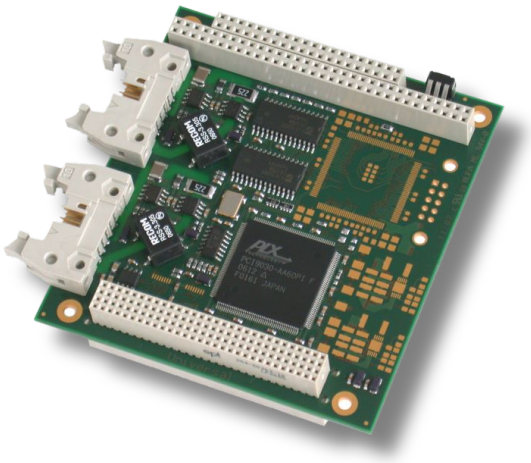
CAN-PCI104/200

PCI-104-CAN-Interface



(C.2046.04 with optional ISA connector)

Hardware Manual

to Product C.2046.02,
C.2046.04,
C.2046.08

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N O T E

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This manual contains important information and instructions on safe and efficient handling of the CAN-PCI104/200. Carefully read this manual before commencing any work and follow the instructions.
The manual is a product component, please retain it for future use.

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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.

Rev.	Chapter	Changes versus previous version	Date
1.0	-	First English manual	2007-11-26
1.1	-	Safety Information and Classification of Warning Messages and Safety Instructions inserted	2016-02-17
	1.2	Notes inserted	
	2.	Chapter revised, safety messages inserted	
	3.5	Chapter “Software Support” revised	
	5.	New chapter “Adapter Cable ” , DSUB9 assignment moved	
	6., 7.	Chapter revised	
	8.	Chapter “Order Information” moved and revised	

Technical details are subject to change without further notice.

Classification of Warning Messages and Safety Instructions

This manual contains noticeable descriptions, warning messages and safety instructions, which you must follow to avoid personal injuries or death and property damage.

This is the safety alert symbol.
It is used to alert you to potential personal injury hazards. Obey all safety messages and instructions that follow this symbol to avoid possible injury or death.

DANGER, WARNING, CAUTION

Depending on the hazard level the signal words DANGER, WARNING or CAUTION are used to highlight safety instructions and warning messages. These messages may also include a warning relating to property damage.

DANGER
Danger statements indicate a hazardous situation which, if not avoided, will result in death or serious injury.

WARNING
Warning statements indicate a hazardous situation that, if not avoided, could result in death or serious injury.

CAUTION
Caution statements indicate a hazardous situation that, if not avoided, could result in minor or moderate injury.

NOTICE

Notice statements are used to notify people on hazards that could result in things other than personal injury, like property damage.

NOTICE
This NOTICE statement indicates that the device contains components sensitive to electrostatic discharge.

NOTICE
This NOTICE statement contains the general mandatory sign and gives information that must be heeded and complied with for a safe use.

INFORMATION

INFORMATION
Notes to point out something important or useful.

Safety Instructions

- When working with the CAN-PCI104/200 follow the instructions below and read the manual carefully to protect yourself from injury and the CAN-PCI104/200 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.
- Do not use damaged or defective cables to connect the CAN-PCI104/200 and follow the CAN wiring hints in chapter: "Correct Wiring of 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 domestic animals and property.
- Current circuits which are connected to the device have to be sufficiently protected against hazardous voltage (SELV according to EN 60950-1).
- The CAN-PCI104/200 may only be driven by power supply current circuits, that are contact protected.
  A power supply, that provides a safety extra-low voltage (SELV) according to EN 60950-1, complies with this conditions.

- The device has to be securely installed in the control cabinet before commissioning.
- Protect the CAN-PCI104/200 from dust, moisture and steam.
- Protect the CAN-PCI104/200 from shocks and vibrations.
- The CAN-PCI104/200 may become warm during normal use. Always allow adequate ventilation around the CAN-PCI104/200 and use care when handling.
- Do not operate the CAN-PCI104/200 adjacent to heat sources and do not expose it to unnecessary thermal radiation. Ensure an ambient temperature as specified in the technical data.

DANGER
Hazardous Voltage - **Risk of electric shock** due to unintentional contact with uninsulated live parts with high voltages inside of the system into which the CAN-PCI104/200 is to be integrated.
→ Disconnect all hazardous voltages (mains voltage) before opening the system.
→ Ensure the absence of voltage before starting any electrical work

NOTICE
Electrostatic discharges may cause damage to electronic components.
To avoid this, perform the steps described on page 10 *before* you touch the CAN-PCI104/200, 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.

Intended Use

The intended use of the CAN-PCI104/200 is the operation as PCI-104-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-PCI104/200 is intended for indoor use only.
- The operation of the CAN-PCI104/200 in hazardous areas, or areas exposed to potentially explosive materials is not permitted.
- The operation of the CAN-PCI104/200 for medical purposes is prohibited.

Service Note

The CAN-PCI104/200 does not contain any parts that require maintenance by the user. The CAN-PCI104/200 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.

Abbreviations

API	Application Programming Interface
CAN	Controller Area Network
CPU	Central Processing Unit
CiA	CAN in Automation
HW	Hardware
I/O	Input/Output
n.a.	not applicable
OS	Operating System
SDK	Software Development Kit

Table of contents

1. Overview

1.1 Description of the CAN-PCI104/200

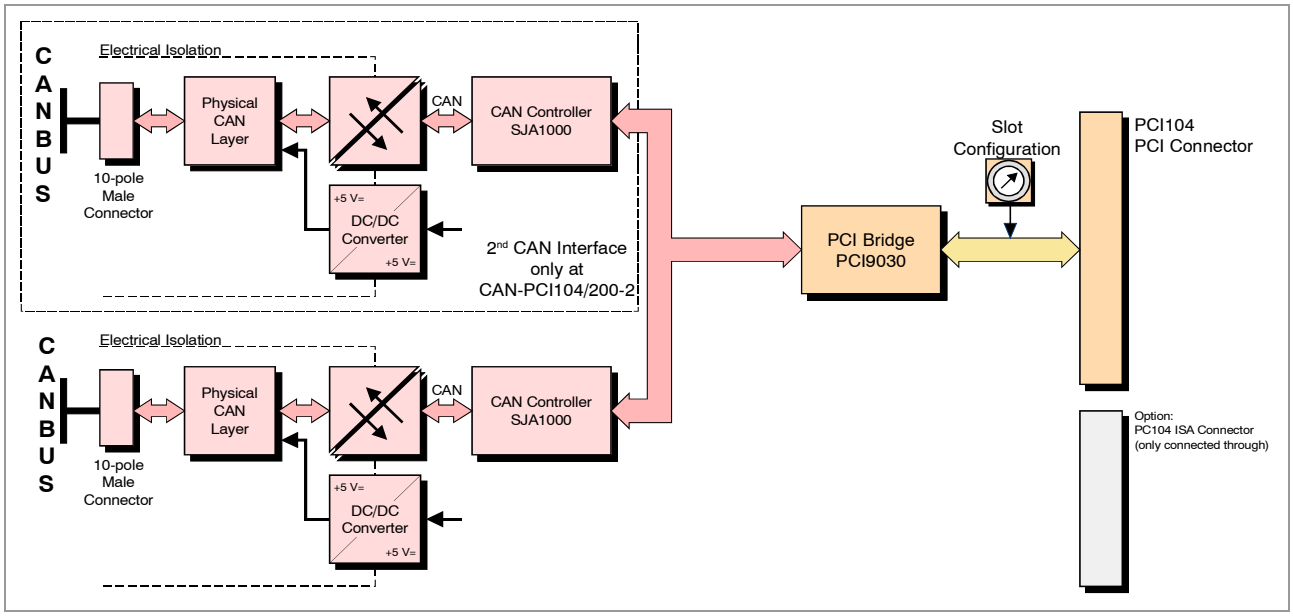


Figure 1: Block circuit diagram of the CAN-PCI104/200

The CAN-PCI104/200-board offers one or two CAN interfaces for the PCI-104 bus or PC/104-Plus bus. Up to 4 CAN-PCI104/200-modules can be operated in a stack. Thus up to 8 CAN interfaces are available.

The module can be operated in PCI-104 systems with 3.3 V or 5 V signalling voltage.

The ISO 11898-2- compliant CAN interface allows a maximum data transfer rate of 1 Mbit/s. Among other properties of the interface the bit rate can be parameterized by software.

The CAN-interface is electrically isolated by a magnetic high speed data coupler and a DC/DC-converter.

Software drivers for many operating systems as Windows and Linux are available. Real-time operating systems as for example QNX are supported as well.

1.2 PCB View with Connectors

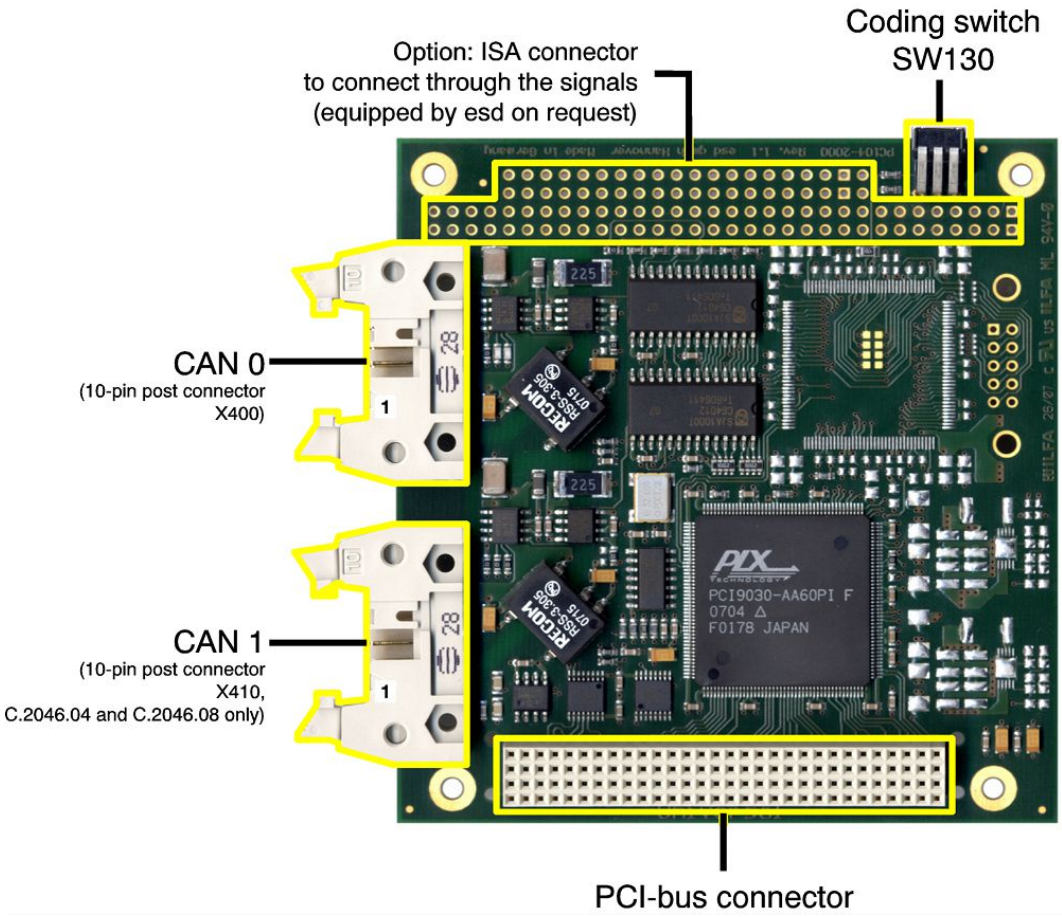


Figure 2: PCB top view of CAN-PCI104/200-2

NOTICE
Read chapter “Hardware Installation” on page 10, before you start with the installation of the hardware!

See also page 15 for signal assignment of the CAN connectors.

2. Hardware Installation

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

DANGER
Hazardous Voltage - **Risk of electric shock** due to unintentional contact with uninsulated live parts with high voltages inside of the system into which the CAN-PCI104/200 is to be integrated.
→ Disconnect all hazardous voltages (mains voltage) before opening the system.
→ Ensure the absence of voltage before starting any electrical work

The CAN-PCI104/200 module can be used in all PCI-104 compatible systems such as portable industry PCs or fixed control plants, therefore the carrier system will be described by the general term ‘computer’ in the following.

NOTICE
Electrostatic discharges may cause damage to electronic components.
In order to avoid this please follow the instructions below before touching the CAN-PCI104/200:

→ Switch off the power supply of your computer but leave it connected to mains to make sure that the computer case remains earthed.

→ Then touch the metal case of the computer to discharge your static electricity.

→ Furthermore, you should prevent your clothes from touching the CAN-PCI104/200, because your clothes might be electrostatically charged as well.

Procedure:

1. Switch off your computer and all connected peripheral devices (monitor, printer, etc.). Switch off the connected CAN devices of the network the CAN module is to be connected to.
2. Discharge your body as described above.
3. Disconnect the system from the mains.

   DANGER
   Hazardous Voltage
   Risk of electric shock due to unintentional contact with uninsulated live parts with high voltages.

   → Disconnect all hazardous voltages (mains voltage) before opening the system.
   → If the system 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).
   → Ensure the absence of voltage before starting any electrical work
4. Remove the computer cover
5. Select a position in the PCI-104-stack.
   To be able to emulate the slot position of a PCI-bus, the CAN-PCI104/200 is equipped with a coding switch and a multiplexer logic (as recommended in PCI-104 specification version 1.0). In the state of delivery the coding switch of the CAN-PCI104/200 is set to “0”, so the module can be operated directly on the host CPU, in slot 1.

   The settings of the coding switch are described in the following table (Table 1).

IMPORTANT
The CAN-PCI104/200-2 (module with 2 CAN-interfaces) only uses one interrupt on the PCI-Bus as well.

Set the position of the coding switch before you mount the CAN-PCI104/200 because it might be difficult to access the coding switch when the module is mounted.

Position of coding switch	PCI-104-stack number	REQ#	GNT#	CLK	INT0#	INT1#	INT2#	INT3#
0, 4, 8, C	1	REQ0#	GNT0#	CLK0	INTA#	INTB#	INTC#	INTD#
1, 5, 9, D	2	REQ1#	GNT1#	CLK1	INTB#	INTC#	INTD#	INTA#
2, 6, A, E	3	REQ2#	GNT2#	CLK2	INTC#	INTD#	INTA#	INTB#
3, 7, B, F	4	REQ3#	GNT3#	CLK3	INTD#	INTA#	INTB#	INTC#

Table 1: Setting the simulated PCI-slot with coding switch SW130

Install the CAN-PCI104/200 on the PCI-104 stack position you have selected.

6. Close the computer case again.
7. Connect the CAN wire.
   Please note that the CAN bus must be terminated at both ends.
   Additionally, the CAN_GND must be connected to earth at exactly one point in the CAN network. Use the special T- connectors and terminator connectors offered by esd.
   A CAN device whose CAN interface is not electrically isolated acts as an earth connection like the CAN_GND.
   Please pay attention to the notes on correct wiring of CAN networks (see from page 25)!

   The CAN-bus interfaces with the ISO11898-2 compliant signals have to be connected to the pin post connectors X400 (CAN 0) and X410 (CAN 1, only equipped in the 2x CAN versions).
8. Connect the computer to mains again (mains connector or safety fuse).
9. Switch on the computer, the peripheral devices and the other CAN devices again.
10. End of hardware installation.
11. Set the interface properties in your operating system.

    Continue with the software installation as described in the manual ‘NTCAN-API, Installation Guide’.

3. Technical Data

3.1 General Technical Data

Power supply voltage	via PCI bus, nominal voltage: 3.3 V ± 5% and 5 V ± 5%
Current consumption	$I_{3.3VTYPICAL}$ = 270 mA $I_{5VTYPICAL}$ = 50 mA (20°C each, both CAN controllers equipped)
Connectors	X100 (120-pin PCI-104-board connector) - PCI bus X400 (10-pin post connector) - CAN interface CAN 0 X410 (10-pin post connector) - CAN interface CAN 1 (C.2046.04, C.2046.08 only) The following options are available on request: X110 (64-pin PC/104 board connector) - ISA bus (optional) X111 (40-pin PC/104 board connector) - ISA bus (optional) X420 (10-pin post connector) - CAN-TTL signals (optional)
Temperature range	CAN-PCI104/200-1, CAN-PCI104/200-2: 0°C ... +50 °C ambient temperature CAN-PCI104/200-2-T: extended temperature range: -40°C ... +75°C ambient temperature
Humidity	max. 90%, non-condensing
Dimensions	according to PCI-104 Specification Version 1.0 (default components layout), according to PC/104-*Plus* Specification Version 2.0 (with optional ISA connector), PCB size: 95,9 mm x 90,2 mm
Weight	< 150 g

Table 2: General data of the module

3.2 PCI-104-Bus

Specification	PCI-104 Specification Version 1.0
Host bus	PCI: (according to PCI Spec. 2.2) data range: 32 bit clock rate: 33 MHz signalling voltage: 3.3 V or 5 V
PCI bridge	PLX 9030
Assignment of the signals INTx, REQ#, GNT#, CLK	configurable with the coding switch (according to PCI-104 Spec. V.1.0)
Connector	PCI-104 board connector, 120-pin

Table 3: Data of PCI-104 bus

3.3 PC/104-Plus Bus (only with optional ISA Connector)

INFORMATION
The optional connectors are not equipped in the standard versions. They can be equipped by esd on request. Please state this option in your order.

Specification	PC/104-Plus Specification Version 2.0
Host bus	PCI: (according to PCI Spec. 2.2) data range: 32 bit clock rate: 33 MHz signalling voltage: 3.3 V or 5 V
PCI bridge	PLX 9030
Assignment of the signals INTx, REQ#, GNT#, CLK	configurable with the coding switch (according to PCI-104 Spec. V.1.0)
ISA bus	ISA-bus signals are only connected through - no local connection
PCI connector	PC/104-Plus board connector, 120-pin
ISA connector	PC/104-Plus board connector, 40-pin and 64-pin

Table 4: PC*/104-Plus* bus data (optional)

3.4 CAN Interface

Number of CAN interfaces	1 (CAN-PCI-104/200-1), 2 (CAN-PCI104/200-2, CAN-PCI104/200-2T)
CAN controller	SJA1000, ISO 11898-1 (CAN 2.0)
Physical Layer	Physical layer Physical layer according to ISO 11898-2, transmission rate programmable up to 1 Mbit/s
Electrical isolation of the CAN interface against the other units	via dual channel digital isolator and DC/DC-converter
Bus termination	terminating resistor has to be set externally, if required

Table 5: Data of the CAN interface

3.5 Software Support

Software drivers for Windows® and Linux® are available. Drivers for other operating systems are also available.

CANopen® and J1939 protocol libraries are available.

For detailed information about the driver availability for your operating system, please contact our sales team (sales@esd.eu).

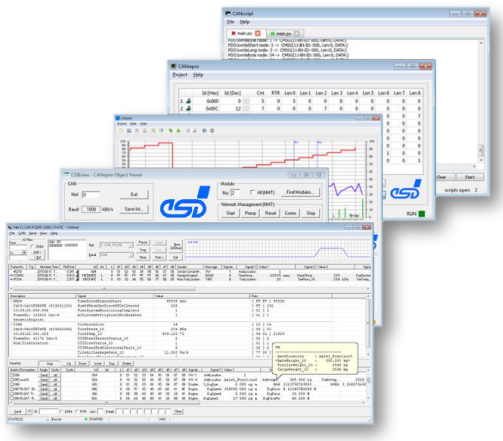
INFORMATION

The CAN layer 2 (NTCAN-API) software installation and the software drivers are described in the NTCAN-API manual (esd-order No.: C.2001.21):

“NTCAN-API Part 1: Application Developers manual” and
“NTCAN-API Part 2: Installation Guide”

CAN Tools

esd offers additional free-of-charge tools for efficient setup and analysis of CAN applications and networks. The tools are operational with all esd PC-CAN interfaces (e.g. PCIe, USB, EtherCAN/2 ...).



The following tools are available:

CANreal	Display and record of CAN message frames
CANplot	Graphically display of CAN data
CANrepro	Replay of pre-recorded CAN messages
CANscript	Python based scripting tool
COBview	Analysis and diagnostics of CANopen® nodes

System Requirements:
- Windows 32 bit or 64 bit system
- 30 MB free HD drive space
- esd CAN driver installed

As part of the software development kit (CAN SDK) of the esd NTCAN-API, the tools are contained on the CAN-CD, which is included in delivery of the CAN-PCI104/200.
The CAN-SDK can also be downloaded free-of-charge from the esd website.

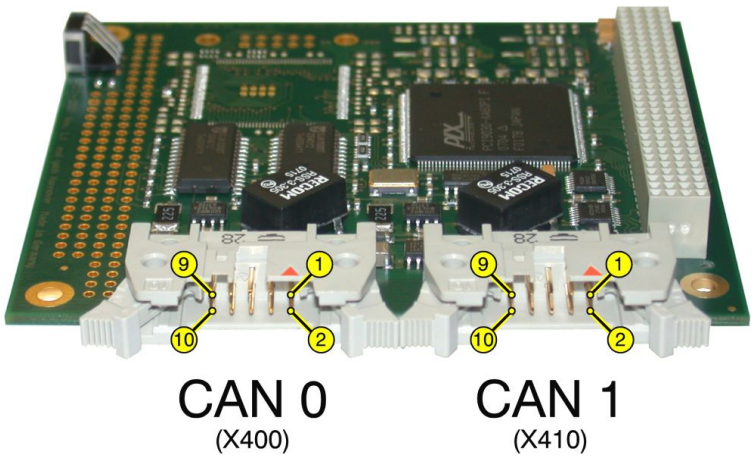
4. Connector Assignment

4.1 CAN Interface (X400, X410)

The signal assignments of the connectors X400 and X410 are compatible to the recommendations of the CiA® DR 303-1, Rev. 1.4. and the pin assignments are equivalent according to the respective interface.

Device connector: 10-pin IDC male header, angled solder pins (90°) and short levers, quality category 2, e.g. Harting order no.: 9185106913, for the connection of ribbon cables

Assignment of the interfaces and pins:



Pin Assignment:

Signal	Pin	Pin	Signal
-	1	2	CAN_GND
CAN_L	3	4	CAN_H
CAN_GND	5	6	-
-	7	8	-
-	9	10	Shield

Signal Description:

CAN_L, CAN_H ... CAN signals
CAN_GND... reference potential of the local CAN physical layer
Shield... shield potential
- ... reserved for future applications, do not connect!

5. Adapter Cable

The CAN-PCI104/200-DSUB/10pol. CAN adapter cable (esd order No.: C.2046.70) is designed to interface the CAN-PCI104/200 CAN board (or compatible) to a standard CiA® DS 303-1 DSUB9 connector.

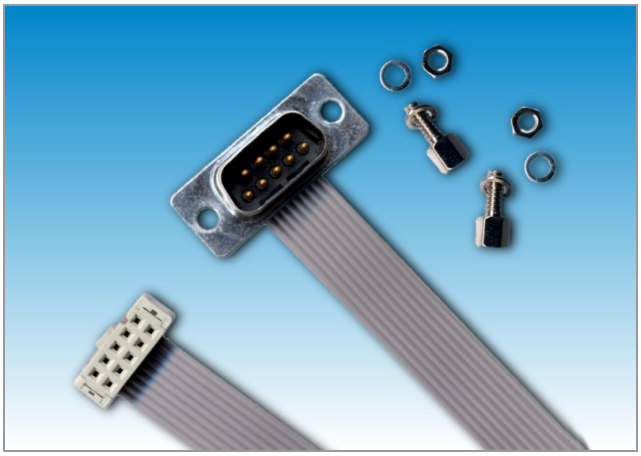


Figure 3: View of the adapter cable

Connector 1:	DSUB9 (IEC 60807) male with bold set
Connector 2:	IDC 10-pin female connector (IEC 60326-3)
Cable type:	ribbon cable, AWG28-10, length = 300 mm ±10 mm
Bolt set:	for DSUB connector, size = UNC4-40, contains 2x bolts, 2x nuts, 2x washer, 2x spring washer

9-pin DSUB to 10-pin IDC Connector

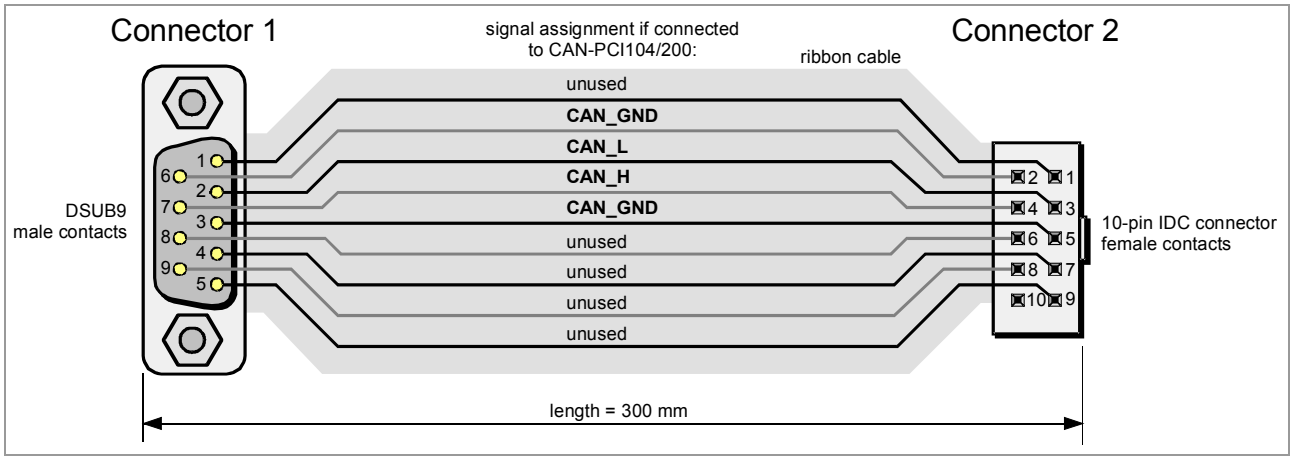


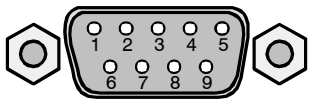
Figure 4: View of the signal assignments of the adapter cable connectors

5.1 Assignment of the DSUB9 Adapter Cable Connector

The 9-pin DSUB CAN connector of the adapter cable can be connected to the CAN interfaces of the CAN-PCI104/200. The pin assignment of the DSUB connector is compatible to the recommendations of the CiA DR 303_1, Rev. 1.4.

Device connector: 9-pin DSUB connector, male

Pin Position:



Pin Assignment:

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

Signal Description:

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

6. Correct Wiring of Electrically Isolated CAN Networks

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

6.1 Standards concerning CAN Wiring

The flexibility in CAN network design is one of the key strengths of the various extensions and additional standards like e.g. CANopen, ARINC825, DeviceNet and NMEA2000 that have been built on the original ISO 11898-2 CAN standard. In using this flexibility comes the responsibility of good network design and balancing these tradeoffs.

Many CAN organizations and standards have scaled the use of CAN for applications outside the original ISO 11898. They have made system level tradeoffs for data rate, cable length, and parasitic loading of the bus.

However for CAN network design margin must be given for signal loss across the complete system and cabling, parasitic loadings, network imbalances, ground offsets against earth potential and signal integrity. **Therefore the practical maximum number of nodes, bus length and stub length are typically much lower.**

esd has concentrated her recommendations concerning CAN wiring on the specifications of the ISO 11898-2. Thus this wiring hints forgoes to describe the special features of the derived standards CANopen, ARINC825, DeviceNet and NMEA2000.

The consistent compliance to ISO 11898-2 offers significant advantages:

- Durable operation due to well proven design specifications
- Minimizing potential failures due to sufficient margin to physical limits
- Trouble-free maintenance during future network modifications or during fault diagnostics due to lack of exceptions

Of course reliable networks can be designed according the specifications of CANopen, ARINC825, DeviceNet and NMEA2000, **however it must be observed that it is strictly not recommended to mix the wiring guidelines of the various specifications!**

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

6.2.1 General Rules

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

1	A cable type with a wave impedance of about 120 Ω ±10% with an adequate conductor 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 CAN_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.

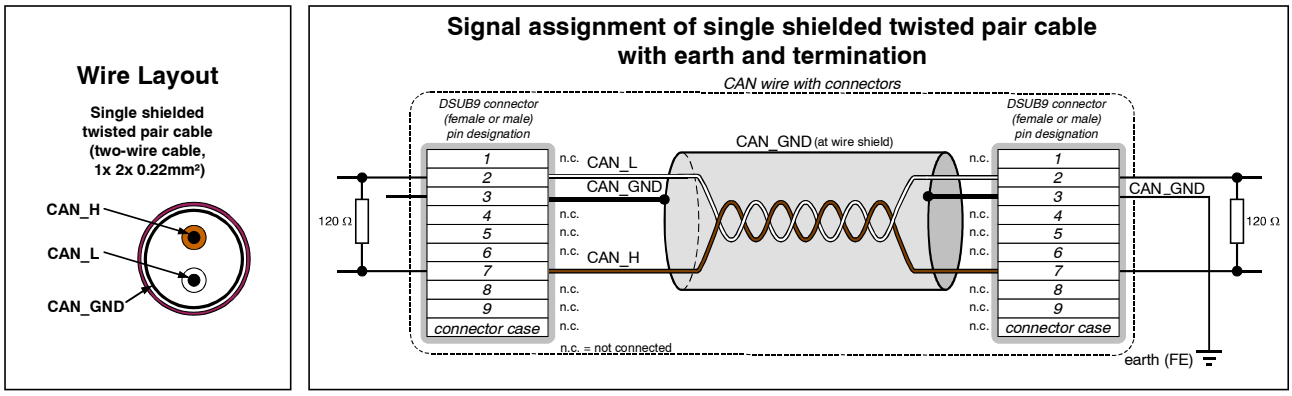


Figure 5: CAN wiring for light industrial environment

6.2.2 Cabling

- To connect CAN devices with just one CAN connector per net use a short stub (< 0.3 m) and a T-connector (available as accessory). If this devices are located at the end of the CAN network, the CAN terminator “CAN-Termination-DSUB9” can be used.

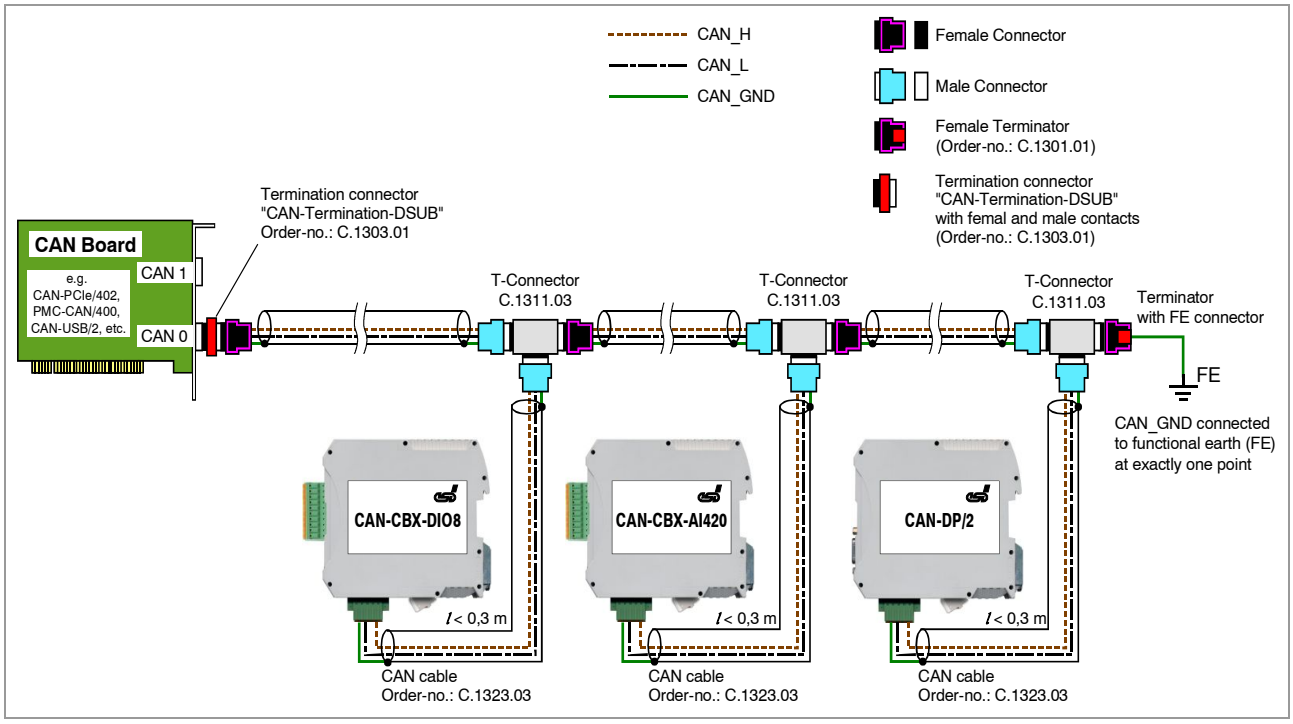


Figure 6: Example for proper wiring with single shielded single twisted pair wires

6.2.3 Termination

- A termination resistor has to be connected at both ends of the CAN bus.
  If an integrated CAN termination resistor which is equipped at the CAN interface at the end of the bus is connected, this one has to be used for termination instead of an external CAN termination plug.

- 9-pin DSUB-termination connectors with integrated termination resistor and male and female contacts (gender changer) are available from esd (order no. C.1303.01).

- DSUB termination connectors with male contacts (order no. C.1302.01) or female contacts (order no. C.1301.01) and additional functional earth contact are available, if CAN termination and grounding of CAN_GND is required.

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

6.3.1 General Rules

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

1	A cable type with a wave impedance of about 120 Ω ±10% with an adequate conductor 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** to CAN_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.

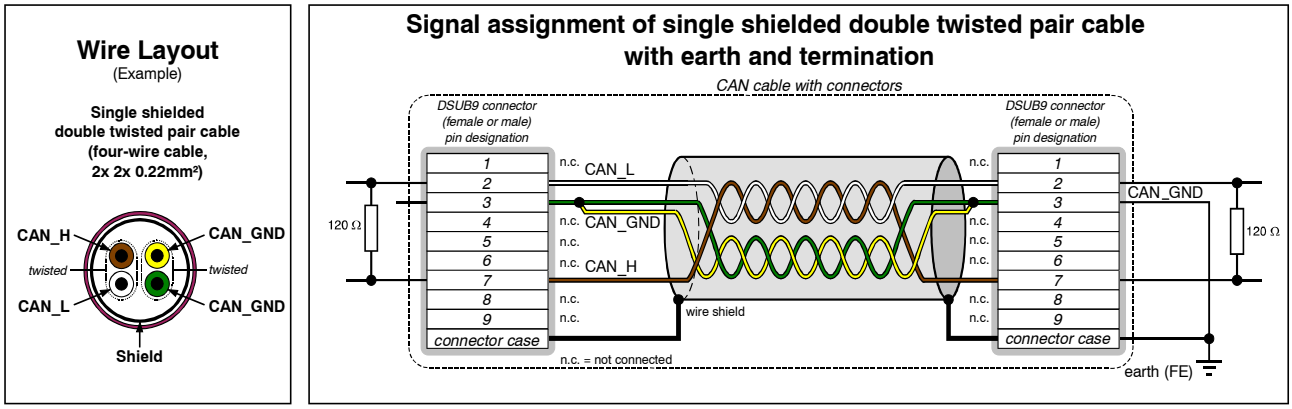


Figure 7: CAN wiring for heavy industrial environment

6.3.2 Device Cabling

NOTICE
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.

If a mixed application of single twisted and double twisted cables is unavoidable, take care that the CAN_GND line is not interrupted!

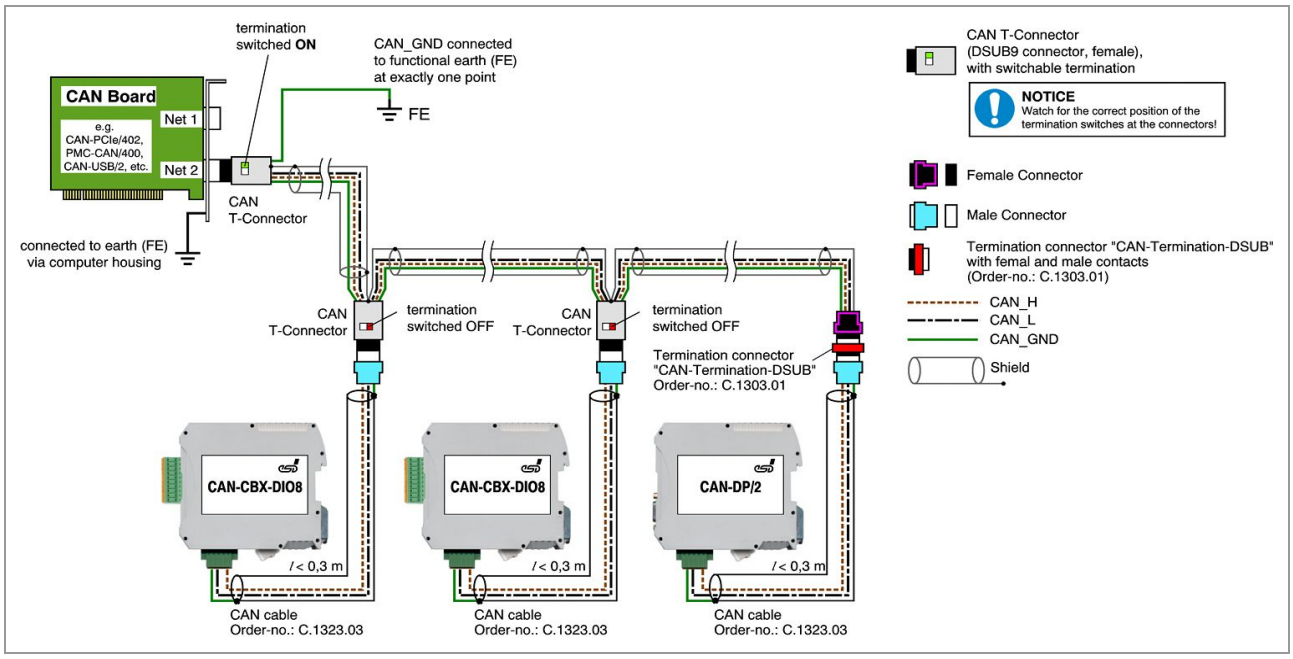


Figure 8: Example of proper wiring with single shielded double twisted pair cables

6.3.3 Termination

- A termination resistor has to be connected at both ends of the CAN bus.
  If an integrated CAN termination resistor which is equipped at the CAN interface at the end of the bus is connected, this one has to be used for termination instead of an external CAN termination plug.

- 9-pin DSUB-termination connectors with integrated termination resistor and male and female contacts (gender changer) are available from esd (order no. C.1303.01).

- 9-pin DSUB-connectors with integrated switchable termination resistor can be ordered e.g. from ERNI (ERBIC CAN BUS MAX, female contacts, order no.:154039).

6.4 Electrical Grounding

- For CAN devices with electrical isolation the CAN_GND must be connected between the CAN devices.
- CAN_GND should be connected to the earth potential (FE) at **exactly one** point of the network.
- Each *CAN interface with electrical connection to earth potential* acts as a grounding point. For this reason it is recommended not to connect more than one *CAN device with electrical connection to earth potential.*
- Grounding can be made e.g. at a termination connector (e.g. order no. C.1302.01 or C.1301.01).

6.5 Bus Length

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
666.6̄	80	-
500	130	100
333.3̄	180	-
250	270	250
166	420	-
125	570	500
100	710	650
83,3̄	850	-
66.6̄	1000	-
50	1400	1000
33.3̄	2000	-
20	3600	2500
12.5	5400	-
10	7300	5000

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

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

NOTICE
Please note the recommendations of ISO 11898 regarding to the configuration of the cable cross-section in dependance of the cable length.

6.6 Examples for CAN Cables

esd recommends the following two-wire and four-wire cable types for CAN network design. These cable types are used by esd for ready-made CAN cables, too.

6.6.1 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.)

6.6.2 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.)

INFORMATION
Ready-made CAN cables with standard or custom length can be ordered from **esd**.

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.

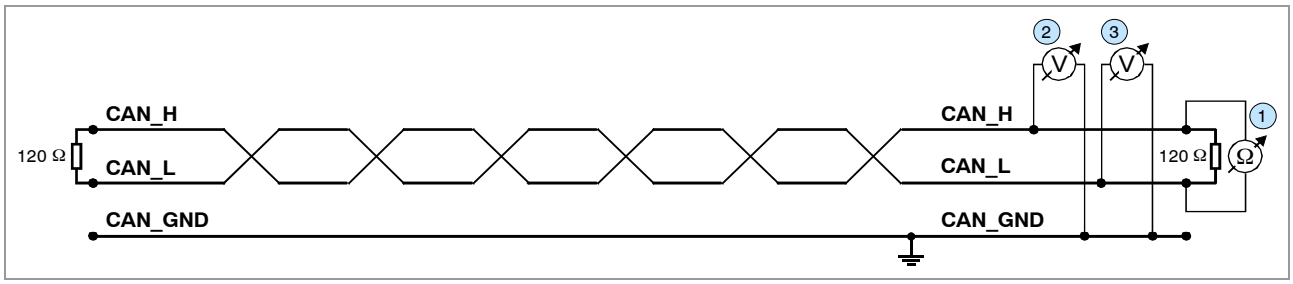


Figure 9: Simplified diagram of a CAN network

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 avoided. 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 one end of the network ① (see figure above).

The measured value should be between 50 Ω and 70 Ω.

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 connected
- 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 should be connected to the functional earth potential (FE) at only **one** point. This test will check 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. Reconnect CAN_GND to earth potential.

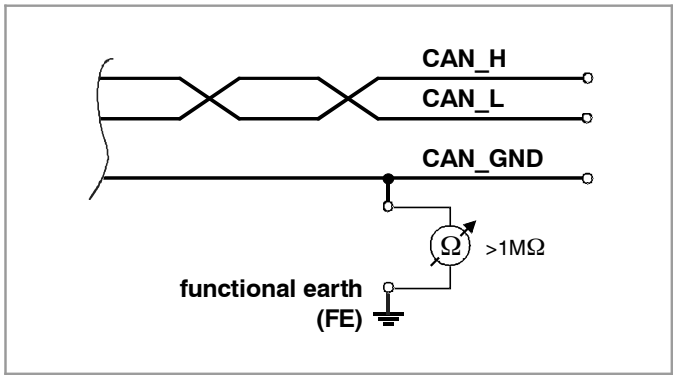


Figure 10: Simplified schematic diagram of ground test measurement

The measured 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 generally 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 V measured to CAN_GND. 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 CAN_GND (2) (see figure at previous page).
4. Measure the DC voltage between CAN_L and CAN_GND (3) (see figure at previous page).

Normally the voltage should be between 2.0 V and 3.0 V.

If it is lower than 2.0 V or higher than 3.0 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.

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

7.5 CAN Transceiver Resistance Test

CAN transceivers have circuits that control CAN_H and CAN_L. Experience has shown that electrical damage of the circuits may increase the leakage current in these circuits.

To measure the current leakage through the CAN circuits, please use a 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 indication for a faulty transceiver is a very high deviation between the two measured input resistances (>> 200 %).

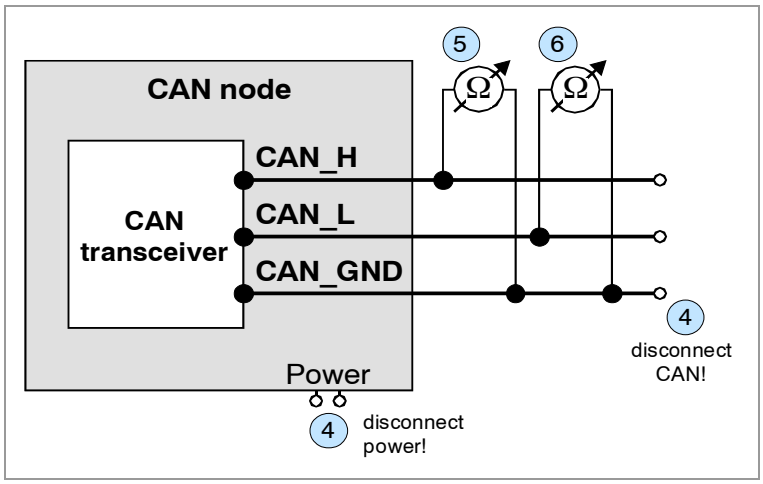


Figure 11: Measuring the internal resistance of CAN transceivers

7.6 Support by esd

If you have executed the fault diagnostic steps of this troubleshooting guide and you even can not find a solution for your problem our support department will be able to assist.
Please contact our support via email at **support@esd.eu** or by phone **+40-511-37298-130**.

8. Order Information

Type	Description	Order No.
CAN-PCI104/200-1	Passive PCI104 to CAN interface board, - SJA1000 CAN controller - 1x CAN 2.0A/B interface - physical layer according to ISO 11898, electrically isolated; - CAN via connector for flat ribbon cable Drivers, tool and documentation for Windows & Linux on CD-ROM - also available as PC104+ with ISA and PCI connector (on request)	C.2046.02
CAN-PCI104/200-2	As C.2046.02 but with 2 CAN 2.0A/B interfaces	C.2046.04
CAN-PCI104/200-2-T	Passive PCI104 to CAN interface board for an extended temperature range from -40°C up to +75°C, - SJA1000 CAN controller - 2 CAN 2.0A/B interface - physical layer according to ISO 11898, electrically isolated; - CAN via connector for flat ribbon cable Drivers, tools and documentation for Windows & Liux on CD-ROM Attention: the passive interface can result to restrictions for the achievable effective bandwidth depending on the performance of the host CPU.	C.2046.08
CAN layer 2 drivers for Windows and Linux are included in delivery.		
Accessories:		
CAN-PCI104/200-DSUB/10pol. CAN	CAN-PCI104/200-DSUB/10pol. CAN-Adapter IDC 10-pin female connector (IEC 60326-3) to DSUB9 male, 30 cm ribbon cable	C.2046.70
Software:		
CAN-layer 2 object licences including CD-ROM: CAN-DRV-LCD VxWorks CAN-DRV-LCD QNX CAN-DRV-LCD RTX CAN-DRV-LCD On Time RTOS-32		 C.1101.55 C.1101.32 C.1101.35 C.1101.45
CANopen object licences including CD-ROM: CANopen-DRV-LCD Windows/Linux CANopen-DRV-LCD VxWorks CANopen-DRV-LCD QNX CANopen-DRV-LCD RTX		 C.1101.06 C.1101.18 C.1101.17 C.1116.16
J1939 Stack for esd CAN hardware: J1939 stack for Windows (object code) J1939 stack for Linux (object code)		 C.1130.10 C.1130.11
For detailed information about the driver availability for your operating system, please contact our sales team.		

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-PCI104/200-ME	Hardware manual in English	C.2046.21
CAN-API-ME	NTCAN-API: Application Developers Manual NTCAN-API: Driver Installation Guide	C.2001.21
CANopen-ME	CANopen manuals in English	C.2002.21

Table 7: 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.