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ISO 11898-1

Second edition
2015-12-15

Road vehicles — Controller area network (CAN) —

Part 1: Data link layer and physical signalling

Véhicules routiers — Gestionnaire de réseau de communication (CAN) —

Partie 1: Couche liaison de données et signalisation physique

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Foreword

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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).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT), see the following URL: Foreword — Supplementary information.

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The committee responsible for this document is ISO/TC 22, *Road vehicles*, Subcommittee SC 31, *Data communication*.

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This second edition cancels and replaces the first edition (ISO 11898-1:2003), which has been technically revised. It also incorporates the Corrigendum ISO 11898-1:2003/Cor 1:2006.

ISO 11898 consists of the following parts, under the general title *Road vehicles — Controller area network (CAN)*:

— *Part 1: Data link layer and physical signalling*

— *Part 2: High-speed medium access unit* [1)]

— *Part 3: Low-speed, fault-tolerant, medium-dependent interface*

— *Part 4: Time-triggered communication*

— *Part 5: High-speed medium access unit with low-power mode* [1)]

— *Part 6: High-speed medium access unit with selective wake-up functionality* [1)]

1) Parts 2, 5, and 6 are being revised. They will be merged under a new edition of Part 2.

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Introduction

ISO 11898 was first published as one document in 1993. It covered the CAN data link layer, as well as the high-speed physical layer.

In the reviewed and restructured ISO 11898 series:

— Part 1 defines the data link layer including the logical link control (LLC) sub-layer and the medium access control (MAC) sub-layer, as well as the physical signalling (PHS) sub-layer;

— Part 2 defines the high-speed physical medium attachment (PMA);

— Part 3 defines the low-speed fault-tolerant physical medium attachment (PMA);

— Part 4 defines the time-triggered communication;

— Part 5 defines the power modes of the high-speed physical medium attachment (PMA);

— Part 6 defines the selective wake-up functionality of the high-speed physical medium attachment (PMA).

NOTE ISO 11898-2 is updated in parallel to the update of this part of ISO 11898 to combine the functions described in ISO 11898-2, ISO 11898-5 and ISO 11898-6. (The future edition of ISO 11898-2 will cancel and replace the current ISO 11898-2:2003, ISO 11898-5:2007 and ISO 11898-6:2013)

Figure 1 shows the relations between the OSI reference layers and the parts of the ISO 11898 series.

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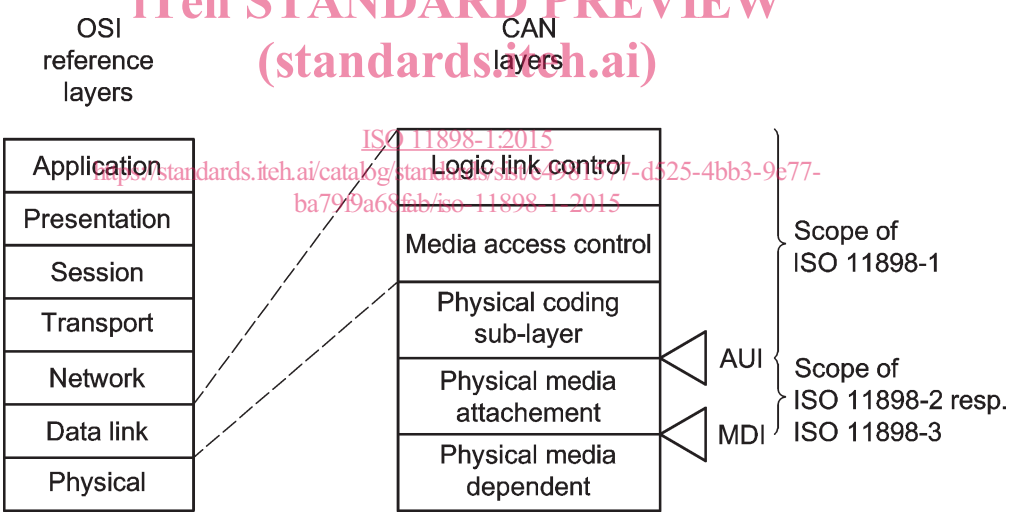

NOTE ISO 11898-2 refers to the future edition that will cancel and replace the current ISO 11898-2:2003, ISO 11898-5:2007 and ISO 11898-6:2013.

Figure 1 — CAN data link and physical sub-layers relation to the OSI model

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Road vehicles — Controller area network (CAN) —

Part 1:
Data link layer and physical signalling

1 Scope

This part of ISO 11898 specifies the characteristics of setting up an interchange of digital information between modules implementing the CAN data link layer. Controller area network is a serial communication protocol, which supports distributed real-time control and multiplexing for use within road vehicles and other control applications.

This part of ISO 11898 specifies the Classical CAN frame format and the newly introduced CAN Flexible Data Rate Frame format. The Classical CAN frame format allows bit rates up to 1 Mbit/s and payloads up to 8 byte per frame. The Flexible Data Rate frame format allows bit rates higher than 1 Mbit/s and payloads longer than 8 byte per frame.

This part of ISO 11898 describes the general architecture of CAN in terms of hierarchical layers according to the ISO reference model for open systems interconnection (OSI) according to ISO/IEC 7498-1. The CAN data link layer is specified according to ISO/IEC 8802-2 and ISO/IEC 8802-3.

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This part of ISO 11898 contains detailed specifications of the following (see Figure 2):

- logical link control sub-layer;
- medium access control sub-layer;
- physical coding sub-layer.

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There are three implementation options. They are the following:

- support of the Classical CAN frame format only, not tolerating the Flexible Data Rate frame format;
- support of the Classical CAN frame format and tolerating the Flexible Data Rate frame format;
- support of the Classical CAN frame format and the Flexible Data Rate frame format.

The last option is recommended to be implemented for new designs.

NOTE Implementations of the first option can communicate with implementations of the third option only as long as the Flexible Data Rate frame format is not used; otherwise, Error Frames are generated. There are opportunities to run implementations of the first option also in CAN networks using the Flexible Data Rate frame format, but these are not in the scope of this part of ISO 11898.

2 Conformance

The data link layer conformance test plan is not in the scope of this part of ISO 11898. For an implementation to be compliant with this part of ISO 11898, the logical link control sub-layer and the medium access control sub-layer shall comply with all mandatory specifications and values given in this part of ISO 11898. If optional specifications and values are implemented, they shall comply, too.

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3 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. 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, *Information technology — Open Systems Interconnection — Basic Reference Model: The Basic Model — Part 1*

ISO/IEC/IEEE 8802-3:2014, *Standard for Ethernet — Part 3*

4 Terms and definitions

For the purpose of this part of ISO 11898, the following terms and definitions apply.

4.1
arbitration phase
phase where the nominal bit time is used

4.2
bit stuffing
frame coding method providing bus state changes required for periodic resynchronization when using an NRZ bit representation

Note 1 to entry: Whenever the transmitting logic encounters a certain number (stuff width) of consecutive bits of equal value in the data, it automatically stuffs a bit of complementary value—a stuff bit—into the outgoing bit stream. Receivers de-stuff the Data Frames and the Remote Frames, i.e. the inverse procedure is carried out.

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4.3
bus
topology of a communication network, where all nodes are reached by passive links which allow transmission in both directions

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4.4
bus comparator
electronic circuit converting physical signals used for transfer across the communication medium back into logical information or data signals

4.5
bus driver
electronic circuit converting information or data signals into physical signals so that these signals can be transferred across the communication medium

4.6
bus state
one of two complementary logical states: dominant or recessive

Note 1 to entry: The dominant state represents the logical 0, and the recessive state represents the logical 1. During simultaneous transmission of dominant and recessive bits, the resulting bus state is dominant. When no transmission is in progress, the bus is idle. During idle time, it is in recessive state

4.7
Classical Base Frame Format
format for Data Frames or Remote Frames using an 11-bit identifier, which are transmitted with one single bit rate and up to and including 8 data bytes

4.8
Classical Extended Frame Format
format for Data Frames or Remote Frames using a 29-bit identifier, which are transmitted with one single bit rate and up to and including 8 data bytes

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4.9
Classical Frame
Data Frame or Remote Frame using the Classical Base Frame Format or the Classical Extended Frame Format

4.10
content-based arbitration
CSMA arbitration procedure resolving bus-contention when multiple nodes simultaneously access the bus

4.11
data bit rate
number of bits per time during data phase, independent of bit encoding/decoding

4.12
data bit time
duration of one bit in data phase

4.13
Data Frame
frame containing user data (e.g. one or more signals or one or more suspect parameters of one or more process data)

4.14
data phase
phase where the data bit time is used

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4.15
edge
difference in bus-states between two consecutive time quanta

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4.16
Error Frame
frame indicating the detection of an error condition

4.17
FD enabled
able to receive and to transmit FD Frames, as well as Classical Frames

4.18
FD Base Frame Format
format for Data Frames using an 11-bit identifier, which are transmitted with a flexible bit rate and up to and including 64 data bytes

4.19
FD Extended Frame Format
format for Data Frames using a 29-bit identifier, which are transmitted with a flexible bit rate and up to and including 64 data bytes

4.20
FD Frame
Data Frame using the FD Base Frame Format or FD Extended Frame Format

4.21
FD intolerant
only able to receive or to transmit Classical Frames, disturbing FD Frames

4.22
FD tolerant
not able to receive or to transmit FD Frames but not disturbing them

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4.23
frame
Protocol Data Unit of the data link layer specifying the arrangement and meaning of bits or bit fields in the sequence of transfer across the transmission medium

4.24
handle
hardware object label of one or multiple LLC frames (LPDU)

4.25
higher-layer protocol
protocol above the Data Link Layer protocol according to the Open System Interconnection model

[SOURCE: ISO/IEC 7498-1]

4.26
identifier
does not indicate the destination of the frame but reflects the priority of a particular frame and denotes the meaning of the data

4.27
idle
state of the network, when there is recessive state after the completion of a frame

4.28
idle condition
detection of a sequence of eleven consecutive sampled recessive bits

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4.29
integrating
status of a node waiting on an idle condition after it has started the protocol operation during bus-off recovery or after a protocol exception event

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4.30
minimum time quantum
smallest time quantum that can be configured for the specific implementation

4.31
multicast
addressing where a single frame is addressed to a group of nodes simultaneously

Note 1 to entry: Broadcast is a special case of multicast, whereby a single frame is addressed to all nodes simultaneously.

4.32
multi master
network with several nodes where every node is able to temporarily control the action of other nodes

4.33
node
assembly, linked to a communication network, capable of communicating across the network according to a communication protocol specification

Note 1 to entry: A CAN node is a node communicating across a CAN network.

4.34
node clock
time base to coordinate the bit-time-related state machines in CAN implementations

4.35
nominal bit rate
number of bits per time during arbitration phase, independent of the bit encoding/decoding

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4.36
nominal bit time
duration of one bit in arbitration phase

4.37
Non-Return-to-Zero
method of representing binary signals, i.e. within one and the same bit time, the signal level does not change, where a stream of bits having the same logical value provides no edges

4.38
Overload Frame
frame indicating an overload condition

4.39
priority
attribute to a frame controlling its ranking during the arbitration

Note 1 to entry: A high priority increases the probability that a frame wins the arbitration process.

4.40
protocol
formal set of conventions or rules for the exchange of information between nodes, including the specification of frame administration, frame transfer and PL

4.41
protocol exception event
exception from the formal set of conventions or rules to be able to tolerate future new frame formats

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4.42
receiver
any node that is not transmitter or integrating when the bus is not idle

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4.43
Remote Frame
frame that requests the transmission of a dedicated Data Frame

4.44
stuff bit count
number of stuff bits in a frame before the CRC field, not including fixed stuff bits

4.45
time-triggered communication
option where a frame can be transmitted in a defined time slot, which also provides a network-wide synchronization of clocks, as well as disabling of the automatic retransmission of frames, so that dedicated data and remote frames avoid collisions with data and remote frames transmitted by other nodes

4.46
transceiver
electronic circuit that connects a CAN node to a CAN network, consisting of a bus comparator and a bus driver

4.47
transmitter
node originating a data frame or remote frame, and stays transmitter until the bus is idle again or until the node loses arbitration

5 Symbols and abbreviated terms

ACK Acknowledgement

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AUI	Attachment Unit Interface
BCH	Bose-Chaudhuri-Hocquenghem
BRS	Bit Rate Switch
CAN	Controller area network
CBFF	Classical Base Frame Format
CEFF	Classical Extended Frame Format
CRC	Cyclic Redundancy Check
CSMA	Carrier Sense Multiple Access
DF	Data Frame
DLC	Data Length Code
DLL	Data Link Layer
EF	Error Frame
EOF	End Of Frame
ESI	Error State Indicator
FBFF	FD Base Frame Format
FCE	Fault Confinement Entity
FD	Flexible Data Rate
FDF	FD Format indicator
FEFF	FD Extended Frame Format
HLP	Higher-Layer Protocols
IDE	IDentifier Extension
IPT	Information Processing Time
LAN	Local Area Network
LLC	Logical Link Control
LME	Layer Management Entity
LPDU	LLC Protocol Data Unit
LSDU	LLC Service Data Unit
MAC	Medium Access Control
MAU	Medium Attachment Unit
MDI	Medium Dependent Interface
MPDU	MAC Protocol Data Unit

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MSB	Most Significant Bit
MSDU	MAC Service Data Unit
NRZ	Non-Return-to-Zero
OF	Overload Frame
OSI	Open Systems Interconnection
OVLD	Overload
PCI	Protocol Control Information
PCS	Physical Coding Sub-layer
PDU	Protocol Data Unit
PL	Physical Layer
PMA	Physical Medium Attachment
r0	Reserved bit in Classical Extended Frame Format
res	Reserved bit in FD Frames
RF	Remote Frame
RRS	Remote Request Substitution
RTR	Remote Transmission Request
SAP	Service Access Point
SDU	Service Data Unit
SJW	Synchronization Jump Width
SOF	Start Of Frame
SP	Sample Point
SRR	Substitute Remote Request
SSP	Secondary Sample Point
TDC	Transmitter Delay Compensation

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6 Basic concepts of CAN

6.1 CAN properties

CAN has the following properties:

— multi-master priority-based bus access;

— non-destructive content-based arbitration;

— all frame transfer is done as broadcast;

— multicast frame transfer by acceptance filtering;

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