



CAN-USB/2

USB 2.0-CAN-Interface



Hardware Manual

to Product C.2066.xx



NOTE

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esd electronic system design gmbh
Vahrenwalder Str. 207
30165 Hannover
Germany

Phone: +49-511-372 98-0

Fax: +49-511-372 98-68

E-Mail: info@esd.eu

Internet: www.esd.eu

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Document History

The changes in the document listed below affect changes in the hardware as well as changes in the description of the facts, only.

Revision	Chapter	Changes versus previous version	Date
1.4	6	Updated chapter 'Correctly Wiring Electrically Isolated CAN Networks'	2013-03-06
	8	New Declaration of Conformity	
	9	Updated chapter 'Order Information'	

Technical details are subject to change without further notice.



Safety Instructions

- When working with CAN-USB/2 follow the instructions below and read the manual carefully to protect yourself from injury and the CAN-USB/2 from damage.
- Do not open the housing of the CAN-USB/2.
- Never let liquids get inside the CAN-USB/2. Otherwise, electric shocks or short circuits may result.
- Protect the CAN-USB/2 from dust, moisture and steam.
- Protect the CAN-USB/2 from shocks and vibrations.
- The CAN-USB/2 may become warm during normal use. Always allow adequate ventilation around the CAN-USB/2 and use care when handling.
- Do not operate the CAN-USB/2 adjacent to heat sources and do not expose it to unnecessary thermal radiation. Ensure an ambient temperature as specified in the technical data.
- Do not use damaged or defective cables to connect the CAN-USB/2 and follow the CAN wiring hints in chapter: "Correctly Wiring Electrically Isolated CAN Networks".
- In case of damages to the device, which might affect safety, appropriate and immediate measures must be taken, that exclude an endangerment of persons and objects.
- Current circuits which are connected to the device have to be sufficiently protected against hazardous voltage (SELV according to EN 60950-1).
- The CAN-USB/2 may only be driven by power supply current circuits, that are contact protected.
A power supply, that provides a safety extra-low voltage (SELV or PELV) according to EN 60950-1, complies with this conditions.

Qualified Personal

This documentation is directed exclusively towards personal qualified in control and automation engineering. The installation and commissioning of the product may only be carried out by qualified personal, which is authorized to put devices, systems and electric circuits into operation according to the applicable national standards of safety engineering.

Conformity

The CAN-USB/2 is an industrial product and meets the demands of the EU regulations and EMC standards printed in the conformity declaration at the end of this manual.

Warning: In a residential, commercial or light industrial environment the CAN-USB/2 may cause radio interferences in which case the user may be required to take adequate measures.

Intended Use

The intended use of the CAN-USB/2 is the operation as an USB 2.0-CAN-Interface

The guarantee given by esd does not cover damages which result from improper use, usage not in accordance with regulations or disregard of safety instructions and warnings.

- The operation of the CAN-USB/2 in hazardous areas, or areas exposed to potentially explosive materials is not permitted.
- The operation of the CAN-USB/2 for medical purposes is prohibited.

Service Note

The CAN-USB/2 does not contain any parts that require maintenance by the user. The CAN-USB/2 does not require any manual configuration of the hardware. Unauthorized intervention in the device voids warranty claims.

Disposal

Devices which have become defective in the long run have to be disposed in an appropriate way or have to be returned to the manufacturer for proper disposal. Please, make a contribution to environmental protection.

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1. Overview

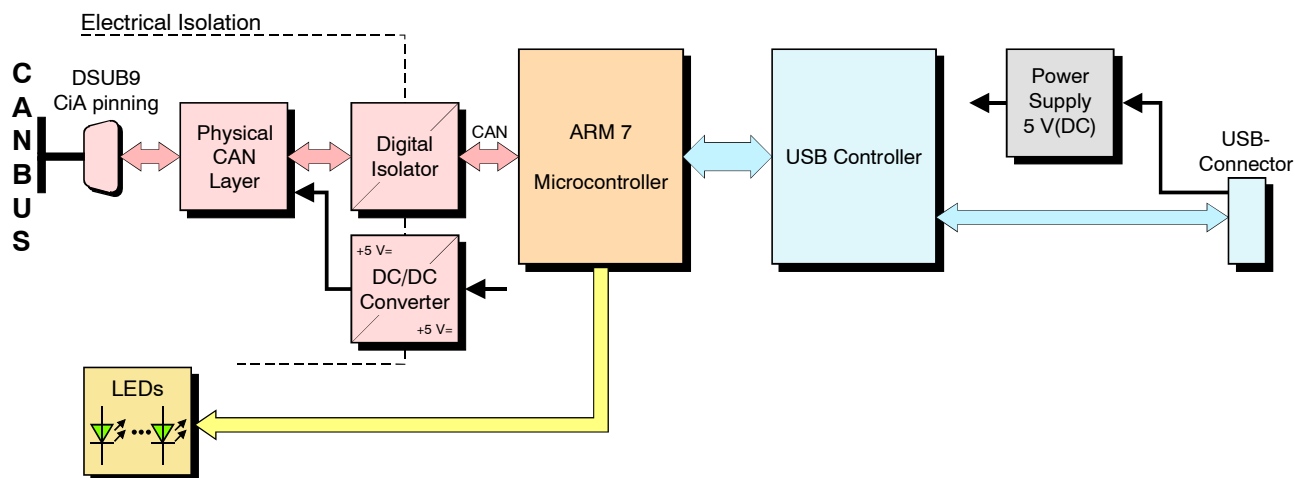


Figure 1: Block-circuit diagram of CAN-USB/2 module

The CAN-USB/2 module is an intelligent CAN interface with an ARM7 micro controller for local CAN data management. The module supports the USB 2.0 Hi-Speed interface with data transfer rates of 480 Mbit/s.

The ISO 11898-compliant CAN interface allows a maximum data transfer rate of 1 Mbit/s. Like many other features of CAN interfaces, the bit rate can be set by means of software. CAN interface and other voltage potentials are electrically isolated by means of a digital isolator and DC/DC converters.

The supply voltage is fed via the USB bus. The module is equipped with four green LEDs in the front panel which indicate the current module status.

2. Case View with LED and Connector Description

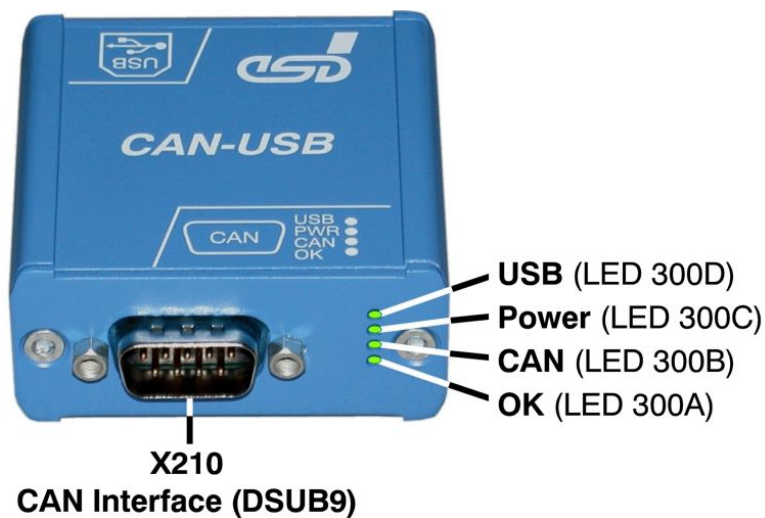


Figure 2: PCB top view



Figure 3: USB Interface


2.1 LED-Displays


LED			Description
NAME	Number	Status	
USB	LED300D	on	USB module is enumerated (a node-ID is assigned to the USB module)
Power	LED300C	on	module is in operation, the 5 V power supply is applied to the module
CAN	LED300B	on	data is received or send on the CAN bus
OK	LED300A	on	CAN interface is initialized, bit rates are set
		off	bit rate not set
		fast flashing (appr. 10 Hz)	CAN interface is initialized and in mode 'Listen Only'; the bit rate is already set
		slow flashing (appr. 1 Hz)	CAN interface is initialized and in mode 'Automatic Baudrate Detection' (from firmware version 1.0.0.4 and CAN driver version 2.5.2 on)

Table 1: Description of LED display

3. Hardware Installation

To put the CAN-USB/2 into operation, please follow the installation notes.

Step	Procedure	see page
	<p>Read the safety instructions at the beginning of this document carefully, before you start with the hardware installation!</p>	4
1.	Connect the CAN-USB/2-module with the USB bus of the PC	-
2.	<p>Please note that the CAN bus has to be terminated at both ends! esd offers special T-connectors and termination connectors. Additionally the CAN_GND signal has to be connected to earth at exactly one point in the CAN network. Therefore the CAN termination connectors offered by esd have got a grounding contact.</p> <p>A CAN participant with a CAN interface which is not electrically isolated corresponds to the grounding of the CAN-GND.</p>	-
3.	Switch on the power supply voltage of the CAN-USB/2.	-


	<p>Note: The software installation is described in the manual 'CAN-API, Installation Guide'.</p>
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4. Technical Data

4.1 General Technical Data

Temperature range	0...50°C ambient temperature
Humidity	90 %, non-condensing
Power supply	via USB 2.0 bus, nominal voltage: 5 V current consumption: max. 250 mA *
Connectors	X210 (DSUB9/male) - CAN bus X300 (USB socket, series B) - USB bus
Case dimensions	55 mm x 55 mm x 25 mm
IP-rating	IP 40
Weight	70 g

Table 2: General data of the module

	<p>Note: Please note that the current consumption of the module of 250 mA has to be supplied (high powered bus-powered device). The maximum current consumption of 250 mA has to be guaranteed also if a hub is used. Therefore it is highly recommended to use a self-powered hub.</p>
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4.2 USB-Interface and Microcontroller

USB-interface	USB 2.0, bit rate up to 480 Mbit/s
Microcontroller	ARM7 microcontoller

Table 3: USB interface and microcontroller

4.3 CAN Interface

Number of CAN interfaces	1
CAN protocol	ISO 11898-1 (11 and 29 bit CAN identifier are supported)
Physical Layer	CAN High Speed interface according to ISO 11898-2, transmission rate programmable from 10 Kbit/s to 1 Mbit/s
Bus termination	terminating resistor has to be set externally, if required
Electrical isolation of CAN-interfaces from other units	via digital isolators and DC/DC-converters

Table 4: Data of the CAN interface

4.4 Serial Interface

Number	4 asynchronous serial interfaces
Controller	integrated in CPU or external DUART
Bit rate	Value range: 9600 Baud ... 115200 Baud Default setting: 9600 Baud, 8 Bit, No Parity 1 Stop-Bit
Physical Interface	Serial 1: RS232 with RxD, TxD, RTS CTS, DSR, DTR Serial 2: RS232 with RxD, TxD Serial 3: RS485 Serial 4:
Software	Standard operating system driver
Connector	9-pin DSUB

Table 5: Data of the serial interface

4.5 Software Support

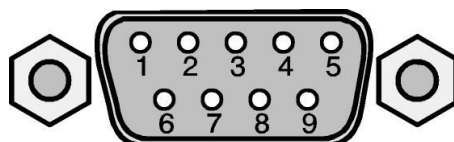
Device drivers for Windows® and Linux® are available. Drivers for other operating systems, especially real-time operating systems, are available on request.

5. Connector Assignments

5.1 CAN Interface at DSUB9 Connector

Device connector: RJ45 socket, 8-pin

Pin Position:



Pin Assignment:

Signal	Pin	Signal
CAN_GND	6	1 reserved
CAN_H		2 CAN_L
reserved	8	3 CAN_GND
reserved		4 reserved
	9	5 Shield

Signal Description:

CANx_L, CANx_H ... CAN signals of the CAN interface x (x... 1 - 4)

CANx_GND... reference potential of the local CAN physical layer of CAN interface x (x... 1 - 4)

- ... reserved for future applications, do not connect!

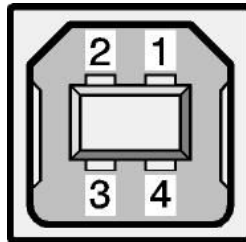
5.2 USB Socket



Note:

The module may only be operated at USB nets with USB interface version numbers \geq 1.1-interface! Using versions earlier than 2.0 reduces the data transfer rate.

Pin Position:



Pin Assignment:

Pin	Signal
1	V_{BUS}
2	D-
3	D+
4	GND
Shell	Shield

USB socket (series B)

6. Correctly Wiring Electrically Isolated CAN Networks

For the CAN wiring all applicable rules and regulations (EC, DIN), e.g. regarding electromagnetic compatibility, security distances, cable cross-section or material, have to be met.

6.1 Light Industrial Environment (*Single Twisted Pair Cable*)

6.1.1 General Rules

i	<p>Note: esd grants the EC Conformity of the product, if the CAN wiring is carried out with at least single shielded single twisted pair cables that match the requirements of ISO 118982-2. Single shielded <i>double</i> twisted pair cable wiring as described in chapter 6.2. ensures the EC Conformity as well.</p>
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The following **general rules** for CAN wiring with single shielded *single* twisted pair cable must be followed:

1	A cable type with a wave impedance of about $120 \Omega \pm 10\%$ with an adequate wire cross-section (0.22 mm^2) has to be used. The voltage drop over the wire has to be considered!
2	For light industrial environment use at least a two-wire CAN cable. Connect <ul style="list-style-type: none"> • the two twisted wires to the data signals (CAN_H, CAN_L) and • the cable shield to the reference potential (CAN_GND)!
3	The reference potential CAN_GND has to be connected to the functional earth (FE) at exactly one point.
4	A CAN net must not branch (exception: short cable stubs) and has to be terminated with the characteristic impedance of the line (generally $120 \Omega \pm 10\%$) at both ends (between the signals CAN_L and CAN_H and not at GND)!
5	Keep cable stubs as short as possible ($l < 0.3 \text{ m}$)!
6	Select a working combination of bit rate and cable length.
7	Keep away cables from disturbing sources. If this cannot be avoided, double shielded wires are recommended.

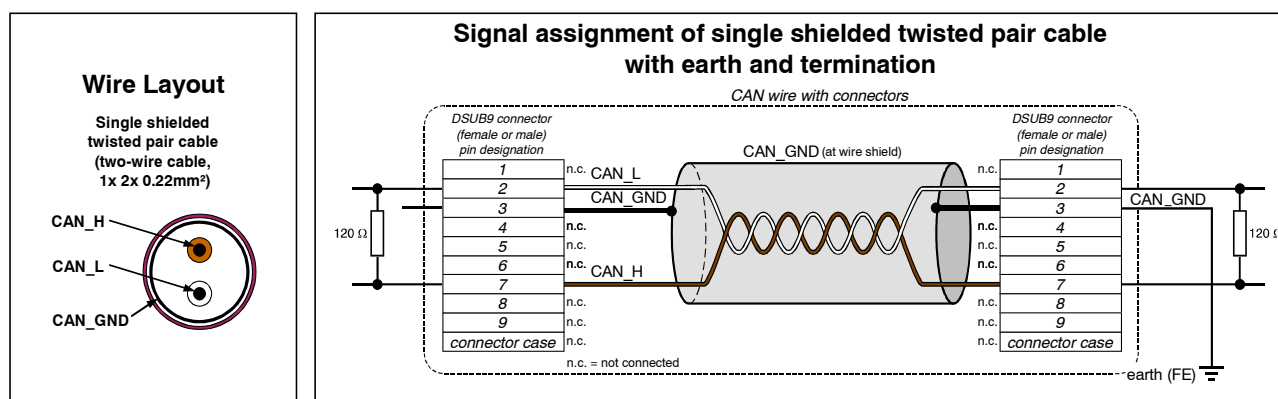


Figure. 4: CAN wiring for light industrial environment

6.1.2 Cabling

- for devices which have only one CAN connector per net use T-connector and stub (shorter than 0.3 m) (available as accessory)

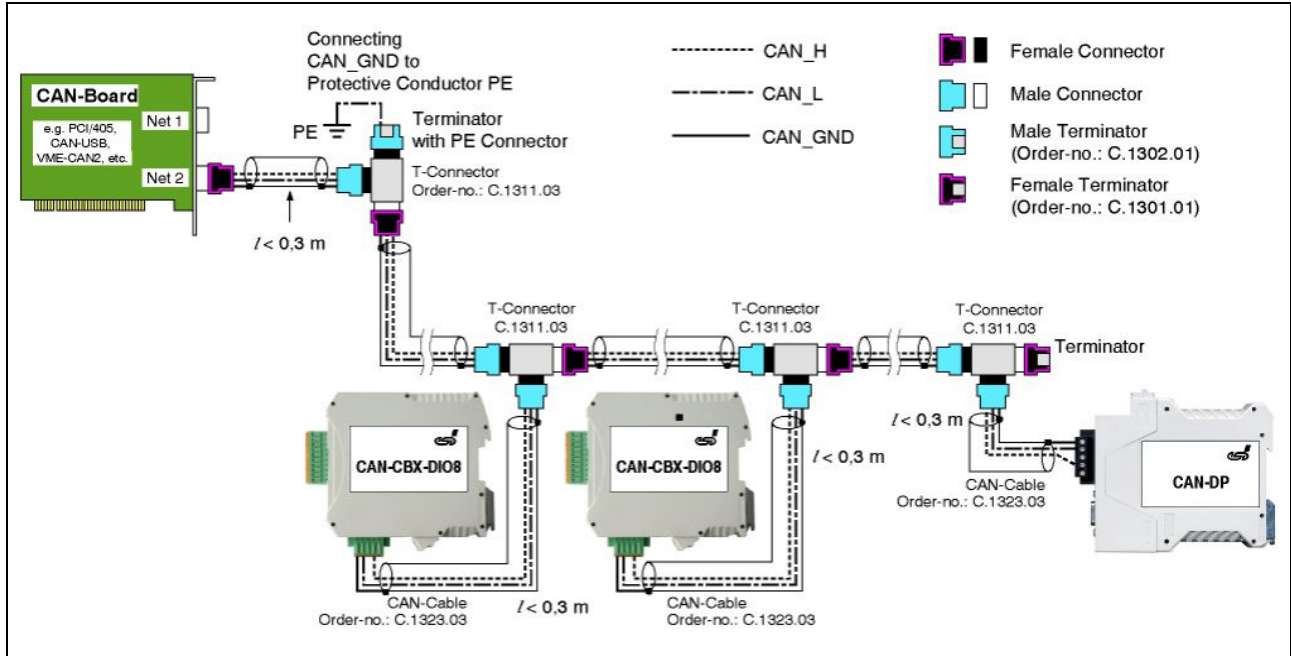


Figure. 5: Example for proper wiring with single shielded single twisted pair wires

6.1.3 Termination

- Use external termination plugs, because they can be rediscovered more easily than internal terminations within the CAN devices!
- 9-pin DSUB-termination connectors with male and female contacts and earth terminal are available as accessories

6.2 Heavy Industrial Environment (*Double Twisted Pair Cable*)

6.2.1 General Rules

The following **general rules** for the CAN wiring with single shielded *double* twisted pair cable must be followed:

1	A cable type with a wave impedance of about $120 \Omega \pm 10\%$ with an adequate wire cross-section (0.22 mm^2) has to be used. The voltage drop over the wire has to be considered!
2	For heavy industrial environment use a four-wire CAN cable. Connect <ul style="list-style-type: none"> • two twisted wires to the data signals (CAN_H, CAN_L) and • the other two twisted wires to the reference potential (CAN_GND) and • the cable shield to functional earth (FE) at least at one point!
3	The reference potential CAN_GND has to be connected to the functional earth (FE) at exactly one point.
4	A CAN bus line must not branch (exception: short cable stubs) and has to be terminated with the characteristic impedance of the line (generally $120 \Omega \pm 10\%$) at both ends (between the signals CAN_L and CAN_H and not at GND)!
5	Keep cable stubs as short as possible ($l < 0.3 \text{ m}$)!
6	Select a working combination of bit rate and cable length.
7	Keep away CAN cables from disturbing sources. If this can not be avoided, double shielded cables are recommended.

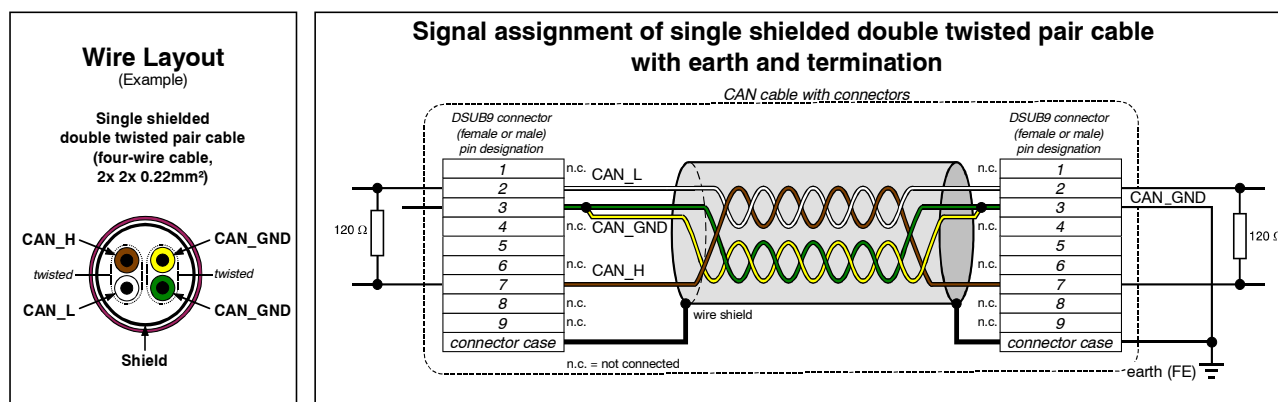


Figure. 6: CAN wiring for heavy industrial environment

6.2.2 Device Cabling

- To connect CAN devices which are equipped with one CAN connector per net, use T-connectors and cable stubs (shorter than 0.3 m).



Attention:

If single shielded *double* twisted pair cables are used, realize the T-connections by means of connectors that support connection of two CAN cables at one connector where the cable's shield is looped through e.g. DSUB9 connector from ERNI (ERBIC CAN BUS MAX, order no.:154039).

The usage of esd's T-connector type C.1311.03 is not recommended for single shielded *double* twisted pair cables because the shield potential of the conductive DSUB housing is not looped through this T-connector type.

Furthermore, mixed use of single twisted and double twisted cables should be avoided!

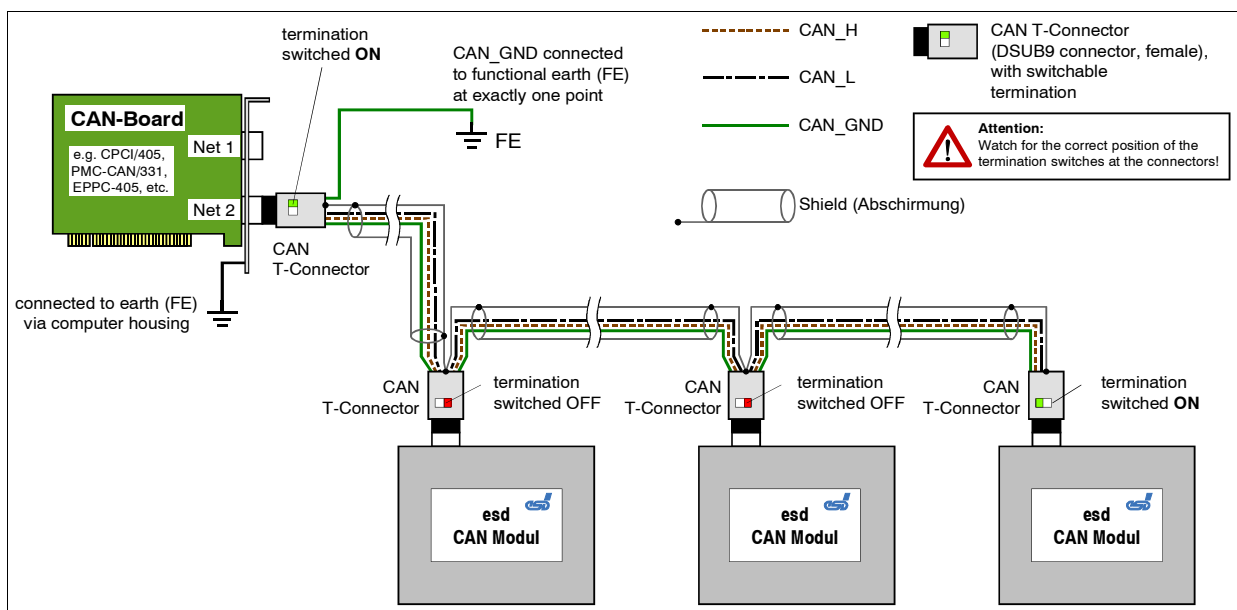


Figure. 7: Example for proper wiring with single shielded double twisted pair cables

6.2.3 Termination

- Use external termination plugs, because they can later be rediscovered more easily than internal terminations within the CAN devices!
- A 9-pin DSUB-connector with integrated switchable termination resistor can be ordered e.g. from ERNI (ERBIC CAN BUS MAX, female contacts, order no.:154039).

6.3 Electrical Grounding


- CAN_GND has to be connected between the CAN devices, because esd CAN devices are electrically isolated from each other!
- CAN_GND has to be connected to the earth potential (FE) at **exactly one** point of the network!
- Each CAN interface without electrically isolated interface acts as an earthing point. For this reason do not connect more than one CAN device without electrically isolated CAN interface!
- Earthing can e.g. be made at a connector/T-connector.

6.4 Bus Length

- Optical couplers are delaying the CAN signals. esd modules typically reach a wire length of 37 m at 1 Mbit/s within a closed net without impedance disturbances like e.g. cable stubs >> 0.3 m.

Bit rate [Kbits/s]	Typical values of reachable wire length with esd interface l_{max} [m]	CiA recommendations (07/95) for reachable wire lengths l_{min} [m]
1000	37	25
800	59	50
666.6	80	-
500	130	100
333.3	180	-
250	270	250
166	420	-
125	570	500
100	710	650
66.6	1000	-
50	1400	1000
33.3	2000	-
20	3600	2500
12.5	5400	-
10	7300	5000

Table 6: Recommended cable lengths at typical bit rates (with esd-CAN interfaces)



Note: Please note the recommendations according to ISO 11898 for the selection of the cross section of the wire depending of the wire length.


6.5 Examples for CAN Cables

6.5.1 Cable for Light Industrial Environment Applications (Two-Wire)

Manufacturer	Cable Type
U.I. LAPP GmbH Schulze-Delitzsch-Straße 25 70565 Stuttgart Germany www.lappkabel.com	e.g. UNITRONIC ®-BUS CAN UL/CSA (1x 2x 0.22) (UL/CSA approved) Part No.: 2170260 UNITRONIC ®-BUS-FD P CAN UL/CSA (1x 2x 0.25) (UL/CSA approved) Part No.: 2170272
ConCab GmbH Äußerer Eichwald 74535 Mainhardt Germany www.concab.de	e. g. BUS-PVC-C (1x 2x 0.22 mm ²) Order No.: 93 022 016 (UL appr.) BUS-Schleppflex-PUR-C (1x 2x 0.25 mm ²) Order No.: 94 025 016 (UL appr.)

6.5.2 Cable for Heavy Industrial Environment Applications (Four-Wire)

Manufacturer	Cable Type
U.I. LAPP GmbH Schulze-Delitzsch-Straße 25 70565 Stuttgart Germany www.lappkabel.com	e.g. UNITRONIC ®-BUS CAN UL/CSA (2x 2x 0.22) (UL/CSA approved) Part No.: 2170261 UNITRONIC ®-BUS-FD P CAN UL/CSA (2x 2x 0.25) (UL/CSA approved) Part No.: 2170273
ConCab GmbH Äußerer Eichwald 74535 Mainhardt Germany www.concab.de	e. g. BUS-PVC-C (2x 2x 0.22 mm ²) Order No.: 93 022 026 (UL appr.) BUS-Schleppflex-PUR-C (2x 2x 0.25 mm ²) Order No.: 94 025 026 (UL appr.)

	<p>Note: Configured CAN cables can be ordered from esd.</p>
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7. CAN Troubleshooting Guide

The CAN Troubleshooting Guide is a guide to find and eliminate the most frequent hardware-error causes in the wiring of CAN-networks.

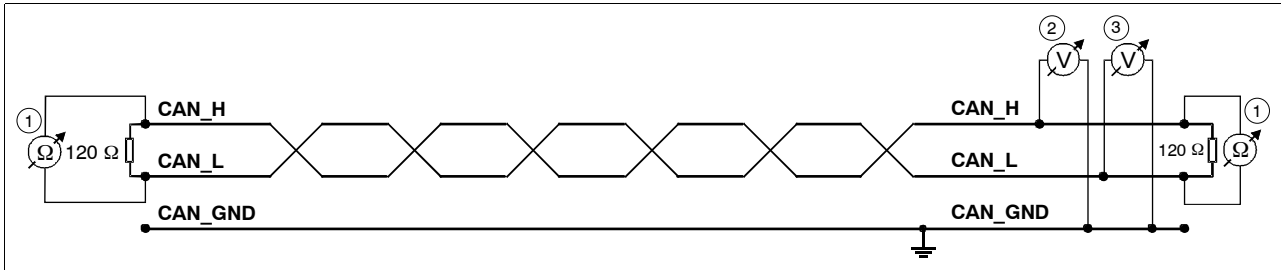


Figure. 8: Simplified diagram of a CAN network

7.1 Termination

The termination is used to match impedance of a node to the impedance of the transmission line being used. When impedance is mismatched, the transmitted signal is not completely absorbed by the load and a portion is reflected back into the transmission line. If the source, transmission line and load impedance are equal these reflections are eliminated. This test measures the series resistance of the CAN data pair conductors and the attached terminating resistors.

To test it, please

1. Turn off all power supplies of the attached CAN nodes.
2. Measure the DC resistance between CAN_H and CAN_L at the ends of the network (1) (see figure above) and at the centre of the network (if the network cable consists of more than one line section).

The measured value should be between 50 Ω and 70 Ω. The measured value should be nearly the same at each point of the network.

If the value is below 50 Ω, please make sure that:

- there is no short circuit between CAN_H and CAN_L wiring
- there are not more than two terminating resistors
- the nodes do not have faulty transceivers.

If the value is higher than 70 Ω, please make sure that:

- there are no open circuits in CAN_H or CAN_L wiring
- your bus system has two terminating resistors (one at each end) and that they are 120 Ω each.

7.2 Electrical Grounding

The CAN_GND of the CAN network has to be connected to the functional earth potential (FE) at only **one** point. This test will indicate if the CAN_GND is grounded in several places.

To test it, please

1. Disconnect the CAN_GND from the earth potential (FE).
2. Measure the DC resistance between CAN_GND and earth potential (see figure on the right).
3. Connect CAN_GND to earth potential.

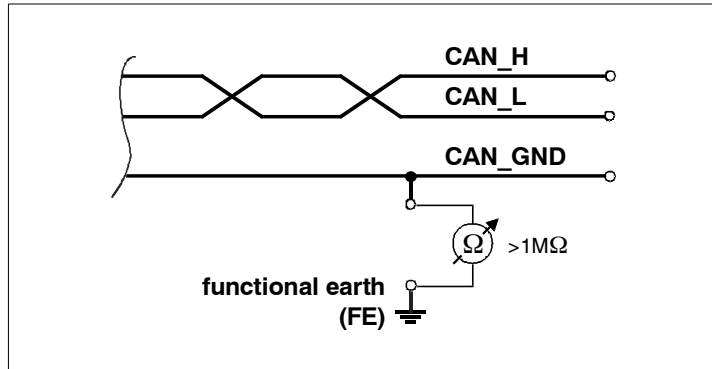


Figure 9: Simplified schematic diagram of ground test measurement

The resistance should be higher than 1 MΩ. If it is lower, please search for additional grounding of the CAN_GND wires.

7.3 Short Circuit in CAN Wiring

A CAN bus might possibly still be able to transmit data if there is a short circuit between CAN_GND and CAN_L, but the error rate will increase strongly. Make sure that there is no short circuit between CAN_GND and CAN_L!

7.4 CAN_H/CAN_L-Voltage

Each node contains a CAN transceiver that outputs differential signals. When the network communication is idle the CAN_H and CAN_L voltages are approximately 2.5 volts. Faulty transceivers can cause the idle voltages to vary and disrupt network communication.

To test for faulty transceivers, please

1. Turn on all supplies.
2. Stop all network communication.
3. Measure the DC voltage between CAN_H and GND ②
(see figure above).
4. Measure the DC voltage between CAN_L and GND ③
(see figure above).

Normally the voltage should be between 2.0 V and 4.0 V.

If it is lower than 2.0 V or higher than 4.0 V, it is possible that one or more nodes have faulty transceivers. For a voltage lower than 2.0 V please check CAN_H and CAN_L conductors for continuity. For a voltage higher than 4.0 V, please check for excessive voltage.

To find the node with a faulty transceiver please test the CAN transceiver resistance (see below).

7.5 CAN Transceiver Resistance Test

CAN transceivers have one circuit that controls CAN_H and another circuit that controls CAN_L. Experience has shown that electrical damage to one or both of the circuits may increase the leakage current in these circuits.

To measure the current leakage through the CAN circuits, please use an resistance measuring device and:

1. Switch off the node and disconnect it from the network ④ (see figure below).
2. Measure the DC resistance between CAN_H and CAN_GND ⑤ (see figure below).
3. Measure the DC resistance between CAN_L and CAN_GND ⑥ (see figure below).

The measured resistance has to be about 500 k Ω for each signal. If it is much lower, the CAN transceiver it is probably faulty.

Another sign for a faulty transceiver is a very high deviation between the two measured input resistance (>> 200%).

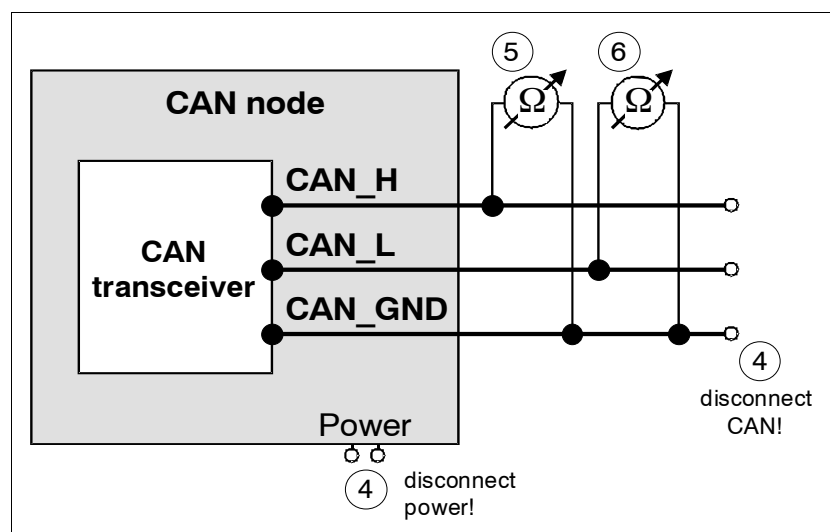


Figure. 10: Measuring the internal resistance of CAN transceivers

8. Declaration of Conformity

EG-KONFORMITÄTSERKLÄRUNG EC DECLARATION OF CONFORMITY



Adresse **esd electronic system design gmbh**
Address **Vahrenwalder Str. 207**
30165 Hannover
Germany

esd erklärt, dass das Produkt
esd declares, that the product

CAN-USB/2

Typ, Modell, Artikel-Nr.
Type, Model, Article No.

C.2066.02

die Anforderungen der Normen
fulfills the requirements of the standards

EN 61000-6-2:2005,
EN 61000-6-3:2007

gemäß folgendem Prüfbericht erfüllt.
according to test certificate.

H-K00-0272-06

Das Produkt entspricht damit der EG-Richtlinie „EMV“
Therefore the product corresponds to the EC-Directive 'EMC'

2004/108/EG

Das Produkt entspricht der EG-Richtlinie „RoHS“
The product corresponds to the EC-Directive 'RoHS'

2011/65/EU

Diese Erklärung verliert ihre Gültigkeit, wenn das Produkt nicht den Herstellerunterlagen
entsprechend eingesetzt und betrieben wird, oder das Produkt abweichend modifiziert wird.
*This declaration loses its validity if the product is not used or run according to the manufacturer's
documentation or if non-compliant modifications are made.*

Name / Name T. Ramm
Funktion / Title CE-Koordinator / CE Coordinator
Datum / Date Hannover, 2013-01-07

Rechtsgültige Unterschrift / authorized signature

9. Order Information

Type	Properties	Order No.
CAN-USB/2	1 x CAN 2.0A/B, ISO 11898, USB 2.0	C.2066.02
* includes CAN layer 2 software driver on CD-ROM for Windows and Linux		
Software		
CANopen-LCD Windows/Linux	CANopen® license for Linux and Windows incl. CD-ROM	C.1101.06
J1939 Stack for Windows	J1939 Stack for esd-CAN-Hardware, includes Windows-XP object code, J1939 Simulation Tool, esd CAN Windows driver license	C.1130.10

For detailed information about the driver availability of your special operating system, please contact our sales team.

Table 7: Order information

PDF Manuals

Manuals are available in English and usually in German as well. Available manuals are listed in the following table.

Please download the manuals as PDF documents from our esd website www.esd.eu for free.

Manuals		Order No.
CAN-USB/2-MD	Hardware manual in German	C.2066.21
CAN-USB/2-ME	Hardware manual in English	C.2066.21
CAN-API-ME	API manual 1/2: Functions (English) API manual 2/2: Installation (English)	C.2001.21
J1939-ME	J1939 software manual in English	C.1130.21
CANopen-ME	CANopen manuals in English	C.2002.21

Table 8: Available manuals

Printed Manuals

If you need a printout of the manual additionally, please contact our sales team: sales@esd.eu for a quotation. Printed manuals may be ordered for a fee.