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

**Part 5:
Specification for an in-vehicle network
connected to the diagnostic link
connector**

*Véhicules routiers — Communication de diagnostic sur gestionnaire
de réseau de communication (DoCAN) —*

*Partie 5: spécification pour un réseau véhicule connecté sur la prise
de diagnostic*



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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 document 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).

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

This second edition cancels and replaces the first edition (ISO 15765-5:2021), which has been technically revised.

The main changes are as follows:

- clarification on network address translation between OSI-layers;
- editorial corrections.

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

The ISO 15765 series defines common requirements for vehicle diagnostic systems using the controller area network (CAN), as specified in the ISO 11898 series.

The ISO 15765 series presumes the use of external test equipment for inspection, diagnostics, repair and other possible use cases connected to the vehicle.

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 has been structured according to 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 OSI layer 4 to OSI layer 1 framework requirements specified or referenced in the ISO 15765 series are structured according to [Figure 1](#), which shows the related documents of OSI layer 4 to OSI layer 1.

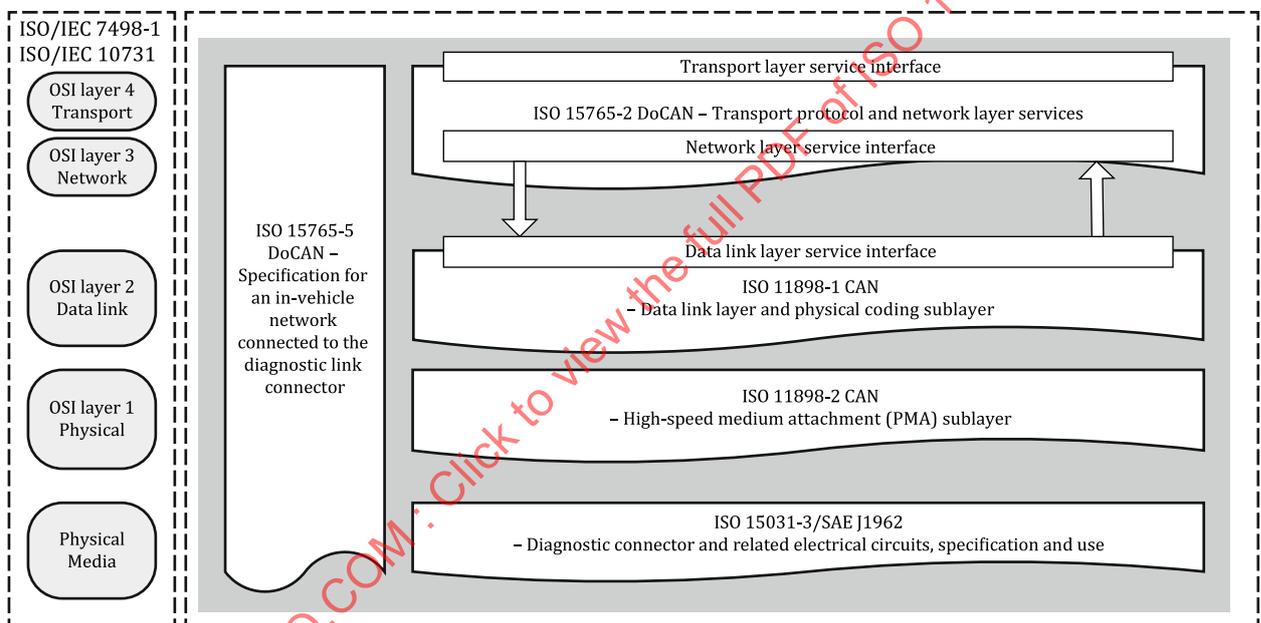


Figure 1 — CAN documents reference according to OSI model

The documents include the following content:

- transport layer (TL) -related requirements with reference to ISO 15765-2;
- network layer (NL) -related requirements with reference to ISO 15765-2;
- data link layer (DLL) -related requirements with reference to ISO 11898-1, which are composed of:
 - DLL protocol entity requirements;
 - DLL device interface requirements;
 - DLL network system requirements;
- physical layer (PHY) -related requirements with reference to ISO 11898-2, which are composed of:
 - physical coding sub-layer (PCS) requirements, which are composed of:
 - PCS entity requirements;

- PCS interface requirements;
- PCS network system requirements;
- physical media attachment (PMA) requirements, which are composed of:
 - PMA protocol entity requirements;
 - PMA device interface requirements;
- physical media dependent (PMD) requirements, which are composed of:
 - PMD entity requirements;
 - PMD device interface requirements;
 - PMD network system requirements.

The PCS is implemented in the CAN protocol controller. The PMA sub-layer is implemented normally in the CAN transceiver or the system base chip (SBC). Optionally it can comprise also additional protection circuitry. The media-dependent sub-layer comprises the connectors and the cabling.

Figure 2 shows an implementation example of the data link and physical layers block diagram.

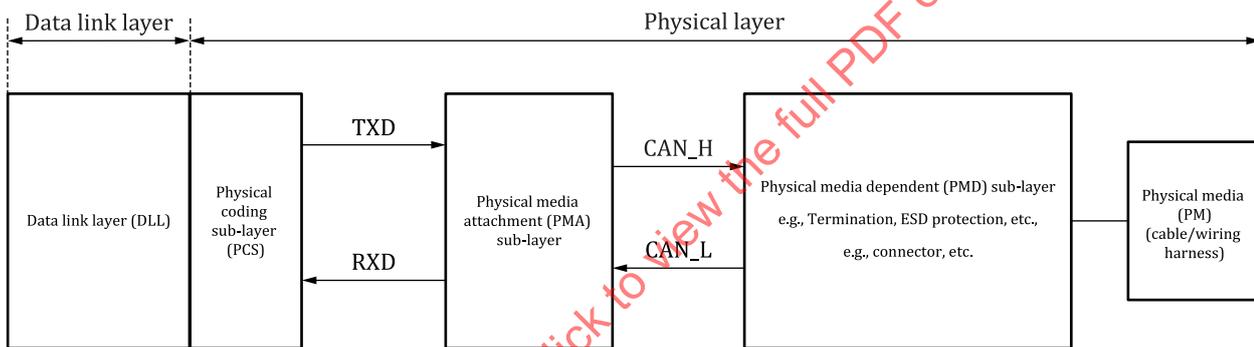


Figure 2 — Implementation example of lower OSI layers block diagram

The above structure is chosen to provide the following implementers with relevant requirements:

- transceiver developers;
- device (e.g. electronic control unit) developers;
- system network developers.

All requirements are numbered and headlined uniquely, so that each implementer can reference them.

Annex A provides a description of the compatibility between test equipment and in-vehicle network connected to the diagnostic link connector.

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

Part 5: Specification for an in-vehicle network connected to the diagnostic link connector

1 Scope

This document specifies the OSI layers 4 to 1 (transport layer, network layer, data link layer and physical layer) requirements related to the connection between the external test equipment externally connected to the diagnostic link connector and the in-vehicle CAN network to successfully establish and maintain communication utilizing the communication parameters (communication profile) specified in (application-type) standards referencing this document.

The SIC (signal improvement capability) transceiver options, as specified in ISO 11898-2, are out of scope in this document.

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 11898 (all parts), *Road vehicles — Controller area network (CAN)*

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*

ISO 15765-4, *Road vehicles — Diagnostic communication over Controller Area Network (DoCAN) — Part 4: Requirements for emissions-related systems*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in the ISO 11898 series, ISO 15765-2, ISO 15765-4 and the following apply.

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

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

3.1

segment

TL_PDU which consists of the TL_PCI and TL_DATA

3.2 application-type standard

standard which specifies application-related use cases, requirements and communication profile parameter values of the protocol stack

4 Symbols and abbreviated terms

4.1 Symbols

–	empty table cell or feature undefined
Δf	oscillator tolerance
f_{Ba}	nominal arbitration bit rate
f_{Bd}	data bit rate
l_{CABLE}	cable length between in-vehicle CAN node and diagnostic link connector
t_{Ba}	arbitration bit time
t_{Bd}	data bit time
t_{BIT}	bit time
t_{BIT_RX}	receive bit time
t_{BIT_TX}	transmit bit time
t_{Qa}	nominal arbitration bit time quantum length
t_{Qd}	nominal data bit time quantum length
t_{SJWa}	arbitration bit synchronisation jump width
t_{SJWd}	data bit synchronisation jump width
t_Q	time quantum
t_{SPa}	nominal arbitration bit sample point position
t_{SPd}	nominal data bit sample point position
X	table cell selected or feature defined

4.2 Abbreviated terms

AE	address extension
AL	application layer
ASP	abstract service primitive
CAN	controller area network
CAN FD	controller area network flexible data-rate
CBFF	classical base frame format

CEFF	classical extended frame format
DCC	diagnostic communication channel
DiagNormAddr	diagnostic message with normal addressing
DiagNormFixAddr	diagnostic message with normal fixed addressing
DiagExtAddr	diagnostic message with extended addressing
DLL	data link layer
DoCAN	diagnostic communication over controller area network
Ftype	frame type
FBFF	FD base frame format
FEFF	FD extended frame format
L_	data link
MSb	most significant bit
Mtype	message type
N_	network
NL	network layer
N_PDU	network protocol data unit
OSI	open system interconnection
PDU	protocol data unit
PCS	physical coding sub-layer
PHY	physical layer
PMA	physical media attachment
PMD	physical media dependent
Ptype	packet type
RDiagMixAddr	remote diagnostic message with mixed addressing
SA	source address
SIC	signal improvement capability
SJW	synchronisation jump width
SP	sample point
T_Data	T_Data interface
TA	target address
TAtype	target address type

TL transport layer
 T_PDU transport protocol data unit

5 Conventions

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

6 In-vehicle network to external test equipment connection

6.1 Connectivity scenarios between external test equipment and vehicle

This document specifies the requirements for the diagnostic link connector providing access to CAN FD network. A backward compatibility to classical CAN is described in [Annex A](#).

6.2 Technical requirements overview

[Table 1](#) provides an overview of the technical requirements and associated requirement numbers.

Table 1 — Technical requirements overview

REQ #	Technical requirement title
OSI4	Transport layer (TL)
OSI4.1	TL – ISO 15765-2 T_Data interface primitive parameter mapping
OSI4.2	TL – ISO 15765-2 TX_DL = 8
OSI4.3	TL – ISO 15765-2 TX_DL > 8
OSI3	Network layer (NL)
OSI3.1	NL – ISO 15765-2 N_Data interface primitive parameter mapping
OSI3.2	NL – ISO 15765-2 network layer services
OSI3.3	NL – ISO 15765-2 network layer timing parameters
OSI3.4	NL – ISO 15765-2 uniqueness of node diagnostic address
OSI3.5	NL – ISO 15765-2 supported addressing formats
OSI3.6	NL – ISO 15765-2 functional addressing
OSI3.7	NL – ISO 15765-2 reception of N_PDU
OSI2	Data link layer (DLL)
OSI2.1	DLL – Data interface primitive parameter mapping – Mapping of upper OSI layer service interface parameters
OSI2.2	DLL – Data interface primitive parameter mapping – ISO 11898-1
OSI2.3	DLL – Mapping of N_AI into the 11-bit CAN identifier
OSI2.4	DLL – Mapping of N_AI into the 29-bit CAN identifier
OSI2.5	DLL – Device acceptance of CAN identifier
OSI1	Physical layer (PHY)
OSI1.1	PHY – PCS entity requirements – ISO 11898-1 conformance
OSI1.2	PHY – PCS interface requirements – Classical CAN bit timing parameters
OSI1.3	PHY – PCS interface requirements – CAN FD sampling method
OSI1.4	PHY – PCS interface requirements – CAN FD bit timing parameters
OSI1.5	PHY – PCS interface requirements – CAN FD transmitter delay compensation
OSI1.6	PHY – PCS interface requirements – Termination resistance
OSI1.7	PHY – PMA entity requirements – ISO 11898-2 conformance

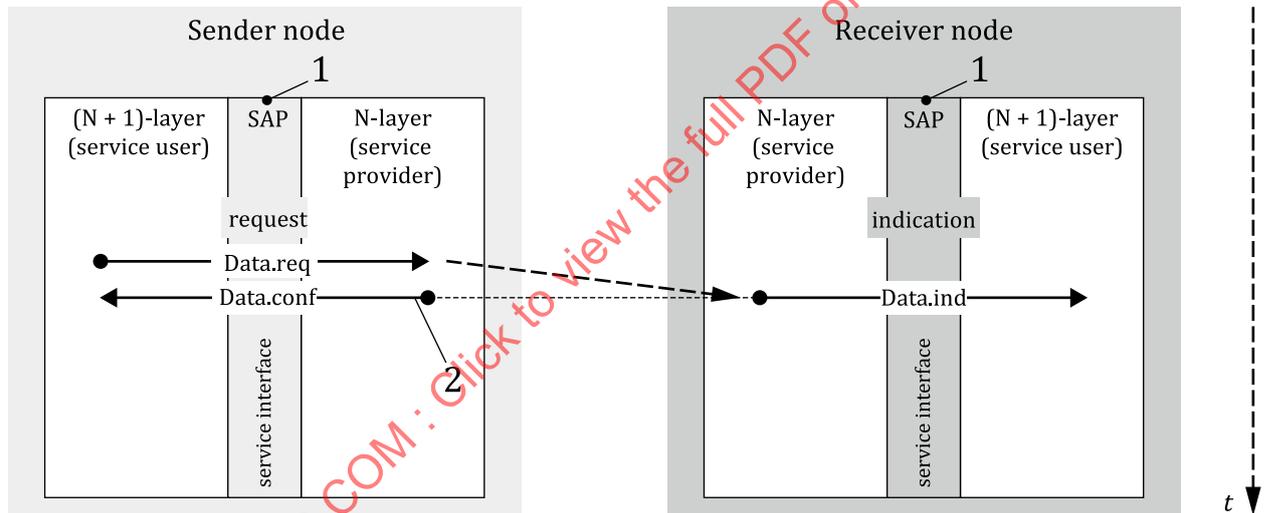
Table 1 (continued)

REQ #	Technical requirement title
OSI1.8	PHY – PMA entity requirements – Qualification
OSI1.9	PHY – PMD entity requirements – Diagnostic link connector
OSI1.10	PHY – PMD entity requirements – DoCAN pin assignment on diagnostic link connector
OSI1.11	PHY – PMD entity requirements – Cable characteristics between vehicle network connected to the diagnostic link connector for data bit rates > 500 kbit/s
OSI1.12	PHY – PMD network system requirements
OSI1.13	PHY – PMD network system requirements – Cable length between single CAN node and diagnostic link connector

6.3 ASP – Data.req, Data.ind and Data.conf service interface

The abstract service primitive interface defines the service and parameter mapping from the application layer (AL) to the session layer.

Figure 3 shows the Data.req (request), Data.ind (indication) and Data.conf (confirmation) abstract service primitive interface.



Key

- 1 service access point
- 2 read back from N-layer service provider

Figure 3 — Data.req, Data.ind and Data.conf abstract service primitive interface

6.4 ASP – Parameter mapping and configuration of OSI layers

Each OSI layer contains layer-specific information to manipulate or edit the PDU depending on whether the PDU is provided as a Data.req (sender node), Data.ind (receiver node) or Data.conf (sender node).

A PDU, which is sent by an application (service user), is assembled by each applicable OSI-layer based on PDU identification information. A PDU, which is received by the OSI-layers (service provider), has PDU identification information used by each applicable OSI layer to disassemble the PDU before it is transferred to the application (service user).

A specific implementation of the abstract service primitive interface parameter management for each OSI-layer is not specified in this document.

6.5 Transport layer (TL)

6.5.1 TL – Data interface primitive parameter mapping

This requirement specifies the A_Data to T_Data interface primitive parameter mapping.

REQ	OSI4.1 TL – ISO 15765-2 T_Data interface primitive parameter mapping
The T_Data service primitive shall use the service primitive parameters as specified in Table 2 .	

Table 2 — T_Data service primitive parameter mapping

TL	.req	.ind	.conf	Description
T_Ptype	X	X	X	packet type: (DiagNormAddr, DiagNormFixAddr, DiagExtAddr, RDiagMixAddr)
T_TAtype	X	X	X	functional, physical
T_Length	X	X	—	length of PDU
T_Data	X	X	—	transport layer data
T_Result	—	X	X	result
Key				
X supported				
— not supported				

6.5.2 TL – Message segmentation

The TL performs message segmentation into segments of 8 byte. The support of the ISO 15765-2 transport protocol is determined by the client communication interface.

REQ	OSI4.2 TL – ISO 15765-2 TX_DL = 8
The TL shall support the transport protocol feature TX_DL = 8 as specified in ISO 15765-2.	

The TL performs message segmentation into segments greater than 8 byte. The support of the ISO 15765-2 transport protocol is determined by the client communication interface.

REQ	OSI4.3 TL – ISO 15765-2 TX_DL > 8
The TL shall support the transport protocol feature TX_DL > 8 as specified in ISO 15765-2.	

6.5.3 TL – ISO 15765-2 segment flow control

The TL controls the segment flow by means of the FlowControl segment.

REQ	OSI4.4 TL – ISO 15765-2 definition of FlowControl parameter values
The TL shall be capable of adapting to any valid parameter in a FlowControl segment as specified in ISO 15765-2.	

6.6 Network layer (NL)

6.6.1 NL – Data interface primitive parameter mapping

The requirements specified in this subclause are applicable to NL implementations.

REQ	OSI3.1 NL – ISO 15765-2 N_Data interface primitive parameter mapping
The N_Data service primitive shall use the service primitive parameters as specified in Table 3 .	

Table 3 — N_Data service primitive parameter mapping

NL	.req	.ind	.conf	Description
N_Ptype	X	X	X	packet type: (DiagNormAddr, DiagNormFixAddr, DiagExtAddr, RDiagMixAddr)
N_AI[TAtype]	X	X	X	N_AI[TAtype] #1: physical addressing, CBFF, 11-bit CAN identifier, N_AI[TAtype] #2: functional addressing, CBFF, 11-bit CAN identifier, N_AI[TAtype] #3: physical addressing, FBFF, 11-bit CAN identifier, N_AI[TAtype] #4: functional addressing, FBFF, 11-bit CAN identifier, N_AI[TAtype] #5: physical addressing, CEFF, 29-bit CAN identifier, N_AI[TAtype] #6: functional addressing, CEFF, 29-bit CAN identifier, N_AI[TAtype] #7: physical addressing, FEFF, 29-bit CAN identifier, N_AI[TAtype] #8: functional addressing, FEFF, 29-bit CAN identifier.
N_AI[SA]	X	X	X	source address;
N_AI[TA]	X	X	X	target address to be added to PDU if N_Ptype = DiagExtAddr.
N_AI[AE]	X	X	X	address extension to be added to PDU if N_Ptype = RDiagMixAddr.
N_Length	X	X	—	length of PDU;
N_Data	X	X	—	network layer data;
N_Result	—	X	X	result;
Key				
X supported				
— not supported				

6.6.2 NL – ISO 15765-2 network layer services

A detailed specification of the NL services is given in ISO 15765-2.

REQ	OSI3.2 NL – ISO 15765-2 network layer services
The NL services of the vehicle's ECU(s) shall be in accordance with ISO 15765-2.	

6.6.3 NL – ISO 15765-2 network layer timing parameters

A detailed specification of the NL timing parameter values is given in ISO 15765-2.

REQ	OSI3.3 NL – ISO 15765-2 network layer timing parameters
The NL timing parameters of the vehicle's ECU(s) shall be in accordance with ISO 15765-2.	

6.6.4 NL – ISO 15765-2 uniqueness of node diagnostic address

The node diagnostic address in a CAN network is used to indicate to all nodes on the network that the node with this diagnostic address is the target.

REQ	OSI3.4 NL – ISO 15765-2 uniqueness of node diagnostic address
The diagnostic address ('xx ₁₆ ') shall be assigned to only one node in the network.	

6.6.5 NL – ISO 15765-2 supported addressing formats

ISO 15765-2 specifies several addressing formats. The addressing information is contained in the N_Ptype interface parameter.

REQ	OSI3.5 NL - ISO 15765-2 supported addressing formats
The NL shall use one of the following addressing formats as specified in ISO 15765-2:	
— N_Ptype = DiagNormAddr: no address information N_AI[SA, TA] mapped in N_PDU data field;	
— N_Ptype = DiagNormFixAddr: no address information N_AI[SA, TA] mapped in N_PDU data field;	
— N_Ptype = DiagExtAddr: address information N_AI[TA] mapped in N_PDU data field;	
— N_Ptype = RDiagMixAddr: address information N_AI[AE] mapped in N_PDU data field.	

Functional addressing is used to reach more than one CAN node connected to the network.

REQ	OSI3.6 NL - ISO 15765-2 functional addressing
A functional addressed N_PDU shall not exceed the TX_DL limitation as specified in ISO 15765-2.	

Physical addressing is used to reach only one CAN node connected to the network.

REQ	OSI3.7 NL - ISO 15765-2 reception of N_PDU
The NL shall extract the N_AI from the received N_PDU depending on the addressing format as specified in REQ 3.5.	

6.7 Data link layer (DLL)

6.7.1 DLL - Data interface primitive parameter mapping

The DLL protocol entity transfers data frames between network nodes on the CAN network. The following requirements are applicable to DLL implementations.

REQ	OSI2.1 DLL - Data interface primitive parameter mapping - Mapping of upper OSI layer service interface parameters
The L_Data service primitive shall use the service primitive parameters as specified in Table 4 .	

Table 4 — L_Data service primitive parameter mapping

DLL	.req	.ind	.conf	Description
Format	X	X	—	N_AI[TAtype] #1: physical address, CBFF, 11-bit CAN identifier; N_AI[TAtype] #2: functional address, CBFF, 11-bit CAN identifier; N_AI[TAtype] #3: physical addressing, FBFF, 11-bit CAN identifier; N_AI[TAtype] #4: functional addressing, FBFF, 11-bit CAN identifier; N_AI[TAtype] #5: physical addressing, CEFF, 29-bit CAN identifier; N_AI[TAtype] #6: functional addressing, CEFF, 29-bit CAN identifier; N_AI[TAtype] #7: physical addressing, FEFF, 29-bit CAN identifier; N_AI[TAtype] #8: functional addressing, FEFF, 29-bit CAN identifier.
Key				
X supported				
— not supported				

Table 4 (continued)

DLL	.req	.ind	.conf	Description
Identifier	X	X	X	If 11-bit CAN identifier: target and source address are mapped to a PDU-specific CAN identifier value.
	X	X	X	If 29-bit CAN identifier: target and source address are mapped into the CAN identifier TA and SA fields of the PDU-specific CAN identifier value.
DLC	X	X	—	data length code;
Data	X	X	—	(CAN) data field;
Transfer_Status	—	—	X	status of a transmission;
Key				
X supported				
— not supported				

The DLL is specified in ISO 11898-1.

REQ	OSI2.2 DLL - Data interface primitive parameter mapping - ISO 11898-1 conformance
The DLL shall conform with ISO 11898-1 and shall support the optional data frame formats (FBFF and FEFF).	

6.7.2 DLL - Service interface parameter requirements

The DLL uses the value of the L_Ftype service interface parameter to identify the address information $N_AI[TAtype, TA, SA]$ mapping into the CAN identifier.

For 11-bit CAN identifiers the DLL uses the value included in the L_Ftype service interface parameter to set the applicable 11-bit CAN identifier.

REQ	OSI2.3 DLL - Mapping of N_AI into the 11-bit CAN identifier
The DLL shall support the mapping of N_AI into the 11-bit CAN identifier based on the L_Ftype service interface parameter value as specified in Table 5 .	

Table 5 — Mapping of N_AI into the 11-bit CAN identifier

L_Ftype	$N_AI[]$	11-bit CAN ID	Description
DiagNormAddr (diagnostics with normal addressing)	TA, SA	XXX XXXX XXXX ₂	The $N_AI[SA]$ and $N_AI[TA]$ values are mapped to a predefined CAN identifier.
DiagExtAddr (diagnostics with extended addressing)	SA	XXX XXXX XXXX ₂	The $N_AI[SA]$ value is mapped to a predefined CAN identifier.
RDiagMixAddr (remote diagnostics with mixed addressing)	TA, SA	XXX XXXX XXXX ₂	The $N_AI[SA]$ and $N_AI[TA]$ values are mapped to a predefined CAN identifier.
Key			
X don't care			

REQ	OSI2.4 DLL - Mapping of N_AI into the 29-bit CAN identifier
The DLL shall support the mapping of N_AI into the 29-bit CAN identifier L_PDU based on the L_Ftype service interface parameter value as specified in Table 6 .	

Table 6 — Mapping of N_AI into the 29-bit CAN identifier

L_Ftype	N_AI[]	29-bit CAN ID	Description
DiagNormFixAddr (diagnostics with normal fixed addressing)	TA, SA	18 ₁₆ DB ₁₆ TA SA	The N_AI [SA] and N_AI [TA] (functional request address) values are mapped to predefined byte locations in the CAN identifier as specified in ISO 15765-2.
		18 ₁₆ DA ₁₆ TA SA	The N_AI [SA] and N_AI [TA] (physical request address) values are mapped to predefined byte locations in the CAN identifier as specified in ISO 15765-2.
RDiagMixAddr (remote diagnostics with mixed addressing)	TA, SA	18 ₁₆ CD ₁₆ TA SA	The N_AI [SA] and N_AI [TA] functional request address values are mapped to predefined byte locations in the CAN identifier as specified in ISO 15765-2.
		18 ₁₆ CE ₁₆ TA SA	The N_AI [SA] and N_AI [TA] physical request/response address values are mapped to predefined byte locations in the CAN identifier as specified in ISO 15765-2.

6.7.3 DLL – Device acceptance of CAN identifier

A CAN node accepts a CAN identifier if the value matches with its internally stored supported set of CAN identifiers.

REQ	OSI2.5 DLL – Device acceptance of CAN identifier
A DLL shall accept a CAN identifier of its supported CAN identifier set (11-bit and/or 29-bit).	

6.8 Physical layer (PHY)

6.8.1 PHY – Classical CAN

6.8.1.1 PHY – Physical coding sub-layer (PCS) entity requirements

The PCS is specified in ISO 11898-1.

REQ	OSI1.1 PHY – PCS entity requirements – ISO 11898-1 conformance
The PCS shall conform with ISO 11898-1.	

6.8.1.2 PHY – PCS classical CAN interface requirements

The PCS classical CAN interface requirements provide detailed specification about bit timing and bit sampling of the arbitration phase and the data phase.

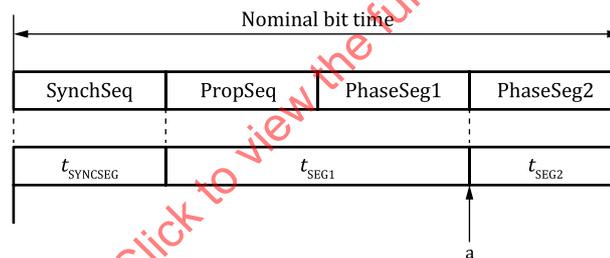
REQ	OSI1.2 PHY – PCS interface requirements – Classical CAN bit timing parameters
The PCS classical CAN interface shall only support one-bit timing parameter set as specified in Tables 7 and 8 or Tables 9 and 10 .	

The CAN bit timing parameter values used in this document are based on equivalent terms in ISO 11898-1:

- t_{SYNCSEG} = SyncSeg = $1 \times t_Q$
- t_{SEG1} = PropSeg + PhaseSeg1 = $t_{\text{BIT}} - t_{\text{SYNCSEG}} - t_{\text{SEG2}}$
- t_{SEG2} = PhaseSeg2
- t_{SJW} = synchronisation jump width
- t_{BIT} = t_B (nominal bit time)
- t_Q = time quantum
- t_{SP} = nominal sample point position = $(1 - t_{\text{SEG2}}/t_{\text{BIT}}) \times 100 \%$

Conformity with the nominal bit time tolerance requirement given in this document is directly dependent on the classical CAN system clock tolerance of the external test equipment and the programmed nominal bit time value. In a classical CAN controller, the nominal bit time value is an integer multiple of its system clock periods. When the programmable nominal bit time value is set exactly to the required nominal bit time value, accuracy is only affected by the system clock tolerance. Otherwise, the accuracy is dependent upon both the deviation of the programmed bit time value from the nominal bit time value and the system clock tolerance. The contributions from drift or ageing of the system clock source and from the inability to achieve the desired nominal bit time value are additive. The bit time tolerance specification is met after consideration of both.

Figure 4 illustrates the partitioning of the classical CAN bit time.



a Nominal sample point position (SP) in single data sampling mode.

Figure 4 — Partitioning of classical CAN bit time

6.8.1.3 PHY - 250 kbit/s classical CAN bit timing parameter values

Table 7 specifies the allowed CAN bit timing parameter values for a bit rate of 250 kbit/s. The external test equipment operates in single data sampling mode.

Table 7 — 250 kbit/s classical CAN bit timing parameter values — Single data sampling mode

Parameter/function	Symbol	Minimum	Nominal	Maximum	Unit	Conditions/comment
Nominal data bit time RX	$t_{\text{BIT_RX}}^a$	3 980	4 000	4 020	ns	$\pm 0,5 \%$
Nominal data bit time TX	$t_{\text{BIT_TX}}^b$	3 994	4 000	4 006	ns	$\pm 0,15 \%$
Time quantum	t_Q	—	—	250	ns	—
Oscillator tolerance	Δf	—	—	0,15	%	—

^a The minimum and maximum value of the nominal bit time $t_{\text{BIT_RX}}$ are worst-case values for the reception of bits from the CAN bus based on a nominal bit rate tolerance of $\pm 0,5 \%$.

^b The minimum and maximum value of the nominal bit time $t_{\text{BIT_TX}}$ are worst-case values for the transmission of bits onto the CAN bus based on the specified external test equipment nominal bit rate tolerance of $\pm 0,15 \%$.

Table 8 presents the only allowed CAN bit timing parameter values for the external test equipment based on standard time quanta (t_Q).

Table 8 — 250 kbit/s classical CAN bit timing parameter values for standard time quanta

t_Q [ns]	t_{SJW} [ns]	t_{SEG1} [ns]	t_{SEG2} [ns]	Nominal sample point position ^a [%]
200	600	3 000	800	80
250	750	3 000	750	81,25

^a The nominal sample point position is specified relative to one-bit time.

6.8.1.4 PHY – 500 kbit/s classical CAN bit timing parameter values

Table 9 specifies the allowed classical CAN bit timing parameter values for a bit rate of 500 kbit/s. The external test equipment operates in single data-sampling mode. The tolerance of the external test equipment nominal bit rate 500 kbit/s is $\pm 0,15\%$.

Table 9 — 500 kbit/s classical CAN bit timing parameter values — Single data sampling mode

Parameter/function	Symbol	Minimum	Nominal	Maximum	Unit	Conditions/ comment
Nominal data bit time RX	t_{BIT_RX} ^a	1 990	2 000	2 010	ns	$\pm 0,5\%$
Nominal data bit time TX	t_{BIT_TX} ^b	1 997	2 000	2 003	ns	$\pm 0,15\%$
Time quantum	t_Q	—	—	125	ns	—
Oscillator tolerance	Δf	—	—	0,15	%	—

^a The minimum and maximum value of the nominal bit time t_{BIT_RX} are worst-case values for the reception of bits from the CAN bus based on a nominal bit rate tolerance of $\pm 0,5\%$.

^b The minimum and maximum value of the nominal bit time t_{BIT_TX} are worst-case values for the transmission of bits onto the CAN bus based on the specified external test equipment nominal bit rate tolerance of $\pm 0,15\%$.

Table 10 presents the only allowed classical CAN bit timing parameter values for the external test equipment based on standard time quanta (t_Q).

Table 10 — 500 kbit/s classical CAN bit timing parameter values for standard time quanta

t_Q [ns]	t_{SJW} [ns]	t_{SEG1} [ns]	t_{SEG2} [ns]	Nominal sample point position ^a [%]
100	300	1 500	400	80
125	375	1 500	375	81,25

^a The nominal sample point position is specified relative to one-bit time.

6.8.2 PHY – CAN FD

6.8.2.1 PHY – CAN FD bit timing parameter values for 5 Mbit/s data phase

REQ	OSI1.3 PHY – PCS interface requirements – CAN FD sampling method
The PCS shall be configured to use the single-sampling method.	

REQ	OSI1.4 PHY – PCS interface requirements – CAN FD bit timing parameter values
The PCS CAN FD interface shall only support one-bit timing parameter set as specified in Table 11 , Table 12 or Table 13 .	

Table 11 — CAN FD bit timing parameter for 5 Mbit/s data phase

Parameter/function	Symbol	Minimum	Nominal	Maximum	Unit	Conditions/ comment
Nominal arbitration bit rate	f_{Ba}	—	500	—	kbit/s	—
Data phase bit rate	f_{Bd}	—	5 000	—	kbit/s	—
Arbitration bit time	t_{Ba}	1 992	2 000	2 008	ns	±0,4 % (including aging)
Data bit time	t_{Bd}	199,2	200,0	200,8	ns	±0,4 % (including aging)
Nominal arbitration bit time quantum length	t_{Qa}	—	25	—	ns	80 t_q /bit
Nominal data bit time quantum length	t_{Qd}	—	25	—	ns	8 t_q /bit
Nominal arbitration bit sample point position ^a	t_{SPa}	—	0,80	—	t_B	80 % of bit time
Nominal data bit sample point position ^a	t_{SPd}	—	0,75	—	t_B	75 % of bit time
Arbitration bit synchronisation jump width	t_{SJWa}	—	16	—	t_Q	typically corresponds to SJW = 1111 ₂
Data bit synchronisation jump width	t_{SJWd}	—	2	—	t_Q	typically corresponds to SJW = 0001 ₂

^a The nominal sample point position shall be located at the specified time after the start of a bit.

6.8.2.2 PHY – CAN FD bit timing parameter values for 4 Mbit/s data phase

Table 12 — CAN FD bit timing parameter for 4 Mbit/s data phase

Parameter/function	Symbol	Minimum	Nominal	Maximum	Unit	Conditions/ comment
Nominal arbitration bit rate	f_{Ba}	—	500	—	kbit/s	—
Data phase bit rate	f_{Bd}	—	4 000	—	kbit/s	—
Arbitration bit time	t_{Ba}	1 992	2 000	2 008	ns	±0,4 % (including aging)
Data bit time	t_{Bd}	249,0	250,0	251,0	ns	±0,4 % (including aging)
Nominal arbitration bit time quantum length	t_{Qa}	—	25	—	ns	80 t_q /bit
Nominal data bit time quantum length	t_{Qd}	—	25	—	ns	10 t_q /bit
Nominal arbitration bit sample point position ^a	t_{SPa}	—	0,80	—	t_B	—
Nominal data bit sample point position ^a	t_{SPd}	—	0,70	—	t_B	—
Arbitration bit synchronisation jump width	t_{SJWa}	—	16	—	t_Q	typically corresponds to SJW = 1111 ₂
Data bit synchronisation jump width	t_{SJWd}	—	3	—	t_Q	typically corresponds to SJW = 0010 ₂

^a The nominal sample point position shall be located at the specified time after the start of a bit.

6.8.2.3 PHY – CAN FD bit timing parameter values for 2 Mbit/s data phase

Table 13 — CAN FD bit timing parameter for 2 Mbit/s data phase

Parameter/function	Symbol	Minimum	Nominal	Maximum	Unit	Conditions/ comment
Nominal arbitration bit rate	f_{Ba}	—	500	—	kbit/s	–
Data phase bit rate	f_{Bd}	—	2 000	—	kbit/s	–
Arbitration bit time	t_{Ba}	1 992	2 000	2 008	ns	±0,4 % (including aging)
Data bit time	t_{Bd}	498,0	500,0	502,0	ns	±0,4 % (including aging)
Nominal arbitration bit time quantum length	t_{Qa}	—	25	—	ns	80 t_q /bit
Nominal data bit time quantum length	t_{Qd}	—	25	—	ns	20 t_q /bit
Nominal arbitration bit sample point position ^a	t_{SPa}	—	0,80	—	t_B	–
Nominal data bit sample point position ^a	t_{SPd}	—	0,70	—	t_B	–
Arbitration bit synchronisation jump width	t_{SJWa}	—	16	—	t_Q	typically corresponds to SJW = 1111 ₂
Data bit synchronisation jump width	t_{SJWd}	—	6	—	t_Q	typically corresponds to SJW = 0101 ₂

^a The nominal sample point position shall be located at the specified time after the start of a bit.

6.8.2.4 PHY – CAN FD transmitter delay compensation

REQ	OSI1.5 PHY – PCS interface requirements – CAN FD transmitter delay compensation
The PCS CAN FD interface shall support transmitter delay compensation as specified in ISO 11898-1.	

6.8.2.5 PHY – PCS network system requirements

No additional requirements apply.

6.8.3 PHY – Physical media attachment (PMA) requirements

6.8.3.1 PHY – PMA entity requirements

The PMA requirements are specified in ISO 11898-2.

REQ	OSI1.7 PHY – PMA entity requirements – ISO 11898-2 conformance
This PMA shall conform with ISO 11898-2.	

The qualification of PMA requirements is specified in ISO 11898-2.

REQ	OSI1.8 PHY – PMA entity requirements – Qualification
For data bit rate of 2 Mbit/s (see Table 13) the PMA entity shall conform with ISO 11898-2.	
For data bit rates of 4 Mbit/s (see Table 11) and 5 Mbit/s (see Table 12) the PMA entity shall conform with ISO 11898-2.	