230-2. This has to be regarded for both directions.

The message buffer is controlled by the session layer and requested by the data link layer when a message start is detected and as soon as the message length is available.

7.2 Application layer protocol

This part of ISO 14229 uses the application layer protocol as defined in ISO 14229-1.

7.3 Application layer timing

7.3.1 General

The sub-clauses specify the application and session layer timing parameters and how those apply to the client and the server.

7.3.2 Application layer timing parameter values

$P2_{Server\_max}$ shall be handled in session layer according to ISO 14229-2.

$P3_{Client}$ / $S3_{Client}$: The $P3_{Client\_min}$ timing value of ISO 14230-2 is mapped to the $P3_{Client}$ timing value in ISO 14229-2. It is only relevant for the client. The $P3_{Client\_max}$ timing value of ISO 14230-2 is mapped to the $S3_{Client\_max}$ timing value in this document. The monitoring of $S3_{Client}$ is performed in the session layer.

8 Presentation layer requirements

The presentation layer requirements are the responsibility of the vehicle manufacturer.

9 Session layer requirements

The session layer requirements are specified in ISO 14229-2.

10 Transport/network layer interface adaptation

10.1 General information

This part of ISO 14229 makes use of the network layer services defined in ISO 14229-2 for the transmission and reception of diagnostic messages. This section defines the mapping of the data link independent transport/network layer protocol data units (T_PDU) onto the K-Line data link specific network layer protocol data units (N_PDU).

NOTE The transport/network layer services are used to perform the application layer and diagnostic session management timing.

10.2 DoK-Line transport/network layer interface adaptation

10.2.1 Mapping of data link independent service primitives onto K-Line data link dependent service primitives

Table 4 specifies the mapping interface between the ISO 14230-2 DoK-Line Part 2: Data link layer services and the ISO 14229-2 UDS Part 2: Session layer services.

Table 4 — Mapping of T_PDU service primitives onto DL_PDU service primitives

Session to transport/network layer service primitives (data link independent according to ISO 14229-2)	DoK-Line data link layer service primitives (data link dependent according to ISO°14230-2)
T_Data.indication	DoK-Line_Data.indication
T_DataSOM.indication	DoK-Line_Data_FB.indication
T_Data.confirm	DoK-Line_Data.confirm
T_Data.request	DoK-Line_Data.request

The DoK-Line_Data_FB.indication service primitive is mapped to T_DataSOM.indication to generally indicate start of reception on K-Line data link.

10.2.2 Mapping of T_PDU onto DL_PDU for message transmission

The parameters of the application layer protocol data unit defined to request the transmission of a diagnostic service request/response are mapped in accordance with Table 5 onto the parameters of the network layer protocol data unit for the transmission of a message in the client/server.

Table 5 — Mapping of T_PDU parameter onto DL_PDU parameter

T_PDU parameter (data link independent according to ISO 14229-2)	N_PDU parameter (DoK-Line data link dependent according to ISO°14230-2)
T_Mtype	Mtype
T_SA	DoK-Line_SA
T_TA	DoK-Line_TA
T_TAtype	DoK-Line_TAtype
T_AE	Not supported for K-Line
T_Data [ ]	<MessageData>
T_Length	<Length>
T_Result	< Result_DoK-Line >

The network layer confirmation of the successful transmission of the message (DoK-Line_Data.con) is forwarded to the application, because it is needed in the application for starting those actions, which shall be executed immediately after the transmission of the request/response message (ECUReset, BaudrateChange, etc.).

The address mapping between the network layer and the OSI higher layers is not necessarily an exact copy of the address values as encoded on the data link layer and therefore depends on the implementation concept.

The mapping is defined in ISO 14230-2. Values for emissions-related OBD are defined in ISO 14230-4.

11 Data link layer diagnostic implementation requirements

11.1 General information

This part of ISO 14229 makes use of the data link layer specification defined in ISO 14230-2 for the transmission and reception of diagnostic messages.

11.2 Data segmentation

DoK_Data segmentation (see ISO 14230-2) is not supported.

11.3 Session handling

The session handling depending on $S3_{Client}$ is specified in ISO 14229-2. This part of ISO 14229 describes how the data link layer and session layer are synchronized concerning $S3_{Client}$ timeout.

The $S3_{Client}$ timeout is handled by the session layer. The data link layer utilizes a $P3_{Client\_max}$ timeout.

The $S3_{Server}$ timeout and $P3_{Client\_max}$ timeout are synchronized, i.e. in case of $S3_{Server}$ timeout $P3_{Client\_max}$ timeout shall apply as well. In addition, $P3_{Client\_max}$ timeout applies to the defaultSession.

In case of a $P3_{Client\_max}$ timeout the serial communication link is closed and a new initialization phase has to be detected before reception of the next request is accepted (see ISO 14230-2).

NOTE 1 A protocol initialization phase is required in case of

— first request of the client after server power on;

— $P3_{Client\_max}$ timeout in default session;

— $P3_{Client\_max}$ timeout in non-default session (related to $S3_{Server}$ timeout which is linked to ISO 14229-2 only and not applicable for the data link layer).

NOTE 2 Client has to monitor $P3_{Client}$ in its data link layer to perform protocol initialization.

NOTE 3 Synchronization of $S3_{Server}$ timeout and $P3_{Client\_max}$ timeout is achieved by timing requirement concerning $P3_{Client\_max}$ (see 11.4).

11.4 Timings

$P2_{Server\_min}$ shall be handled in data link layer ISO 14230-2.

$P3_{Cient\_max}$ / $S3_{Client}$:

— For communication on the serial data link there is no differentiation in timeout handling between defaultSession and non-default session. Therefore $S3_{Client}$ timeout is also applicable for default session via $P3_{Client\_max}$ timeout.

— The $P3_{Client\_max}$ time is restricted to 5 000 ms.

NOTE $P3_{Client\_max}$ cannot be altered by application layer services (e.g. AccessTimingParameters). Due to this restriction the timeout monitoring of default session, which is specific to DoK-Line only, can be done by data link layer without impact on service primitives related to application layer.

11.5 Protocol initialization, start and stop of communication

The initialization sequences (5-BAUD-INIT initialization sequence or FastInitialization with WakeUpPattern and StartCommunication service) and the StopCommunication service as defined in ISO 14230-2 are completely handled in data link layer.

If the data link layer receives a StopCommunication request, it shall call the available Session layer interface (ChangeParameter.request) to change the diagnostic session to defaultSession. Additionally, the data link layer shall stop monitoring of $P3_{Client}$ timeout in the default session.

Physical/functional addressing: The handling of physical and functional addressing is performed in the data link layer. It is not possible on serial data link to send a functionally addressed TesterPresent message in parallel to any other physically addressed message. This requires that the client sends the messages for the keep-alive-logic in the same timing schedule as any other message and observes the appropriate data link layer timing value ($P3_{Client}$).

11.6 Error handling

To fulfil ISO 14230-2 requirements regarding error handling and correct handling of $P3_{Client\_max}$ timeouts, an L_Data.indication with parameter (_NOT_OK) has to be called in the following error situations:

— $P4_{Sender\_max}$ timeout,

— request error (incorrect header/checksum),

— incorrect source or target address.

As long as no valid initialization pattern was detected, these indications shall not be given.

12 Non-volatile server memory programming process

The non-volatile server memory programming process is defined in ISO 14229-1. No K-Line specific requirements apply.

Bibliography

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[3] ISO 11898-1, *Road vehicles — Controller area network (CAN) — Part 1: Data link layer and physical signalling*

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[5] ISO 13400 (all parts), *Road vehicles — Diagnostic communication over Internet Protocol (DoIP)*

[6] ISO 15031-5, *Road vehicles — Communication between vehicle and external equipment for emissions-related diagnostics — Part 5: Emissions-related diagnostic services*

[7] ISO 15031-6, *Road vehicles — Communication between vehicle and external equipment for emissions-related diagnostics — Part 6: Diagnostic trouble code definitions*

[8] ISO 15765-2, *Road vehicles — Diagnostic communication over Controller Area Network (DoCAN) — Part 2: Transport protocol and network layer services*

[9] ISO 15765-4, *Road vehicles — Diagnostic communication over Controller Area Network (DoCAN) — Part 4: Requirements for emissions-related systems*

[10] ISO 27145 (all parts), *Road vehicles — Implementation of World-Wide Harmonized On-Board Diagnostics (WWH-OBD) communication requirements*

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