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Road vehicles — Implementation of WWH-OBD communication requirements —

Part 4: Connection between vehicle and test equipment

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

Partie 4: Connexion entre véhicule et équipement d'essai

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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order to decide whether it will be confirmed for a further three years, revised to become an International Standard, or withdrawn.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again after a further three years, at which time it must either be transformed into an International Standard or be withdrawn.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 27145-4 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 upon introduction of additional communication media as noted in the scope of this document.

Introduction

This document set defines the communication between a vehicle's OBD system and test equipment implemented 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 WWH OBD systems.

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 application (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 ISO/PAS 27145-4;

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

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

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

in accordance with Table 1.

Table 1 — Enhanced and WWH-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 4:
Connection between vehicle and test equipment

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 defines the requirements to successfully establish, maintain and terminate communication with a vehicle that implements the requirements of the WWH-OBD global technical regulation. This requires plug-and-play communication capabilities of the vehicle as well as any test equipment that intends to establish communication with a vehicle. This document details all the OSI layer requirements to achieve this goal.

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

ISO 11898-2, *Road vehicles — Controller area network (CAN) — Part 2: High-speed medium access unit*

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

ISO 15031-3, *Road vehicles — Communication between vehicle and external equipment for emissions-related diagnostics — Part 3: Diagnostic connector and related electrical circuits, specification and use*

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

ISO 15765-2, *Road vehicles — Diagnostics on Controller Area Networks (CAN) — Part 2: Network layer services*

ISO 15765-3, *Road vehicles — Diagnostics on Controller Area Networks (CAN) — Part 3: Implementation of unified diagnostic services (UDS on CAN)*

ISO 15765-4, *Road vehicles — Diagnostics on Controller Area Networks (CAN) — Part 4: Requirements for emissions-related systems*

ISO/PAS 27145-1, *Road vehicles — Implementation of WWH-OBD communication requirements — Part 1: General information and use case definition*

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*

IEEE 802.3, *IEEE Standard for Information technology — Telecommunications and information exchange between systems — Local and metropolitan area networks — Specific requirements — Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications*

3 Terms and definitions

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

4 Symbols and abbreviated terms

C_{AC1}, C_{AC2}	capacitance of a.c. termination
C_{DC}	capacitance of d.c. termination
C_{CAN_H}	capacitance between CAN_H and ground potential
C_{CAN_L}	capacitance between CAN_L and ground potential
C_{DIFF}	capacitance between CAN_H and CAN_L
L_{CABLE}	max. cable length between OBD connector and external test equipment
R_{AC1}, R_{AC2}	resistance of a.c. termination
R_{DC1}, R_{DC2}	resistance of d.c. termination
t_{SEG1}	timing segment 1
t_{SEG2}	timing segment 2
$t_{SYNCSEG}$	synchronization segment
t_{BIT}	bit time
t_{BIT_RX}	receive bit time
t_{BIT_TX}	transmit bit time
t_{TOOL}	external test equipment CAN interface propagation delay (without external test equipment cable delay)

t_{CABLE}	external-test-equipment cable propagation delay (without external test equipment CAN interface delay)
t_{Q}	time quantum
Δf	oscillator tolerance
ECU	electronic control unit
OBD	on-board diagnostics
Prop_Seg	propagation segment
Phase_Seg1	phase segment 1
Phase_Seg2	phase segment 2
SA	source address
SJW	synchronization jump width
SP	nominal sample point
Sync_Seg	synchronization segment
TA	target address
WWH-OBD	World wide harmonized OBD

5 Conventions

ISO/PAS 27145 is based on the conventions specified in the O.S.I. Service Conventions (ISO/IEC 10731) as they apply for diagnostic services. Therefore the requirements for the individual OSI layers are defined in the sub-clauses listed in Table 2 — Requirements and applicable sub-clauses for the O.S.I. layers.

Table 2 — Requirements and applicable sub-clauses for the O.S.I. layers

Applicability	OSI 7 layers	Applicable sub-clause for CAN
Seven layer according to ISO/IEC 10731	Application (layer 7)	7.2
	Presentation (layer 6)	7.3
	Session (layer 5)	7.4
	Transport (layer 4)	7.5
	Network (layer 3)	
	Data link (layer 2)	7.6
	Physical (layer 1)	7.7

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/PAS 27145 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 remaining parts of ISO/PAS 27145 remain unaltered.

a) Controller Area Network based wired connection (section 7)

   This is the type of connection which describes the usage of the WWH-OBD communication services on existing ISO15765-4 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) TCP/IP over Ethernet wired connection

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

   This type of connection is not defined yet in ISO/PAS 27145-4 but will be contained in future versions of this standard.

7 CAN based wired connection

7.1 Initialization sequence

The external test equipment shall support the initialization sequence as specified in this part of ISO/PAS 27145. Figure 1 — Initialization sequence overview provides an overview of the CAN initialization sequence. The following descriptions of the external test equipment initialization sequence make use of the off-page-connectors A to G as shown in Figure 1 — Initialization sequence overview to reference certain entry and exit points.

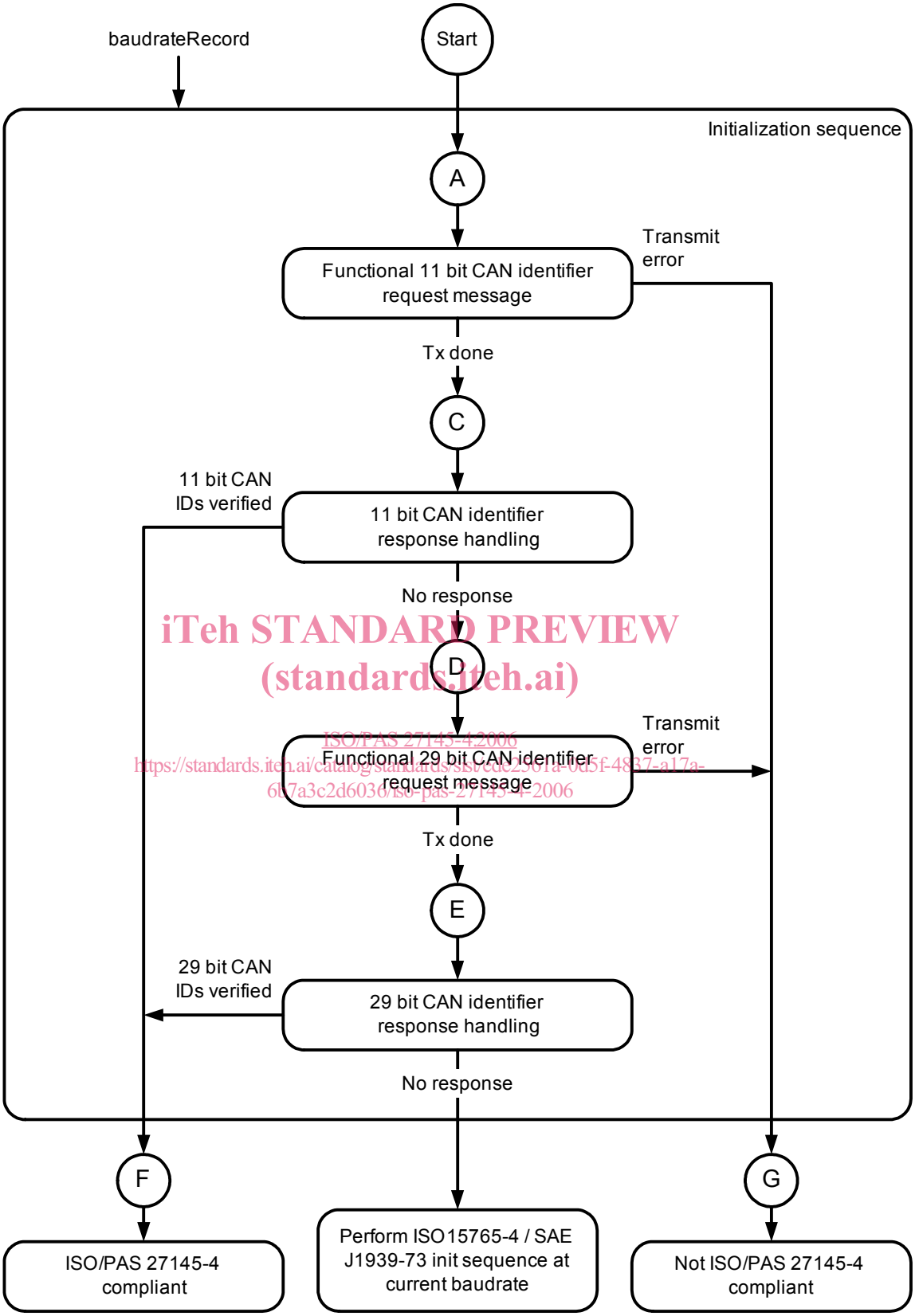

Figure 1 — Initialization sequence overview

The purpose of the external test equipment initialization sequence is to automatically detect whether the vehicle supports WWH-OBD or legislated ISO 15765-4 diagnostic communication on CAN using the physical layer specified in section 7.7. In addition the specific CAN configuration used for communication is determined (specific communication baud-rate, CAN identifier format). Furthermore, the initialization sequence determines the V-OBD system's ECUs (based on the CAN-IDs as defined in section 7.5.2.2) expected to respond to ISO/PAS 27145-3 service 0x12 requests. The individual steps to be performed by the external test equipment are defined in greater detail in Figure 2 — Functional 11 bit CAN identifier request transmission, Figure 3 — 11 bit CAN identifier response handling, Figure 4 — 29 bit CAN identifier request transmission and Figure 5 — 29 bit CAN identifier response handling. The same letters are used for off-page connectors (e.g. details for off-page connector A are described in Figure 2 — Functional 11 bit CAN identifier request transmission).

NOTE For each WWH-OBD diagnostic service that requires the determination of “supported” information, the external test equipment has to update its list of expected responding WWH-OBD ECUs prior to any data parameter requests (see ISO/PAS 27145-2 and ISO/PAS 27145-3 for the corresponding services and data identifiers).

The external test equipment shall support to perform the initialization sequence at multiple CAN baud-rates sequentially using one of the following baud-rates (also referred to as baudrateRecord) at a time:

— 250 kBit/s

— 500 kBit/s

The parameter baudrateRecord shall be used to specify the baud-rate to be used for the initialization. If the baudrateRecord parameter contains a single baud-rate, then a single baud-rate initialization sequence shall be performed using the specified single baud-rate (e.g. 500 kBit/s). If the baudrateRecord parameter contains multiple baud-rates, then a multiple baud-rate initialization sequence including a baud-rate detection procedure shall be performed using the specified multiple baud-rates (e.g. 250 kBit/s and 500 kBit/s).

By default the baudrateRecord contains all baud-rates specified in 7.7.2. The default content of the parameter baudrateRecord can be superseded by any other list of baud-rates, e.g. single 500 kBit/s baud-rate as specified in 8.3.3. For legislated-OBD baud-rates, the external test equipment shall use the appropriate CAN bit timing parameter values defined in 7.7.3.

The external test equipment initialization sequence contains provisions for legacy vehicles using either CAN (same or different physical layer as defined for WWH-OBD) or a different protocol (non-CAN) on the CAN pins of the ISO 15031-3 diagnostic connector. This is to prevent legacy communication networks from being disturbed by ISO/PAS 27145-compliant external test-equipment.

The initialization sequence is designed to support detection of the following CAN-identifier structures:

a) 11 bit CAN identifier verification procedure (see section 7.1.2), and

b) 29 bit CAN identifier verification procedure (see 7.1.3).

7.1.1 External test equipment error detection provisions

Where a vehicle uses CAN with a physical layer different from that specified for WWH-OBD (see section 7.7) or a non-CAN protocol on the CAN pins of the OBD connector, the transmit procedure given as follows shall guarantee that in all cases the external test equipment will detect that the vehicle does not support CAN as specified for WWH-OBD and will stop the transmission of the request message immediately.

Where the vehicle uses CAN and the physical layer according to section 7.7, the transmit procedure given as follows shall guarantee that in all cases the external test equipment will detect that it uses the wrong baud-rate or the wrong physical layer configuration for the transmission of the request message and will stop disturbing the CAN bus or whatever the vehicle's physical layer is immediately. Under normal in-vehicle conditions (i.e. no error frames during in-vehicle communication when the external test equipment is disconnected), the external test equipment will disable its CAN interface prior to the situation where the internal error counters of the OBD ECU(s) reach critical values.

To achieve this, the external test equipment shall support the following features.

— Possibility to stop sending immediately during transmission of any CAN frame. The CAN interface should be disconnected within 12 µs from reception of a bus frame error signal. The maximum time for the disconnection is 100 µs. With the CAN interface disconnected, the external test equipment shall not be able to transmit dominant bits on the CAN bus.

— Possibility to immediately detect any frame error on the CAN bus.

NOTE The second provision implies that the external test equipment can not solely rely on the usual CAN-controller error handling since it will most likely flag a frame error only after the “bus-off ”-state has been reached (refer to ISO 11898-1 for further details).

7.1.2 11 bit CAN identifier verification procedure

7.1.2.1 Request message transmit procedure

The purpose of the 11 bit CAN identifier verification procedure is to determine whether 11 bit CAN identifiers are being used in legislated-OBD communication and, if multiple baud-rates are specified in the baudrateRecord parameter, to determine the baud-rate to be used for communication.

The procedure shall be performed as defined in Figure 2 — Functional 11 bit CAN identifier request transmission.

a) The external test equipment shall set up its CAN interface using the first baud-rate contained in the baudrateRecord. It shall use the CAN bit timing parameter values defined for this baud-rate (see section 7.7.3).

b) Following the CAN interface set-up, the external test equipment shall connect to the CAN bus and immediately transmit a functionally addressed request message with service 0x12 and the desired FunctionalGroupID (e.g. “Emissions system” or “Overall roadworthiness”) as specified in ISO/PAS 27145-3 using the WWH-OBD 11 bit functional request CAN identifier as defined in section 7.5.2.2.2.

c) The external test equipment shall check for any CAN error. If the request message is successfully transmitted onto the CAN bus, the external test equipment shall indicate a successful transmission and proceed to off-page connector C.

d) If an acknowledge check error is detected, then the external test equipment shall continue to retry the transmission of the request message until the timeout N_As (25 ms) has elapsed.

e) If any other CAN error occurred, or an acknowledge check error occurred after the N_As timeout (25 ms) has elapsed, then the external test equipment shall disconnect its CAN Interface from the CAN bus. It shall check whether more baud-rates are contained in the baudrateRecord. If no further baud-rate is contained in the baudrateRecord, it shall indicate that the request was not transmitted successfully (off-page connector G).

f) If the end of the baudrateRecord is not reached, the external test equipment shall set up its CAN interface using the next baud-rate in the baudrateRecord. Following the CAN interface set-up, the external test equipment shall restart the transmission of the request message (off-page connector B).