BS ISO 27145-1:2012

BSI Standards Publication

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

Part 1: General information and use case definition

National foreword

This British Standard is the UK implementation of ISO 27145-1:2012. It supersedes DD ISO/PAS 27145-1:2006, which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee AUE/16, Electrical and electronic equipment.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Published by BSI Standards Limited 2012

ISBN 978 0 580 67602 4

ICS 43.040.10; 43.180

Compliance with a British Standard cannot confer immunity legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 31 August 2012.

Amendments issued since publication

Date	Text affected

BS ISO 27145-1:2012

INTERNATIONAL STANDARD

ISO 27145-1

First edition
2012-08-15

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

Part 1: General information and use case definition

Véhicules routiers — Mise en application des exigences de communication pour le diagnostic embarqué harmonisé à l'échelle mondiale (WWH-OBD) — Partie 1: Informations générales et définition de cas d'usage

Reference number
ISO 27145-1:2012(E)

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Published in Switzerland

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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 27145-1 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 3, *Electrical and electronic equipment*.

This first edition of ISO 21745-1 cancels and replaces ISO/PAS 27145-1:2006, 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*

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. Where mapped on this model, the services specified by ISO 27145 are divided 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 ISO 27145-4 with reference to ISO 13400-2, ISO 15765-2 and ISO 15765-4,

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

— data link layer (layer 2), specified in ISO 27145-4 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 ISO 27145-4 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 seven layer</th><th colspan="3">WWH-OBD 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 and 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.

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

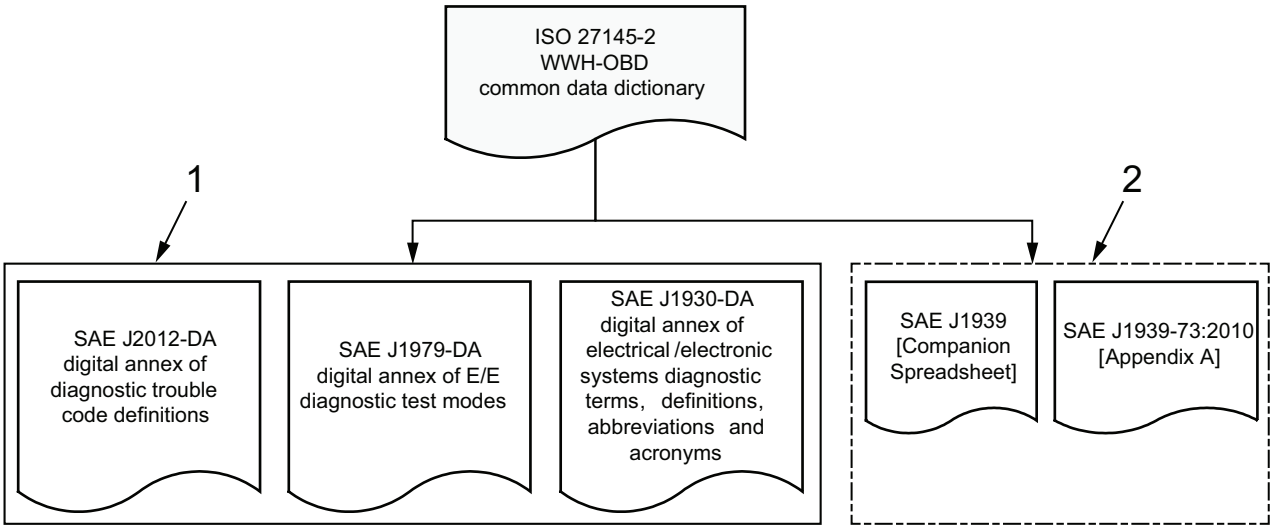
— SAE J1930-DA: this digital annex contains all standardized naming objects, terms and abbreviated terms.

— 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.

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”, and 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

INTERNATIONAL STANDARD ISO 27145-1:2012(E)

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

Part 1: General information and use case definition

1 Scope

This part of ISO 27145 provides an overview of the structure and the partitioning of the different parts of ISO 27145 and shows the relationship between the parts. In addition, it outlines the use case scenarios where the ISO 27145 series is used. All terminology that is common throughout the ISO 27145 series is also outlined.

ISO 27145 is intended to become the single communication standard for access to OBD-related information. To allow for a smooth migration from the existing communication standards to this future world-wide communication standard, the initial communication concept is based on the ISO 15765 series, i.e. Diagnostic communication over Control Area Network (DoCAN).

The intention is for the future communication concept to be based on the ISO 13400 series, i.e. Diagnostic communication over Internet Protocol (DoIP) utilizing Ethernet. In view of the usage of standard network layer protocols, future extensions to optional physical layers (e.g. wireless) are possible.

ISO 27145 has been extended to define the world-wide harmonized On-Board Diagnostics (OBD) communication standard. Based on the results of the initialization, the external test equipment determines which protocol and diagnostic services are supported by the vehicle's emissions-related system, i.e.

— legislated OBD: ISO 15031 series (based on DoCAN), and

— legislated WWH-OBD: ISO 27145 series (based on DoCAN and DoIP).

IMPORTANT — Use cases deriving from country-specific implementation of Global Technical Regulation (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 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 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*

ISO 27145-4, *Road vehicles — Implementation of World-Wide Harmonized On-Board Diagnostics (WWH-OBD) communication requirements — Part 4: Connection between vehicle and test equipment*

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

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

3.1.1
calibration identifier
CALID
identification code for a specific software/calibration contained in a server/ECU

NOTE If regulations require calibration identifications for emissions-related software, these are reported in a standardized format as specified in ISO 27145-2.

3.1.2
class A, B1, B2, C malfunction
attribute of a DTC, which characterizes the impact of a failure on emissions or on the OBD system's monitoring capability according to the requirements of the WWH-OBD GTR

3.1.3
continuous malfunction indicator
continuous-MI
malfunction indicator showing a steady indication at all times while the key is in the on (run) position with the engine running [ignition ON – engine ON]

3.1.4
continuous malfunction indicator counter
continuous-MI counter
conveys the amount of time the OBD system was operational during the time a continuous-MI was last activated

NOTE For a detailed definition, see GTR No. 5.

3.1.5
confirmed and active DTC
DTC status, which is detected during two consecutive operation cycles, in which the DTC is still present and commands the MI to be on if the DTC class is A, B1 or B2

NOTE For a DTC of class C, the MI is not illuminated.

3.1.6
cumulative continuous malfunction indicator counter
cumulative continuous-MI counter
cumulated operating hours with a continuous-MI activated

NOTE The cumulative continuous-MI counter counts up to the maximum value provided in a 2-byte counter with 1 h resolution and holds that value. The cumulative continuous-MI counter is not reset to zero by the engine system, a scan tool or a disconnection of a battery.

The cumulative continuous-MI counter operates in the following manner:

a) the cumulative continuous-MI counter begins counting once the continuous-MI is activated;

b) the cumulative continuous-MI counter halts and holds its existing value once the continuous-MI is no longer activated;

c) the cumulative continuous-MI counter continues counting from the point at which it had been held when a continuous-MI was activated.

3.1.7
calibration verification number
CVN
server/ECU calculated verification number used to verify the integrity of the software/calibration contained in a server/ECU

NOTE If regulations require calibration identifications for emissions-related software, those are reported in a standardized format as specified in ISO 27145- 2.

3.1.8
discriminatory display
requires the MI to be activated according to the class in which a malfunction has been classified

3.1.9
malfunction
failure or deterioration of a vehicle or engine system or component, including the OBD system, during which the WWH-OBD GTR specifically identifies the conditions which are considered to be failures

3.1.10
malfunction indicator
MI
display or gauge that clearly informs the driver of the vehicle in the event of a malfunction/failure

NOTE Additional details are included in the WWH-OBD GTR.

3.1.11
malfunction indicator counter
MI counter
conveys the amount of time during which the OBD system operates while a failure/breakdown is active

3.1.12
non-discriminatory display
indicator requiring only a single type of MI activation

3.1.13
on-board diagnostics
OBD
system that monitors some or all computer input and control signals

NOTE Signal(s) outside of the predetermined limits imply a fault in the system or in a related system.

3.1.14
previously active DTC
DTC status that is first detected during two consecutive operation cycles but later detection shows that the fault is no longer present

3.1.15
vehicle identification number
VIN
numeral identifying and specific and unique to each vehicle according to the applicable legal provisions of each national/regional authority

3.1.16
vehicle on-board diagnostics
providing a single access point for external test equipment to retrieve all data of the OBD system

3.2 Abbreviated terms

CALID	calibration identification
CVN	calibration verification number

DTC	diagnostic trouble code
DID	diagnostic data identifier
DLL	data link layer
ECM	engine control module
ECU	electronic control unit
FMI	failure mode indicator
FTB	failure type byte
GTR	global technical regulations
HS	high speed
HS-LPM	high speed – low power mode
MI	malfunction indicator
SPN	suspect parameter number
UDS	unified diagnostic services
VIN	vehicle identification number
VOBD	vehicle on-board diagnostics
WLAN	wireless local area network
WWH-OBD	world-wide harmonized on-board diagnostics
WWH-OBDonCAN	world-wide harmonized on-board diagnostics on controller area network
WWH-OBDonIP	world-wide harmonized on-board diagnostics on internet protocol

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) This part of ISO 27145 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 1979-DA, which specifies all data items;

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

NOTE 1 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) ISO 27145-4 specifies the initialization procedure and includes references to

   1) ISO 15765-4 DoCAN, and

   2) ISO 13400 (all parts) DoIP.

The ISO 27145 series provides an implementer with all documents and references required to support the implementation of legislated on-board diagnostics in accordance with the requirements set forth in the GTR.

— This part of ISO 27145: general information and use case definitions, providing an overview of the series along with the use case definitions and a common set of resources (definitions, references) for use by all subsequent parts.

— ISO 27145-2: common data dictionary, which provides the general data identifier, ranges and record definitions. The actual data are defined in separate/referenced documents, e.g. emissions-related legislated diagnostics in the SAE digital annexes (see also Note 2).

— ISO 27145-3: common message dictionary, which provides the message implementation details from ISO 14229-1 and ISO 14229-2 (UDS) to support the required legislated OBD.

— ISO 27145-4: connection between vehicle and test equipment, which defines the details necessary to implement the communication between the vehicle's OBD systems and test equipment, including the definition/reference of physical layers, data link layers, network layer, transport layer and session layer. It is expected to extend ISO 27145-4 as necessary due to the introduction of additional communication media.

— ISO 27145-5: conformance test, which provides test cases for the vehicle and external test equipment to verify conformance.

— ISO 27145-6: external test equipment, which provides the requirements to be fulfilled by any external test equipment connected to the vehicle.

NOTE 2 It is intended to introduce additional parts of ISO 27145 as necessary in order to consider additional OBD systems not yet covered.

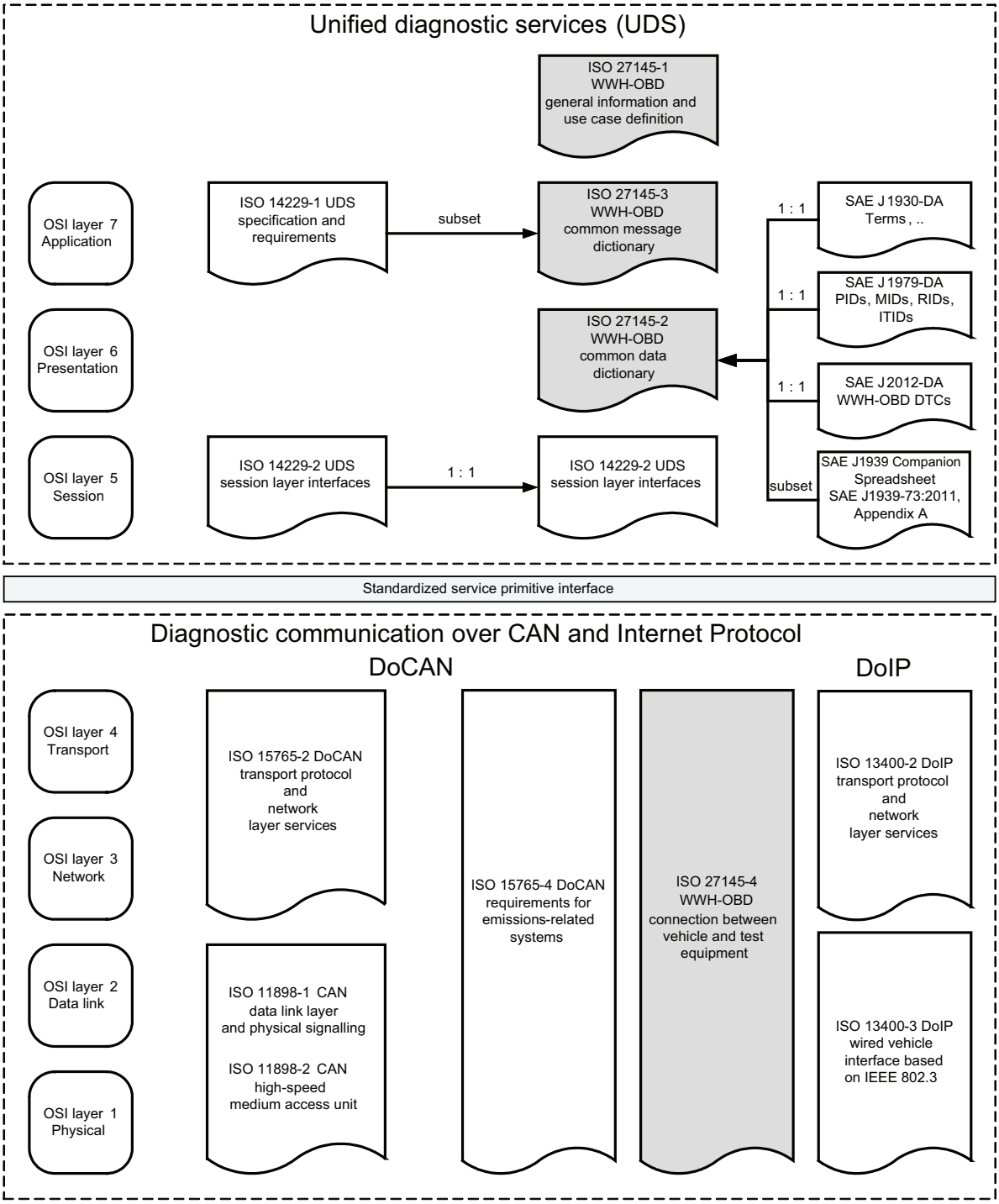


Figure 2 — Implementation of WWH-OBDonCAN and WWH-OBDonIP document reference according to OSI model

6 WWH-OBD use case overview

6.1 Overview

The OBD system is required to make available vehicle diagnostic information under several different use cases as specified by the GTR. These use cases provide the implementer with guidance in the implementation of the VOBD (described in Clause 8), and methodology used on the vehicle to make the required data available.

NOTE WWH-OBD GTR No. 5 defines the basis for world-wide harmonized regulatory requirements. Translation of GTR No. 5 into country-specific regulatory language can define additional use cases.

6.2 WWH-OBD use case clusters

The following is a summary of the use cases applicable to WWH-OBD systems.

Table 2 provides an overview of the main WWH-OBD use cases. A main WWH-OBD use case cluster may have one or more use case definition(s).

Table 2 — WWH-OBD main use case clusters

No.	Main title of use case cluster	Brief description
1	Information about the emissions-related OBD system state	The purpose of this information package is to provide the minimum data set specified as necessary by the WWH-OBD GTR to obtain the vehicle or engine state with respect to its emissions performance, as specified in the GTR. A typical use of this information package may be a “roadside check” performed by an enforcement authority.
2	Information about active emissions-related malfunctions	The purpose of this information package is to provide access to the expanded data set specified as necessary by the WWH-OBD GTR to determine vehicle readiness and characterize the malfunctions detected by the OBD system. A typical use of this information package may be a periodic inspection by enforcement authorities.
3	Information related to diagnosis for the purpose of repair	The purpose of this information package is to provide access to all OBD data required by the WWH-OBD GTR and available from the OBD system. A typical use of this information package may be the diagnostic servicing of the vehicle or system in a workshop environment.

Detailed definitions of each data item listed in the use cases can be found in the emissions-related module of the WWH-OBD GTR.

7 WWH-OBD use case definition

7.1 UC 1 — Information about the emissions-related OBD system state

Table 3 specifies the data set to be supported by the emissions-related VOBD system.

Table 3 — UC 1 Information about the emissions-related OBD system state

Actor	Enforcement agency
Goal	This use case provides an enforcement agency with the malfunction indication (MI) status and associated vehicle system data (e.g. MI counter, readiness status, etc.).
Use case input	Broadcast request message to retrieve the emissions-related WWH-OBD system state.
Use case output	— Discriminatory/non-discriminatory display strategy — The VIN (vehicle identification number) — Presence of a continuous-MI — The readiness status of the OBD system — The number of engine operating hours during which a continuous-MI was last activated (continuous-MI counter) — This information shall be read-only access (i.e. no clearing) within the context of use case 1.
Brief description	The OBD system shall provide the data items as required by the emissions-related module of the WWH-OBD GTR and in the format as specified in ISO 27145-2 for the external roadside check test equipment to assimilate and provide the enforcement agency with the following information.
Typical example	The vehicle's emissions-related system is checked against roadworthiness at the roadside.

7.2 UC 2 — Information about active and confirmed emissions-related malfunctions

Table 4 specifies the data set to be supported by the emissions-related vehicle system if inspection/maintenance (I/M) external test equipment is connected.

Table 4 — UC 2 Information about active and confirmed emissions-related malfunctions

Actor	Any inspection station (I/M station).
Goal	This information provides any inspection station with a subset of engine-related OBD data, including the malfunction indicator status and associated data (MI counters), a list of active/confirmed malfunctions of classes A and B, and associated data (e.g. B1-counter).
Use case input	A predefined sequence of message and data exchange between the I/M equipment and the vehicle's WWH-OBD system ECU(s).
Use case output	— The GTR (and revision) number — Discriminatory/non-discriminatory display strategy — The VIN (vehicle identification number) — The malfunction Indicator status — The readiness status of the OBD system — The number of warm-up cycles and number of engine operating hours since recorded OBD information was last cleared — The number of engine operating hours since the MI was activated (continuous-MI counter) — The value of the B1 counter with the highest number of engine operating hours — The cumulated operating hours with a continuous-MI (cumulative continuous-MI counter) — The confirmed and active DTCs for class A malfunctions — The confirmed and active DTCs for classes B (B1 and B2) malfunctions — The software calibration identification(s) — The calibration verification number(s) — This information shall be read only access (i.e. no clearing) within the context of use case 2.
Brief description	The OBD system shall provide the data items as required by the emissions-related module of the WWH-OBD GTR and in the format as specified in ISO 27145-2 for the external inspection test equipment to assimilate the data and provide an inspector with the following information.
Typical example	The vehicle's emissions-related system is tested at an I/M station.

7.3 UC 3 — Information related to diagnosis for the purpose of repair

Table 5 specifies the data set which shall be supported by the emissions-related vehicle system if a repair shop diagnostic external test equipment is connected.

Table 5 — UC 3 Information related to diagnosis for the purpose of repair

Actor	Repair technicians
Goal	This information provides repair technicians with all OBD data specified in the GTR (e.g. freeze frame information).
Use case input	A predefined sequence of message and data exchange between the external diagnostic test equipment and the vehicle's WWH-OBD system ECU(s)
Use case output	— The GTR (and revision) number — The VIN (vehicle identification number) — The MI status — The readiness status of the OBD system — The number of warm-up cycles and number of engine operating hours since recorded OBD information was last cleared — The monitor status (i.e. disabled for the rest of this driver cycle, complete this drive cycle, or not complete this drive cycle) since last engine shut-off for each monitor used for readiness status — The number of engine operating hours since the MI was activated (continuous-MI counter) — The confirmed and active DTCs for class A malfunctions — The confirmed and active DTCs for class B (B1 and B2) malfunctions — The confirmed and active DTCs for class B1 malfunctions and the number of engine operating hours from the B1 counters — The cumulated operating hours with a continuous-MI (cumulative continuous-MI counter) — The value of the B1 counter with the highest number of engine operating hours — The confirmed and active DTCs for class C malfunctions — The pending DTCs and their associated classes — The previously active DTCs and their associated classes — Real-time information on OEM selected and supported sensor signals, internal parameters and output signals — The freeze frame data — The software CALID(s) [calibration identification(s)] — The CVN(s) [calibration verification number(s)] — The OBD system shall clear all the recorded information related to malfunctions of the engine system and related data (operating time information, freeze frame, etc.) according to the provisions of the WWH-OBD GTR, where this request is provided via the external repair test equipment in accordance with ISO 27145-2.
Brief description	The OBD system shall provide the data items as required by the emissions-related module of the WWH-OBD GTR and in the format as specified in ISO 27145-2 for the external repair test equipment to assimilate the data and provide a repair technician with the following information:
Typical example	The vehicle's emissions-related system is diagnosed by external diagnostic test equipment in a repair shop.

8 Vehicle on-board diagnostic

8.1 VOBD definition

The following specifies general VOBD information including, but not limited to, minimum functionality, system data storage, and application examples. The information provided in this part of ISO 27145 should be used as a reference framework for VOBD system implementers.

The VOBD consists of

— the VOBD system, which consists of the individual OBD system(s) (e.g. ECUs),

— a “single VOBD access method” as required by the WWH-OBD GTR to provide access to the VOBD data set and all other diagnostic functions, and

— the “VOBD data set”, which is defined as a limited set of data provided by the OBD systems to fulfil the requirements of the various use cases as defined in the WWH-OBD GTR.

The VOBD always supports the same request and response behaviour while communicating with the external test equipment.

8.2 The VOBD system

8.2.1 The VOBD system shall be implemented in the vehicle’s electrical architecture and shall meet the communication performance requirements as specified in the WWH-OBD GTR.

The VOBD system provides the flexibility for the extension of the use of the ISO 27145 series (e.g. adding the wireless access to emissions-related OBD data defined in use case 1 in the future).

One of the ECU(s) of the VOBD system may act as a gateway between the external test equipment and the other ECU(s) of the VOBD system in case the OSI layers 1 to 4 of the in-vehicle network are different from those defined within this part of ISO 27145.

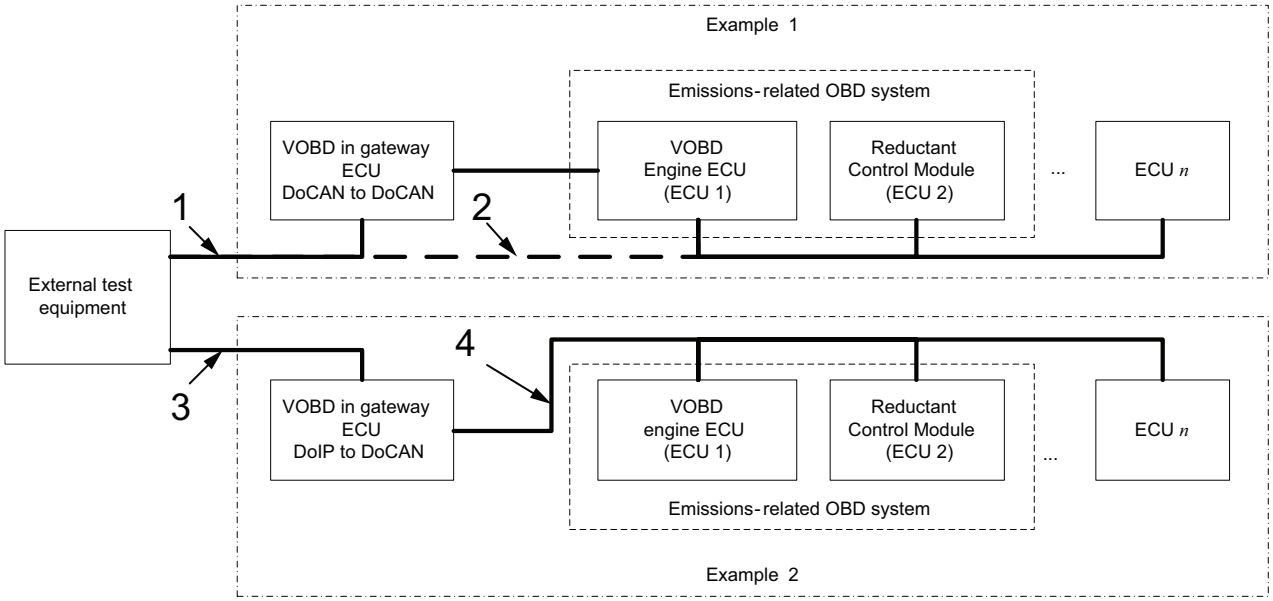
The VOBD system may be (a) dedicated ECU(s), or be provided by another vehicle ECU or system. It is possible that the VOBD functionality can exist as a “software only” module in a vehicle system. The VOBD system provides the flexibility to support not only emissions-related OBD systems, but also other legislated vehicle systems which can be under consideration.

The following are examples for the implementation of the VOBD system in the vehicle’s network.

Figure 3 shows two implementation examples of the VOBD system in a gateway ECU and the engine ECU (ECU 1). The gateway ECU is not part of the example of an emissions-related OBD system.

EXAMPLE 1 The external test equipment communicates to the vehicle gateway or directly to the WWH-OBD GTR compliant emissions-related ECUs using the ISO 27145-4 and ISO 15765-4 DoCAN protocol. The VOBD system is implemented in the gateway ECU and engine ECU (ECU 1).

EXAMPLE 2 The external test equipment communicates to the vehicle gateway using the ISO 27145-4 and ISO 13400-2 DoIP protocol. The gateway communicates to the WWH-OBD GTR compliant emissions-related ECUs using the ISO 15765-4 DoCAN protocol. The VOBD system is implemented in the gateway ECU and engine ECU (ECU 1).



Key

1 connection according to ISO 27145-4 and ISO 15765-4 DoCAN

2 connection according to ISO 27145-4 and ISO 15765-4 DoCAN (in-vehicle network)

3 connection according to ISO 27145-4 and ISO 13400 DoIP

4 connection according to ISO 27145-4 and ISO 15765-4 DoCAN (in-vehicle network)

Figure 3 — Implementation example of VOBD in a gateway ECU and engine ECU

8.2.2 Figure 4 shows two implementation examples of the VOBD system in an engine ECU (ECU 1), which is part of the example of an emissions-related OBD system.

EXAMPLE 1 The external test equipment communicates directly to the WWH-OBD GTR compliant emissions-related ECUs using the ISO 27145-4 and ISO 15765-4 DoCAN protocol. The VOBD system is implemented in the engine ECU (ECU 1).

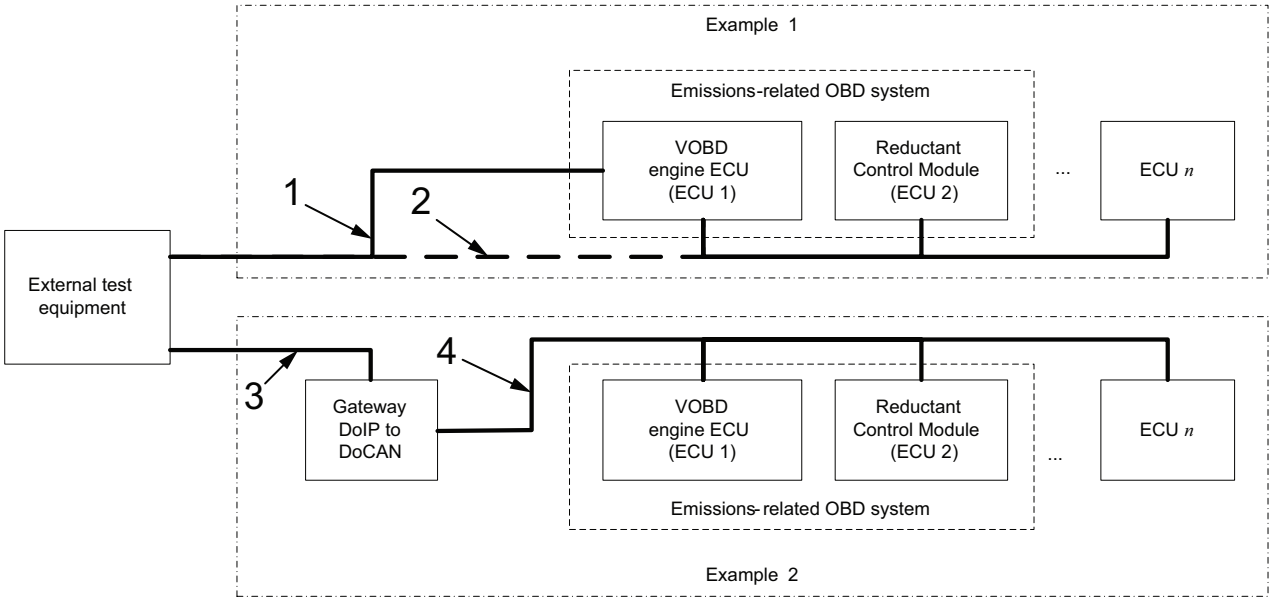
EXAMPLE 2 The external test equipment communicates to the vehicle gateway using the ISO 27145-4 and ISO 13400-2 DoIP protocol. The gateway communicates to the WWH-OBD GTR compliant emissions-related ECUs using the ISO 15765-4 DoCAN protocol. The VOBD system is implemented in the engine ECU (ECU 1).

8.2.3 Figure 5 shows two implementation examples of the VOBD system in an engine ECU (ECU 1) and a Reductant Control Module (ECU 2). Both are part of the example of an emissions-related OBD system.

EXAMPLE 1 The external test equipment communicates directly to the WWH-OBD GTR compliant emissions-related ECUs using the ISO 27145-4 and ISO 15765-4 DoCAN protocol. The VOBD system is implemented in the engine ECU (ECU 1) and a Reductant Control Module (ECU 2).

EXAMPLE 2 The external test equipment communicates with the vehicle gateway using the ISO 27145-4 and ISO 13400-2 DoIP protocol. The gateway communicates with the WWH-OBD GTR compliant emissions-related ECUs using the ISO 15765-4 DoCAN protocol. The VOBD system is implemented in the engine ECU (ECU 1) and a Reductant Control Module (ECU 2).

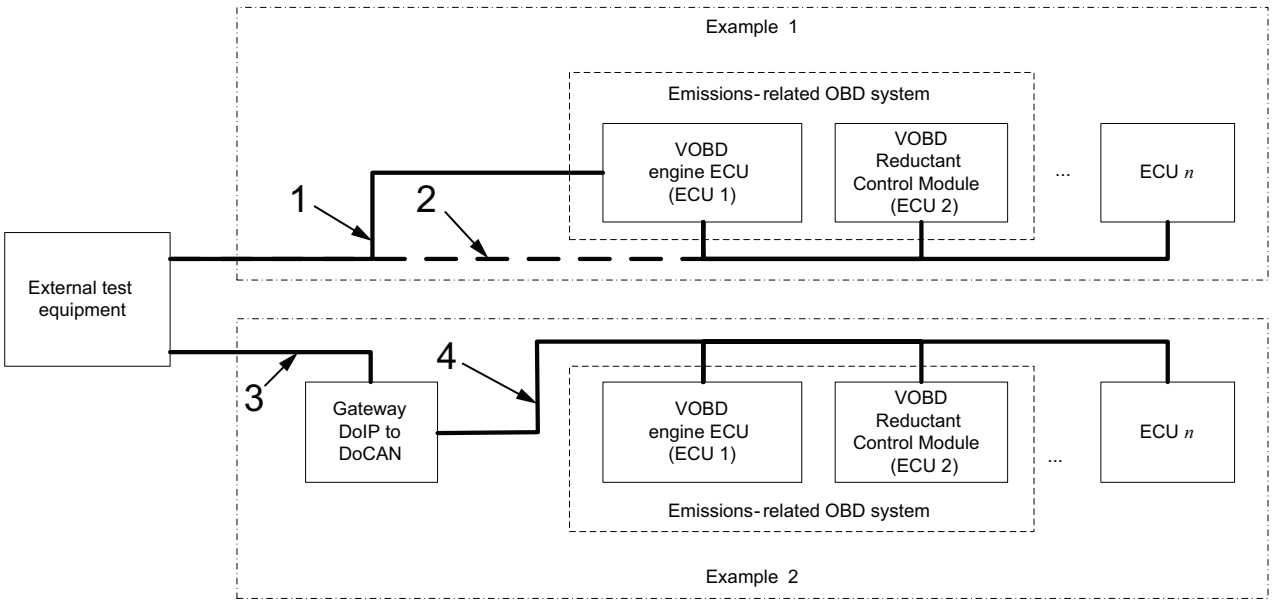
IMPORTANT — It is the manufacturer's responsibility to decide/determine whether the implementation of the example of an emissions-related OBD system is implemented in a single ECU or distributed across multiple networked ECUs.



Key

1 connection according to ISO 27145-4 and ISO 15765-4 DoCAN
2 connection according to ISO 27145-4 and ISO 15765-4 DoCAN (in-vehicle network)
3 connection according to ISO 27145-4 and ISO 13400 DoIP
4 connection according to ISO 27145-4 and ISO 15765-4 DoCAN (in-vehicle network)

Figure 4 — Implementation example of VOBD in an engine ECU



Key

1 connection according to ISO 27145-4 and ISO 15765-4 DoCAN
2 connection according to ISO 27145-4 and ISO 15765-4 DoCAN (in-vehicle network)
3 connection according to ISO 27145-4 and ISO 13400 DoIP
4 connection according to ISO 27145-4 and ISO 15765-4 DoCAN (in-vehicle network)

Figure 5 — Implementation example of VOBD in an engine ECU and a Reductant Control Module

8.3 The VOBD data set

The VOBD data is defined as all data available from the VOBD system. Depending on the various use cases, the OBD data may be provided by the individual OBD systems [e.g. emissions-related ECU(s)] or may be pre-collected.

Therefore, the following two types of data are defined.

a) Burst access data is defined as a limited set of read-only data which shall be provided by the VOBD system upon request from the external test equipment in a very fast manner. Furthermore, the transmission has to be finished within a limited amount of time under all circumstances. Burst access data may be accessed via data caching mode and direct access mode (see 8.4 for the criteria to identify the appropriate method to implement access to this type of data). The VOBD data sets which shall be implemented as burst access data are defined as a limited set of the overall data provided by the OBD system(s) to meet the requirements of the various use cases as defined in the specific modules of the WWH-OBD GTR.

b) Normal access data requires extended transmission time and includes further diagnostic functionality which requires bi-directional interaction between the external test equipment and the VOBD system. Due to its nature, normal access data is only supported via the direct access method defined in 8.4 as the external test equipment can require interaction with the individual OBD system(s). Normal access data is all data defined by the modules of the WWH-OBD GTR, which is not explicitly defined to be of the type burst access data.

Table 6 includes example data (e.g. roadworthiness data) of the VOBD system, which consists of, for example, two emissions-related OBD ECUs.

Table 6 — Example of a VOBD pre-collected emissions OBD vehicle information

Data element	Data (in accordance with ISO 27145-2)
VOBD determined WWH-OBD GTR number	WWH-OBD GTR no.
VOBD determined VIN number	1FMDK02145GA02359
VOBD determined MI status	OFF
VOBD determined readiness status	READY
VOBD determined emissions readiness status	READY
VOBD determined MI counter	0 hours

8.4 The VOBD access method

8.4.1 Overview

The VOBD access method facilitates the access to the vehicle's OBD system(s). The VOBD access method supports two modes:

a) VOBD data caching mode (optional), and/or

b) VOBD direct data mode (mandatory).

The two operating modes are referred to as the single OBD access method as required by the specific modules of the WWH-OBD GTR.

8.4.2 VOBD data caching mode

8.4.2.1 General description

The intention of the data caching mode is to ensure OBD system(s) data availability upon external test equipment request for specific use cases requiring the OBD system(s) to provide burst read-only data access for in-vehicle network communication architectures, which due to their nature are not optimized for the specific use cases. This type of data is referred to as burst access data as defined in 8.3.

The periodic precollected/precached data (data caching) mode is recommended in case the in-vehicle network connecting the OBD system(s) and relevant ECU(s) is too busy with normal operation communication to provide the burst access data as specified in the WWH-OBD GTR.

In this mode, the data cache of the VOBD acts as the source of information defined by those use cases, which require the OBD system(s) to make burst access data available upon the external test equipment's request. The VOBD system continuously caches information from the relevant OBD system(s). This information is then available for specimen/sample inspection by external inspection test equipment.

The information requested by the external test equipment depends on the specific use cases as specified by the specific modules of the WWH-OBD GTR. Each use case requires a set of data supported by the individual OBD system(s).

IMPORTANT — It is the manufacturer's responsibility to determine the necessity of the implementation of VOBD data caching mode to support the burst data access in order to comply with the WWH-OBD GTR communication performance requirements.

8.4.2.2 VOBD data caching sampling period definition

The maximum age of each data item is defined in ISO 27145-4 in compliance with the requirements of the WWH-OBD GTR, which is referred to as maximum data age. In case additional modules of the WWH-OBD GTR are legislated, the ISO 27145 series is expected to be extended accordingly.

IMPORTANT — The maximum data age is different from the communication timing requirements associated with burst access data and normal access data.

EXAMPLE A specific data item can be required not to be older than 10 s, but can be required to be implemented as burst access data.

8.4.2.3 VOBD caching mode implementation

This subclause describes the implementation of the VOBD data caching mode. The gateway ECU utilizes the same diagnostic services that the external test equipment would use in direct data mode to cache read-only data from the example of an emissions-related OBD system ECU(s). Alternatively, the gateway ECU may retrieve the requested information via normal communication on the vehicle's network.

The data caching process (see Figure 6, key items 1 and 2) is continuously executed independent of any request from the external test equipment to the VOBD system in the gateway ECU (see Figure 6, key item 3) and the response (see References [8] and [9]) from the VOBD system in the gateway ECU to the external test equipment (see Figure 6, key item 4). The response (see References [8] and [9]) from the VOBD system in the gateway ECU contains previously cached data (e.g. roadworthiness data of the emissions-related OBD system) (see Figure 6, key items 1 and 2).

In Figure 4, the VOBD caching mode is implemented in the gateway ECU. Key items 1 and 2 show the process of caching burst access data. This process shall be implemented in a way to meet the maximum data age requirements from the specific modules of the WWH-OBD GTR.

Figure 6, key items 3 and 4, describe the process of the gateway ECU providing previously cached data upon request for burst access data from the external test equipment.

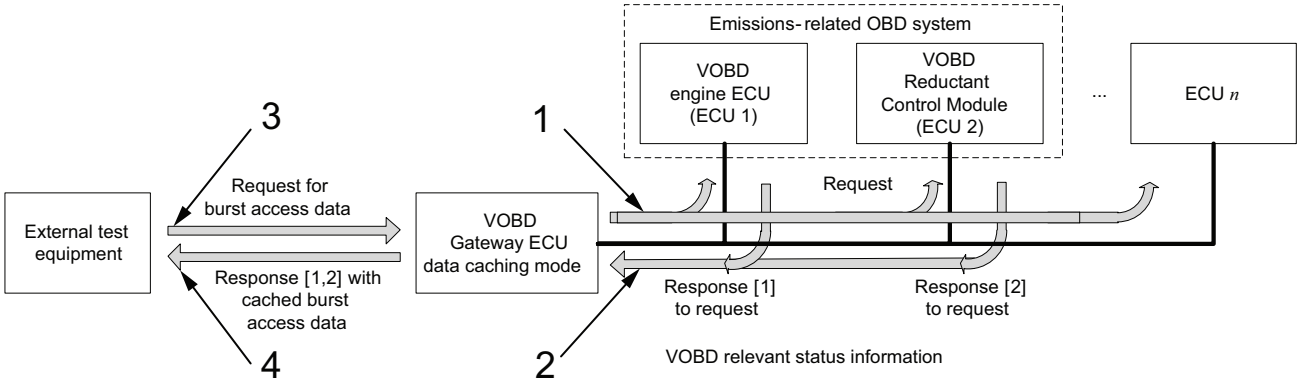
a) The gateway ECU periodically collects (requests) updated roadworthiness data from the emissions-related OBD system which is implemented in ECU 1 and 2.

b) The OBD system(s) (example of an emissions-related OBD system) responds with the requested data if this specific data is supported by the individual OBD system.

c) Where the external test equipment requests burst access data, the gateway ECU implementing the VOBD caching mode responds to specific data requests from the external test equipment.

d) The gateway ECU implementing the VOBD caching mode sends response messages to the external test equipment from its data cache from each example of an emissions-related OBD system ECU(s) which are

part of the VOBD system. In Figure 6, the response (see Reference [8]) contains cached roadworthiness data from ECU 1 and the response (see Reference [9]) contains cached roadworthiness data from ECU 2.



Key

1 request from gateway ECU to emissions-related OBD system ECUs to cache burst access data

2 gateway ECU collects response (see Reference [8]) from engine ECU (ECU 1) and response (see Reference [9]) from Reductant Control Module (ECU 2)

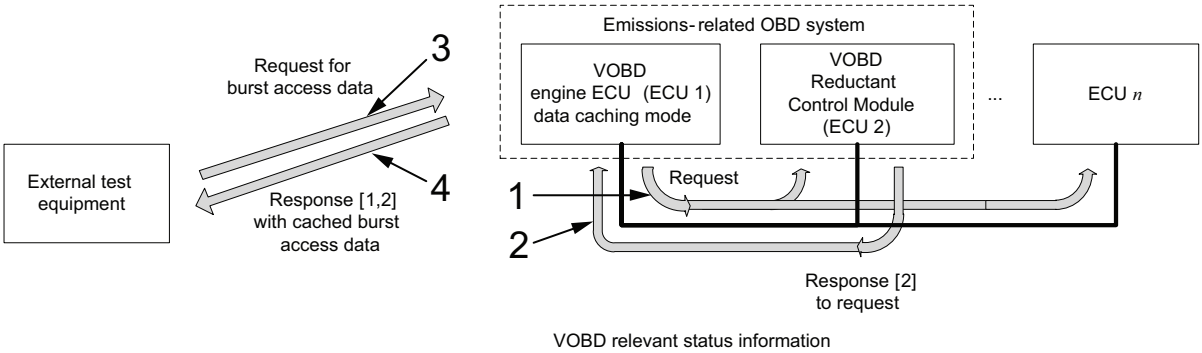
3 request from external test equipment to the VOBD system to retrieve emissions-related burst access data

4 response (see References [8] and [9]) from VOBD system in the gateway ECU containing the cached data (e.g. roadworthiness data) of the emissions-related OBD system.

Figure 6 — VOBD caching methodology of roadworthiness data in a gateway ECU

In Figure 7, the VOBD caching mode is implemented in the engine ECU. The engine ECU utilizes the same diagnostic services that the external test equipment would use in direct data mode to cache read-only data from the example of an emissions-related OBD system ECU(s).

The data caching process (see Figure 7, key items 1 and 2) is continuously executed independent of any request from the external test equipment to the VOBD system in the engine ECU (see Figure 7, key item 3) and the response (see References [8] and [9]) from the VOBD system in the gateway ECU to the external test equipment (see Figure 7, key item 4). The response (see References [8] and [9]) from the VOBD system in the gateway ECU contains previously cached data (e.g. roadworthiness data of the emissions-related OBD system) (see Figure 7, key items 1 and 2).



Key

1 request from engine ECU (ECU 1) to emissions-related OBD system ECUs and the engine ECU's internal VOBD implementation to cache burst access data

2 engine ECU (ECU 1) collects response (see Reference [8]) from its internal VOBD implementation and response (see Reference [9]) from the Reductant Control Module (ECU 2)

3 request from external test equipment to VOBD system in the engine ECU (ECU 1) to retrieve burst access data

4 response (see References [8] and [9]) from VOBD system in the engine ECU (ECU 1) containing the cached data (e.g. roadworthiness data) of the emissions-related OBD system

Figure 7 — Example of VOBD cached roadworthiness data in the engine ECU

8.4.3 VOBD direct data mode

8.4.3.1 General description

The pass-through data (direct data) mode is recommended in case the in-vehicle network connecting the OBD system(s) and relevant ECU(s) meet the communication performance requirements of the specific module of the WWH-OBD GTR. This mode of operation is recommended for the burst data access, if the OBD system and vehicle network performance is sufficient to comply with the WWH-OBD GTR communication performance requirements. This choice should minimize the impact of possible future evolutions, e.g. new OBD systems required by specific modules of the WWH-OBD GTR.

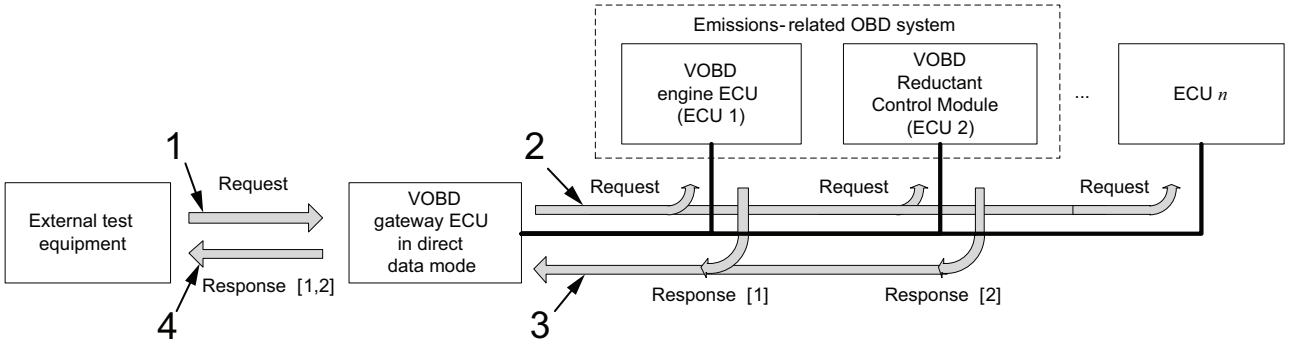
In this mode, the VOBD system is in a pass-through (direct data) mode of operation and acts as a message header converter in case the data link between the external test equipment and the ECU(s), containing the VOBD system, is different.

8.4.3.2 VOBD direct data mode implementation

The external test equipment requests VOBD emissions-related OBD system status information (e.g. roadworthiness data) from the VOBD.

The implementation is based on the VOBD direct data mode in an ECU (e.g. gateway ECU) which is not part of the sample/specimen emissions-related OBD system. The VOBD in direct data mode performs any necessary modifications to the original external test equipment request and forwards this request to the vehicle's internal network. The emissions-related OBD system, which is implemented in ECU 1 and 2, sends two response messages to the gateway ECU containing the VOBD function in direct data mode. ECU n does not send a response message because it is not part of the emissions-related OBD system. The VOBD function passes the response messages through and the gateway ECU performs any necessary modifications to the message frame to meet the data link requirements of the connection between the vehicle and the external test equipment.

In Figure 8, the VOBD function is implemented in the gateway ECU, engine ECU and Reductant Control Module. The gateway ECU routes the request from the external test equipment to the example of an emissions-related OBD system ECU(s). Those ECU(s) respond individually on the request if the requested data is supported by the ECUs. The gateway ECU routes the two response messages back to the external test equipment, one response (see Reference [8]) containing roadworthiness data from ECU 1 and one response (see Reference [9]) containing roadworthiness data from ECU 2.



Key

1 request from external test equipment to VOBD system to retrieve normal access data or burst access data

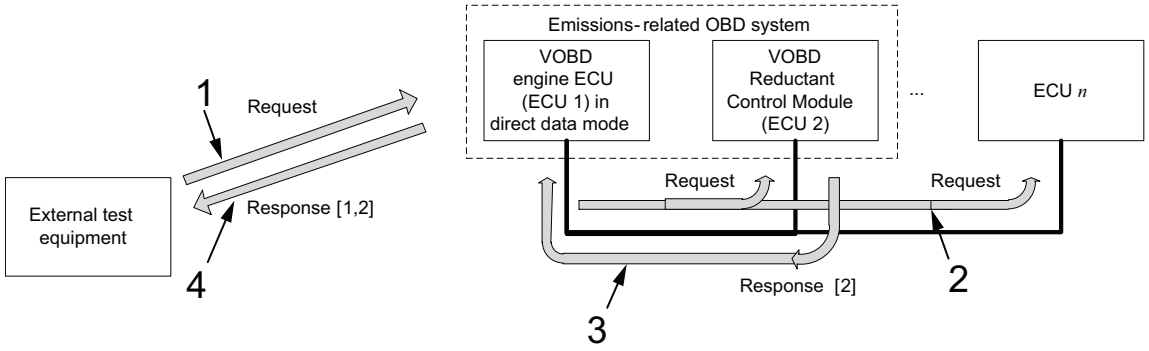
2 gateway ECU routes external test equipment request to emissions-related OBD system ECUs

3 response (see Reference [8]) of the engine ECU (ECU 1) and response (see Reference [9]) of the Reductant Control Module (ECU 2) containing data of the emissions-related OBD system

4 gateway ECU routes response (see Reference [8]) of the engine ECU (ECU 1) and response (see Reference [9]) of the Reductant Control Module (ECU 2) to the external test equipment

Figure 8 — Implementation example of VOBD direct data mode in a gateway ECU

In Figure 9, the VOBD function is implemented in an engine ECU (ECU 1) which is part of the sample emissions-related OBD system. The response behaviour of the engine ECU is the same as described for the gateway ECU in the previous example.



Key

1 request from external test equipment to VOBD system to retrieve normal access data or burst access data

2 engine ECU routes external test equipment request to emissions-related OBD system ECUs

3 response (see Reference [9]) of the Reductant Control Module (ECU 2) containing access data of the emissions-related OBD system

4 engine ECU (ECU 1) sends its response (see Reference [8]) and routes response (see Reference [9]) of the Reductant Control Module (ECU 2) to the external test equipment

Figure 9 — Implementation example of VOBD direct data mode in an engine ECU

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