CiA® 102

Physical layer for industrial applications

Version: 3.0.0
05 February 2010

HISTORY

Date	Changes
1994-04-20	*Publication of version 2.0* as draft standard
2008-04-10	*Publication of version 3.0* as draft standard proposal
	Entirely reviewed; references to CiA 301 and CiA 303-1 included.
2010-02-05	*Publication of version 3.0* as draft standard (now publicly available)

NOTE: This document has been converted into "docx format".
The conversion caused minor layout differences to the predecessor document in "doc format". The technical content word-by-word is the very same.

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CAN in Automation e. V.
Kontumazgarten 3
DE - 90429 Nuremberg, Germany
Tel.: +49-911-928819-0
Fax: +49-911-928819-79
Url: www.can-cia.org
Email: headquarters@can-cia.org

CONTENTS

1 Scope

This specification describes the Controller Area Network physical layer for general industrial applications using transmission rates of up to 1 Mbit/s. In addition to the internationally standardized high-speed transceiver, it specifies a number of transmission rates in order to achieve a generic compatibility between CAN devices, in particular with CANopen devices.

This specification is suitable for all CAN tools and generic interface devices (e.g. USB/CAN dongles) to be used for CAN-based industrial networks.

2 Normative references

/CiA301/	CiA 301, CANopen application layer and communication profile
/CiA303-1/	CiA 303-1, CANopen additional specification – Part 1: Cabling and connector pin assignment
/ISO11898-1/	ISO 11898-1, Road vehicles – Controller area network (CAN) – Part 1: Data link layer and physical signalling
/ISO11898-2/	ISO 11898-2, Road vehicles – Controller area network (CAN) – Part 2: High-speed medium access unit
/ISO11898-5/	ISO 11898-5, Road vehicles – Controller area network (CAN) – Part 5: High-speed medium access unit with low-power mode

3 Definitions and abbreviations

3.1 Definitions

For the purposes of this specification, the definitions given in /ISO11898-1/, /ISO11898-2/, and /ISO11898-5/ apply.

3.1.1 CAN device

electronic control unit featuring a CAN controller chip and a CAN transceiver chip

3.1.2 T-connector

passive component comprising three connectors

3.2 Abbreviations

CAN	Controller Area Network
EMC	Electro-magnetic compatibility
GND	Ground
LC	Inductor capacitor
SHLD	Shield
RC	Resistor capacitor
TVS	Transient voltage suppression

4 Physical signalling

4.1 Introduction

The settings of bit-timing parameters for CAN controller chips are not standardized in /ISO11898-1/.

4.2 Device design

Normally, the device designer sets the bit-timing parameters. One of the transmission rates as specified in /CiA301/ shall be used. For convenience, the recommended bit-rates are shown in Table 1.

NOTE Not all CAN transceiver chips compliant to /ISO11898-2/ support the lower bit-rates. Also high-clocked CAN controller chips are not always able to support the lower bit-rates.

It is recommended to parameterize the CAN controller chips regarding the sample point as specified in /CiA301/.

Table 1 – Recommended bit rates

Bit rate	Nominal bit time
1 Mbit/s	1 µs
800 kbit/s	1,25 µs
500 kbit/s	2 µs
250 kbit/s	4 µs
125 kbit/s	8 µs
50 kbit/s	20 µs
20 kbit/s	50 µs
10 kbit/s	100 µs

4.3 System design

All devices in a network shall use the very same bit-rate. The configured sample points should be the same or as close as possible to each other. Using different sample point configurations may lead to shorter network length or require more accurate oscillators in order to achieve a suitable resynchronization.

5 Physical medium attachment

5.1 Introduction

Devices connected to networks compliant to this specification shall use transceiver chips compliant to /ISO11898-2/ or /ISO11898-5/. The low-power mode of transceiver chips compliant to /ISO11898-5/ does not fall into the scope of this specification.

5.2 Device design

In order to increase EMC performance and to protect the transceiver chip, the device designer may use additional circuitry such as bi-directional TVS diodes, metal oxide varistors, crowbars, or RC/LC filters.

5.3 System design

In order to increase EMC performance and to protect the transceiver chip, the system designer may use (biased) split termination resistors and other additional circuitry (e.g. ferrite bead, common mode choke, or feed-through capacitors). It is also possible to shield the bus-line cable.

6 Medium dependent interface

6.1 Introduction

The network topology is a two-wire bus-line (CAN_H and CAN_L) with common return (CAN_GND) being terminated at both ends by resistors representing the characteristic impedance of the bus-line. The pin assignments for different connectors are recommended in /CiA303-1/. For general-purpose applications it is recommended to use 9-pin D-sub connectors.

6.2 Device design

There are two basic concepts how to connect the device to the bus-lines:

- Interconnected bus line sections – The bus lines consist of a number of sections, which are interconnected; two options are allowed:
    - A T-connector is used to interconnect the bus-line sections and the CAN device.
    - The CAN device provides two bus connectors, interconnecting the bus line

- Undivided bus-line – The bus-line consists of a single cable without interconnecting devices (device: one plug connector; bus-line: one socket connector per device, plus one socket and one plug connector with termination resistors on both ends).

The plug connectors shall not provide external power supply for transceiver and optocouplers.

6.3 System design

The wiring topology should be as close as possible to a single line structure, in order to minimize reflections. The maximum network length depends on the selected bit-rate and the location of the sample point. The maximum length of the network shall not exceed 1 000 m. The system designer should consider the general recommendations given in /CiA303-1/.

For network length below 40 m it is recommended to use a 124-Ω resistor to terminate the bus-lines at both network ends. For other network lengths, general recommendations are given in /CiA303-1/.

The ground pins of all transceiver chips are interconnected. The parameters of specific resistance per stub-cable length, total network length, current, and location of the power supply input should be chosen in a way, that the difference between ground potentials of the transceiver chips does not exceed 2 V.

NOTE At bus line lengths greater than 40 m, the specific resistance of the bus cable should be lower than the value given in /ISO11898-2/. The recommendations given in /CiA303-1/ should be considered.

If necessary, galvanic isolation may be applied, in order to reduce the current through the ground line. In general, it is advantageous to locate the power supply input in the centre of the bus-lines. It is recommended that the external positive power supply is in the range +7 V < V+ < +13 V with a maximum of up to 100 mA. Other values should be double-checked with the used connectors in the entire network.

NOTE If the devices use 24-V or higher voltage power supplies, it is recommended to select appropriate CAN transceiver chips.

The bus wires may be routed parallel, twisted and/or shielded, depending on the EMC requirements. If non-terminated stub-cables are used, the maximum length of them should be considered, for details see /CiA303-1/. The cable stubs should be as short as possible, especially at higher bit-rates. At 1 Mbit/s, the length of the cable-stubs should not exceed 0,3 m (see /ISO11898-2/); this includes also the device-internal cable stubs.

It is possible to use repeater devices to increase the number of bus nodes, which are connected to the network system. From the data link layer point of view, it is one logical network comprising several segments. Repeaters are also used to increase the allowed distance between the bus nodes.