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Road vehicles — Interchange of digital information — Controller area network (CAN) for high-speed communication

Véhicules routiers — Échange d'information numérique — Gestionnaire de réseau de communication à vitesse élevée (CAN)

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Contents

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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.

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.

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

Road vehicles — Interchange of digital information — Controller area network (CAN) for high-speed communication

1 Scope

This International Standard specifies characteristics of setting up an interchange of digital information between Electronic Control Units (ECUs) of road vehicles equipped with the Controller Area Network at transmission rates above 125 kbit/s up to 1 Mbit/s.

The Controller Area Network (CAN) is a serial communication protocol which supports distributed real-time control and multiplexing.

This specification of CAN describes the general architecture of CAN in terms of hierarchical layers according to the ISO reference model for Open Systems Interconnection (OSI) specified in ISO 7498. The data link layer and physical layer are specified according to ISO 8802-2 and ISO 8802-3. This International Standard contains detailed specifications of aspects of CAN belonging to the

a) physical layer;

b) data link layer

— Logical Link Control (LLC) sublayer,

— Medium Access Control (MAC) sublayer.

All other layers of the OSI model do not have counterparts within this specification of CAN protocol but are part of the user's level.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 11898. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 11898 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 7498:1984, *Information processing systems — Open Systems Interconnection — Basic Reference Model.*

ISO 7637-3:—[1], *Road vehicles — Electrical disturbance by conduction and coupling — Part 3: Passenger cars and light commercial vehicles with nominal 12 V supply voltage and commercial vehicles with 24 V supply voltage — Electrical transient transmission by capacitive and inductive coupling via lines other than supply lines.*

ISO 8802-2:1989, *Information processing systems — Local area networks — Part 2: Logical link control.*

1) To be published.

ISO/IEC 8802-3:1993, *Information technology — Local and metropolitan area networks — Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications.*

3 Definitions and abbreviations

For the purposes of this International Standard, the following definitions apply.

3.1 Data link layer definitions

3.1.1 bit rate: Number of bits per time during transmission, independent of bit representation.

3.1.2 bit stuffing: Technique used in bit-oriented protocols in order

— to achieve data transparency (arbitrary bit patterns may not be interpreted as protocol information), and

— to provide "dominant" to "recessive" edges, and vice versa, which are necessary for correct resynchronization when using a Non-Return-to-Zero bit representation.

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 destuff the frame, i.e. the inverse procedure is carried out.

3.1.3 bus: Topology of a communication network, where all nodes are reached by passive links which allow transmission in both directions.

3.1.4 bus value: One of two complementary logical values: "dominant" or "recessive". The "dominant" value represents the logical "0", and the "recessive" represents the logical "1". During simultaneous transmission of "dominant" and "recessive" bits, the resulting bus value will be "dominant".

3.1.5 contention-based arbitration: Carrier Sense Multiple Access (CSMA) arbitration procedure where simultaneous access of multiple nodes results in a contention. One frame will survive the contention uncorrupted.

3.1.6 frame: Data link protocol data unit specifying the arrangement and meaning of bits or bit fields in the sequence of transfer across the transmission medium.

3.1.7 multicast: Addressing where a single frame is addressed to a group of nodes simultaneously. Broadcast is a special case of multicast, whereby a single frame is addressed to all nodes simultaneously.

3.1.8 multi-master: System partitioned into several nodes where every node may temporarily control the action of other nodes.

3.1.9 node: Any assembly, linked to a communication line, capable of communicating across the network according to a communication protocol specification.

3.1.10 non-return-to-zero: Method of representing binary signals. Within one and the same bit time, the signal level does not change, i.e. a stream of bits having the same logical value provides no edges.

3.1.11 priority: Attribute to a frame controlling its ranking during arbitration. A high priority increases the probability that a frame wins the arbitration process.

3.1.12 protocol: Formal set of conventions or rules for the exchange of information between nodes, including the specification of frame administration, frame transfer and physical layer.

3.1.13 receiver: Device that converts physical signals used for transmission back into logical information or data signals.

3.1.14 transmitter: Device that converts information or data signals to electrical or optical signals so that these signals can be transferred across the communication medium.

3.2 Physical layer definitions

3.2.1 common mode bus voltage range: Boundary voltage levels of V_{CAN_L} and V_{CAN_H}, for which proper operation is guaranteed if up to the maximum number of ECUs are connected to the bus line.

3.2.2 differential internal capacitance, C_{diff} **(of an ECU):** Capacitance seen between CAN_L and CAN_H during the recessive state when the ECU is disconnected from the bus line. (See figure 1.)

3.2.3 differential internal resistance, R_{diff} **(of an ECU):** Resistance which is seen between CAN_L and CAN_H during the recessive state when the ECU is disconnected from the bus line. (See figure 1.)

3.2.4 differential voltage, V_{diff}**:** value

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

with the voltages V_{CAN_L} and V_{CAN_H} denoting the voltages of CAN_L and CAN_H relative to ground of each individual ECU.

3.2.5 internal capacitance, C_{in} **(of an ECU):** Capacitance seen between CAN_L (or CAN_H) and ground during the recessive state when the ECU is disconnected from the bus line. (See figure 1.)

3.2.6 internal delay time, t_{ECU} **(of an ECU):** Sum of all asynchronous delay times occurring on the transmitting and receiving path relative to the bit timing logic unit of the protocol IC of each individual ECU disconnected from the bus line.

3.2.7 internal resistance, R_{in} **(of an ECU):** Resistance which is seen between CAN_L (or CAN_H) and ground during the recessive state when the ECU is disconnected from the bus line. (See figure 1.)

3.2.8 physical layer: Electrical circuit realization that connects an ECU to a bus. The total number of ECUs connected on a bus is limited by electrical loads on the bus line.

3.2.9 physical media (of the bus): Pair of parallel wires, shielded or unshielded, dependent on EMC requirements. The individual wires are designated as CAN_L and CAN_H. The names of the corresponding pins of ECUs are also denoted by CAN_L and CAN_H respectively.

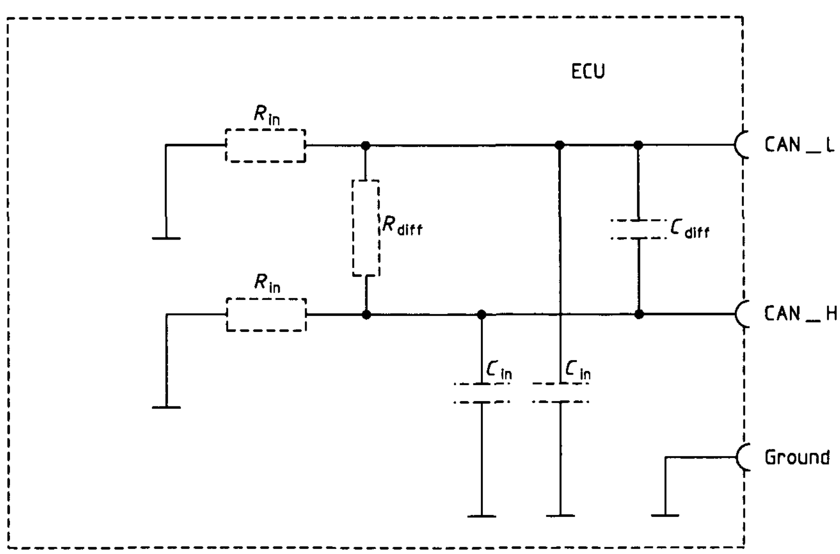

Figure 1 — Definitions of internal capacitances and internal resistances of ECU

3.3 List of abbreviations

ACK	Acknowledgement
ECU	Electronic Control Unit
EOF	End of Frame
CAN	Controller Area Network
CRC	Cyclic Redundancy Check
DLC	Data Length Code
IC	Integrated Circuit
FCE	Fault Confinement Entity
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
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 Signalling
PMA	Physical Medium Attachment
RTR	Remote Transmission Request
SOF	Start of Frame

4 Basic concepts of CAN

CAN has the following properties:

— multi-master priority-based bus access;

— non-destructive contention-based arbitration;

— multicast frame transfer by acceptance filtering;

— remote data request;