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Road vehicles — Controller area network (CAN) —

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

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

Partie 3: Interface à basse vitesse, tolérant les pannes, dépendante du support

Reference number
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ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

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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.

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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.

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ISO 11898-3 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 3, *Electrical and electronic equipment*.

This first edition of ISO 11898-3 cancels and replaces ISO 11519-2:1994, which has been technically revised.

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*

— *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*

Introduction

ISO 11898, first published in November 1993, covered the controller area network (CAN) data link layer as well as the high-speed physical layer.

In the reviewed and restructured ISO 11898:

— ISO 11898-1 describes the data link layer protocol as well as the medium access control;

— ISO 11898-2 specifies the high-speed medium access unit (MAU) as well as the medium dependent interface (MDI).

ISO 11898-1:2003 and ISO 11898-2:2003 cancel and replace ISO 11898:1993.

In addition to the high-speed CAN, the development of the low-speed CAN, which was originally covered by ISO 11519-2, gained new means such as fault tolerant behaviour. The subject of this part of ISO 11898 is the definition and description of requirements necessary to obtain a fault tolerant behaviour as well as the specification of fault tolerance itself. In particular, it describes the medium dependent interface and parts of the medium access control.

Road vehicles — Controller area network (CAN) —

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

1 Scope

This part of ISO 11898 specifies characteristics of setting up an interchange of digital information between electronic control units of road vehicles equipped with the controller area network (CAN) at transmission rates above 40 kBit/s up to 125 kBit/s. The CAN is a serial communication protocol which supports distributed control and multiplexing.

This part of ISO 11898 describes the fault tolerant behaviour of low-speed CAN applications, and parts of the physical layer according to the ISO/OSI layer model. The following parts of the physical layer are covered by this part of ISO 11898:

— medium dependent interface (MDI);

— physical medium attachment (PMA).

In addition, parts of the physical layer signalling (PLS) and parts of the medium access control (MAC) are also affected by the definitions provided by this part of ISO 11898.

All other layers of the OSI model either do not have counterparts within the CAN protocol and are part of the user's level or do not affect the fault tolerant behaviour of the low speed CAN physical layer and therefore are not part of this part of ISO 11898.

2 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

2.1
bus
topology of a communication network where all nodes are reached by passive links which allow transmission in both directions

2.2
bus failure
failures caused by a malfunction of the physical bus such as interruption, short circuits

2.3
bus value
one of two complementary logical values: dominant or recessive

NOTE The dominant value represents a logical "0" the recessive represents a logical "1". During simultaneous transmission of dominant and recessive bits, the resulting bus value will be dominant.

2.4
bus voltage
voltage of the bus line wires CAN_L and CAN_H relative to ground of each individual CAN node

NOTE V_{CAN_L} and V_{CAN_H} denote the bus voltage.

2.5
differential voltage
V_{diff}
voltage seen between the CAN_H and CAN_L lines

NOTE $V_{diff} = V_{CAN\_H} - V_{CAN\_L}$

2.6
fault free communication
mode of operation without loss of information

2.7
fault tolerance
ability to operate under specified bus failure conditions at least with a reduced performance

EXAMPLE Reduced signal to noise ratio.

2.8
transceiver loop time delay
delay time from applying a logical signal to the input on the logical side of the transceiver until it is detected on the output on the logical side of the transceiver

2.9
low power mode
operating mode with reduced power consumption

NOTE A node in low power mode does not disturb communication between other nodes.

2.10
node
assembly, connected to the communication line, capable of communicating across the network according to the given communication protocol specification

2.11
normal mode
operating mode of a transceiver which is actively participating (transmitting and/or receiving) in network communication

2.12
operating capacitance
C_{OP}
overall capacitance of bus wires and connectors seen by one or more nodes, depending on the topology and properties of the physical media

2.13
physical layer
electrical circuit realization that connects an ECU to the bus

2.14
physical medium (of the bus)
pair of wires, parallel or twisted, shielded or unshielded

NOTE The individual wires are denoted as CAN_H and CAN_L.

2.15
receiver
device that transforms physical signals used for the transmission back into logical information or data signals

2.16
transmitter
device that transforms logical information or data signals to electrical signals so that these signals can be transmitted via the physical medium

2.17
transceiver
device that adapts logical signals to the physical layer and vice versa

3 Abbreviated terms

ACK	Acknowledge
CAN	Controller Area Network
CRC	Cyclic Redundancy Check
CSMA	Carrier Sense Multiple Access
DLC	Data Length Code
ECU	Electronic Control Unit
EOF	End of Frame
FCE	Fault Confinement Entity
IC	Integrated Circuit
LAN	Local Area Network
LLC	Logical Link Control
LME	Layer Management Entity
LPDU	LLC Protocol Data Unit
LSB	Least Significant Bit
LSDU	LLC Service Data Unit
LS-MAU	Low-Speed Medium Access Unit
MAC	Medium Access Control
MAU	Medium Access Unit
MDI	Medium Dependent Interface
MPDU	MAC Protocol Data Unit
MSB	Most Significant Bit
MSDU	MAC Service Data Unit
NRZ	Non-Return-to-Zero
OSI	Open System Interconnection
PL	Physical Layer
PLS	Physical Layer Signalling
PMA	Physical Medium Attachment
RTR	Remote Transmission Request
SOF	Start of Frame

4 OSI reference model

According to the OSI reference model shown in Figure 1, the CAN architecture represents two layers:

— data link layer;

— physical layer.

This part of ISO 11898 describes the physical layer of a fault tolerant low-speed CAN transceiver. Only a few influences to the data link layer are given.

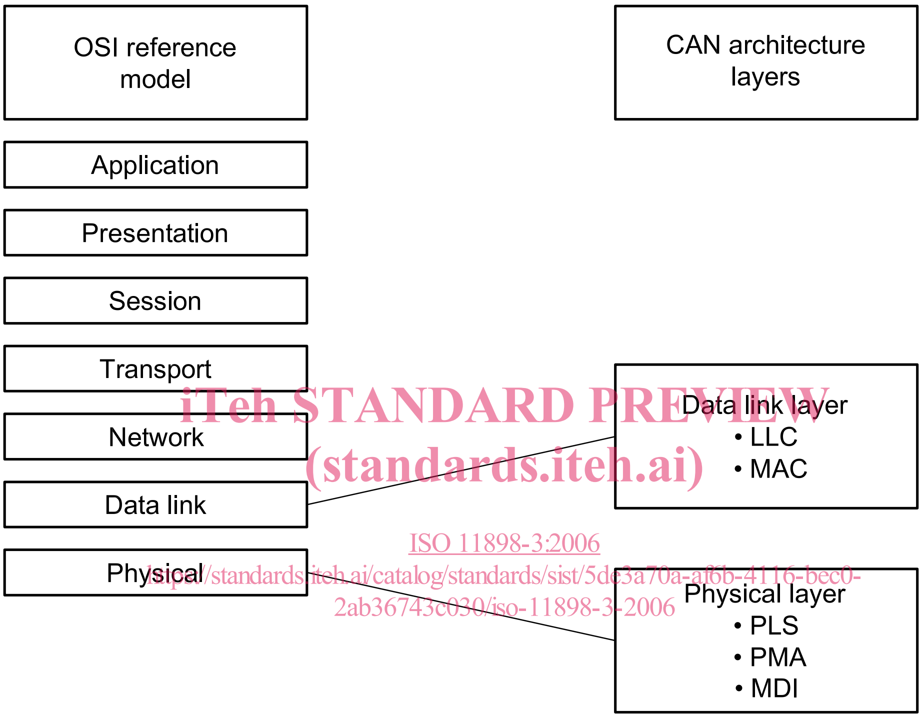


Figure 1 — OSI reference model/CAN layered architecture

5 MDI specification

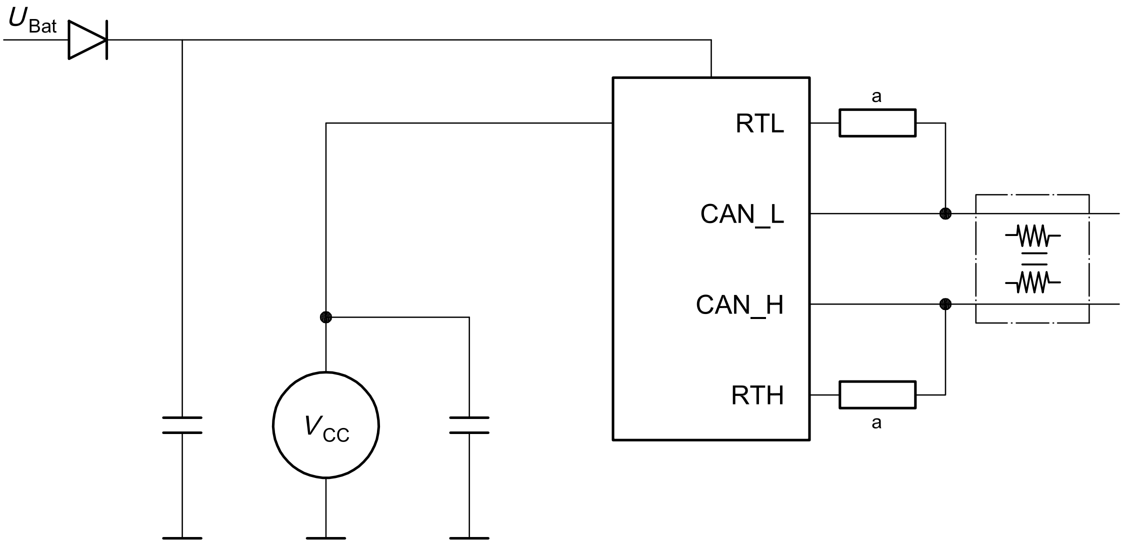
5.1 Physical media

5.1.1 General

The physical media used for the transmission of CAN broadcasts shall be a pair of parallel (or twisted) wires, shielded or unshielded, dependent on EMC requirements. The individual wires are denoted as CAN_H and CAN_L. In dominant state, CAN_L has a lower voltage level than in recessive state, and CAN_H has a higher voltage level than in recessive state.

5.1.2 Node bus connection

The two wires CAN_H and CAN_L are terminated by a termination network, which shall be realized by the individual nodes themselves. The overall termination resistance of each line should be greater than or equal to 100 Ω. However, the termination resistor's value of a designated node should not be below 500 Ω, due to the semiconductor manufacturers' constraints. To represent the recessive state CAN_L is terminated to V_{CC} and CAN_H is terminated to GND. Figure 2 illustrates the normal termination of a designated bus node.



Key

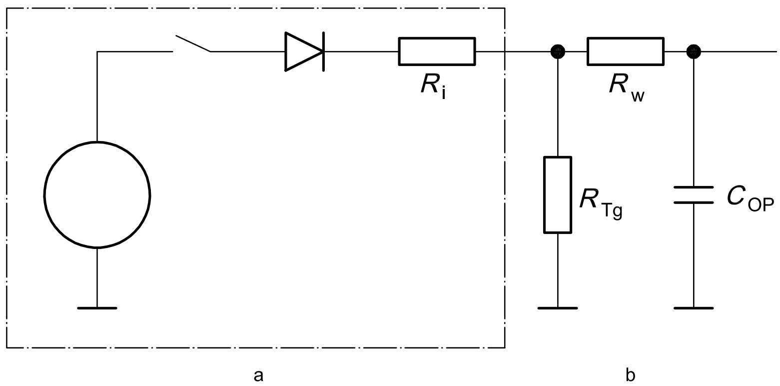
a Optional.

Figure 2 — Termination of a single bus node

In Figure 2, the termination resistors are denoted as optional. That means that under certain conditions not all nodes need an individual termination, if the requirements of proper overall termination are fulfilled.

5.1.3 Operating capacitance

The following specifications are valid for a simple wiring model which in general is used in automotive applications. It consists of a pair of twisted copper cables which are connected in a topology described in 5.1.4. The following basic model shown in Figure 3 and 4 is used for the calculations.

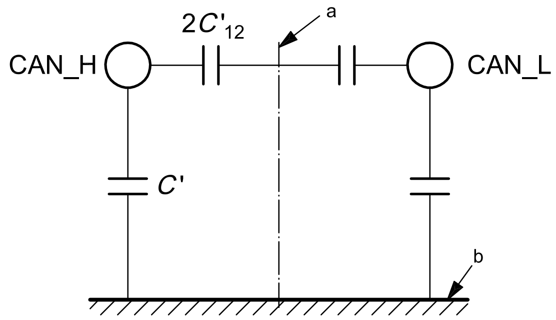


Key

a Driver.

b Wire.

Figure 3 — Substitute circuit for bus line



Key

a Symmetric axis.

b Ground.

Figure 4 — Operating capacitance referring to network length l

The operating capacitance is calculated using Equation 1.

$$C_{OP} = l\,(C' + 2C'_{12}) + n\,C_{node} + k\,C_{plug} \quad (1)$$

where

C_{OP} is the operating capacitance;

C' is the capacitance between the lines and ground referring to the wire length in metres (m);

C'_{12} is the capacitance between the two wires (which is assumed to be symmetrical) referring to the wire length in metres (m);

C_{node} is the capacitance of an attached bus node seen from the bus side;

C_{plug} is the capacitance of one connecting plug;

l is the overall network cable length;

n is the number of nodes;

k is the number of plugs.

EXAMPLE A typical value for the operating capacitance referring to the overall network cable length in respect to the exemplary network described below is given by:

$$(C' + 2C'_{12}) = 120\ [\text{pF/m}]$$

5.1.4 Medium timing

The maximum allowed operating capacitance is limited by network inherent parameters such as:

- overall termination resistance R_{term};
- wiring model and topology;
- communication speed;
- sample point and voltage thresholds;
- ground shift, etc.

