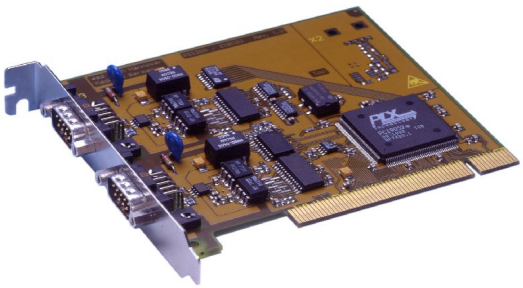
CAN-PCI/200

PCI-CAN-Interface



Hardware Manual

to Product C.2021.xx

esd electronic system design gmbh
Vahrenwalder Str. 207 • 30165 Hannover • Germany
http://www.esd.eu
Phone: +49 (0) 511 3 72 98-0 • Fax: +49 (0) 511 3 72 98-68

N O T E

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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
1.1	-	Added new trademarks	2012-04-13
1.1	-	New safety instructions	2012-03-01
1.1	1.2	New picture of the top layer	2012-03-01
1.1	2	Update chapter “Hardware Installation”	2012-03-01
1.1	5	Update chapter “Correctly Wiring Electrically Isolated CAN Networks”	2012-03-01
1.1	6	Added new chapter “CAN Troubleshooting Guide”	2012-03-01
1.1	8	Update chapter “Order Information”	2012-03-01

Technical details are subject to change without further notice.

Safety Instructions

- When working with CAN-PCI/200 follow the instructions below and read the manual carefully to protect yourself from injury and the CAN-PCI/200 from damage.
- The device is a built-in component. It is essential to ensure that the device is mounted in a way that cannot lead to endangering or injury of persons or damage to objects.
- The device has to be securely installed in the control cabinet before commissioning.
- Protect the CAN-PCI/200 from dust, moisture and steam.
- Protect the CAN-PCI/200 from shocks and vibrations.
- The CAN-PCI/200 may become warm during normal use. Always allow adequate ventilation around the CAN-PCI/200 and use care when handling.
- Do not operate the CAN-PCI/200 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-PCI/200 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-PCI/200 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.

Attention !
Electrostatic discharges may cause damage to electronic components.
To avoid this, please perform the steps described on page 8 *before* you touch the CAN-PCI/200, in order to discharge the static electricity from your body.

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-PCI/200 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 for the use in industrial environment.

Intended Use

The intended use of the CAN-PCI/200 is the operation as a PCI-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 CAN-PCI/200 is intended for installation in PCI systems only.
- The operation of the CAN-PCI/200 in hazardous areas, or areas exposed to potentially explosive materials is not permitted.
- The operation of the CAN-PCI/200 for medical purposes is prohibited.

Service Note

The CAN-PCI/200 does not contain any parts that require maintenance by the user. The CAN-PCI/200 does not require any manual configuration of the hardware.

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

1.1 Description of the Module

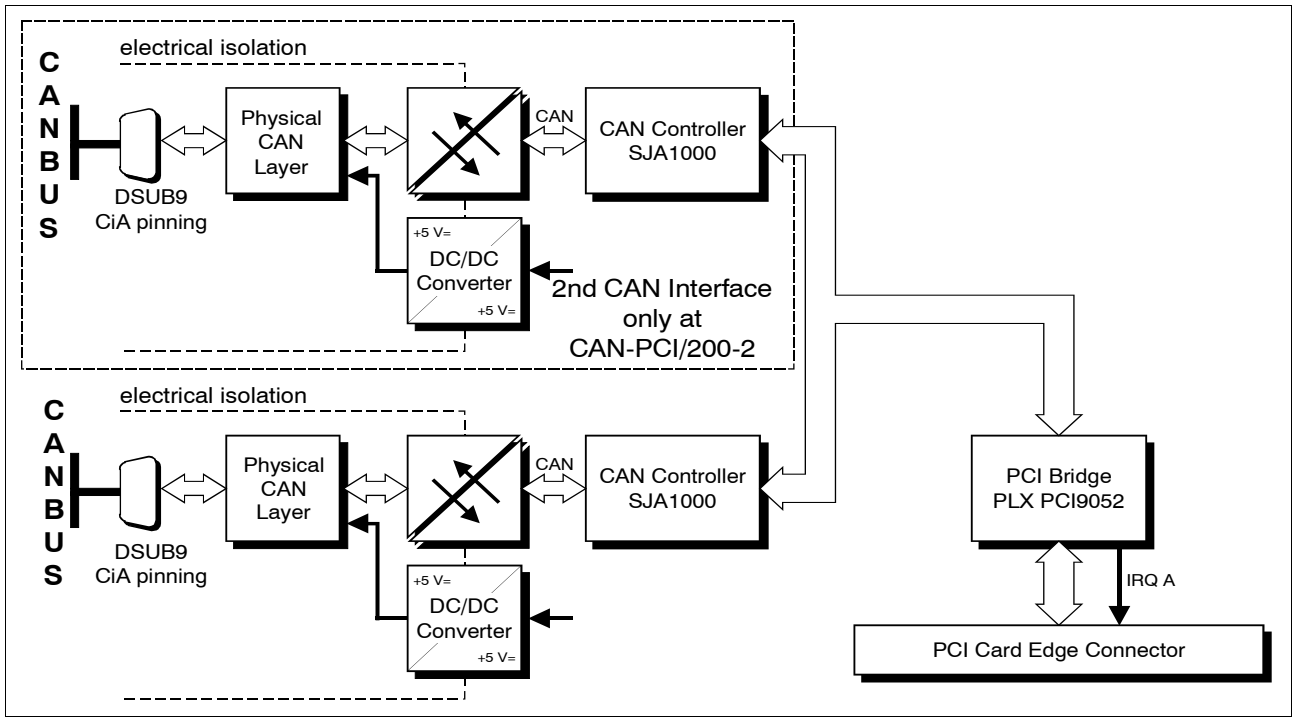


Figure 1: Block circuit diagram of CAN-PCI/200

The CAN-PCI/200 is a PC board designed for the PCI bus. It is available with one or optional two CAN interfaces.
The ISO 11898 compliant CAN interfaces allow a data transfer rate of 1 Mbit/s. Among many other features, the bit rate can be set by software. The CAN interface is electrically isolated from the other potentials by optocouplers and DC/DC-converters.

1.2 PCB View with Connectors

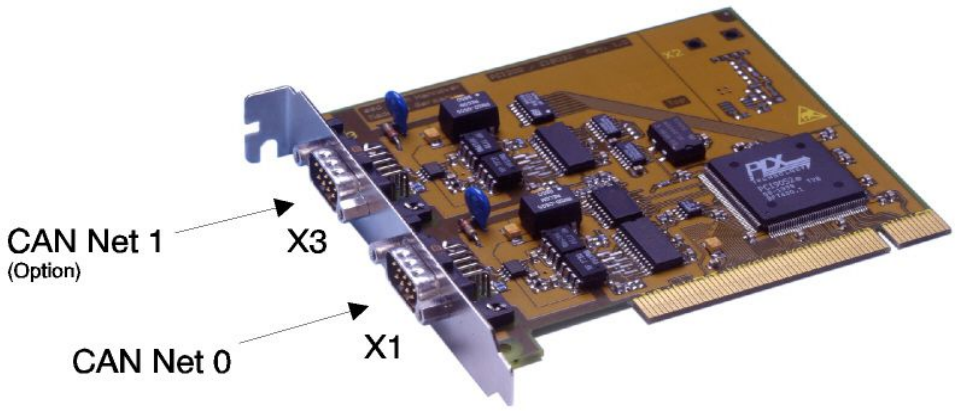


Figure 2: Top layer view of the module with 2x CAN

2. Hardware Installation

Read the safety instructions at the beginning of this document carefully, before you start with the hardware installation!

Danger!
Electric shock risk. Never carry out work while power supply voltage is switched on!

Attention !
Electrostatic discharges may cause damage to electronic components. To avoid this, please discharge the static electricity from your body by touching the metal case of the PC *before* you touch the CAN-PCI/200.

Procedure:

1. Switch off your computer and all connected peripheral devices (monitor, printer, etc.). Switch off the connected CAN devices.
2. Discharge your body as described above.
3. Disconnect the power supply of the PC from the mains.
   If the computer does not have a flexible mains cable, but is directly connected to mains, disconnect the power supply via the safety fuse and make sure that the fuse cannot switch on again unintentionally (i.e. with caution label).

   Danger!
   Never carry out work while power supply voltage is switched on!
4. Open the case.
5. Select an open PCI slot and remove the slot cover at the back of the PC. Unfasten the screw which fixes the slot cover and retain it for fixing the module afterwards.
   The CAN module can be inserted into every PCI slot.
6. Insert the CAN-PCI/200 board into the selected PCI slot. Carefully push the board down until it snaps into place.
7. Attach the board.
   Use the screw you removed from the slot cover in step 5.
8. Close the computer case again.
9. Connect the CAN cable. Please note the wiring hints in chapter 5.

   The first CAN interface (CAN net 0) has to be connected via the lower DSUB connector (X1) and the second CAN interface (CAN net 1) has to be connected via the upper DSUB connector (X3).
10. Connect the computer to mains again (mains connector or safety fuse).
11. Switch on the computer and the peripheral devices.
12. End of hardware installation.

    Continue with the software installation.

3. Technical Data

3.1 General Technical Data

Ambient temperature	0...50 °C
Humidity	90 %, non-condensing
Supply voltage	via PCI-bus, Nominal voltage / current (typ., at 20 °C): 5 V ±5% — 0.18 A (1x CAN) 5 V ±5% — 0.24 A (2x CAN)
Connectors	X1 (DSUB9/male) - CAN X3 (DSUB9/male) - optional CAN-Net 0 X100 (Card Edge) - PCI-Bus
Dimensions	106,68 mm x 119,91 mm (PCB only)
Weight	85 g (1 x CAN) 100g (2 x CAN)

Table 1: General technical data of the module

3.2 PCI-Bus

Host-Bus	PCI bus according to PCI Local Bus Specification 2.1
PCI bus width	32 bit
Controller	PLX 9052
Interrupt	Interrupt-signal A
Slot position	no restrictions for the slot position, PCI bridges are tolerated
Board dimensions	compatible with all 'short' PCI-card slots
Connector	PCI-card edge connector

Table 2: PCI bus data

3.3 CAN Interface

Number of CAN interfaces	1, optional 2 CAN interfaces
CAN controller	SJA1000
CAN protocol	Basic CAN 2.0A ISO 11898-1
Physical Layer	physical layer according to ISO 11898-2, transmission rate is programmable from 10 kbit/s to 1 Mbit/s
Bus termination	terminating resistor has to be set externally
Electrical separation of CAN interfaces from other units and from each other	separation by means of optocouplers and DC/DC-converters
DeviceNet-Option	adapter board with DeviceNet connector in Phoenix Combicon style, optocouplers and CAN driver according to DeviceNet specification 'DeviceNet Communication Model and Protocol, Rel. 2.0'

Table 3: Data of the CAN interface

3.4 Software Support

Software drivers are available for Windows® and Linux®. Drivers for other operating systems are available as well. For detailed information about the driver availability of your special operating system, please see chapter '8. Order Information' at page 24 or contact our sales team: sales@esd.eu.

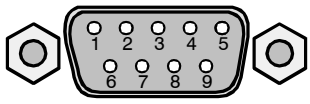
4. Connector Assignments

4.1 CAN

The signal assignments of CAN-net 0 (X1) and of the optional CAN-net 1 (X3) are identical.

Device connector: 9-pin DSUB connector, male

Pin Position:



Pin Assignment:

Signal	Pin		Signal
(CAN_GND)	6	1	reserved
CAN_H	7	2	CAN_L
reserved	8	3	CAN_GND
reserved	9	4	reserved
		5	reserved

Signal Description:

CAN_L, CAN_H ...	CAN signal lines
CAN_GND ...	reference potential of the local CAN physical layer
(CAN_GND)...	optional reference potential of the local CAN physical layer
reserved ...	reserved for future applications, do not connect!

5. Correct Wiring of 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.

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

5.1.1 General Rules

Note:
esd only grants the compliance with directive 2004/108/EC, if the CAN wiring is carried out with single shielded double twisted pair cables that match the requirements of ISO 118982-2 (table 9).

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 Ω ±10% with an adequate wire cross-section (0.22 mm²) 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 • 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 Ω ±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 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.

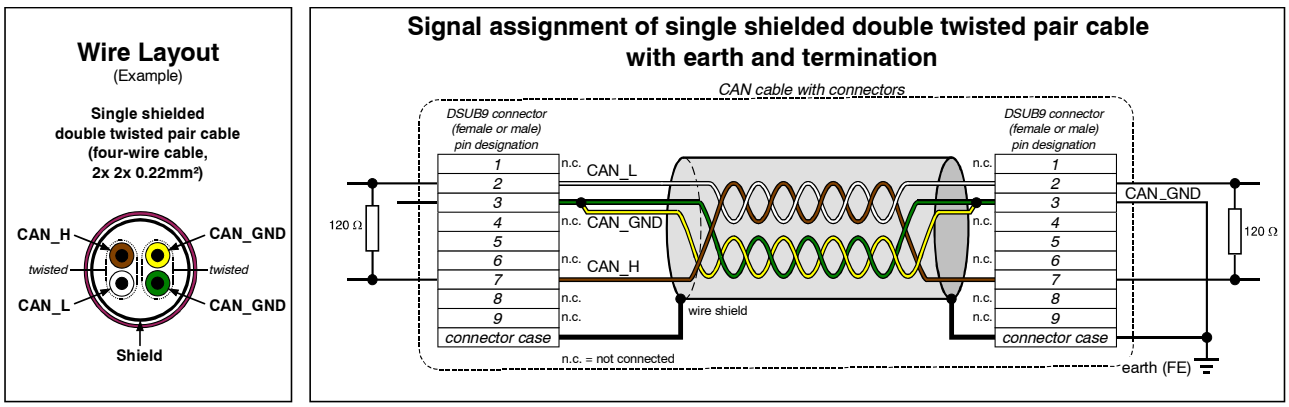


Figure. 3: CAN wiring for heavy industrial environment

5.1.2 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!

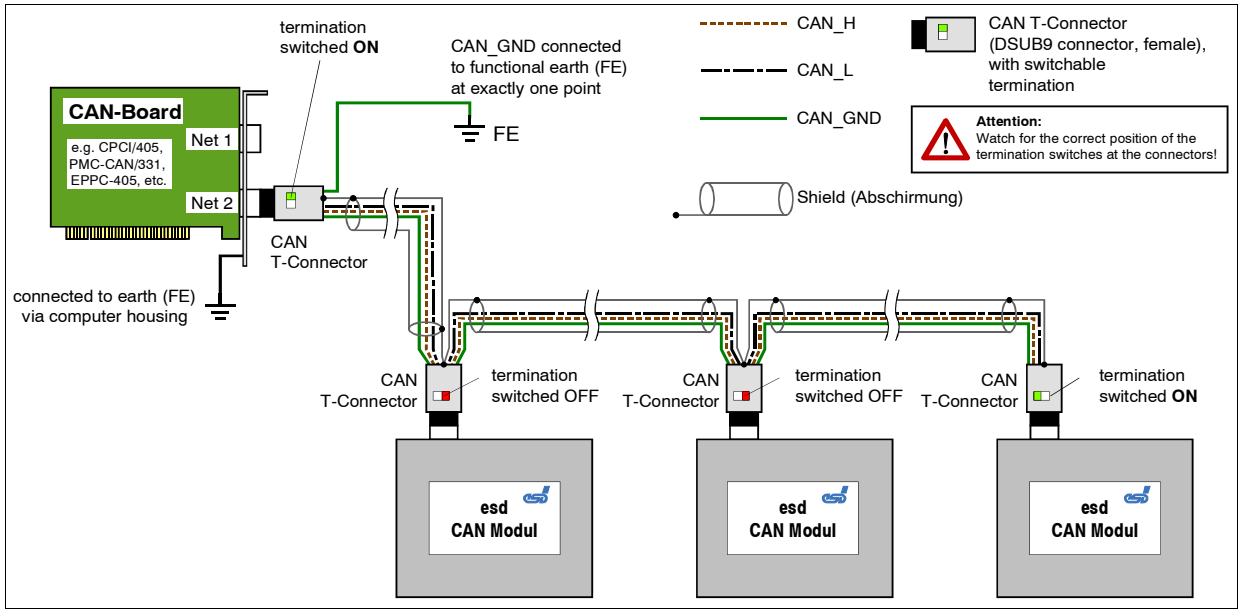


Figure. 4: Example for proper wiring with single shielded double twisted pair cables

5.1.3 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).

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

5.2.1 General Rules

Note:
esd only grants the compliance with directive 2004/108/EC, if the CAN wiring is carried out with single shielded double twisted pair cables that match the requirements of ISO 118982-2 (table 9).

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 Ω ±10% with an adequate wire cross-section (0.22 mm²) 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 • 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 Ω ±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 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.

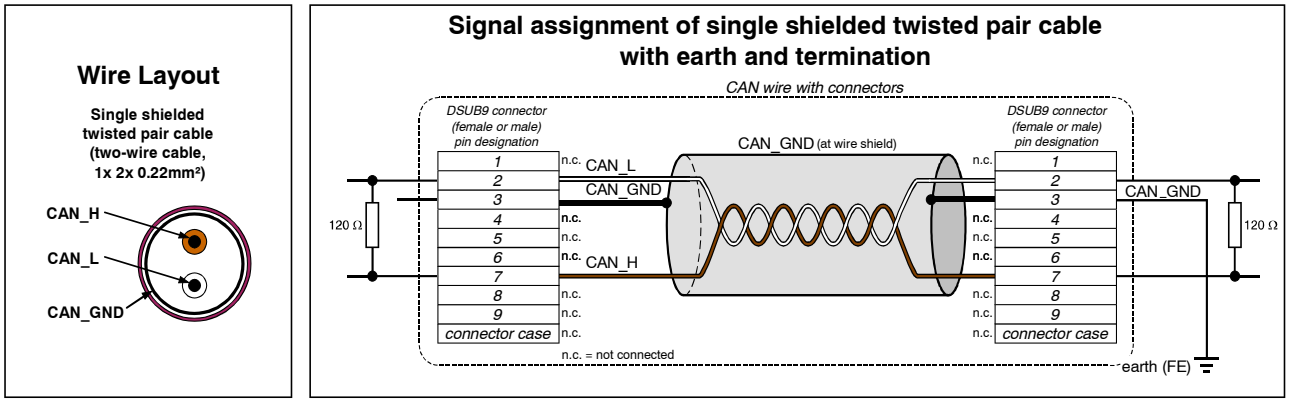


Figure. 5: CAN wiring for light industrial environment

5.2.2 Cabling

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

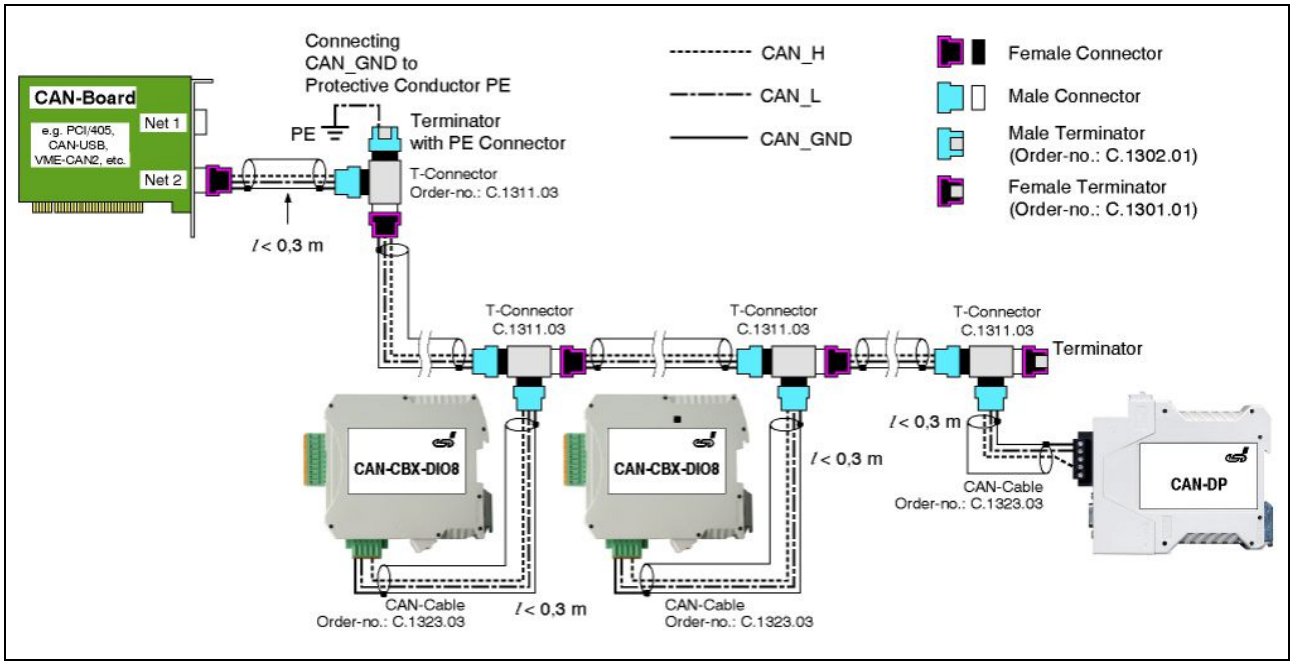


Figure. 6: Example for proper wiring with single shielded single twisted pair wires

5.2.3 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

5.3 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.

5.4 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 4: 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.

5.5 Examples for CAN Cables

5.5.1 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 mm²) Order No.: 93 022 016 (UL appr.) BUS-Schleppflex-PUR-C (1x 2x 0.25 mm²) Order No.: 94 025 016 (UL appr.)

5.5.2 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 mm²) Order No.: 93 022 026 (UL appr.) BUS-Schleppflex-PUR-C (2x 2x 0.25 mm²) Order No.: 94 025 026 (UL appr.)

Note:
Configured CAN cables can be ordered from **esd**.

6. 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.

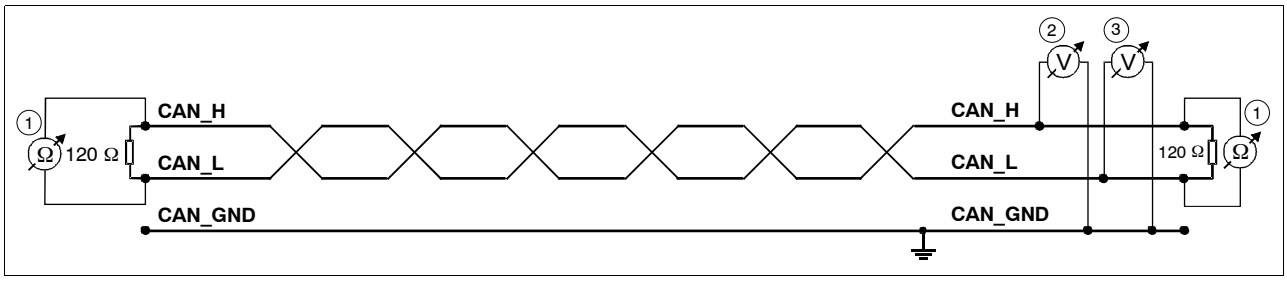


Figure. 7: Simplified diagram of a CAN network

6.1 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.

6.2 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.

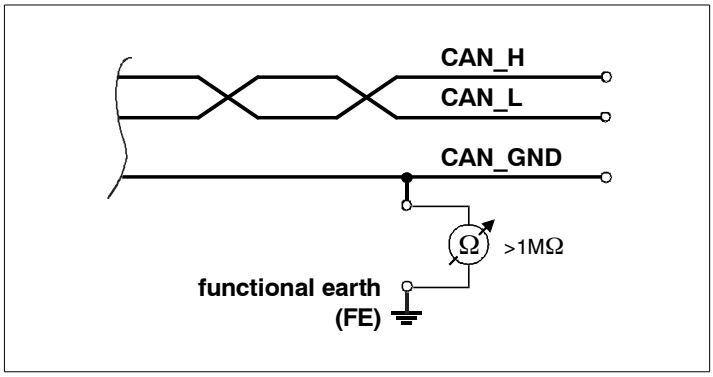


Figure. 8: Simplified schematic diagram of ground test measurement

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

6.3 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!

6.4 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).

6.5 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 kΩ 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%).

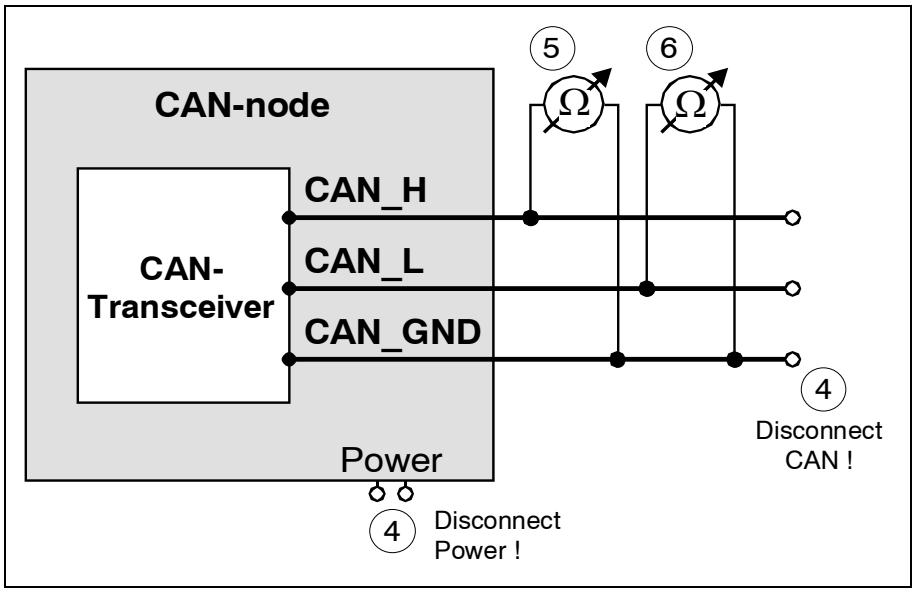


Figure. 9: Measuring the internal resistance of CAN transceivers

7. Declaration of Conformity

EG-KONFORMITÄTSERKLÄRUNG
EC DECLARATION OF CONFORMITY

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

esd erklärt, dass das Produkt *esd declares, that the product*		Typ, Modell, Artikel-Nr. *Type, Model, Article No.*
Produktname	**CAN-PCI/200**	**C.2021.02**
Produktname	**CAN-PCI/200-2**	**C.2021.04**

die Anforderungen der Normen *fulfills the requirements of the standards*	**EN 61000-6-2:2005,** **EN 61000-6-3:2007+ A1:2011**
gemäß folgendem Prüfbericht erfüllt. *according to test certificate.*	**H-K00-0470-12**
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, 2012-04-25

Rechtsgültige Unterschrift / *authorized signature*

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8. Order Information

Type	Properties	Order No.
CAN-PCI/200-1	1x CAN, ISO 11898-1, ISO 11898-2 *	C.2021.02
CAN-PCI/200-2	2x CAN, ISO 11898-1, ISO 11898-2 *	C.2021.04
	* CAN layer 2 drivers for Windows and Linux are included in delivery.	
Software Drivers*		
CAN-DRV LCD QNX	CAN-driver Object license for QNX incl. CD-ROM	C.1101.32
CAN-DRV LCD RTX	CAN-driver Object license for RTX incl. CD-ROM	C.1101.35
CAN-DRV LCD VxWorks	CAN-driver Object license for VxWorks incl. CD-ROM	C.1101.55
CANopen-LCD Windows/Linux	CANopen license for Linux and Windows incl. CD-ROM	C.1101.06
CANopen-LCD QNX	CANopen license for QNX incl. CD-ROM	C.1101.17
CANopen-LCD RTX	CANopen license for RTX incl. CD-ROM	C.1101.16
CANopen-LCD VxWorks	CANopen license for VxWorks incl. CD-ROM	C.1101.18
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
J1939 Stack for Linux	J1939 Stack for esd-CAN-Hardware, includes Linux object code, esd CAN driver license for Linux	C.1130.11
* For detailed information about the driver availability of your special operating system, please contact our sales team.		

Table 5: Order information

PDF Manuals
Manuals are available in English and usually in German as well. For availability of English manuals see table below.
Please download the manuals as PDF documents from our esd website www.esd.eu for free.

Manuals		Order No.
CAN-PCI/200-MD	Hardware manual in German	C.2021.20
CAN-PCI/200-ME	Hardware manual in English	C.2021.21
CAN-API-MD	NTCAN-API-manual in German: Part 2: Installation	C.2001.20
CAN-API-ME	NTCAN-API-manual in English: Part 1: Structure, Function, C/C++ API, Part 2: Installation	C.2001.21
CANopen-ME	CANopen manuals in English	C.2002.21

J1939-ME	J1939 software manual in English	C.1130.21

Table 6: 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.