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Road vehicles — Diagnostics on Controller Area Networks (CAN) —

Part 3: Implementation of unified diagnostic services (UDS on CAN)

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

Partie 3: Mise en œuvre des services de diagnostic unifiés (SDU sur CAN)

Reference number
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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 15765-3 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 3, *Electrical and electronic equipment*.

ISO 15765 consists of the following parts, under the general title *Road vehicles — Diagnostics on Controller Area Networks (CAN)*:

— *Part 1: General information*

— *Part 2: Network layer services*

— *Part 3: Implementation of unified diagnostic services (UDS on CAN)*

— *Part 4: Requirements for emissions-related systems*

Introduction

This part of ISO 15765 has been established in order to enable the implementation of unified diagnostic services, as specified in ISO 14229-1, on controller area networks (UDS on CAN).

To achieve this, it is based on the Open Systems Interconnection (OSI) Basic Reference Model specified in ISO/IEC 7498 and ISO/IEC 10731, which structures communication systems into seven layers. When mapped on this model, the services specified by ISO 15765 are divided into

— unified diagnostic services (layer 7), specified in this part of ISO 15765,

— network layer services (layer 3), specified in ISO 15765-2,

— CAN services (layers 1 and 2), specified in ISO 11898,

in accordance with Table 1.

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

Open Systems Interconnection (OSI) layers	Vehicle manufacturer enhanced diagnostics	Legislated on-board diagnostics (OBD)
Diagnostic application	User defined	ISO 15031-5
Application layer	ISO 15765-3	ISO 15031-5
Presentation layer	N/A	N/A
Session layer	ISO 15765-3	N/A
Transport layer	N/A	N/A
Network layer	ISO 15765-2	ISO 15765-4
Data link layer	ISO 11898-1	ISO 15765-4
Physical layer	User defined	ISO 15765-4

Road vehicles — Diagnostics on Controller Area Networks (CAN) —

Part 3:
Implementation of unified diagnostic services (UDS on CAN)

1 Scope

This part of ISO 15765 specifies the implementation of a common set of unified diagnostic services (UDS), in accordance with ISO 14229-1, on controller area networks (CAN) in road vehicles as specified in ISO 11898. It gives the diagnostic services and server memory programming requirements for all in-vehicle servers connected to a CAN network and external test equipment. It does not specify any requirement for the in-vehicle CAN bus architecture.

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 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 11898-3, *Road vehicles — Controller area network (CAN) — Part 3: Low-speed, fault-tolerant, medium dependent interface*[1)]

ISO 15031-6, *Road vehicles — Communication between vehicle and external equipment for emissions-related diagnostics — Part 6: Diagnostic trouble code definitions*[1)]

ISO 15765-1, *Road vehicles — Diagnostics on controller area network (CAN) — Part 1: General information*

ISO 15765-2, *Road vehicles — Diagnostics on controller area network (CAN) — Part 2: Network layer service*[1)]

ISO 15765-4, *Road vehicles — Diagnostics on controller area network (CAN) — Part 4: Requirements for emissions-related systems*[1)]

SAE J1939-21, *Recommended practice for a serial control and communications vehicle network — Data link layer*[2)]

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1) To be published.

2) Society of Automotive Engineers standard.

3 Terms, definitions and abbreviated terms

For the purposes of this document, the terms and definitions given in ISO 14229-1, ISO 15765-1 and ISO 15765-2 and the following abbreviated terms apply.

DA	destination address
ID	identifier
DLC	data length code
GW	gateway
LSB	least significant bit
MSB	most significant bit
NA	network address
SA	source address
SM	subnet mask
TOS	type of service

4 Conventions

This part of ISO 15765 is based on conventions defined in ISO 14229-1, which are guided by OSI Service Conventions (see ISO/TR 8509) as they apply for diagnostic services.

5 Unified diagnostic services (UDS) applicability to OSI model

See Figure 1.

6 Application and session layers

6.1 Application layer services

This part of ISO 15765 uses the application layer services as defined in ISO 14229-1 for client-server based systems to perform functions such as test, inspection, monitoring, diagnosis or programming of on-board vehicle servers.

6.2 Application layer protocol

This part of ISO 15765 uses the application layer protocol as defined in ISO 14229-1.

6.3 Application layer and diagnostic session management timing

IMPORTANT — Any N_USData.indication with <N_Result> not equal to N_OK that is generated in the server shall not result in a response message from the server application.

6.3.1 General

The following specifies the application layer and session layer timing parameters and how they are handled for the client and the server.

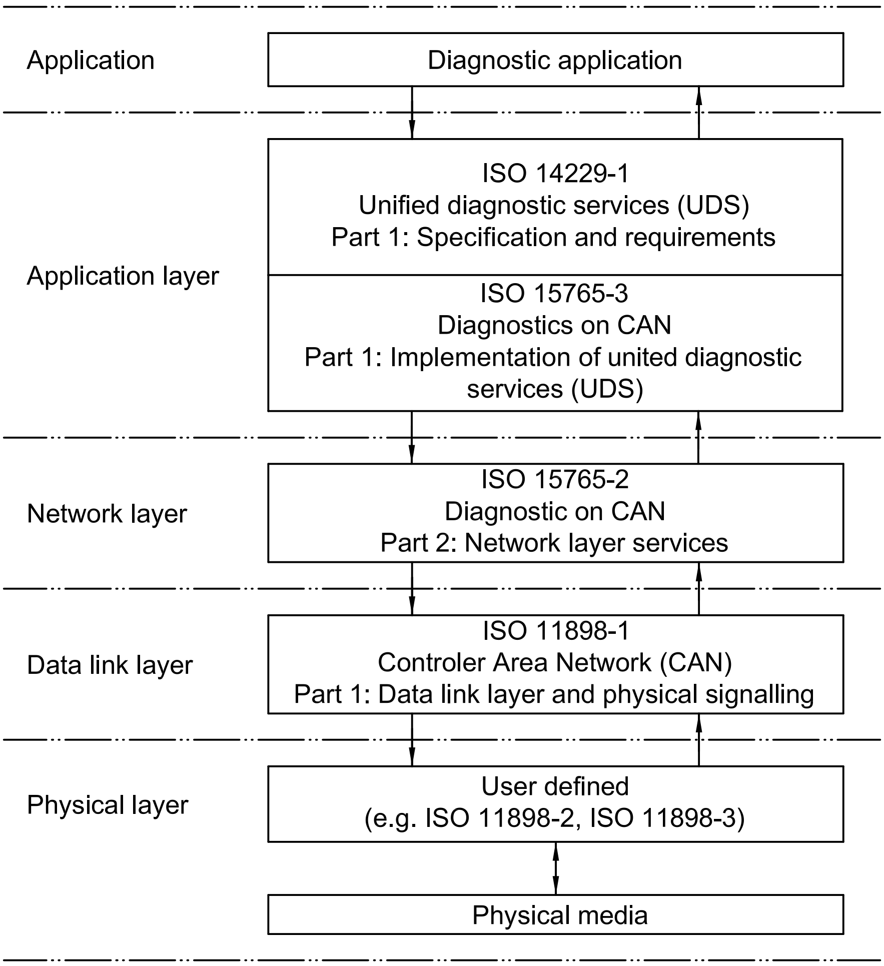

Figure 1 — Implementation of UDS on CAN in OSI model

The following communication scenarios shall be distinguished from one another:

a) physical communication during

   1) default session, and

   2) non-default session — session handling required;

b) functional communication during

   1) default session, and

   2) non-default session — session handling required.

For all cases, the possibility of requesting an enhanced response-timing window by the server via a negative response message, including a response code 78 hex, shall be considered.

The network layer services as defined in ISO 15765-2 are used to perform the application layer and diagnostic session management timing in the client and the server.

6.3.2 Application layer timing parameter definitions

The application layer timing parameter values for the default diagnostic session shall be in accordance with Table 2.

Table 2 — Application layer timing parameter definitions for the defaultSession

Timing parameter	Description	Type	Min.	Max.
$P2_{CAN\_Client}$	Timeout for the client to wait after the successful transmission of a request message (indicated via N_USData.con) for the start of incoming response messages (N_USDataFirstFrame.ind of a multi-frame message or N_USData.ind of a SingleFrame message).	Timer reload value	$P2_{CAN\_Server\_max}$ + $\Delta P2_{CAN}$	N/A [a]
$P2^*_{CAN\_Client}$	Enhanced timeout for the client to wait after the reception of a negative response message with response code 78 hex (indicated via N_USData.ind) for the start of incoming response messages (N_USDataFirstFrame.ind of a multi-frame message or N_USData.ind of a SingleFrame message).	Timer reload value	$P2^*_{CAN\_Server\_max}$ + $\Delta P2_{CAN\_rsp}$	N/A [b]
$P2_{CAN\_Server}$	Performance requirement for the server to start with the response message after the reception of a request message (indicated via N_USData.ind).	Performance requirement	0	50 ms
$P2^*_{CAN\_Server}$	Performance requirement for the server to start with the response message after the transmission of a negative response message (indicated via N_USData.con) with response code 78 hex (enhanced response timing).	Performance requirement	0 [c]	5000 ms
$P3_{CAN\_Client\_Phys}$	Minimum time for the client to wait after the successful transmission of a physically addressed request message (indicated via N_USData.con) with no response required before it can transmit the next physically addressed request message (see 6.3.5.3).	Timer reload value	$P2_{CAN\_Server\_max}$	N/A [d]
$P3_{CAN\_Client\_Func}$	Minimum time for the client to wait after the successful transmission of a functionally addressed request message (indicated via N_USData.con) before it can transmit the next functionally addressed request message in case no response is required or the requested data is only supported by a subset of the functionally addressed servers (see 6.3.5.3).	Timer reload value	$P2_{CAN\_Server\_max}$	N/A [d]

[a] The maximum time a client waits for a response message to start is at the discretion of the client, provided that $P2_{CAN\_Client}$ is greater than the specified minimum value of $P2_{CAN\_Client}$.

[b] The value that a client uses for $P2^*_{CAN\_Client}$ is at the discretion of the client, provided it is greater than the specified minimum value of $P2^*_{CAN\_Client}$.

[c] During the enhanced response timing, the minimum time between the transmission of consecutive negative messages, each with response code 78 hex, shall be ½ $P2^*_{CAN\_Server\_max}$, with a maximum tolerance of ± 20% of $P2^*_{CAN\_Server\_max}$.

[d] The maximum time a client waits until it transmits the next request message is at the discretion of the client, provided that for non-default sessions the $S3_{Server}$ timing is kept active in the server(s).

The parameter $\Delta P2_{CAN}$ considers any system network design-dependent delays such as delays introduced by gateways and bus bandwidth plus a safety margin (e.g. 50 % of worst case). The worst-case scenario (transmission time necessary for one "round trip" from client to server and back from server to client), based on system design, is impacted by

a) the number of gateways involved,

b) CAN frame transmission time (baud rate),

c) CAN bus utilization, and

d) the CAN device driver implementation method (polling vs interrupt) and processing time of the network layer.

The value of $\Delta P2_{CAN}$ is divided into the time to transmit the request to the addressed server and the time to transmit the response to the client:

$$\Delta P2_{CAN} = \Delta P2_{CAN\_Req} + \Delta P2_{CAN\_Rsp}$$

Figure 2 provides an example of how $\Delta P2_{CAN}$ can be composed.

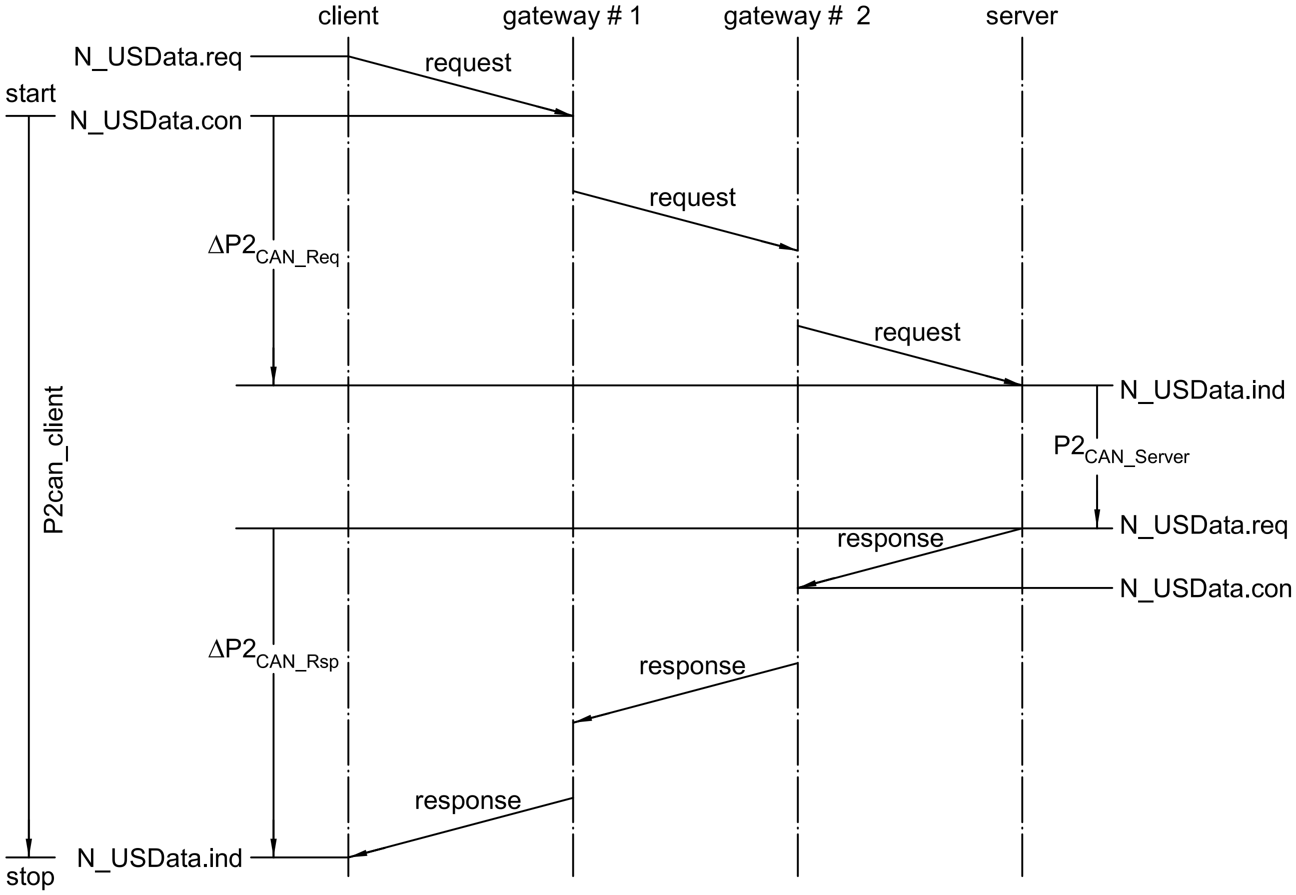

Figure 2 — Example for $\Delta P2_{CAN}$ — SingleFrame request and response message

NOTE For the sake of simplicity in describing the timing parameters, in all the figures that follow it is assumed that the client and the server are located on the same network. All descriptions and figures are presented in a time-related sequential order.