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Road vehicles — Diagnostic communication over Controller Area Network (DoCAN) —

Part 4:
Requirements for emissions-related systems

Véhicules routiers — Diagnostic sur gestionnaire de réseau de communication (DoCAN) —

Partie 4: Exigences applicables aux systèmes associés aux émissions

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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

— This document was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 31, *Data communication*.

— This fourth edition cancels and replaces the third edition (ISO 15765-4:2016), which has been technically revised.

— The main changes compared to the previous edition are as follows:

— Corrected all occurrences of ⊣⊨ $P2_{CAN\_max}$ and changed to $\Delta P2_{CAN\_max}$;

— Clause 6 title has been changed to application;

— Subclause 6.1 title has been changed to vehicle communication initialisation sequence;

— Subclause 6.2 title has been changed to external test equipment communication initialisation sequence;

— Changed N_As/N_Ar timeout value to 33 ms;

— Inconsistency in 10.3.3 regarding the acceptance of physically addressed request messages;

— A list of all parts in the ISO 15765 series can be found on the ISO website.

— Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

This document has been established in order to define common requirements for vehicle diagnostic systems implemented on a Controller Area Network (CAN) communication link, as specified in ISO 11898. Although primarily intended for diagnostic systems, it also meets requirements from other CAN-based systems needing a network layer protocol.

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[1], which structures communication systems into seven layers.

When mapped on this model, the application protocol and lower OSI layers framework requirements specified/referenced in ISO 15765 series standard is structured according to Figure 1.

Figure 1 illustrates a standards-based documentation concept, which consists of the lower OSI layers framework, which specifies requirements related to the transport layer, network layer, data link layer, and physical layer standards of the OSI layers 4, 3, 2, and 1.

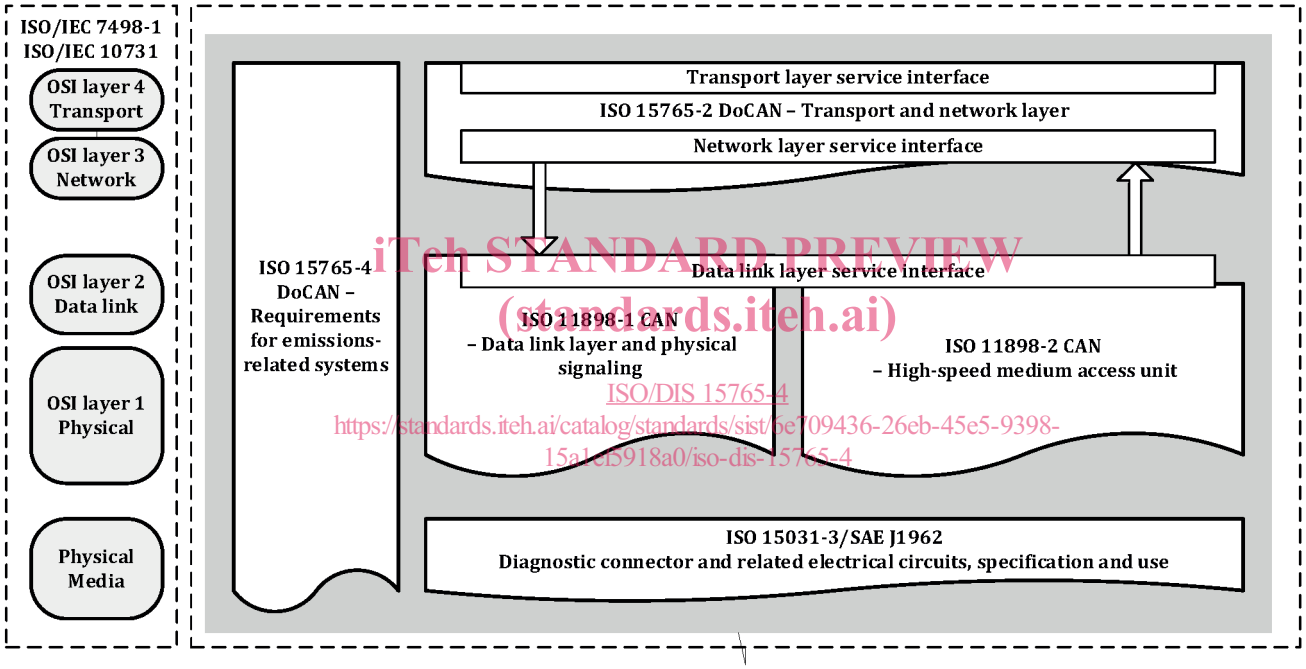


Figure 1 — DoCAN related OSI layers framework

Road vehicles — Diagnostic communication over Controller Area Network (DoCAN) —

Part 4: Requirements for emissions-related systems

1 Scope

This document specifies requirements for Controller Area Networks (CAN) between the in-vehicle network and the diagnostic link connector of the vehicle. The network presumes the use of an external test equipment for inspection and repair diagnostics, and other possible use cases. This document does not specify any requirements related to the in-vehicle CAN network architecture. This document defines the requirements to enable the in-vehicle CAN network to successfully establish, maintain, and terminate communication with the devices externally connected to the diagnostic link connector.

This document places restrictions on those International Standards for the fulfilment of the regulations. It does not specify in-vehicle CAN bus architecture, but seeks to ensure that the vehicle's regulated CAN communications comply with external test equipment requirements.

This document is the entry point for DoCAN (Diagnostic communication over Controller Area Network). Based on the results of the initialisation, the external test equipment determines which protocol and diagnostic services are supported by the vehicle's emissions-related system.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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/IEC 7498-1:1994, *Information technology — Open Systems Interconnection — Basic Reference Model: The Basic Model*

ISO/IEC 10731:1994, *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 14229-2, *Road vehicles — Unified diagnostic services (UDS) — Part 2: Session layer services*

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

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC 7498-1, ISO 15765, ISO 11898 series, and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
on-board diagnostics on emissions diagnostic services
OBDonEDS
application protocol request and response messages defined in ISO 15031-5/SAE J1979-1 dedicated to the diagnostics of emissions-related systems

3.2
on-board diagnostics on unified diagnostic services
OBDonUDS
application protocol request and response messages defined in ISO 14229 series and in ISO 27145-3 or SAE J1979-2 dedicated to the diagnostics of emissions-related systems

4 Symbols and abbreviated terms

4.1 Symbols

Symbol	Definition	Unit
C_{AC1}, CAC2	capacitance of a.c. termination	F
C_{CAN_H}	capacitance between CAN_H and ground potential	F
C_{CAN_L}	capacitance between CAN_L and ground potential	F
C_{DIFF}	capacitance between CAN_H and CAN_L	F
Δf	oscillator tolerance	Hz
l_{CABLE}	maximum cable length between diagnostic link connector and external test equipment	m
$P_{2\_Client\_Max}$	timeout value of the client application to receive a response on a request message	
$P_{2\_CAN\_Client}$	client application wait time on server response on CAN	
PropSeg	propagation segment	
PhaseSeg1	phase segment 1	
PhaseSeg2	phase segment 2	
R_{AC1}, R_{AC2}	resistance of a.c. termination	Ω
SyncSeg	synchronization segment	
t_{BIT}	bit time	µs
t_{BIT_RX}	receive bit time	µs
t_{BIT_TX}	transmit bit time	µs
t_{CABLE}	external-test-equipment cable propagation delay (without external test equipment CAN interface delay)	µs
t_{SP}	nominal sample point position	µs
t_{SEG1}	timing segment 1	µs
t_{SEG2}	timing segment 2	µs
t_{SJW}	resynchronization jump width	µs
$t_{SYNCSEG}$	synchronization segment	µs
t_{TOOL}	external test equipment CAN interface propagation delay (without external test equipment cable delay)	µs
t_Q	time quantum	µs

4.2 Abbreviated terms

N_{BS}	block size
CAN	controller area networks
N_{CF}	consecutive frame
DID	data identifier
DLC	data length code
DoCAN	diagnostic communication over CAN
ECU	electronic control unit
ECM	engine control module
N_{FC}	flow control
N_{FF}	first frame
N_{FS}	flow status
OBD	on-board diagnostics
PID	parameter identifier
N_SA	source address
N_{SF}	single frame
SJW	synchronisation jump width
SP	nominal sample point
N_TA	target address
TCM	transmission control module

5 Conventions

This document is based on OSI service conventions as specified in ISO/IEC 10731.

6 Application

6.1 Vehicle communication initialisation sequence

6.1.1 OBDonUDS protocol identification

Vehicles that support OBDonUDS shall have ECUs that reply to the functional request service identifier 22_{16} and DID $F810_{16}$ for protocol identification.

6.1.2 OBDonEDS protocol identification

Vehicles that support OBDonEDS shall have ECUs that reply to the functional request service identifier 01_{16} and PID 00_{16} for protocol identification.

6.1.3 Others

Vehicles that do not respond to either request (6.1.1, 6.1.2) do not support regulated OBD diagnostics specified in this document.

6.2 External test equipment communication initialisation sequence

The external test equipment shall support the initialisation sequence specified in this document.

The purpose of the external test equipment initialisation sequence is to automatically detect, whether the vehicle supports regulated OBDonUDS or OBDonEDS using CAN as the physical layer specified in Clause 12.

Furthermore, the initialisation sequence determines the communication compliance status of vehicles by analysing their responses as specified in 6.1.1 and 6.1.2.

For each regulated OBDonUDS or OBDonEDS service that requires the determination of "supported" information, the external test equipment updates its list of expected responding ECUs prior to any data parameter requests.

The external test equipment initialisation sequence supports single bit rate initialisation (e.g. 500 kBit/s) and multiple bit rate initialisation (e.g. 250 kBit/s and 500 kBit/s) and is separated into the following tests:

a) 11-bit CAN identifier validation (see 6.4.1);

b) 29-bit CAN identifier validation (see 6.4.2).

The external test equipment initialisation sequence shall contain provisions for legacy vehicles using either CAN or a non-CAN protocol on the CAN pins of the ISO 15031-3 diagnostic link connector.

6.3 Bit rate validation procedure

6.3.1 bitrateRecord

The parameter "bitrateRecord" contains the bit rates as specified in 12.2.

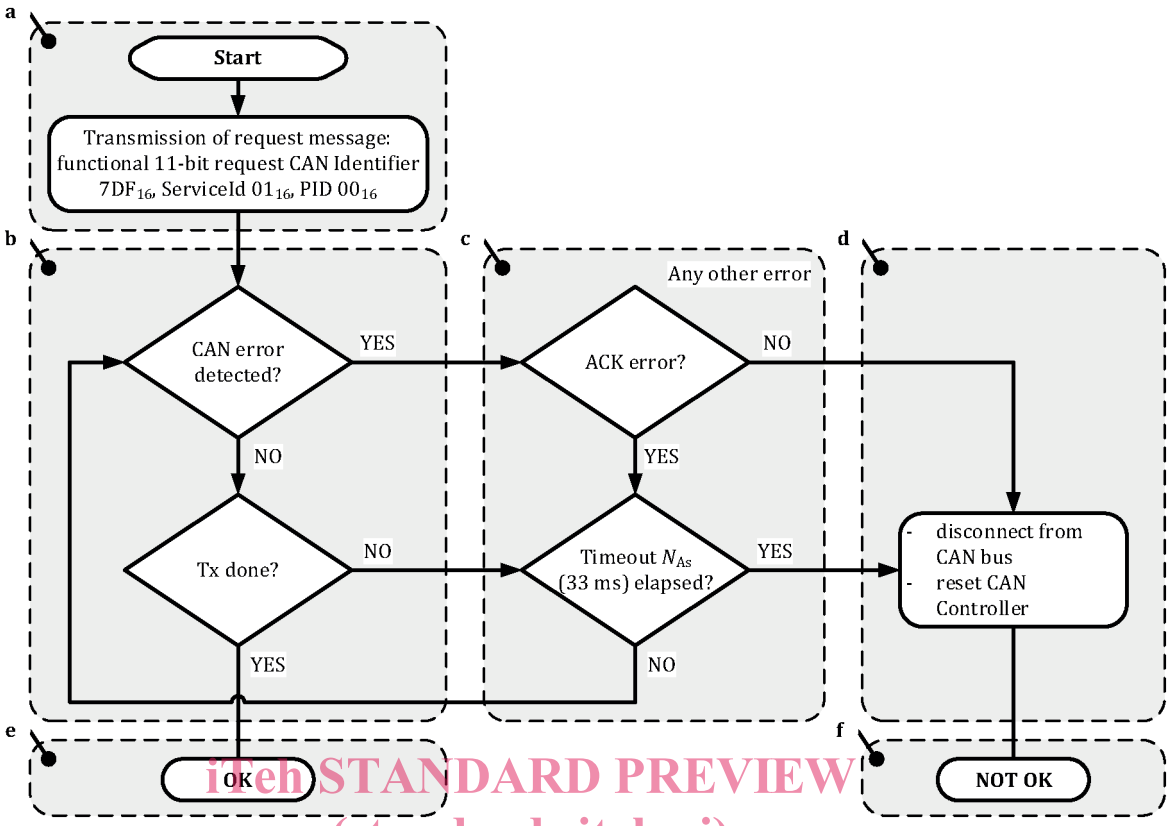
The bitrateRecord shall be used to specify the type of initialisation to be performed. If the bitrateRecord parameter contains a single bit rate, then a single bit rate initialisation sequence shall be performed using the specified single bit rate (e.g. 500 kBit/s). If the bitrateRecord parameter contains multiple bit rates, then a multiple bit rate initialisation sequence shall be performed including a bit rate detection procedure as defined in Figure 2.

Figure 2 shall be performed using the specified multiple bit rates (e.g. 250 kBit/s and 500 kBit/s). The external test equipment shall use the appropriate CAN bit timing parameter values specified in 12.3.

6.3.2 Bit rate validation

If multiple bit rates are specified in the bitrateRecord parameter, the procedure as defined in Figure 2 shall be used to determine the bit rate to be used in communication with the vehicle's emissions-related system.

The external test equipment shall set up its CAN interface using the first bit rate contained in the bitrateRecord. It shall use the CAN bit timing parameter values specified for this bit rate (see 6.3).



Key

a Following the CAN interface setup, the external test equipment shall connect to the CAN bus and immediately transmit a functionally addressed request message with service identifier 01_{16} and PID "supported PIDs" using the regulated OBDonEDS 11-bit functional request CAN identifier as defined in 10.5.2.

NOTE The immediate transmission is needed in order to activate the CAN error monitoring, since initialising the CAN controller at the wrong bit rate without transmitting any data can leave the CAN controller in a state of generating error frames on the CAN bus.

b 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 with the validation of the CAN identifier as specified in 6.4.1.

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

d If any other CAN error occurred, or an acknowledge check error still occurs after the N_As timeout has elapsed, then the external test equipment shall disconnect its CAN interface from the CAN bus.

e Proceed with sequence according to Figure 3 Key 'a'.

f The external test equipment shall check whether more bit rates are contained in the bitrateRecord. If the end of the bitrateRecord is not reached, the external test equipment shall set up its CAN interface using the next bit rate in the bitrateRecord and restart the bit rate validation at Key 'a' in Figure 2. If no further bit rate is contained in the bitrateRecord, it shall be assumed that the request was not transmitted successfully. This indicates that the vehicle does not comply to this part of ISO 15765.

Figure 2 — Perform bit rate validation

6.3.3 External test equipment error detection provisions

Where the vehicle uses a CAN with a physical layer different from that specified for OBDonEDS and OBDonUDS (see Clause 12) or a non-CAN protocol on the CAN pins of the diagnostic link connector, the transmit procedure, specified in this document, shall guarantee that in all cases, the external test equipment shall detect that the vehicle does not support CAN as specified for regulated OBDonUDS or OBDonEDS and shall stop the transmission of the request message immediately.

Where the vehicle uses CAN and the physical layer in accordance with Clause 12, the transmit procedure given as follows shall guarantee that in all cases, the external test equipment shall detect that it uses the wrong bit rate for the transmission of the request message and shall stop disturbing the CAN bus 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 shall disable its CAN interface prior to the situation where the internal error counters of the regulated OBDonUDS or OBDonEDS ECU(s) reach critical values.

To achieve this, the external test equipment shall implement the following provisions:

— possibility to immediately stop sending 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.

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

6.4 CAN identifier validation procedure

6.4.1 CAN identifier validation procedure OBDonEDS

The response handling procedure shall be used to receive 11-bit CAN identifier response messages from regulated OBDonEDS ECU(s) or to indicate that no response message has been received. If regulated OBDonEDS-related ECUs are detected, this procedure also builds the list of available ECUs on the regulated OBDonEDS-compliant vehicle. The response validation procedure shall be performed as defined in Figure 3, after the 11-bit CAN identifier request message transmit procedure (see Figure 2) has succeeded (“OK”).

