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Road vehicles — Implementation of WWH-OBD communication requirements —

Part 1:
General information and use case definition

Véhicules routiers — Mise en application des exigences de communication WWH-OBD —

Partie 1: Informations générales et définition de cas d'usage

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Foreword

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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.

In other circumstances, particularly when there is an urgent market requirement for such documents, a technical committee may decide to publish other types of normative document:

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An ISO/PAS or ISO/TS is reviewed after three years in order to decide whether it will be confirmed for a further three years, revised to become an International Standard, or withdrawn. If the ISO/PAS or ISO/TS is confirmed, it is reviewed again after a further three years, at which time it must either be transformed into an International Standard or be withdrawn.

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

ISO/PAS 27145 consists of the following parts, under the general title *Road vehicles — Implementation of WWH-OBD communication requirements*:

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

— *Part 2: Common emissions-related data dictionary*

— *Part 3: Common message dictionary*

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

NOTE   ISO/PAS 27145-4 will be extended as necessary due to introduction of additional communication media.

Introduction

This document set includes the communication between the vehicle's OBD systems and test equipment implemented across vehicles within the scope of the WWH-OBD GTR (World Wide Harmonized On-Board Diagnostics Global Technical Regulations).

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

To achieve this, it is based on the Open Systems Interconnection (OSI) Basic Reference Model in accordance with 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/PAS 27145 are broken into:

— Diagnostic services (layer 7), specified in ISO/PAS 27145-3;

— Presentation layer (layer 6), specified in ISO/PAS 27145-2;

— Session layer services (layer 5), specified in ISO/PAS 27145-4;

— Transport layer services (layer 4), specified in ISO/PAS 27145-4;

— Network layer services (layer 3), specified in ISO/PAS 27145-4;

— Data link layer (layer 2), specified in ISO/PAS 27145-4;

— Physical layer (layer 1), specified in ISO/PAS 27145-4;

in accordance with Table 1.

Table 1 — Enhanced and legislated OBD diagnostic specifications applicable to the OSI layers

Applicability	OSI 7 layers	Implementation of WWH-OBD communication requirements, e.g. emissions-related UDS
Seven layers according to ISO/IEC 7498-1 and ISO/IEC 10731	Application (layer 7)	ISO/PAS 27145-3 / ISO 14229-1
	Presentation (layer 6)	ISO/PAS 27145-2
	Session (layer 5)	ISO/PAS 27145-4
	Transport (layer 4)	
	Network (layer 3)	
	Data link (layer 2)	
	Physical (layer 1)	

Road vehicles — Implementation of WWH-OBD communication requirements —

Part 1:
General information and use case definition

1   Scope

ISO/PAS 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 worldwide standardized communication standard, the initial communication concept will be based on CAN. In a second step, ISO/PAS 27145 will be extended to define the world-wide harmonized OBD communication standard based on existing industry communications standards (e.g. Internet Protocol) over Ethernet. Due to the usage of standard network layer protocols, future extensions to optional physical layers (e.g. wireless) are possible.

This part of ISO/PAS 27145 gives an overview of the structure and the partitioning of the different parts of this standard, and shows the relation between the parts. In addition, it outlines the use case scenarios where the ISO/PAS 27145 document set will be used. All terminology that is common throughout the ISO/PAS 27145 document set is also outlined here.

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

ISO/IEC 10731, *Information technology — Open Systems Interconnection — Basic Reference Model — Conventions for the definition of OSI services*

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

ISO/PAS 27145-2, *Road vehicles — Implementation of WWH-OBD communication requirements — Part 2: Common emissions-related data dictionary*

ISO/PAS 27145-3, *Road vehicles — Implementation of WWH-OBD communication requirements — Part 3: Common message dictionary*

ISO/PAS 27145-4, *Road vehicles — Implementation of WWH-OBD communication requirements — Part 4: Connection between vehicle and test equipment*

3   Terms and definitions

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

3.1
Calibration Identification
CALID
identification code for a specific 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/PAS 27145-2. Additional details are included in the WWH-OBD GTR.

3.2
Class A, B1, B2, C malfunctions
definitions that apply to emissions-related OBD systems

NOTE   Class A, B1, B2 or C are attributes of a DTC. These attributes characterize the impact of a malfunction on emissions or on the OBD system's monitoring capability according to the requirements of the WWH-OBD GTR. Additional details are included in ISO/PAS 27145-3.

3.3
Continuous-Malfunction Indicator
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)

3.4
Continuous-Malfunction Indicator Counter
counter which conveys the amount of time during which the OBD system has been operated while a Continuous-MI is activated

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

3.5
Calibration Verification Number
CVN
server/ECU calculated verification number of a calibration identification number 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/PAS 27145-2. Additional details are included in the WWH-OBD GTR.

3.6
discriminatory display
applying to emissions-related OBD systems, requires the MI to be activated according to the class in which a malfunction has been classified

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

3.7
Global Technical Regulation
GTR
(See 3.15.)

3.8
malfunction
failure or deterioration of a vehicle or engine system or component, including the OBD system

NOTE   The WWH-OBD GTR will specifically identify what conditions are considered to be malfunctions.

3.9
Malfunction Indicator
MI
indicator which clearly informs the driver of the vehicle in the event of a malfunction

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

3.10
Malfunction Indicator Counter
counter which conveys the amount of time during which the OBD system has operated while a malfunction is active

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

3.11
non-discriminatory display
applying to emissions-related OBD systems, requires only a single type of MI activation

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

3.12
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.

3.13
Vehicle Identification Number
VIN
identification number specific and unique to each vehicle following the applicable legal provisions of each national/regional authority

3.14
Vehicle On-Board Diagnostics
VOBD
provides a single access point for external test equipment to retrieve all data of the OBD system

3.15
World Wide Harmonized – On-Board Diagnostics Global Techical Regulation
WWH – OBDGTR
defines the use-cases and requirements for OBD systems

NOTE   See Reference [1] in the Bibliography for further details regarding the WWH-OBD GTR.

4   Symbols and abbreviated terms

CALID   Calibration Identification

CVN   Calibration Verification Number

DTC   Diagnostic Trouble Code

ECM   Engine Control Module

ECU   Electronic Control Unit

GTR   Global Technical Regulations

MI	Malfunction Indicator
OBD	On-Board Diagnostics
UDM	Urea Dosing Module
VIN	Vehicle Identification Number
VOBD	Vehicle On-Board Diagnostics
WLAN	Wireless Local Area Network
WWH-OBD	Word Wide Harmonized On-Board Diagnostics
WWH-OBD GTR	World Wide Harmonized On-Board Diagnostics Global Technical Regulation

5   Conventions

ISO/PAS 27145 is based on the conventions discussed in the O.S.I. Service Conventions (ISO/IEC 10731:1994) as they apply for diagnostic services.

6   Document overview

The ISO/PAS 27145 document set 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 WWH-OBD GTR (Global Technical Regulation).

— ISO/PAS 27145-1: General information and use case definitions (this part), provides an overview of the document set along with the use case definitions and a common set of resources (definitions, references) for use by all subsequent parts.

— ISO/PAS 27145-2: Common emissions-related data dictionary, provides data definitions for emissions-related legislated diagnostics (see also Note below).

— ISO/PAS 27145-3: Common message dictionary, provides the message implementation details from ISO 14229 – UDS to support the required legislated OBD.

— ISO/PAS 27145-4: Connection between vehicle and test equipment, 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. This part of the standard will be extended as necessary due to introduction of additional communication media.

NOTE   Additional parts of this standard will be introduced as necessary to consider further OBD systems not yet covered by this standard.

7   Use case description

7.1   Overview

The OBD system is required to make available vehicle diagnostic information under several different use cases as specified by the WWH-OBD GTR (Global Technical Regulation). These use cases provide the implementer with guidance in the implementation of the VOBD (described later in this document), and methodology used on the vehicle to make the required data available. This part of the standard will be extended as necessary due to introduction of additional WWH-OBD GTR use cases (i.e. non emissions-related).

7.2   Emissions-related use cases

7.2.1   Use case summary

The following is a summary of the use cases applicable to emissions-related OBD systems:

⎯ **Use case 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 emission performance as specified in the WWH-OBD GTR. A typical use of this information package may be a 'Roadside Check' performed by an enforcement authority.

⎯ **Use case 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 characterise the malfunctions detected by the OBD system. A typical use of this information package may be a periodic inspection by enforcement authorities.

⎯ **Use case 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 definition of each data item listed in the use cases can be found in the emissions-related module of the WWH-OBD GTR.

7.2.2   Use case 1 – Information about the emissions-related OBD system state

This use case provides an enforcement agency with the Malfunction Indication status and associated vehicle system data (e.g. MI counter, readiness status etc.).

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/PAS 27145-2 for the external roadside check test equipment to assimilate and provide the enforcement agency with the following information.

a)   The WWH-OBD GTR (and revision) number.

b)   Discriminatory / Non-Discriminatory display strategy.

c)   The VIN (Vehicle Identification Number).

d)   Presence of a Continuous-MI.

e)   The readiness status of the OBD system.

f)   The number of engine operating hours since the Malfunction Indicator has been activated (Continuous-MI counter).

This information shall be read-only access (i.e. no clearing) within the context of use case 1.

7.2.3   Use case 2 – Information about active and confirmed emissions-related malfunctions

This information will provide 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).

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/PAS 27145-2 for the external inspection test equipment to assimilate the data and provide an inspector with the following information:

a)   The WWH-OBD GTR (and revision) number.

b)   Discriminatory/non-discriminatory display strategy.

c)   The VIN (Vehicle Identification Number).

d)   The Malfunction Indicator status.

e)   The Readiness status of the OBD system.

f)   The number of warm-up cycles and number of engine operating hours since recorded OBD information was last cleared.

g)   The number of engine operating hours since the Malfunction Indicator has been activated (Continuous-MI counter).

h)   The cumulated operating hours with a Continuous-MI (cumulative Continuous-MI counter).

i)   The confirmed and active DTCs for Class A malfunctions.

j)   The confirmed and active DTCs for Classes B (B1 and B2) malfunctions.

k)   The confirmed and active DTCs for Class B1 malfunctions.

This information shall be read only access (i.e. no clearing) within the context of use case 2.

7.2.4   Use case 3 – Information related to diagnosis for the purpose of repair

This information will provide repair technicians with all OBD data specified in the WWH-OBD GTR (e.g. Freeze Frame information).

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/PAS 27145-2 for the external repair test equipment to assimilate the data and provide a repair technician with the following information:

a)   The WWH-OBD GTR (and revision) number.

b)   The VIN (Vehicle Identification Number).

c)   The Malfunction Indicator status.

d)   The Readiness status of the OBD system.

e)   The number of engine operating hours since the Malfunction Indicator has been activated (Continuous-MI counter).

f)   The confirmed and active DTCs for Class A malfunctions.

g)   The confirmed and active DTCs for Classes B (B1 and B2) malfunctions.

h) The confirmed and active DTCs for Class B1 malfunctions and the number of engine operating hours from the B1 counters.

i) The confirmed and active DTCs for Class C malfunctions.

j) The pending DTCs and their associated class.

k) The previously active DTCs and their associated class.

l) Real-time information on OEM selected and supported sensor signals, internal parameters and output signals.

m) The freeze frame data.

n) The software CALID(s) [calibration identification(s)].

o) 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.) in accordance with the provisions of the WWH-OBD GTR, when this request is provided via the external repair test equipment according to ISO/PAS 27145-2.

8 Vehicle On-Board Diagnostic (VOBD)

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 standard 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,

— 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 will always support the same request and response behaviour when communicating with the external test equipment.

8.2 VOBD system

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/PAS 27145 document set to support (pre-processed) burst access data (e.g. add 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 O.S.I. layers 1 through 4 of the in-vehicle network are different from those defined within this document.

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 may 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 that may or may not be under consideration today.

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

Figure 1 shows an implementation example of the VOBD system in a Gateway ECU and the Engine ECU (ECU 1). The Gateway ECU is not part of the e.g. emissions-related OBD system.
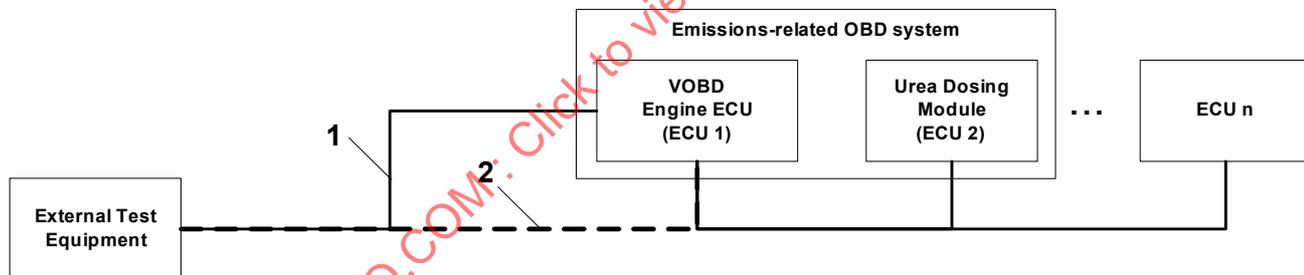

Key
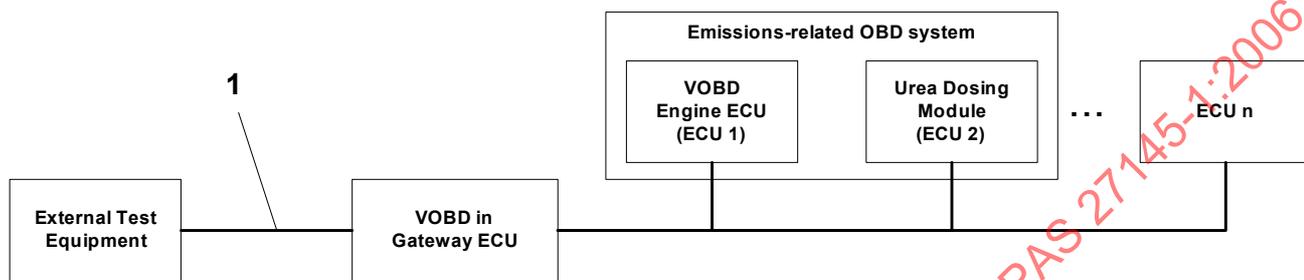
1   connection according to ISO/PAS 27145-4

Figure 1 — Implementation example of VOBD in a Gateway ECU and Engine ECU

Figure 2 shows an implementation example of the VOBD system in an Engine ECU (ECU 1) which is part of the e.g. emissions-related OBD system. In this case the Engine ECU (ECU 1) provides all VOBD related data to the external test equipment.


Key

1   connection according to ISO/PAS 27145-4. ECU 2 will not respond to requests from the external test equipment for VOBD-related data, therefore no data needs to be routed through ECU 1

2   external test equipment directly connected to in-vehicle network if in-vehicle network is compatible with ISO/PAS 27145-4

Figure 2 — Implementation example of VOBD in an Engine ECU

Figure 3 shows an implementation example of the VOBD system in an Engine ECU (ECU 1) and a Urea Dosing Control Module (ECU 2). Both are part of the e.g. emissions-related OBD system and will respond to the request for VOBD-related data from the external test equipment.

Key
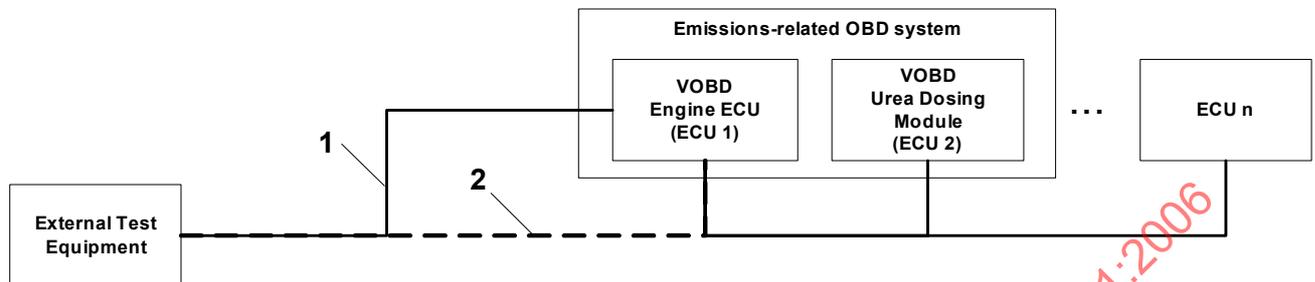
1   connection according to ISO/PAS 27145-4. All VOBD-related data from ECU 2 is routed through ECU 1 to the external test equipment

2   external test equipment directly connected to in-vehicle network if in-vehicle network is compatible with ISO/PAS 27145-4

Figure 3 — Implementation example of VOBD in an Engine ECU and a Urea Dosing Control Module

IMPORTANT — It is the manufacturer's responsibility to either implement the (e.g. emissions-related) OBD system in a single ECU or distribute the implementation across multiple networked ECUs.

8.3   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 two (2) types of data are defined:

a)   **Burst access data** is defined as a limited set of read-only data which has to 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 (refer to clause 8.4 for the criteria to identify the appropriate method to implement access to this type of data). The VOBD data sets which have to 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)   **Direct 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 clause 8.4 as the external test equipment may 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 type burst access data.

Table 2 includes example data (e.g. roadworthiness data) of the VOBD system, which consists of e.g. two (2) emissions-related OBD ECUs.

NOTE   The actual number of ECUs which represent a VOBD system depends on the vehicle system design and is only limited by the addressing scheme used (e.g. maximum of 8 ECUs for 11bit CAN Identifier).

Table 2 — Example of a VOBD pre-collected emissions OBD vehicle information

Data Element	Data (according to ISO/PAS 27145-2)
VOBD determined WWH-OBD GTR number	WWH-OBD GTR #
ECU 1 WWH-OBD GTR number	WWH-OBD GTR #
ECU 2 WWH-OBD GTR number	WWH-OBD GTR #
VOBD determined VIN number	1FMDK02145GA02359
VOBD determined MI Status	OFF
ECU 1 MI Status	OFF
ECU 2 MI Status	OFF
VOBD determined Readiness Status	READY
VOBD determined emissions Readiness Status	READY
ECU 1 Readiness Status	READY
ECU 2 Readiness Status	READY
VOBD determined MI Counter	0 Hours
ECU 1 MI Counter	0 Hours
ECU 2 MI Counter	0 Hours

8.4 VOBD access method

8.4.1 Overview

The VOBD access method facilitates the access to the vehicle's OBD system(s). The VOBD access methods support two (2) modes:

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

b) VOBD direct acccess mode (mandatory).

The two (2) 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 optimised for the specific use cases. This type of data is referred to as burst access data as defined in clause 8.3.

The periodic pre-collected/pre-cached data (data caching) mode is recommended in case the in-vehicle network connecting the OBD system(s) and relevant ECU(s) may be 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 e.g. 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/PAS 27145-2 Common emissions-related data dictionary in compliance with the requirements of the WWH-OBD GTR, which will be referred to as maximum data age. In case additional modules of the WWH-OBD GTR are legislated the ISO/PAS 27145 set of documents will 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 may be required not to be older than 10 seconds but may be required to be implemented as burst access data.

8.4.2.3   VOBD caching mode implementation

This section describes the implementation of the VOBD data caching mode. The Gateway ECU utilises the same diagnostic services as the external test equipment would use in direct access mode to cache read-only data from the e.g. 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 4 - Key 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 4 - Key 3) and the response[1,2] from the VOBD system in the Gateway ECU to the external test equipment (see Figure 4 - Key 4). The response[1,2] from the VOBD system in the Gateway ECU contains previously cached data (e.g. roadworthiness data of the emissions-related OBD system) (see Figure 4 - Key 1 and 2).

In Figure 4 the VOBD caching mode is implemented in the Gateway ECU. The Key 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 4 - Key 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) (e.g. emissions-related OBD system) will respond with the requested data if this specific data is supported by the individual OBD system.

c)   When the external test equipment requests burst access data the Gateway ECU implementing the VOBD caching mode will respond to specific data requests from the external test equipment.

d)   The Gateway ECU implementing the VOBD caching mode will send response messages to the external test equipment from its data cache from each e.g. emissions-related OBD system ECU(s) which are part of the VOBD system. In Figure 4, response[1] contains cached roadworthiness data from ECU 1 and response[2] contains cached roadworthiness data from ECU 2.