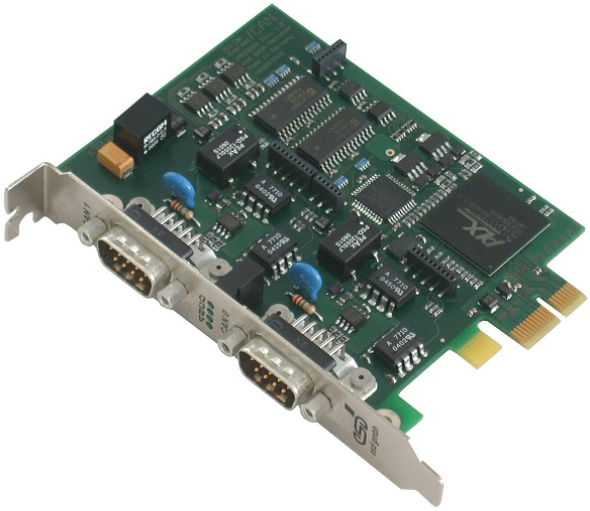
CAN-PCIe/200

Passive CAN-Interface Board for PCI Express



Hardware Manual

to Product C.2042.xx

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N O T E

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Changes in the chapters

The changes in the user's manual listed below affect changes in the firmware as well as changes in the description of the facts only.

Chapter	Changes versus previous version
-	Product name changed from CAN-PCIe/2000 to CAN-PCIe/200.
-	Footer and page numbers changed.

Technical details are subject to change without notice.

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Table of Contents

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1. Overview

1.1 Description of the Module

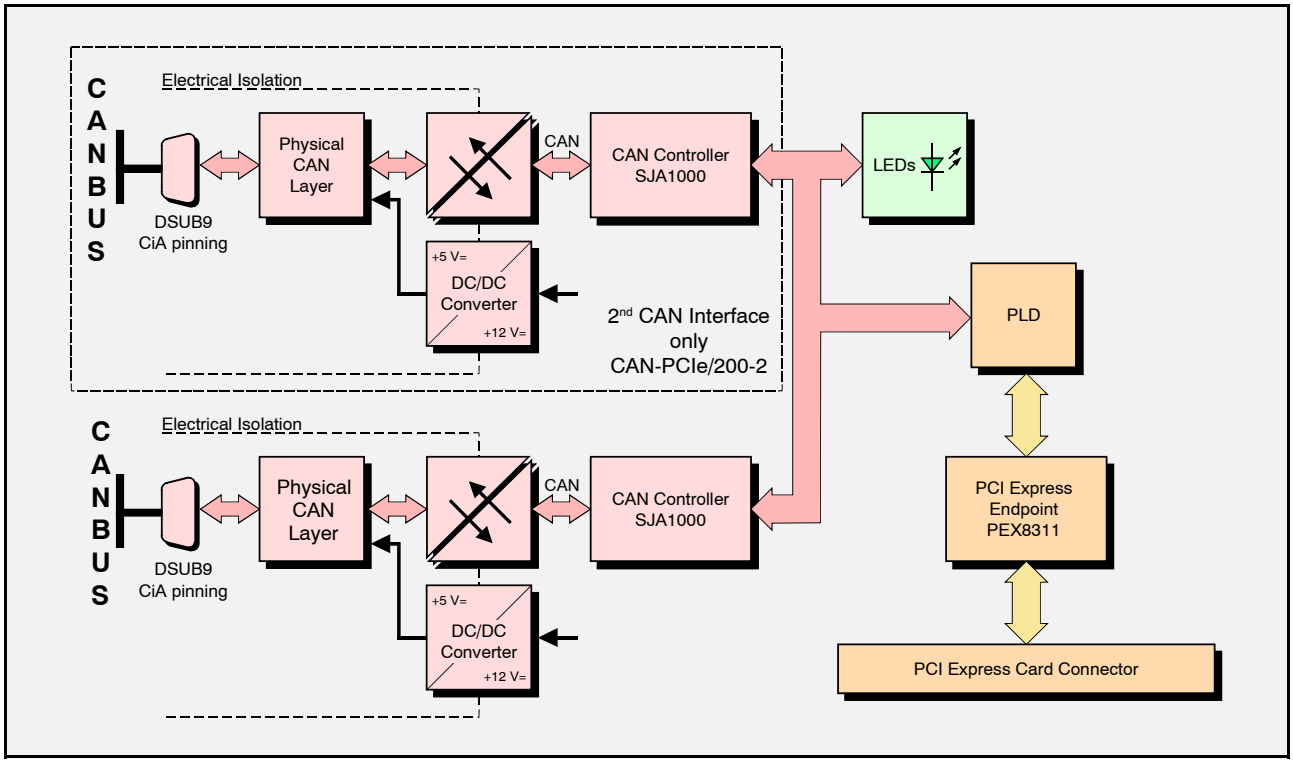


Fig. 1.1: Block circuit diagram of CAN-PCIe/200

The CAN-PCIe/200 is a passive CAN interface board for PCI Express with one, or optionally two CAN interfaces.

The ISO 11898-2 CAN interface allows a maximum data transfer rate of 1 Mbit/s. Among many other features of the CAN interfaces, the baud rate can be set by software.
The maximum effective CAN bit rate value may be limited by the performance of the host CPU, because this is a passive CAN module without a microcontroller on board.

The CAN interface is electrically isolated from the other potentials by optocouplers and DC/DC-converters.

The CAN-PCIe/200 is equipped with four LEDs in the front panel.

1.2 PCB View with Position of the Connectors

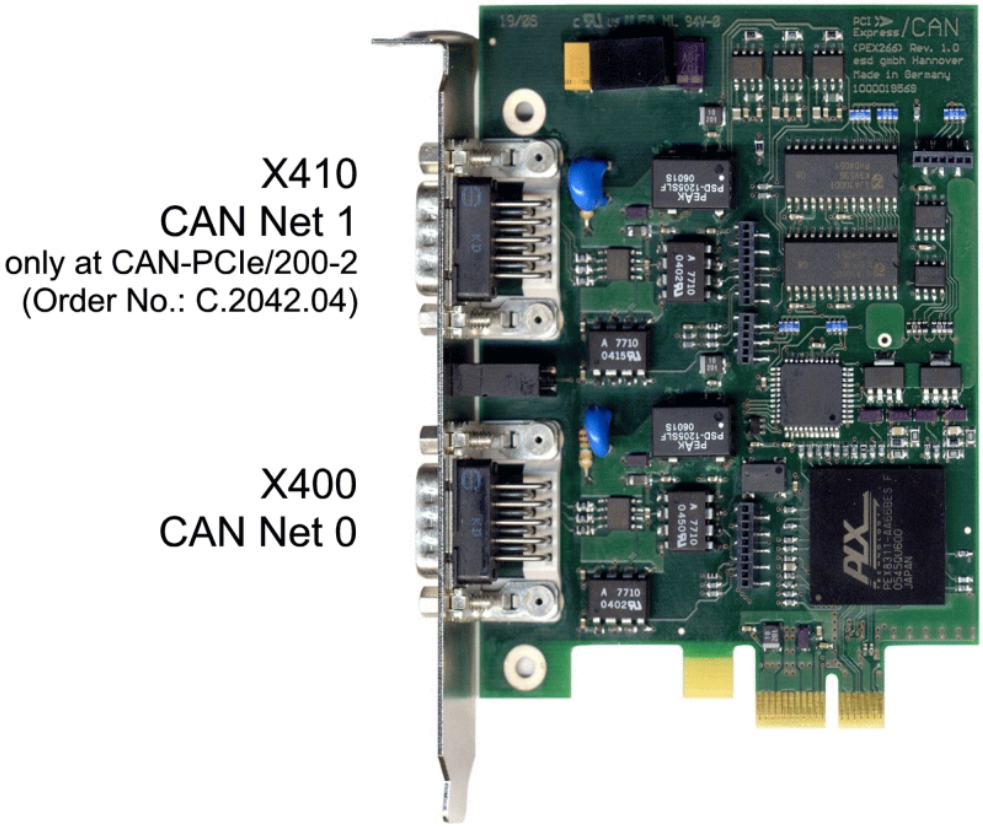
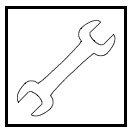


Fig. 1.2: PCB view of CAN-PCIe/200-2 with 2 CAN interfaces



2. Hardware-Installation

Attention!
Electrostatic discharge may cause damage to electronic devices. In order to avoid this, please follow the instructions below *before* you touch the CAN module to discharge your personal static electricity:

- Switch off the power supply of your PC but leave the connector plug in the socket.
- Then touch the metal case of the PC to discharge the static electricity.
- Furthermore you must avoid contact between your clothes and the CAN module.

Procedure:

1. Switch off the PC and all connected peripheral devices (monitor, printer, etc.). Switch off the CAN devices of the net to which the CAN module is to be connected.

2. Discharge yourself as described above.

3. Disconnect the power supply of the PC from the mains.

4. Remove the PC cover.
   Unfasten the mounting screws at the back of the PC and remove the cover.

5. Select an open PCIe 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. Be careful not to insert the board into an ISA slot, because this can damage the PC and the board!

6. Insert the CAN module into the selected PCIe 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. Replace the PC cover.
   Secure the cover with the screws you removed in step 4.

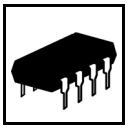
9. Connect the CAN wire.
   Please note that the CAN bus has to be terminated at both ends!
   esd offers special T- connectors and terminator connectors. Additionally the CAN_GND signal has to be connected to earth at **exactly one** point. For easier wiring the termination connectors are equipped with an earth connector (4.8 mm fast-on, male).
   A CAN participant without an electrically isolated interface acts as an earth connection.

   The first CAN interface (CAN net 0) has to be connected via the lower DSUB connector (X400) and the second CAN interface (net 1) has to be connected via the upper DSUB connector (X410).

10. Reconnect the power supply of the PC.

11. Switch on the PC, the peripheral devices and the other CAN participants in any order.

12. End of hardware installation.
    Continue with the software installation as described in the manual “CAN-API, Part 2: Installation Guide".



3. Technical Data

3.1 General Technical Data

Ambient temperature	0...50 ˚C
Humidity	90 %, non-condensing
Power supply voltage	via PCIe-bus, nominal voltage / current consumption (typ. at 20 ˚C): 3.3 V ±5% / 200 mA **and** +12 V ±5% / 80 mA
Connectors	X400 (DSUB9/male) - CAN net 0 X410 (DSUB9/male) - optional CAN net 1 X100 (Card Edge) - PCIe bus
LEDs	4 LEDs
Dimensions	height: 111.15 mm (standard PCI Express Add-In Card Size) lenght: 80 mm
Link width	x1
Weight	approx. 85 g (module with 2 x CAN)

Table 3.1: General data of the module

3.2 PCI Express Interface

PCIe Endpoint	PEX8311
PCIe port	compliant with PCI Express Specification R1.0a
Connector	x1 PCI Express card edge socket

Table 3.2: PCI Express data

3.3 CAN Interface

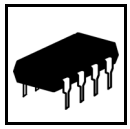
Number	1, optional 2 CAN interfaces
CAN controller	SJA1000, ISO 11898-1 (Basic-CAN 2.0)
Physical Layer	Physical Layer ISO 11898-2 accordant, transmission rate up to 1 Mbit/s
Termination	has to be set externally
Electrical isolation of the CAN interface against other units	both CAN interfaces are electrically isolated via optocouplers and DC/DC-converters against each other and against the PCI bus potentials.

Table 3.3: Data of the CAN interfaces

3.4 Software Support

Software drivers are available for Windows, Linux and QNX. Drivers for other operating systems are available on request. For detailed information about drivers for other operating systems, please contact our support (support@esd-electronics.com).

The CAN-API is described in the manual:
"**CAN-API**, Part 1: Function description"
Order No.: C.2001.21



3.5 Order Information

Type	Description	Order No.
CAN-PCIe/200-1	1 x CAN, ISO11898-1, ISO11898-2	C.2042.02
CAN-PCIe/200-2	2 x CAN, ISO11898-1, ISO11898-2	C.2042.04
CAN-DRV-LCD	Object licence for Windows and Linux incl. CD-ROM	C.1101.02
CAN-PCIe/200-Vx	VxWorks object licence	C.2042.55
CAN-PCIe/200-ME	Hardware manual in English [1*)] (this manual)	C.2042.21
CAN-PCIe/200-ENG	Engineering manual in English [2*)] Contents: Circuit diagrams, PCB top overlay drawing, data sheets of significant components	C.2042.25
CAN-API-MD	Software manual of the CAN-API in English [1*)]	C.2001.21

1*) If ordered together with the product, the manual will be delivered free of charge.
2*) This manual is liable for costs, please contact our support.

Table 3.5: Order information

4. Front Panel View with LED Display

The CAN-PCIe/200 is equipped with four green LEDs located in the front panel.

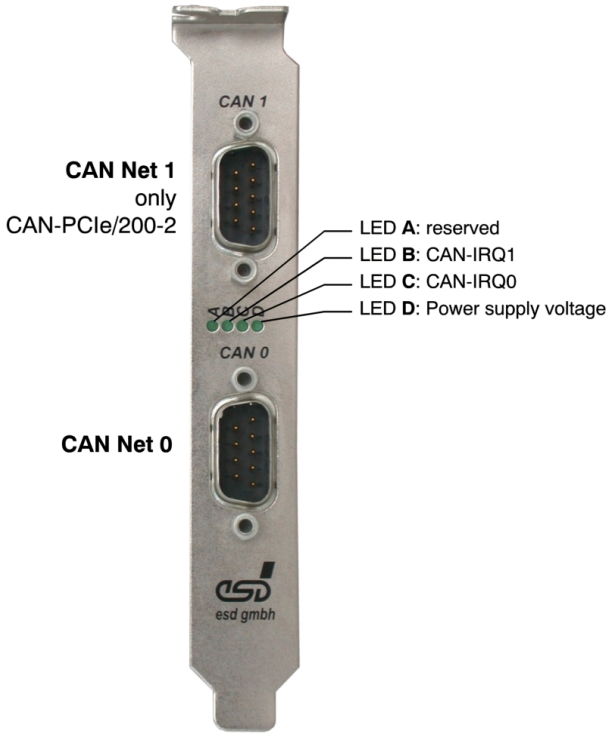


Fig. 4.1: Front panel view

LED			Display function (LED on)
Name	Function	Colour	
A	ADU-CS	green	reserved
B	CAN1-IRQ	green	Interrupt in CAN Net 1 - CAN frames are received or transmitted
C	CAN0-IRQ	green	Interrupt in CAN Net 0 - CAN frames are received or transmitted
D	Power	green	5 V-power supply voltage is on

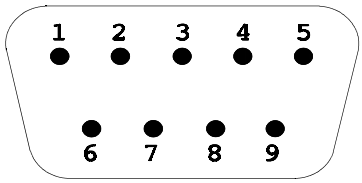
Table 4.1: LEDs

5. Connector Assignment of the CAN Bus Interface

5.1 CAN Interface on DSUB9 Connector

The assignment of the signals to the connector pins of CAN net 0 (X400) is equal to the assignment of the optional second CAN net 1 (X410). The connectors are 9-pin DSUB connectors (male).

Pin Position:



Pin Assignment:

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

9-pin DSUB connector

Signal description:

CAN_L, CAN_H...	CAN signal lines
CAN_GND ...	reference potential of the local physical CAN layer
(CAN_GND) ...	optional reference potential of the local physical CAN layer
reserved ...	reserved for future applications
Shield...	shielding

6. Correctly Wiring Electrically Isolated CAN Networks

Generally all instructions applying for wiring regarding an electromagnetic compatible installation, wiring, cross sections of wires, material to be used, minimum distances, lightning protection, etc. have to be followed.

The following **general rules** for the CAN wiring must be followed:

1.	A CAN net must not branch (exception: short dead-end feeders) and has to be terminated by the wave impedance of the wire (generally 120 W ±10%) at both ends (between the signals CAN_L and CAN_H and **not** at GND)!
2.	A CAN data wire requires **two twisted** wires and a wire to conduct the reference potential (CAN_GND)! For this the shield of the wire should be used!
3.	The reference potential CAN_GND has to be connected to the earth potential (PE) at **one** point. Exactly **one** connection to earth has to be established!
4.	The bit rate has to be adapted to the wire length.
5.	Dead-end feeders have to kept as short as possible (l < 0.3 m)!
6.	When using double shielded wires the external shield has to be connected to the earth potential (PE) at **one** point. There must be not more than **one** connection to earth.
7.	A suitable type of wire (wave impedance ca. 120 Ω ±10%) has to be used and the voltage loss in the wire has to be considered!
8.	CAN wires should not be laid directly next to disturbing sources. If this cannot be avoided, double shielded wires are preferable.

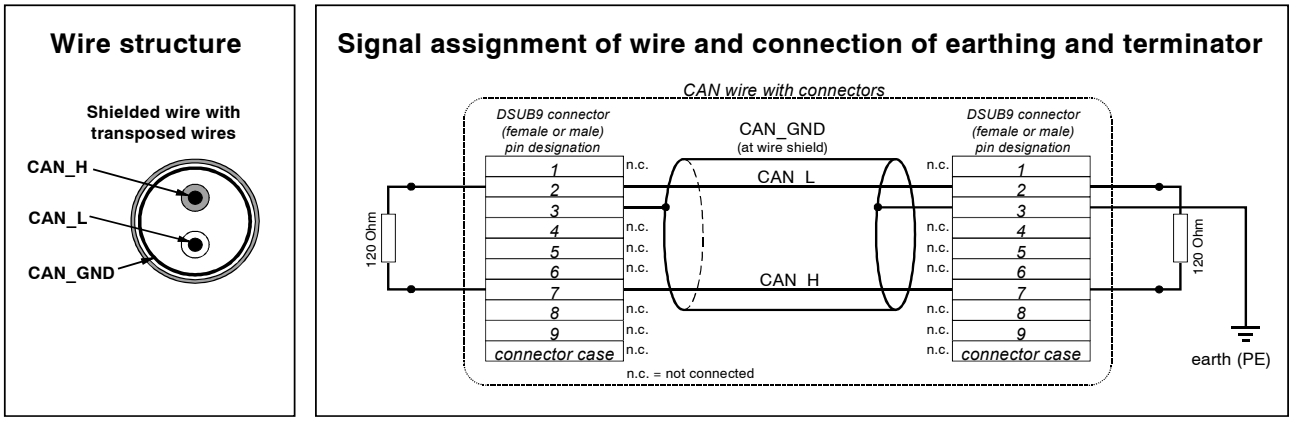


Figure: Structure and connection of wire

Cabling

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

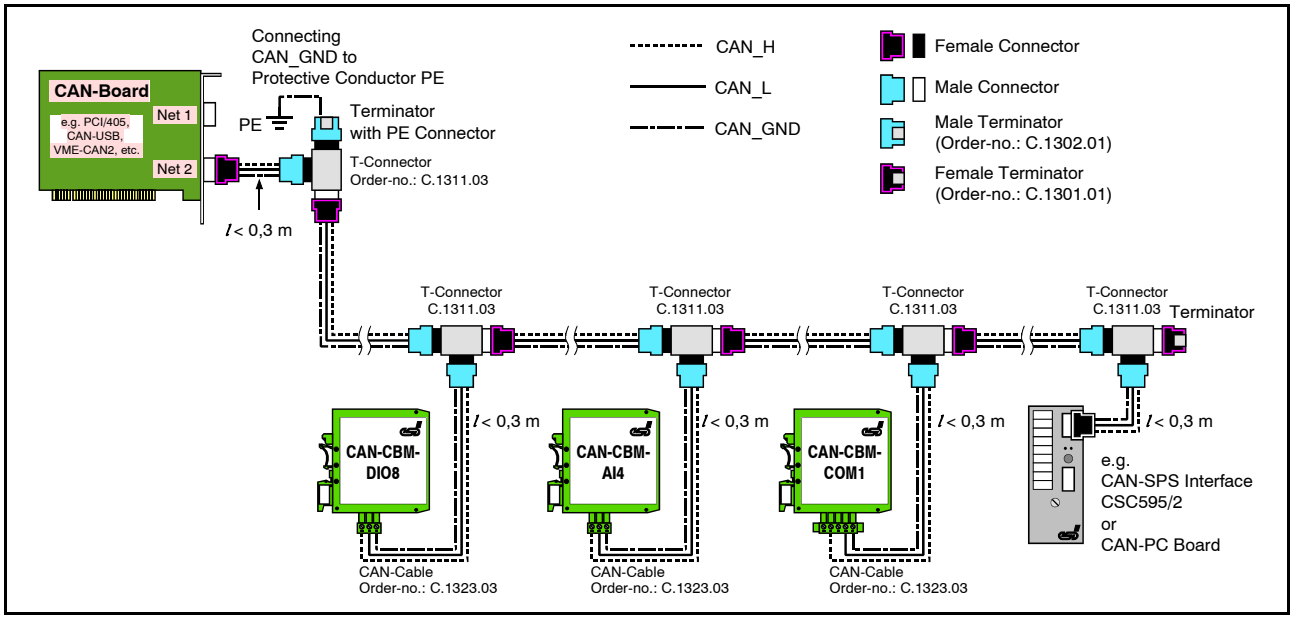


Figure: Example for correct wiring (when using single shielded wires)

Terminal Resistance

- use **external** terminator, because this can later be found again more easily!
- 9-pin DSUB-terminator with male and female contacts and earth terminal are available as accessories

Earthing

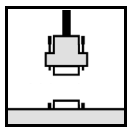
- CAN_GND has to be conducted in the CAN wire, because the individual esd modules are electrically isolated from each other!
- CAN_GND has to be connected to the earth potential (PE) at **exactly one** point in the net!
- each CAN user without electrically isolated interface works as an earthing, therefore: do not connect more than one user without potential separation!
- Earthing CAN e.g. be made at a connector

Wire Length

❍ Optical couplers are delaying the CAN signals. By using fast optical couplers and testing each board at 1 Mbit/s, however, esd CAN guarantee a reachable length of 37 m at 1 Mbit/s for most esd CAN modules within a closed net without impedance disturbances like e.g. longer dead-end feeders. (Exception: CAN-CBM-DIO8, -AI4 and AO4 (these modules work only up to 10 m with 1 Mbit/s))

Bit rate [Kbit/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: Reachable wire lengths depending on the bit rate when using esd-CAN interfaces



Examples for CAN Wires

Manufacturer	Type of wire
U.I. LAPP GmbH Schulze-Delitzsch-Straße 25 70565 Stuttgart Germany www.lappkabel.de	e.g. UNITRONIC ®-BUS CAN UL/CSA (UL/CSA approved) UNITRONIC ®-BUS-FD P CAN UL/CSA (UL/CSA approved)
ConCab GmbH Äußerer Eichwald 74535 Mainhardt Germany www.concab.de	e.g. BUS-PVC-C (1 x 2 x 0.22 mm²) Order No.: 93 022 016 (UL appr.) BUS-Schleppflex-PUR-C (1 x 2 x 0.25 mm²) Order No.: 94 025 016 (UL appr.)
SAB Bröckskes GmbH&Co. KG Grefrather Straße 204-212b 41749 Viersen Germany www.sab-brockskes.de	e.g. SABIX® CB 620 (1 x 2 x 0.25 mm²) Order No.: 56202251 CB 627 (1 x 2 x 0.25 mm²) Order No.: 06272251 (UL appr.)

Note: Completely configured CAN wires can be ordered from **esd**.

7. CAN-Bus Troubleshooting Guide

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

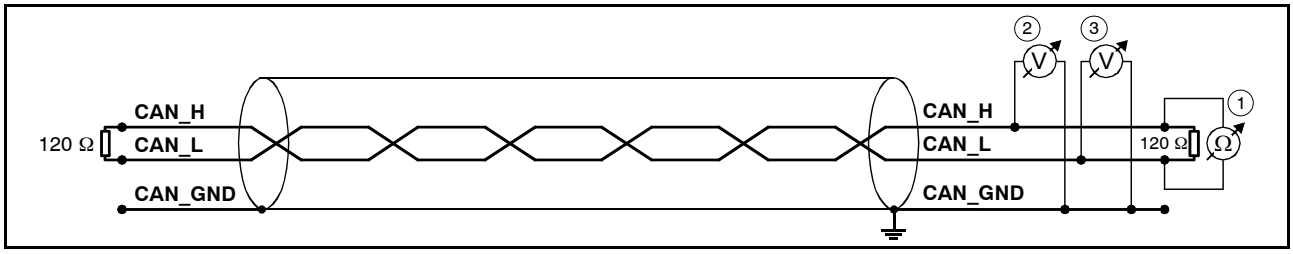


Figure: Simplified diagram of a CAN network

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.

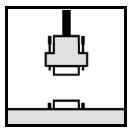
To test it, please

1. Turn off all power supplies of the attached CAN nodes.
2. Measure the DC resistance between CAN_H and CAN_L at the middle and ends of the network (1) (see figure above).

The measured value should be between 50 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 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 next page).

7.3 Ground

The shield of the CAN network has to be grounded at only one location. This test will indicate if the shielding is grounded in several places.

To test it, please

1. Disconnect the shield wire from the ground.
2. Measure the DC resistance between Shield and ground.
3. Connect Shield wire to ground.

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

7.4 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. Disconnect the node from the network. Leave the node unpowered (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).

Normally the resistance should be between 1 M Ω and 4 M Ω or higher. If it is lower than this range, the CAN transceiver is probably faulty.

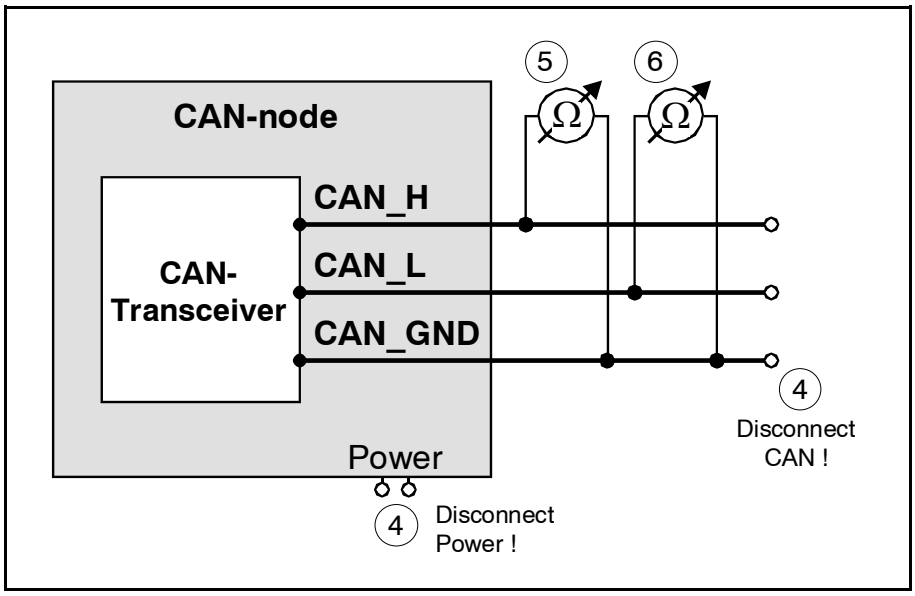


Figure: Simplified diagram of a CAN node