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ISO 27145-4

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Road vehicles — Implementation of World-Wide Harmonized On-Board Diagnostics (WWH-OBD) communication requirements —

Part 4: Connection between vehicle and test equipment

Véhicules routiers — Mise en application des exigences de communication pour le diagnostic embarqué harmonisé à l'échelle mondiale (WWH-OBD) —

Partie 4: Connexion entre véhicule et équipement d'essai

Reference number
ISO 27145-4:2012(E)

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 27145-4 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 3, *Electrical and electronic equipment*.

This first edition of ISO 27145-4 cancels and replaces ISO/PAS 27145-4:2006, which has been technically revised.

ISO 27145 consists of the following parts, under the general title *Road vehicles — Implementation of World-Wide Harmonized On-Board Diagnostics (WWH-OBD) communication requirements*:

— *Part 1: General information and use case definition*

— *Part 2: Common data dictionary*

— *Part 3: Common message dictionary*

— *Part 4: Connection between vehicle and test equipment*

The following parts are under preparation:

— *Part 6: External test equipment*

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0 Introduction

0.1 Overview

The ISO 27145 series includes the communication between the vehicle's on-board diagnostics (OBD) systems and external test equipment within the scope of the World-Wide Harmonized On-Board Diagnostics Global Technical Regulations (WWH-OBD GTR).

It has been established in order to apply the unified diagnostic services (specified in ISO 14229-1) to WWH-OBD systems.

The ISO 27145 series includes the communication between the vehicle's WWH-OBD systems and external (off-board) "generic" test equipment within the scope of the country-specific regulatory requirements.

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 27145 are broken into

— diagnostic services (layer 7), specified in ISO 27145-3 with reference to ISO 14229-1,

— presentation layer (layer 6), specified in 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 ISO 14229-2,

— transport layer services (layer 4), specified in this part of ISO 27145 with reference to ISO 13400-2, ISO 15765-2 and ISO 15765-4,

— network layer services (layer 3), specified in this part of ISO 27145 with reference to ISO 15765-4, ISO 15765-2 and ISO 13400-2,

— data link layer (layer 2), specified in this part of ISO 27145 with reference to ISO 11898-1, ISO 11898-2, ISO 15765-4, ISO 13400-3 and IEEE 802.3, and

— physical layer (layer 1), specified in this part of ISO 27145 with reference to ISO 11898-1, ISO 11898-2, ISO 15765-4, ISO 13400-3 and IEEE 802.3,

in accordance with Table 1.

Table 1 — WWH-OBD specification reference applicable to the OSI layers

<table>
<tr><th>Applicability</th><th>OSI 7 layer</th><th colspan="3">WWH-OBD document reference</th></tr>
<tr><td rowspan="8">Seven layers according to ISO/IEC 7498-1 and ISO/IEC 10731</td><td>Application (layer 7)</td><td colspan="3">ISO 14229-1, ISO 27145-3</td></tr>
<tr><td>Presentation (layer 6)</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="3">ISO 14229-2</td></tr>
<tr><td>Transport (layer 4)</td><td rowspan="2">ISO 15765-2 DoCAN,
ISO 15765-4 DoCAN,</td><td rowspan="4">ISO 27145-4</td><td rowspan="2">ISO 13400-2 DoIP
TCP & IP</td></tr>
<tr><td>Network (layer 3)</td></tr>
<tr><td>Data link (layer 2)</td><td rowspan="2">ISO 11898-1 CAN DLL,
ISO 11898-2 CAN HS,
ISO 15765-4 DoCAN</td><td rowspan="2">ISO 13400-3 DoIP,
IEEE 802.3</td></tr>
<tr><td>Physical (layer 1)</td></tr>
</table>

0.2 SAE document reference concept

ISO 27145 makes reference to several SAE documents which contain the terms, data and diagnostic trouble code (DTC) definitions.

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ISO 27145-2 defines a common data dictionary for the ISO 27145 series, according to the definitions in the following documents (see Figure 1).

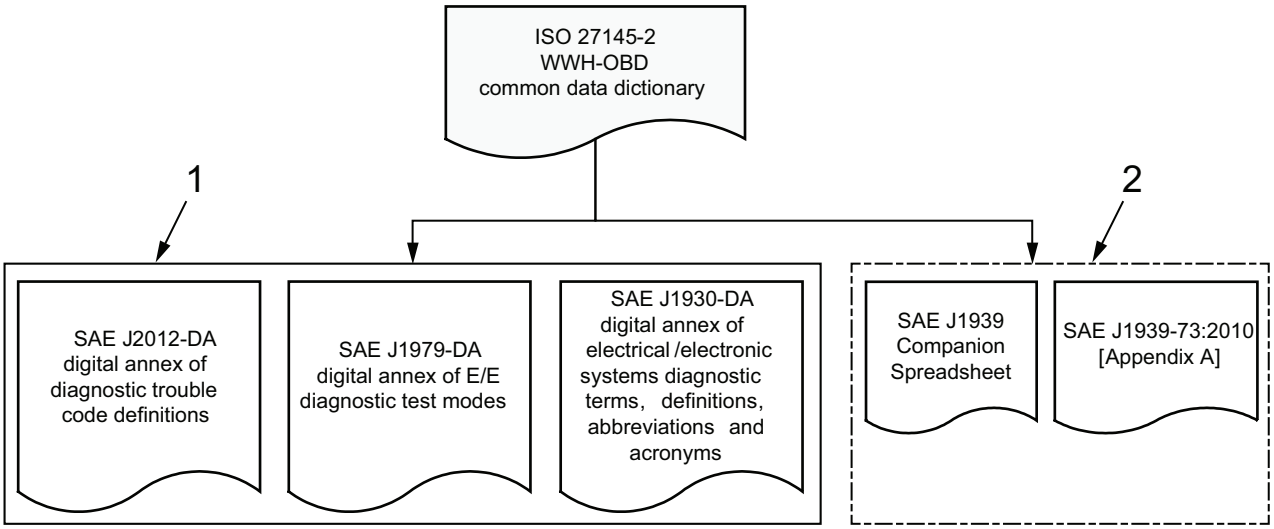
— SAE J1930-DA: this digital annex contains all standardized naming objects, terms and abbreviated terms.

— SAE J1939 Companion Spreadsheet and SAE J1939-73: SAE J1939 Companion Spreadsheet indexes names for suspect parameter numbers (SPNs) that provide an alternative presentation format for SAE J2012-DA DTCs. SPNs are combined with failure mode indicators (FMIs) to form the full alternative presentation. FMIs are described in SAE J1939-73:2010, Appendix A.

NOTE The SAE J1939 Companion Spreadsheet is a document which supplements the SAE J1939 family of standards and contains SPNs and parameter group numbers (PGNs).

— SAE J1979-DA: this digital annex contains all standardized data items such as data identifiers (DIDs), test identifiers (TIDs), monitor identifiers (MIDs) and infotype identifiers (ITIDs).

— SAE J2012-DA: this digital annex contains all standardized data items such as DTC definitions and FTB (failure type byte) definitions.



Key

1 SAE digital annexes: data definitions

2 SAE J1939 series of documents: DTC definitions

Figure 1 — SAE digital annex document reference

0.3 SAE digital annex revision procedure

New regulatory requirements drive new in-vehicle technology to lower emissions, improve safety, etc. It is important to standardize new technology-related OBD monitor data and DTCs in order to support the external (off-board) “generic” test equipment. All relevant information is proposed by the automotive industry, represented by members of the appropriate SAE task force.

ISO 27145-2 references a “Change request form” for use with new data items to be defined by the SAE task force for standardization. It is intended that the standardized data items be defined in SAE J1930-DA, SAE J1979-DA, SAE J2012-DA and SAE J1939. It is intended that the documents be published on the SAE store website once the information has been balloted and approved.

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The revision request forms and instructions for updating the registers to ISO 27145 can be obtained on the following data registration websites:

— For SAE J1930-DA: http://www.sae.org/servlets/works/committeeHome.do?comtID=TEVDS7

  The column entitled “Resources” shows a document with the title: J1930-DA_Revision_Request_Form.doc. Double click on the name to download the document with the filename: “SAE_J1930-DA_Revision_Request_Form.doc”.

— For SAE J1939: http://www.sae.org/

  Search “J1939 Request”, select “J1939 Request Processing Group”, select “J1939 Request Processing Form and Guidelines”.

— For SAE J1979-DA: http://www.sae.org/servlets/works/committeeHome.do?comtID=TEVDS14

  The column entitled “Resources” shows a document with the title: J1979-DA_Revision_Request_Form.doc. Double click on the name to download the document with the filename: “SAE_J1979-DA_Revision_Request_Form.doc”.

— For SAE J2012-DA: http://www.sae.org/servlets/works/committeeHome.do?comtID=TEVDS9

  The column entitled “Resources” shows a document with the title: J2012-DA_Revision_Request_Form.doc. Double click on the name to download the document with the filename: “SAE_J2012-DA_Revision_Request_Form.doc”.

It is intended that the revision request form be filled out with the request.

It is intended that e-mails with completed revision request forms as attachments be sent to:

E-mail: saej1930@sae.org

E-mail: saej1979@sae.org

E-mail: saej2012@sae.org

E-mail: saej1939@sae.org

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Road vehicles — Implementation of World-Wide Harmonized On-Board Diagnostics (WWH-OBD) communication requirements —

Part 4: Connection between vehicle and test equipment

1 Scope

This part of ISO 27145 defines the requirements to successfully establish, maintain and terminate communication with a vehicle that implements the requirements of the WWH-OBD GTR (Global technical regulation No. 5; see Reference [16]). This requires plug and play communication capabilities for the vehicle as well as for any test equipment that intends to establish communication with a vehicle. This part of ISO 27145 details all the OSI layer requirements to achieve this goal.

This part of ISO 27145 is intended to become the single communication standard for access to information relating to vehicle on-board diagnostics (VOBD). To allow for a smooth migration from the existing communication standards to this future world-wide standardized communication standard, the communication concept as specified in this part of ISO 27145 is based on two different data links:

— Diagnostic communication over Controller Area Network (DoCAN), ISO 15765-4;

— Diagnostic communication over Internet Protocol (DoIP), ISO 13400 (all parts).

NOTE It is intended that this part of ISO 27145 will be extended as necessary upon introduction of additional communication media.

IMPORTANT — Use cases deriving from country-specific implementation of GTR No. 5 into local legislation are not included in this part of ISO 27145.

2 Normative references

The following referenced documents are indispensable for the application 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 13400-2:2012, *Road vehicles — Diagnostic communication over Internet Protocol (DoIP) — Part 2: Transport protocol and network layer services*

ISO 13400-3, *Road vehicles — Diagnostic communication over Internet Protocol (DoIP) — Part 3: Wired vehicle interface based on IEEE 802.3*

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

ISO 15765-4:2011, *Road vehicles — Diagnostic communication over Controller Area Network (DoCAN) — Part 4: Requirements for emissions-related systems*

ISO 27145-1, *Road vehicles — Implementation of World-Wide Harmonized On-Board Diagnostics (WWH-OBD) communication requirements — Part 1: General information and use case definition*

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ISO 27145-2, *Road vehicles — Implementation of World-Wide Harmonized On-Board Diagnostics (WWH-OBD) communication requirements — Part 2: Common data dictionary*

ISO 27145-3, *Road vehicles — Implementation of World-Wide Harmonized On-Board Diagnostics (WWH-OBD) communication requirements — Part 3: Common message dictionary*

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 27145-1, ISO 27145-2 and ISO 14229-1 apply.

3.2 Abbreviated terms

CAN	controller area network
DHCP	dynamic host configuration protocol
DID	data identifier
DoCAN	diagnostic communication over CAN
DoIP	diagnostic communication over internet protocol
DTC	diagnostic trouble code
ECU	electronic control unit
FMI	failure mode indicator
FTB	failure type byte
GTR	global technical recommendation
IP	internet protocol
N_PDU	network layer protocol data unit
NRC	negative response code
OBD	on-board diagnostics
OSI	open systems interconnection
SA	source address
SPN	suspect parameter number
T_PDU	transport/network layer protocol data unit
TA	target address
TCP	transmission control protocol
WWH-OBD	world-wide harmonized on-board diagnostics
VOBD	vehicle on-board diagnostics

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4 Conventions

The ISO 27145 series is based on the conventions discussed in the OSI Service Conventions (ISO/IEC 10731) as they apply to diagnostic services.

5 Document overview

Figure 2 shows the reference documents for the ISO 27145 series.

The ISO 27145 series specifies or includes the following references:

a) ISO 27145-1 specifies the general structure of the ISO 27145 series and the WWH-OBD GTR applicable use cases.

b) ISO 27145-2 specifies the common data dictionary with references to:

   1) SAE J1930-DA, which defines the terms, definitions, abbreviated terms, etc.;

   2) SAE J1939 Companion Spreadsheet, which specifies the SPNs;

   3) SAE J1939-73:2010, Appendix A, which specifies the FMIs;

   4) SAE J1979-DA, which specifies all data items;

   5) SAE J2012-DA, which specifies the DTC definitions and FTB definitions.

NOTE The SAE J1939 series of documents is concerned with the definition of emissions-related SPNs and FMIs for use as DTCs.

c) ISO 27145-3 specifies the diagnostic services defined in ISO 14229-1 that are applicable to WWH-OBD GTR.

d) ISO 14229-2 specifies the standardized service primitive interface to separate application and session layers from protocol transport and network layers.

e) This part of ISO 27145 specifies the initialization procedure and includes references to:

   1) ISO 15765-4 DoCAN;

   2) ISO 13400 (all parts) DoIP.

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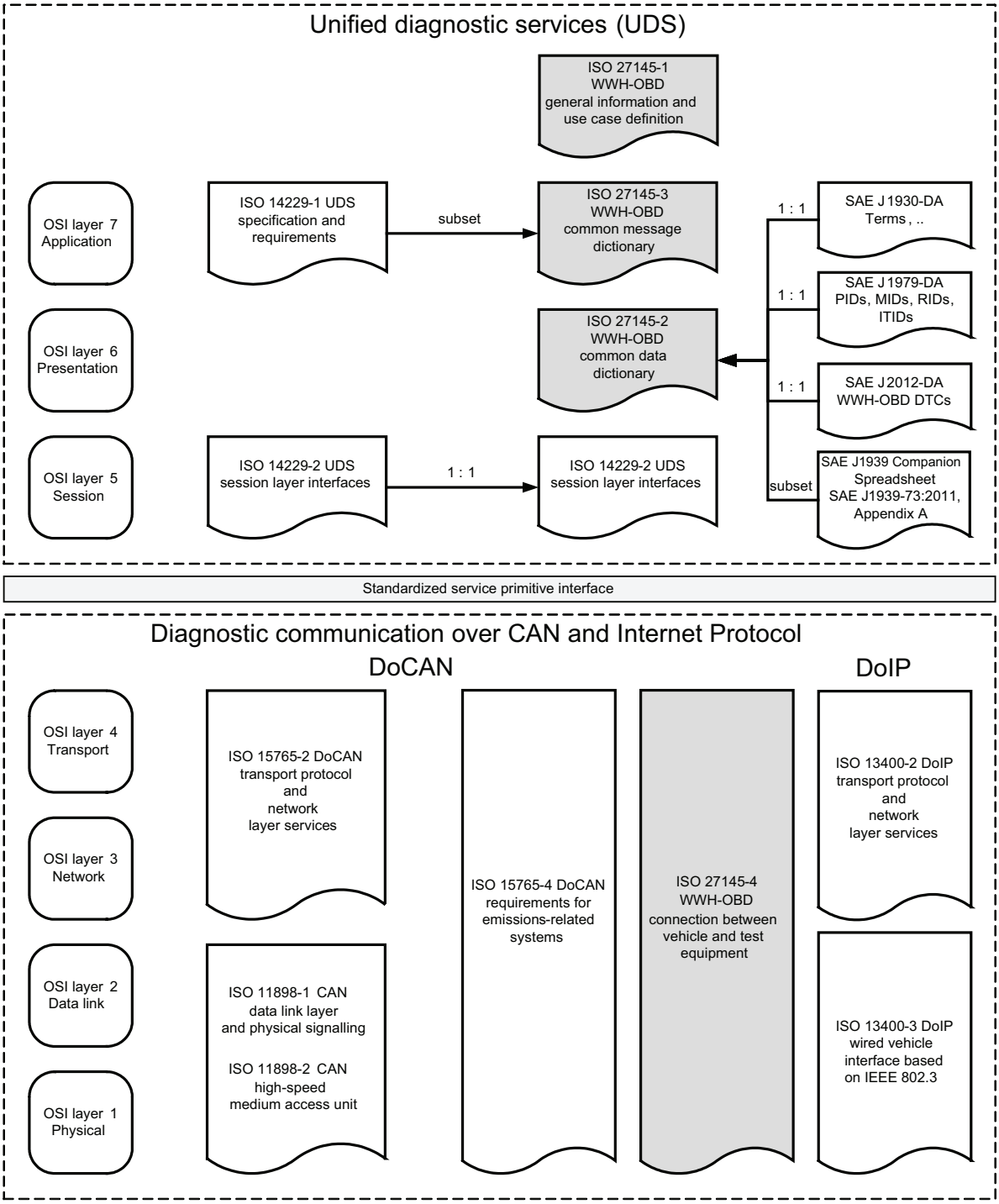

Figure 2 — Implementation of WWH-OBDonCAN and WWH-OBDonIP document reference according to OSI model

6 Vehicle and external test equipment connection requirements

6.1 Overview

To provide a future-oriented long-term stable communication standard which is based on existing industry communication standards while allowing for backward-compatibility to existing automotive networks, ISO 27145

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is designed to support different types of connections between external test equipment and a vehicle. Regardless of the underlying physical layer, data link and network layer the other parts of ISO 27145 remain unaltered.

a) CAN-based wired connection (see Clause 7)

   This is the type of connection which describes the use of WWH-OBD communication services on an existing ISO 15765-4-compliant vehicle interface. It has been defined to allow for a smooth migration from a CAN-based vehicle interface to an Ethernet-based connection to a vehicle.

b) DoIP over Ethernet wired connection (see Clause 8)

   This is the type of connection which utilizes the Internet Protocol as the network layer on a Fast Ethernet (IEEE 802.3) connection.

6.2 Data link independent requirements

WWH-OBD-compliant servers/ECUs are required to support the InfoType “ECUNAME” with services readDataByIdentifier 0x22 and dataIdentifier 0xF80A (see SAE J1979-DA). The mapping between a server/ECU logical address and the name (ECUNAME) of the server/ECU shall be performed by the external test equipment.

6.3 Support of only one WWH-OBD-compliant external test equipment at a time

The in-vehicle WWH-OBD system shall support only one type of WWH-OBD-compliant external test equipment at a time:

— If the vehicle supports DoCAN, then the WWH-OBD-compliant external test equipment shall use the source addresses (SA) specified in ISO 15765-4:2011, 10.5, which deals with mapping of diagnostic addresses.

— If the vehicle supports DoIP, then the WWH-OBD-compliant external test equipment shall use the SA 0xE000 specified in ISO 13400-2:2012, Table 39, which gives an overview of logical addressing.

7 Wired CAN connection based on ISO 15765-4

7.1 Network scenario requirements

Using ISO 11898-1 and ISO 11898-2 (CAN) and ISO 15765-4 (DoCAN), a variety of network scenarios can be used to access vehicles for the use cases defined in ISO 27145-1. See ISO 14229-2 for network scenario examples.

7.2 Initialization sequence

The external test equipment shall support the initialization sequence as specified in ISO 15765-4.

7.3 ISO 27145-3 WWH-OBD protocol validation sequence

The external test equipment shall support the ISO 27145-3 WWH-OBD protocol validation sequence specified in ISO 15765-4.

7.4 Application layer — DoCAN

7.4.1 General

All application-specific requirements for data content and formatting shall be supported as specified in ISO 27145-2 and ISO 27145-3.

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7.4.2 Diagnostic protocol communication types

The following communication types shall be supported for the diagnostic protocol implementation for WWH-OBD on CAN as specified in ISO 14229-2:

a) functional communication;

b) physical communication.

The following WWH-OBD communication types on DoCAN shall be supported by WWH-OBD-compliant servers/ECUs (for details, see ISO 14229-2):

— functional communication during defaultSession;

— functional communication during defaultSession with enhanced response timing;

— physical communication during defaultSession;

— physical communication during defaultSession with enhanced response timing.

Each diagnostic service specified in ISO 27145-3 shall be transmitted by the external test equipment with the addressing method (functionally, physically) as specified in ISO 27145-3. Specific requirements on the use of individual services with either functional or physical addressing are given in ISO 27145-3.

EXAMPLE Short diagnostic requests (less than 7 bytes) which are supported by most of the ECUs can be transmitted using functional addressing, while requests for multiple data identifiers (DIDs) (see ISO 27145-2) which are explicitly requested from a single server/ECU shall be requested using physical addressing.

7.4.3 Maximum number of WWH-OBD servers/ECUs

The maximum number of WWH-OBD-compliant servers/ECUs is limited by the address range definitions in ISO 15765-4.

7.4.4 Diagnostic protocol timing parameters

The application layer timing parameter values for the default diagnostic session shall be in accordance with ISO 27145-3.

For all diagnostic services specified in ISO 27145-3, the possibility of the server requesting an enhanced response-timing window via a negative response message, including a negative response code (NRC) 0x78 (requestCorrectlyReceived-ResponsePending), shall be supported if specified for the diagnostic service in ISO 14229-2 (see $P4_{Server}$).

7.4.5 External test equipment logical addresses

The external test equipment implementing the use cases defined in ISO 27145-1 shall implement the CAN identifiers and the address as specified in ISO 15765-4 for the external legislated diagnostic test equipment when requesting WWH-OBD data from a WWH-OBD-compliant vehicle.

7.4.6 Server/ECU logical addressing

A WWH-OBD-compliant vehicle shall implement the CAN identifiers and the address as specified in ISO 15765-4 for each WWH-OBD-compliant server/ECU.

7.5 Presentation layer

All presentation-layer-specific requirements for data content and formatting shall be supported as defined in ISO 27145-2.

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7.6 Session layer

All WWH-OBD communication shall take place during the default diagnostic session; therefore, no session layer timing handling is required for WWH-OBD communication. Further details are given in ISO 14229-2.

There shall always be exactly one diagnostic session active in a WWH-OBD-related server/ECU. A WWH-OBD-related server/ECU shall always start the default diagnostic session when powered up. If no other diagnostic session is started, then the default diagnostic session shall run as long as the WWH-OBD-related server/ECU is powered.

A WWH-OBD-related server/ECU shall be capable of providing all diagnostic functionality defined for WWH-OBD in the default diagnostic session and under normal operating conditions.

NOTE If in multi-tester environments (e.g. additional on-vehicle monitoring unit) a different session is active while external test equipment transmits requests, then the default diagnostic session need only be entered if the WWH-OBD communication requirements (including application requirements) cannot be fulfilled in the currently active non-default session.

There shall be no need to send any diagnostic service to the WWH-OBD-related server/ECU to keep the default diagnostic session active.

7.7 Transport layer

7.7.1 General information

All transport-layer-specific-requirements shall be supported as defined in ISO 15765-2. This part of ISO 27145 makes use of the session layer T_PDU (transport/network layer protocol data unit) service primitives defined in ISO 14229-2 for the transmission and reception of diagnostic messages. Subclauses 7.7.2 and 7.7.3 define the mapping of the data-link-independent T_PDUs onto the data-link-specific N_PDUs (network layer protocol data units) defined in this part of ISO 27145.

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

7.7.2 Mapping of data-link-independent service primitives onto DoCAN data-link-dependent service primitives

Table 2 defines the mapping of T_PDU service primitives onto N_PDU service primitives.

Table 2 — Mapping of T_PDU service primitives onto N_PDU service primitives

Session to transport layer service primitives (data-link-independent according to ISO 14229-2)	**DoCAN network layer service primitives** (data-link-dependent according to ISO 15765-2)
T_Data.indication	N_USData.indication
T_DataSOM.indication	N_USDataFF.indication
T_Data.confirm	N_USData.confirm
T_Data.request	N_USData.request

7.7.3 Mapping of T_PDU onto N_PDU for message transmission

The parameters of the application layer protocol data unit for requesting the transmission of a diagnostic service request/response are mapped in accordance with Table 3 onto the parameters of the DoCAN network layer protocol data unit for the transmission of a message by the client/server.

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Table 3 — Mapping of T_PDU parameter onto N_PDU parameter

T_PDU parameter (data-link-independent according to ISO 14229-2)	**N_PDU parameter** (DoCAN data-link-dependent according to ISO 15765-2)
T_Mtype	N_Mtype
T_SA	N_SA
T_TA	N_TA
T_TAtype	N_TAtype
T_AE	N_AE
T_Data [ ]	<MessageData>
T_Length	<Length>
T_Result	<N_Result>

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 and the values for emissions-related WWH-OBD are defined in ISO 15765-4.

7.8 Network layer

The network layer of the external test equipment and the legislated OBD/WWH-OBD-compliant vehicle server(s)/ECU(s) — from the external test equipment point of view — shall be in accordance with ISO 15765-4.

A vehicle compliant with ISO 27145 shall only respond to ISO 27145-3 requests from external test equipment if the external test equipment uses the assigned functional address as specified for the WWH-OBD GTR-defined functional system group, e.g. 0x33 for an emissions-related functional system group. If the external test equipment uses other server/ECU addresses, it may request messages as defined by that protocol.

7.9 Data link layer

The definition of data link layer parameter values shall be in accordance with ISO 15765-4.

7.10 Physical layer

The physical layer and physical signalling of the external test equipment and the servers/ECUs shall be in accordance with ISO 15765-4.

7.11 Diagnostic connector

The diagnostic connector provides the connection between the external test equipment and the WWH-OBD-compliant vehicle. The connector shall be implemented in accordance with ISO 15765-4.

8 Wired Ethernet connection based on ISO 13400

8.1 Network scenario requirements

Using Ethernet and DoIP, a variety of network scenarios can be used to access vehicles for the use cases defined in ISO 27145-1. Due to the complexity of certain network architectures and presence of other network nodes (i.e. other than the vehicle under inspection and the external test equipment), which heavily impacts the message timing, IP address setup and data throughput, the initialization sequence is specified with the following restrictions:

— The vehicle under inspection is directly connected to the external test equipment through a dedicated wire with no additional network equipment installed in the connection path. (See the direct physical connection

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scenario in ISO 13400-1:2011, 9.2. See also ISO 13400-2:2012, 8.3.1 for further details on connection establishment and vehicle discovery in a direct connection scenario.)

NOTE This means that the definitions given in the list items below do not take into account the presence of any type of hub, switch or wireless LAN access point (if Ethernet to WLAN adapters are used) in infrastructure mode or similar equipment. This also implies that DoIP entities of a single vehicle will only be detected during the discovery sequence specified in ISO 13400-2. If more than one vehicle is detected, this is a clear indication of a network setup that does not adhere to the aforementioned requirement.

— Due to the nature of a direct wired connection, the Ethernet transceivers of both the external test equipment and the vehicle under inspection will detect the Ethernet activation almost at the same time.

— The external test equipment and vehicle will assign link-local IP addresses as specified in ISO 13400-2. Dynamic protocol delays and IP address changes caused by a dynamic host configuration protocol (DHCP) server are not considered in the initialization sequence.

— The external test equipment supports both IPv4 and IPv6 addressing to support vehicles with all DoIP entities using either IPv4 or IPv6. DoIP entities on a vehicle using IPv6 will not be capable of communicating with external test equipment that supports only IPv4, and vice versa.

— A WWH-OBD-compliant vehicle shall support either IPv4 or IPv6 as specified in ISO 13400-2.

See ISO 14229-2 for network scenario examples.

8.2 Initialization sequence

When connecting the external test equipment to the vehicle's diagnostic connector, which implements the future Ethernet-based high-speed data link connector, the initialization sequence shall be implemented as specified in Figure 3.

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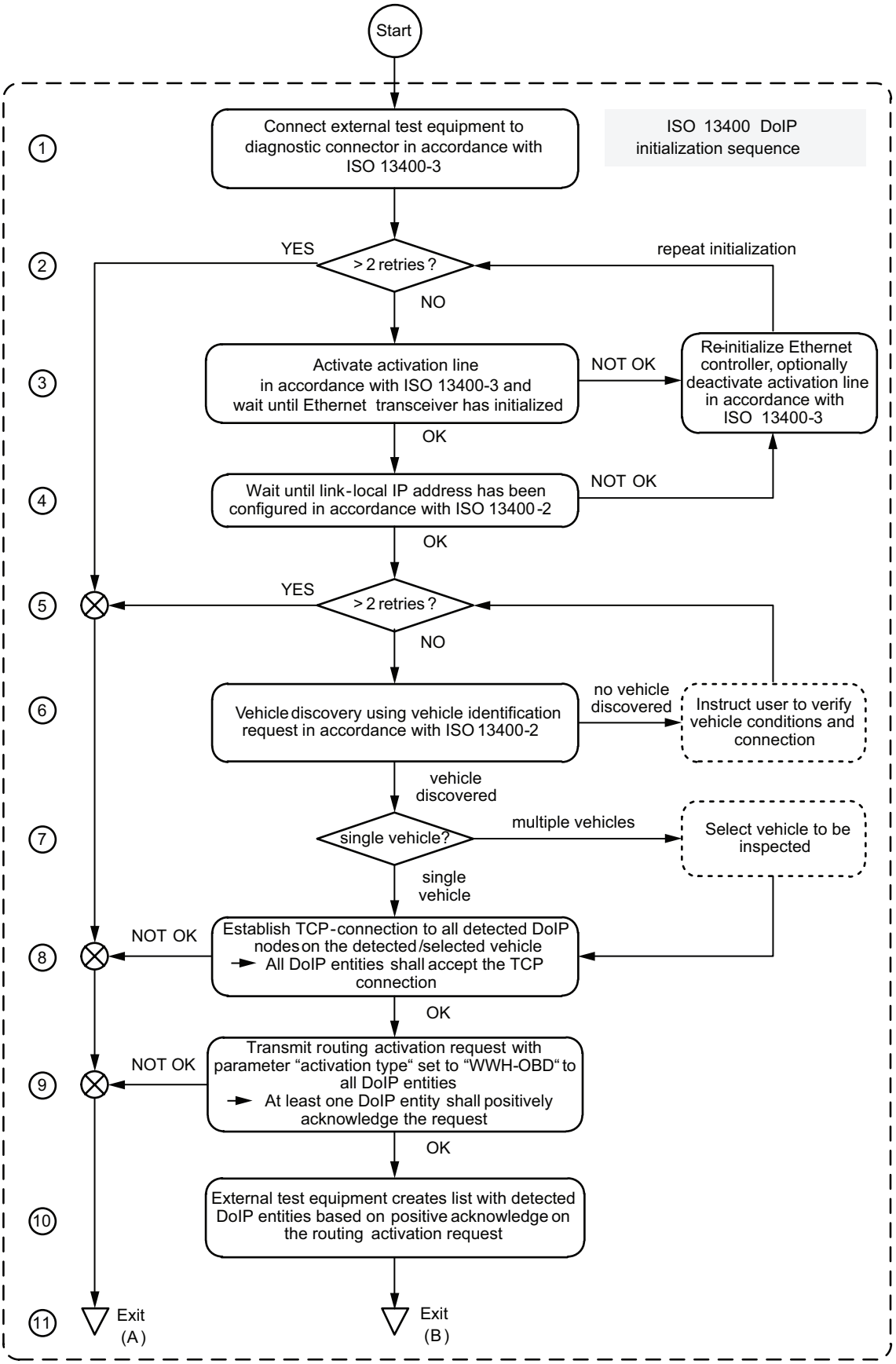

Key

1 Connect the external test equipment to the vehicle's diagnostic connector.

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2 The external test equipment checks if more than two re-initializations have been performed. If not (see *NO*), continue with step 3. If yes (see *YES*), continue with step 11, Exit (A).

3 Upon connection of the external test equipment to the vehicle, the Ethernet activation line defined in ISO 13400-3 shall be activated. After activation of the activation line, the external test equipment shall wait until its Ethernet port is active (i.e. Ethernet transceiver detects link).
If, one second after enabling the activation line, the Ethernet controller still has not detected an active Ethernet link (see *NOT OK*), a reset (*re-initialize*) of the Ethernet transceiver may be performed. The external test equipment may reset (*re-initialize*) its Ethernet controller and repeat the initialization. However, depending on the implemented activation line strategy (hardwired or soft activation), the external test equipment shall optionally keep the activation line enabled or deactivate the activation line. The external test equipment shall retry establishing an Ethernet connection for as long as power is detected on the battery supply voltage pins of the diagnostic connector, and it should instruct the user to verify the correct connection of the diagnostic connector.
Continue with step 4 (see *OK*) if, within one second of enabling the activation line, the Ethernet controller has detected an active Ethernet link.

4 The external test equipment shall perform the link-local IP address assignment as specified in ISO 13400-2.
If the link-local IP address assignment is not successful (see *NOT OK*), then branch back to step 3 and reset (*re-initialize*) the Ethernet controller.
If the link-local IP address assignment is successful (see *OK*), then continue with step 5.

5 The external test equipment checks whether more than two vehicle identification requests have been performed. If not (see *NO*), continue with step 6. If yes (see *YES*), continue with step 11, Exit (A).

6 The external test equipment performs the vehicle discovery in accordance with ISO 13400-2, using the vehicle identification request. If no vehicle is discovered, the external test equipment shall additionally instruct the user to verify that all pre-conditions are met (e.g. connection, ignition key turned to on, etc.), then branch to step 5.
If at least one vehicle is discovered, branch to step 7.

NOTE The above sequence assumes that the vehicle's WWH-OBD-compliant ECUs (including DoIP entities) are powered and are ready to send and receive messages (e.g. usually in the "ignition on" state).

7 The external test equipment checks whether a single vehicle or multiple vehicles have been discovered.
If more than one vehicle has been discovered (see *multiple vehicles*) the external test equipment shall display a selection in order for the user to select the vehicle intended for inspection. If a selection is performed, branch to step 8.
If only one vehicle has been discovered (see *single vehicle*), then branch to step 8.

IMPORTANT — If more than one vehicle is detected, this is an indication that the external test equipment is operating in a networked connection scenario (see ISO 13400-2) and therefore message timing delays might occur. The external test equipment shall ask the user to select the vehicle to be inspected from a list of detected vehicles and shall continue with communication but shall use extended timeouts determined on the basis of the network architecture (which is outside the scope of this part of ISO 27145).

8 The external test equipment shall establish transmission control protocol data (TCP_data) connections to all detected DoIP entities of the selected vehicle, as specified in ISO 13400-2. All detected DoIP entities shall accept the TCP_data connection. If at least one of the DoIP entities rejects the TCP_data connection attempt, the external test equipment shall inform the user (not shown in this figure) and branch to step 11, Exit (A) (ISO 27145-4: Not ISO 13400-2 compliant).
If all detected DoIP entities accept the TCP_data connection (see *OK*), then continue with step 9.
Some DoIP entities might either indicate that generally they do not support WWH-OBD responses or that no WWH-OBD-compliant ECUs are connected to the DoIP gateway. In some cases, DoIP entities might indicate that confirmation (see ISO 13400-2 for further details) is required to activate routing. This shall not be considered as a rejection. In general, for WWH-OBD communication, no authentication will be required by the DoIP entities.

9 After having established TCP_data connections to all DoIP entities, the external test equipment shall activate routing on all established TCP_data connections, as specified in ISO 13400-2, using the routing activation request with the parameter "activation type" set to "WWH-OBD". The requirements specified in ISO 13400-2 relating to the initial inactivity timer shall be met.
At least one DoIP entity shall respond positively to the routing activation request (see *OK*), in which case, branch to step 10.
If no DoIP entity responds positively to the routing activation request (see *NOT OK*), branch to step 11, Exit (A) (ISO 27145-4: Not ISO 13400-2 compliant).

10 The external test equipment shall create a list with detected DoIP entities based on positive acknowledgement of the routing activation request. Continue to step 11.

11 Exit (A): The vehicle is not compliant with this part of ISO 27145 or ISO 13400-2.
Exit (B): The external test equipment has detected DoIP entities and proceeds with the WWH-OBD protocol validation. Perform the ISO 27145-3 response validation as specified in Figure 4.

Figure 3 — ISO 13400 DoIP initialization sequence

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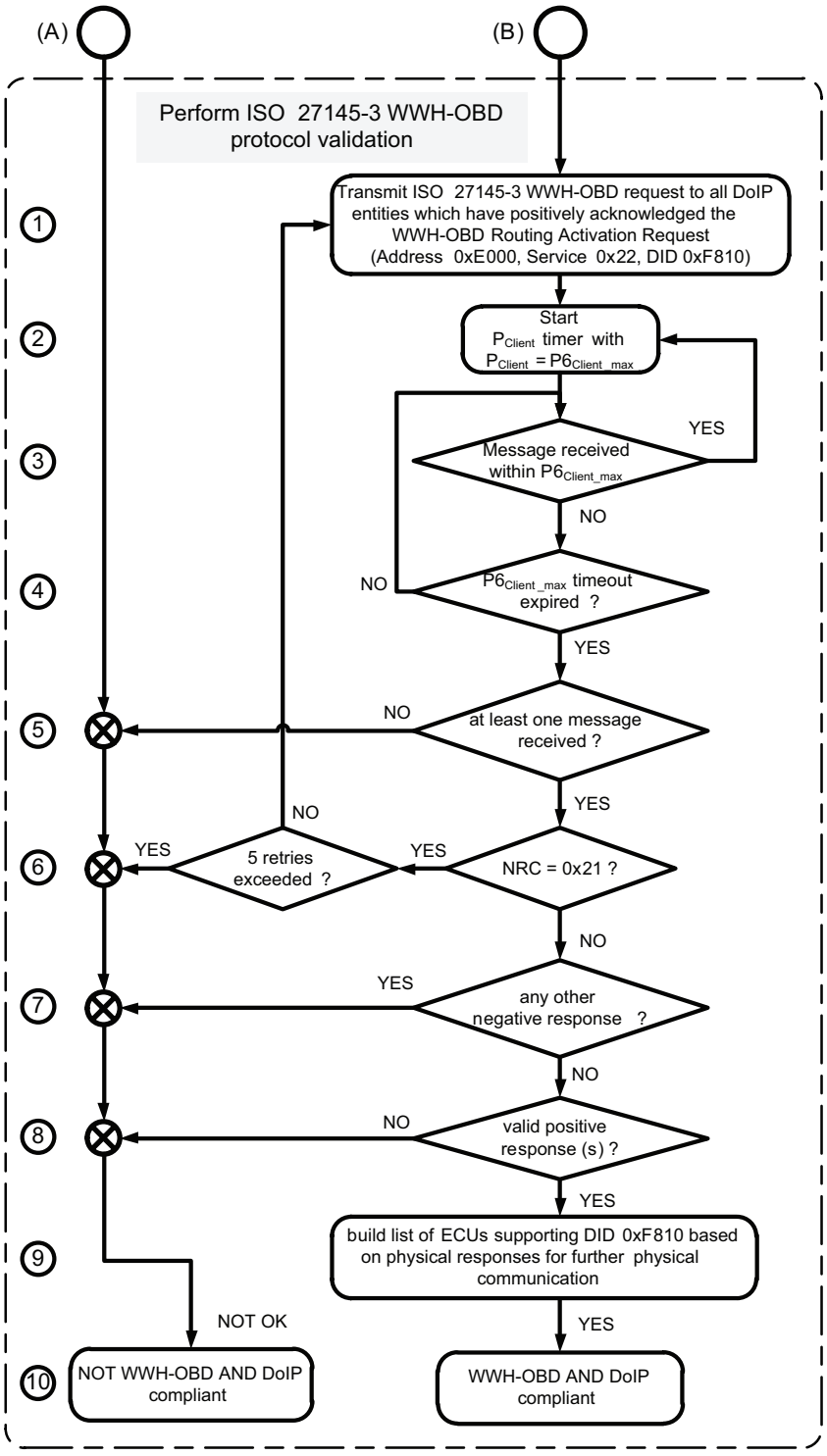
8.3 ISO 27145-3 WWH-OBD protocol validation sequence

Once the ISO 13400 DoIP initialization sequence is successfully completed, the ISO 27145-3 WWH-OBD protocol validation sequence shall be implemented as specified in Figure 4.



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Key

(A) Branch to step 10 (not WWH-OBD AND DoIP compliant).

(B) Branch to step 1.

1 The external test equipment shall transmit the ISO 27145-3 WWH-OBD request (Service 0x22, DID 0xF810 “protocol identification”) to all DoIP entities which have positively acknowledged the routing activation request (see Figure 3, step 10). The external text equipment shall use the functional logical address 0xE000 as specified in ISO 13400-2 (WWH-OBD). After completion, branch to step 2.

2 The external test equipment shall start the P_{Client} timer with $P_{Client} = P6_{Client\_max}$ (see ISO 14229-2).

3 The external test equipment shall check if any response message(s) have been received within $P6_{Client}$.
If yes (see *YES*), then branch to step 2.
If no (see *NO*), then branch to step 4.

4 The external test equipment shall check whether the P_{Client} timer has expired ($\geq P6_{Client\_max}$).
If no (see *NO*), then branch to step 3.
If yes (see *YES*) then branch to step 5.

5 The external test equipment shall check if at least one message has been received.
If no (see *NO*), this ECU is not WWH-OBD-compliant. Branch to step 10 (Not WWH-OBD AND DoIP compliant).
If yes (see *YES*), then branch to step 6.

6 The external test equipment evaluates the response messages and checks for a negative response message including NRC = 0x21 “busyRepeatRequest”.
If NRC = 0x21 (see *YES*), then check whether five re-transmissions of the request message have been exceeded.
If no (see *NO*), branch to step 1 after a delay of 200 ms.
If yes (see *YES*), this ECU is not WWH-OBD compliant. Branch to step 10 (not WWH-OBD AND DoIP compliant).
If NRC ≠ 0x21 (see *NO*), then branch to step 7.

7 The external test equipment evaluates the response messages and checks for any other negative response messages not including NRC = 0x21 “busyRepeatRequest”.
If yes (see *YES*), this ECU is not WWH-OBD compliant. Branch to step 10 (not WWH-OBD AND DoIP compliant).
If no (see *NO*) then branch to step 8.

8 The external test equipment evaluates the response messages and checks for a valid positive response message(s).
If no (see *NO*), this ECU is not WWH-OBD-compliant. Branch to step 10 (Not WWH-OBD AND DoIP compliant).
If yes (see *YES*), branch to step 9.

9 The external test equipment shall create a list of ECUs supporting DID 0xF810 with the data set to 0x01 = ISO 27145-4. Then branch to step 10 (WWH-OBD AND DoIP compliant).

10 Either the vehicle is not WWH-OBD AND DoIP compliant or it is WWH-OBD AND DoIP compliant.

Figure 4 — ISO 27145-3 WWH-OBD protocol validation

8.4 Application layer — DoIP

8.4.1 General

All application-specific requirements for data content and formatting shall be supported as defined in ISO 27145-2 and ISO 27145-3.

8.4.2 Diagnostic protocol communication types

The following diagnostic protocol communication types shall be supported for the diagnostic protocol implementation for WWH-OBD on DoIP:

a) functional communication;

b) physical communication.

The following WWH-OBD communication types on DoIP shall be supported by the WWH-OBD-compliant servers/ECUs (for details, see ISO 14229-2):

— physical communication during defaultSession;

— physical communication during defaultSession with enhanced response timing;

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— functional communication during defaultSession;

— functional communication during defaultSession with enhanced response timing;

The specific requirements of the WWH-OBD communication types for the individual services are defined in ISO 27145-3.

8.4.3 Maximum number of WWH-OBD servers/ECUs

The maximum number of WWH-OBD-compliant servers/ECUs is limited by the address range definitions in ISO 13400-2.

8.4.4 Diagnostic protocol timing parameters

The application layer timing parameter values for the default diagnostic session shall be in accordance with ISO 27145-3.

For all diagnostic services specified in ISO 27145-3, the possibility of the server requesting an enhanced response-timing window via a negative response message, including an NRC 0x78 (requestCorrectlyReceived-ResponsePending), shall be supported if specified for the diagnostic service in ISO 14229-1.

8.4.5 External test equipment logical addresses

External test equipment implementing the use cases defined in ISO 27145-1 shall use a logical address as specified in ISO 13400-2 for the external legislated diagnostic test equipment when requesting WWH-OBD data from a WWH-OBD-compliant vehicle.

8.4.6 Server/ECU logical addressing

A WWH-OBD-compliant vehicle shall use a unique logical address for each WWH-OBD-compliant server/ECU, as specified in ISO 13400-2.

From the external test equipment point of view, each server/ECU in a WWH-OBD-compliant vehicle shall

— support a single 16 bit logical address as defined in ISO 13400-2 for physically addressed request and response messages, and

— receive and process the functional 16 bit WWH-OBD functional group address as specified in ISO 13400-2 for functionally addressed request messages.

8.5 Presentation layer

All presentation-layer-specific requirements for data content and formatting shall be supported as defined in ISO 27145-2.

8.6 Session layer

All WWH-OBD communication shall take place during the default diagnostic session; therefore, no session layer timing handling is required for WWH-OBD communication. See ISO 14229-2 for further details on session layer requirements.

There shall always be exactly one diagnostic session active in a WWH-OBD-related server/ECU. A WWH-OBD-related server/ECU shall always start the default diagnostic session when powered up. If no other diagnostic session is started, then the default diagnostic session shall run as long as the WWH-OBD-related server/ECU is powered.

A WWH-OBD-related server/ECU shall be capable of providing all diagnostic functionality defined for WWH-OBD in the default diagnostic session and under normal operating conditions.

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NOTE If in multi-tester environments (e.g. additional on-vehicle monitoring unit) a different session is active while external test equipment transmits requests, then the default diagnostic session need only be entered if the WWH-OBD communication requirements (including application requirements) cannot be fulfilled in the currently active non-default session.

There shall be no need to send any diagnostic service to the WWH-OBD-related server/ECU in order to keep the default diagnostic session active.

8.7 Transport layer

8.7.1 General information

All transport-layer-specific requirements shall be supported as specified in ISO 13400-2. This part of ISO 27145 makes use of the session layer T_PDU service primitives defined in ISO 14229-2 for the transmission and reception of diagnostic messages. Subclauses 8.7.2 and 8.7.3 define the mapping of the data-link-independent T_PDUs onto the data-link-specific network layer protocol data units (DoIP_PDU) as defined in this part of ISO 27145.

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

8.7.2 Mapping of data-link-independent service primitives onto the Internet Protocol data-link-dependent service primitives

Table 4 defines the mapping of T_PDU service primitives onto DoIP_PDU service primitives.

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

Session to transport layer service primitives (data-link-independent according to ISO 14229-2)	**DoIP network layer service primitives** (data-link-dependent according to ISO 13400-2)
T_Data.indication	DoIP_Data.indication
T_DataSOM.indication	—
T_Data.confirm	DoIP_Data.confirm
T_Data.request	DoIP_Data.request

8.7.3 Mapping of T_PDU onto DoIP_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 DoIP_PDU parameter

T_PDU parameter (data-link-independent according to ISO 14229-2)	**DoIP_PDU parameter** (DoIP data-link-dependent according to ISO 13400-2)
T_Mtype	—
T_SA	DoIP_SA
T_TA	DoIP_TA
T_TAtype	DoIP_TAtype
T_AE	—
T_Data [ ]	<MessageData>
T_Length	<Length>
T_Result	<DoIP_Result>

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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 and the values for emissions-related WWH-OBD are defined in ISO 13400-2.

8.8 Network layer

The network layer of the external test equipment and the legislated OBD/WWH-OBD-compliant vehicle server(s)/ECU(s) — from the external test equipment point of view — shall be in accordance with ISO 13400-2.

A vehicle compliant with ISO 27145 shall only respond to ISO 27145-3 requests from external test equipment if the external test equipment uses the assigned functional address as specified for the WWH-OBD GTR-defined functional system group, e.g. 0x33 for an emissions-related functional system group. If the external test equipment uses other server/ECU addresses, it may request messages as defined by that protocol.

8.9 Data link layer

For WWH-OBD purposes, the data link layer shall be in accordance with ISO 13400-3.

8.10 Physical layer

The physical layer and physical signalling of the external test equipment and the servers/ECUs shall be in accordance with ISO 13400-3.

8.11 Diagnostic connector

The diagnostic connector provides the connection between the external test equipment and the WWH-OBD-compliant vehicle.

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