CAN-PCI/405-B4

PCI-CAN-Interface

Hardware Installation
and
Technical Data

to Product C.2041.04

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Changes in the Chapters

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

Chapter	Changes with respect to previous revision
-	First released version
-	-

Further technical changes are subject to change without notice.

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Contents

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1. Overview

1.1 Description of the Module

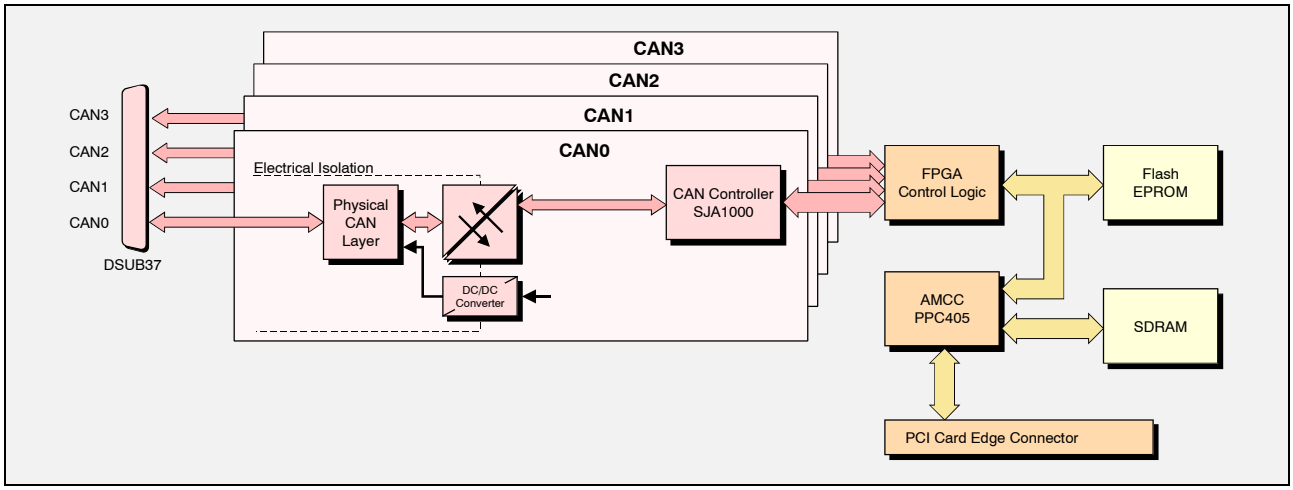

Figure 1: Block circuit diagram of the CAN-PCI/405-B4 module

The CAN-PCI/405-B4 is a PC board designed for the PCI bus. It supports four independent CAN interfaces. The four CAN interfaces can be connected via the 37-pole DSUB panel connector in the slot bracket.

The CAN-PCI/405-B4 provides four ISO 11898-compliant CAN interfaces based on SJA1000 CAN controllers. The CAN interfaces allow a data transfer rate of 1 Mbit/s.
The baud rate can be set by per software.
The interfaces are electrically isolated from the other potentials.

The CAN-PCI/405-B4 produces hardware-generated timestamps with a resolution of 1 µs for all CAN messages. A PowerPC 405GP cares for the local data management of the CAN-PCI/405-B4.

The CAN data are bufferd in a local SDRAM. Security and consistency of data is guaranteed up to 1 Mbit/s.

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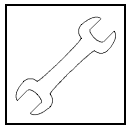


2. Hardware Installation

2.1 Procedure

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.

Execute Hardware Installation:

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 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. Be careful not to insert the board into an ISA slot, because this might damage the PC and the board!

6. Insert the CAN module 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. Replace the PC cover.
   Secure the cover with the according screws at the back of the PC.

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 CAN-PCI/405-B4 is equipped with a 37-pole DSUB panel connector (male) in the slot bracket. Four CAN channels can be connected via the DSUB connector.
   As accessory the cable CAN-PCI/405-B4-1C4 (see order information) is available.

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.
    The software installation is described in the manual ‘CAN-API, Part 2: Installation’.

3. PCB View and LED-Description

3.1 PCB View

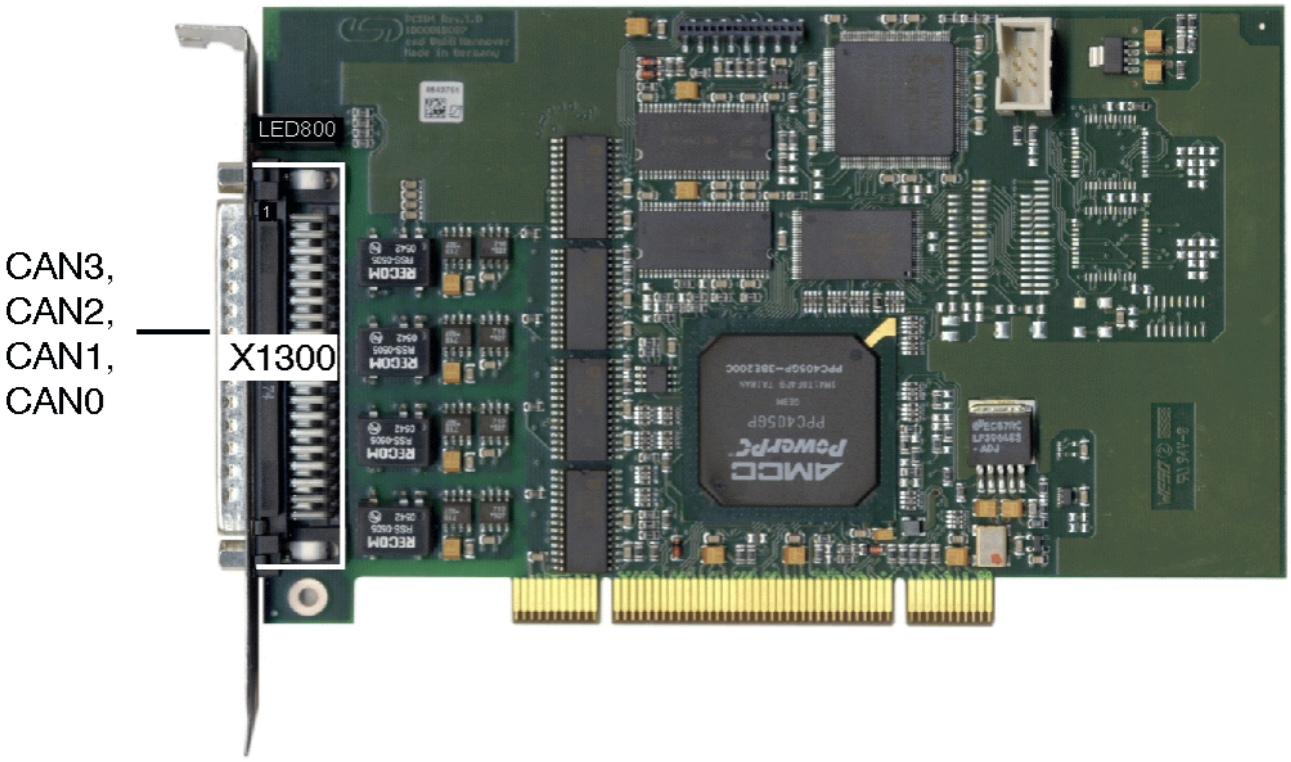


Figure 2: CAN-PCI/405-B4 card view

3.2 LEDs and DSUB37 Connector in the Slot Bracket

Four CAN nets can be connected to the CAN-PCI/405-B4 card via the 37-pole DSUB panel connector in the slot bracket.

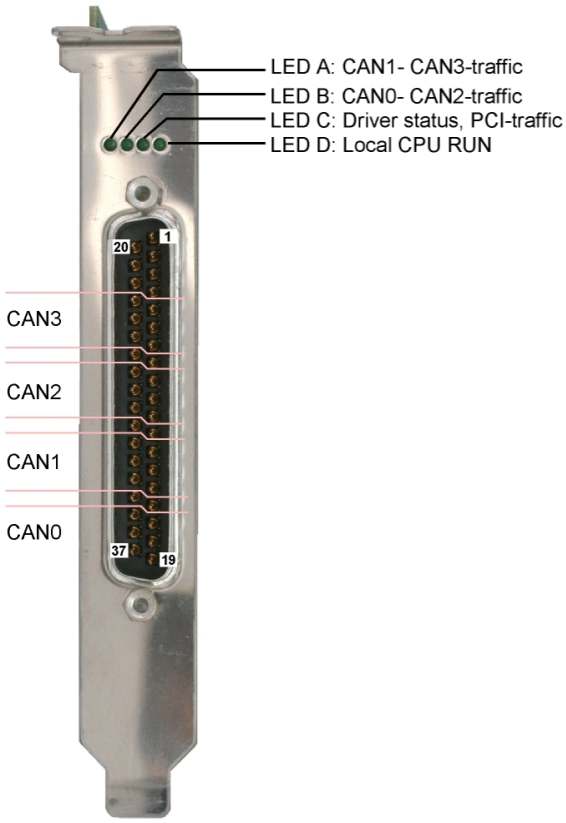
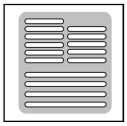


Figure 3: Meaning of the LEDs and connector position

LED	Name	Indication of the Led (LED on)
A	CAN1-, CAN3-traffic	CAN-frames are being received or transmitted on CAN1 and/or CAN3
B	CAN0-, CAN2-traffic	CAN-frames are being received or transmitted on CAN0 and/or CAN2
C	Driver status/ PCI traffic	LED off: No driver loaded LED on: Driver loaded LED flickering: Communication with CAN-board
D	Local CPU RUN	Local CPU is in RUN status (LED lights at every access to the SDRAM, therefore the LED can be blinking or permanently on in normal operation)

Table 1: Name and indication of the LEDs



4. Summary of Technical Data

4.1 General Technical Data

Ambient temperature	0...50 ˚C
Humidity	max. 90 %, non-condensing
Supply voltage	supplied by PCI bus, nominal voltage: 5 V ±5%, 3.3 V ±5%, typical current consumption for 4x CAN (max., at 20 ˚C): 650 mA via 3.3 V-connection and 250 mA via 5 V-connection
Plug-and-socket connectors	X100 (Card Edge) - PCI bus X1300 (DSUB37 panel connector/male) - CAN Net 0-3
Dimensions	167.64 mm x 106.68 mm (without slot bracket and without CAN-connector)
Weight	approx. 130 g

Table 2: General data of CAN-PCI/405-B4

4.2 Microprocessor and Memory

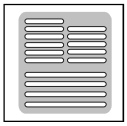
CPU	PowerPC 405GP, 200 MHz, 32 bit
Flash-EPROM	2 MB Flash EPROM
SDRAM	32 MB SDRAM

Table 3: Micro processor and memory

4.3 PCI Bus

Host-Bus	PCI bus according to PCI Local Bus Specification 2.2
PCI data bus	32 bit
Controller	PPC405GP
Interrupt	interrupt signal A
Slot position	no restrictions for the slot position
Board dimension	PCI short card
Connector	PCI card edge connector

Table 4: PCI-bus data



4.4 CAN Interface

Number	4x CAN via DSUB37 panel connector
CAN controller	SJA1000, ISO 11898-1 (CAN 2.0)
Physical Layer	Physical Layer according to ISO 11898-2, transmission rate is programmable from 10 Kbit/s up to 1 Mbit/s
Termination	has to be done externally
Electrical isolation	The CAN interfaces are electrically isolated against each other and against the PCI-bus potentials by optocouplers and DC/DC-converters.

Table 5: Data of the CAN interface

4.5 Software Support

Software drivers are available for Windows-, Linux- and real-time operating systems.

The software installation and the software drivers are described in the manual:

"CAN-API Part 1: Function Description" und
"CAN-API Part 2: Installation Guide"
esd-order No.: C.2001.21

A software package for CANopen support is available for Windows.

4.6 Order Information

Type	Description	Order no.
Hardware:		
CAN-PCI/405-B4	PPC405, 200 MHz, 32 MB SDRAM, 2 MB Flash, 4x CAN via DSUB37 (male) /1 Slot	C.2041.04
Accessories:		
CAN-PCI/405-B4-1C4	Cable DSUB37 (female) to 4x DSUB9 (male), to CAN-PCI/405-B4	C.2041.18
PCI-Host Software drivers (incl. local firmware on CAN-PCI/405-B4):		
CAN-DRV-LCD	Layer-2 driver software Object-Licence for Windows and Linux incl. CD-ROM	C.1101.02
CANopen-LIC	CANopen Object-Licence for Windows and Linux	C.1101.05
Dokumentation:		
CAN-PCI/405-B4-MD	User manual in German [1*)]	C.2041.20
CAN-PCI/405-B4-ME	User manual in English [1*)]	C.2041.21
CAN-API-ME	Software manual for the host software driver in English [1*)]	C.2001.21
CAN-PCI/405-B4-ENG	Engineering manual in Englisch [2*)] Contents: Schematic diagrams, PCB top overlay drawings, data sheets of significant components	C.2041.25

1*)... If module and manual are ordered together, the manual is free of charge.
2*)... This manual is liable for costs, please contact our support.

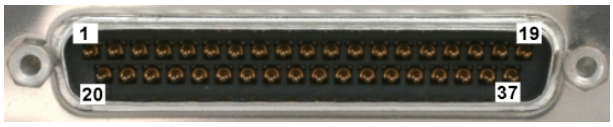
Table 6: Order information

5. Connector Pin Assignment

5.1 CAN Interfaces

All four CAN interfaces are attached via a 37-pole DSUB panel connector (male).

Pin Position:



Pin Assignment:

Signal	Pin		Signal	Channel
n.c.	20	1	n.c.	
n.c.	21	2	n.c.	
n.c.	22	3	n.c.	
CAN_GND3	23	4	n.c.	
CAN3_H	24	5	CAN_GND3	CAN3
CAN3_L	25	6	CAN3_H	
n.c.	26	7	CAN3_L	
CAN_GND2	27	8	n.c.	
CAN2_H	28	9	CAN_GND2	CAN2
CAN2_L	29	10	CAN2_H	
n.c.	30	11	CAN2_L	
CAN_GND1	31	12	n.c.	
CAN1_H	32	13	CAN_GND1	CAN1
CAN1_L	33	14	CAN1_H	
n.c.	34	15	CAN1_L	
CAN_GND0	35	16	n.c.	
CAN0_H	36	17	CAN_GND0	CAN0
CAN0_L	37	18	CAN0_H	
		19	CAN0_L	

37-pole DSUB connector (male)

Signal description:

CANx_L, CANx_H...	CAN signal lines of the CAN interface x (x = 0 ... 3)
CAN_GNDx ...	reference potential of the local CAN physical layer (x = 0 ... 3)
n.c. ...	not connected

5.1.1 Adapter Cable CAN-PCI/405-B4-1C4

The adapter cable CAN-PCI/405-B4-1C4 is designed for the connection to the 37-pole DSUB panel connector (male) of the CAN-PCI/405-B4. The signals of the four CAN interfaces are conducted to four DSUB9 plugs (male).

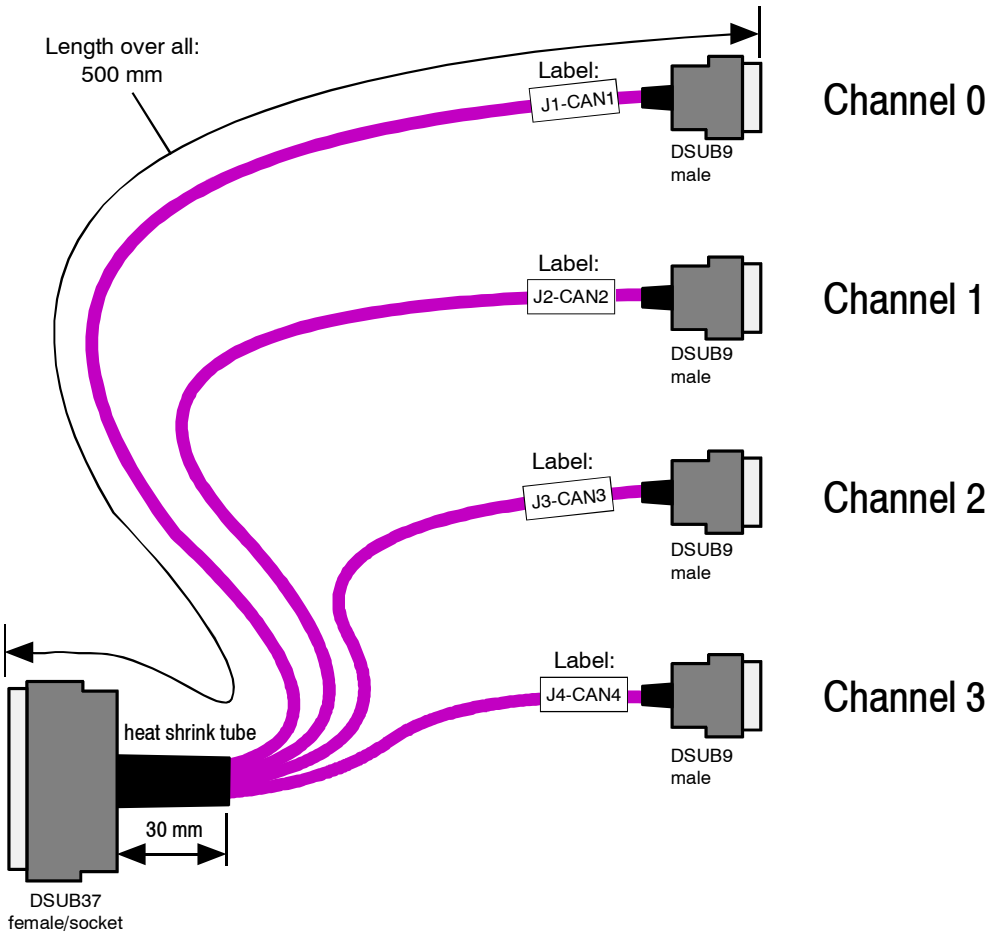
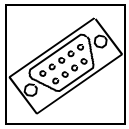
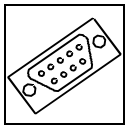


Figure 4: Adapter cable CAN-PCI/405-B4-1C4



Assignments of the cable connectors of CAN-PCI/405-B4-1C4						
Connector side A	Pin no. of DSUB 37 socket (female)	Label of the cable	CAN channel	Connector side B	Pin no. of the DSUB9 plug (male)	Signal
DSUB37 (female)	1	-	-	-		
	2					
	3					
	4					
	5	J4-CAN4	**CAN 3**	DSUB9 (male)	3	CAN_GND3
	6				7	CAN3_H
	7				2	CAN3_L
	8	-	-	-		
	9	J3-CAN3	**CAN 2**	DSUB9 (male)	3	CAN_GND2
	10				7	CAN2_H
	11				2	CAN2_L
	12	-	-	-		
	13	J2-CAN2	**CAN 1**	DSUB9 (male)	3	CAN_GND1
	14				7	CAN1_H
	15				2	CAN1_L
	16	-	-	-		
	17	J1-CAN1	**CAN 0**	DSUB9 (male)	3	CAN_GND0
	18				7	CAN0_H
	19				2	CAN0_L
	20	-	-	-		
	: :					
	37					

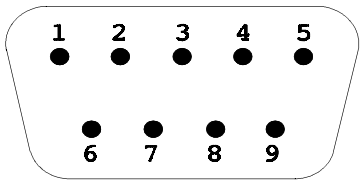
Table 7: Assignments of the cable connectors of CAN-PCI/405-B4-1C4



Connector Pin Assignment

The signals of a CAN channel are conducted to one of the four 9-pole DSUB plugs (male) of the CAN-PCI/405-B4-1C4 adapter cable.

Pin Position:



Pin Assignment:

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

9-pole DSUB plug

Signal description:

CAN_L, CAN_H...	CAN signal-lines
CAN_GND ...	reference potential of the local CAN-Physical Layer
reserved ...	reserved for future applications

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.

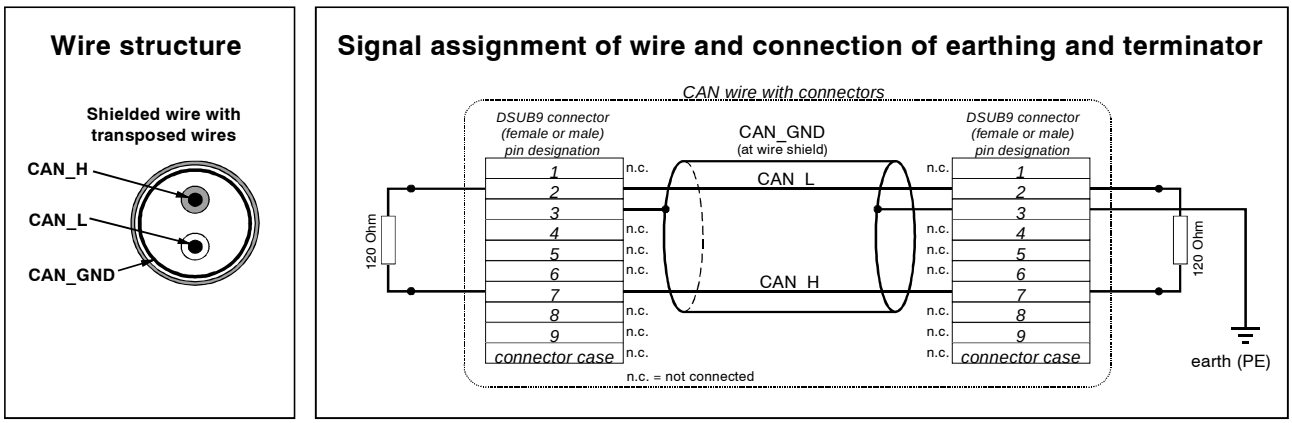


Figure: Structure and connection of wire

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)

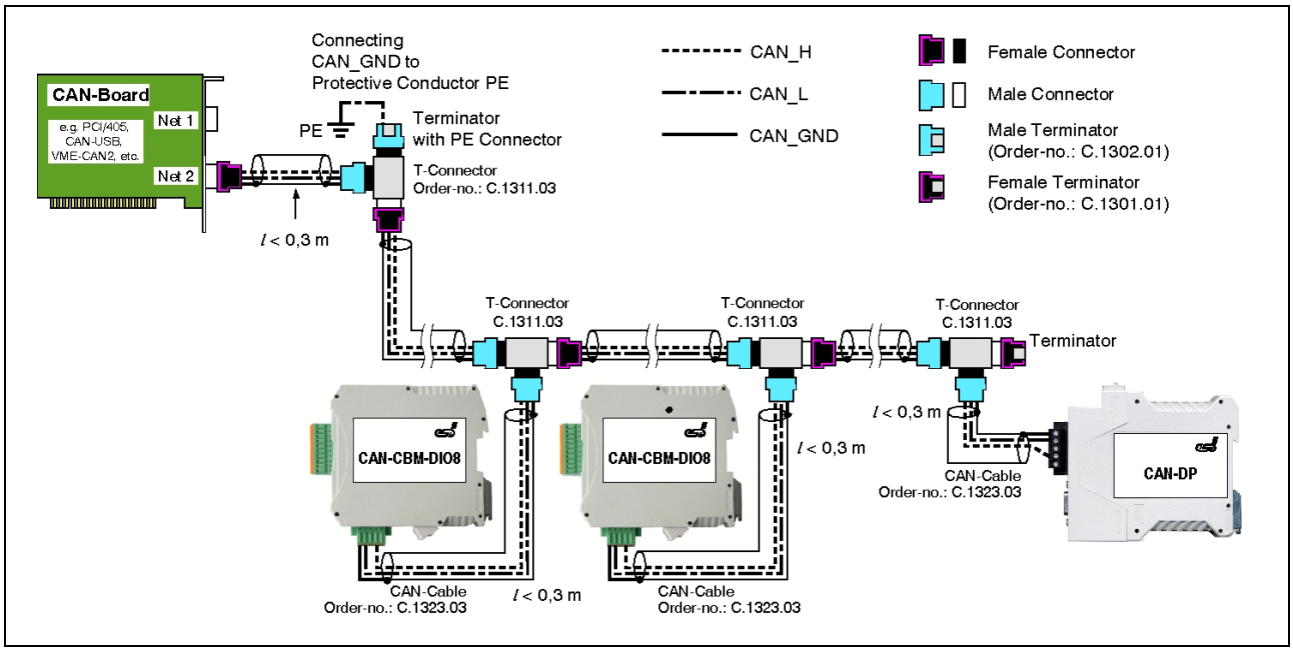


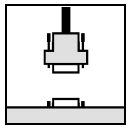
Figure: Example for correct wiring (when using single shielded wires)

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, esd modules typically reach a wire length of 37 m at 1 Mbit/s within a closed net without impedance disturbances like e.g. longer dead-end feeders.

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.

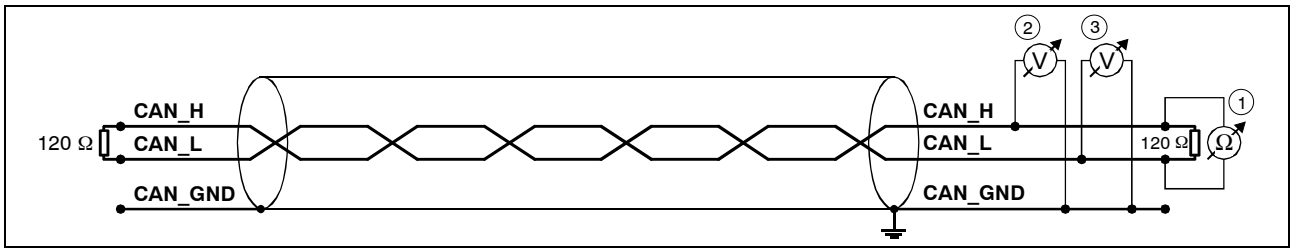


Figure: Simplified diagram of a CAN network

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 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 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 (Shield) from the ground.
2. Measure the DC resistance between Shield and ground (see picture on the right hand).
3. Connect Shield wire to ground.

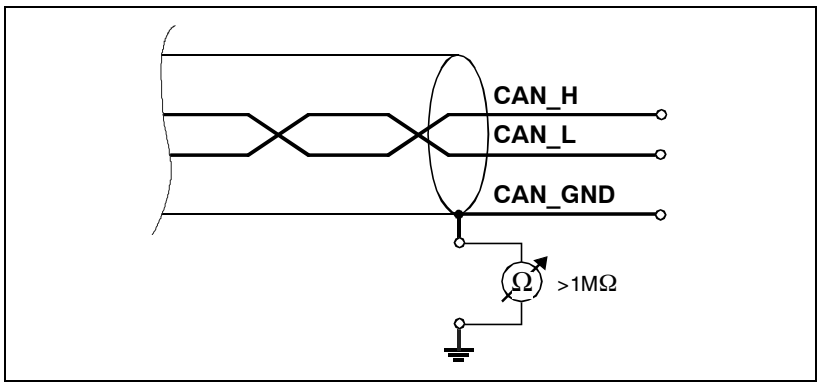


Fig.: Simplified schematic diagram of ground test measurement

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.

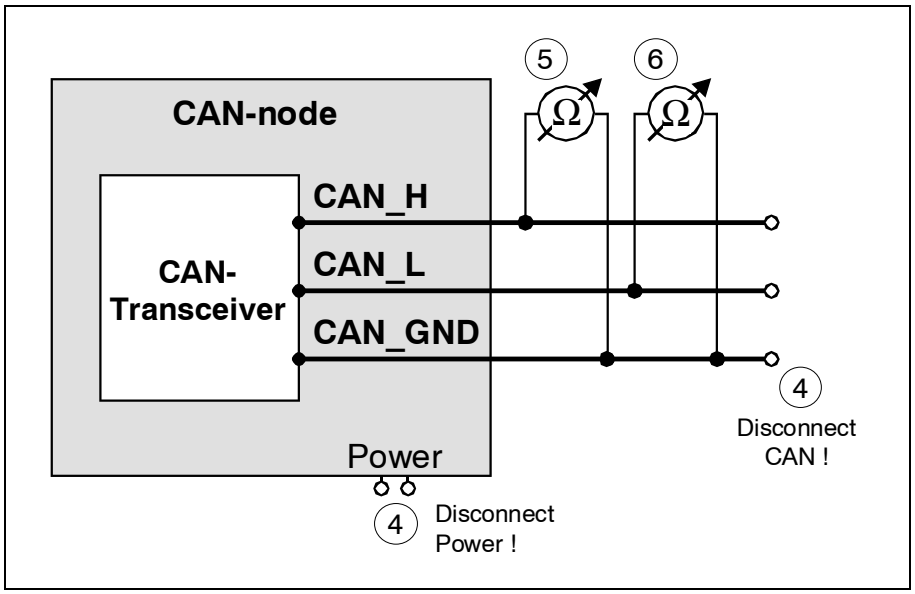


Figure: Simplified diagram of a CAN node