



CAN-USB/Micro

Small CAN USB Interface in DSUB9 Enclosure



Manual

to Product C.2068.xx



NOTE

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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
1.2	5.4	Software support per default via NTCAN driver.	2014-01-17
	9.	EC declaration of conformity updated.	
	10.	Order information updated.	
1.1	5.4, 12.	Notes on software driver support inserted.	2011-06-01
	7.	Documentation corrected: CAN interface is not electrically isolated. Editorial revision of the chapter.	
	8.	CAN transceiver test revised. Editorial revision of the chapter.	
	12.	Order information moved to chapter 12.	
1.0	-	First version	2011-01-28

Technical details are subject to change without further notice.



Safety Instructions

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

Qualified Personal

This documentation is directed exclusively towards qualified personal.

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

Conformity

The CAN-USB/Micro is designed for residential, commercial and light industrial environment and meets the demands of the EU regulations and EMC standards printed in the conformity declaration at the end of this manual.

Warning: In an industrial environment the CAN-USB/Micro may be affected by radio interferences. In this case the user may be required to take adequate measures.

Intended Use

The intended use of the CAN-USB/Micro is the operation as USB-CAN interface.

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

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

Service Note

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

Disposal

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

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1. Overview

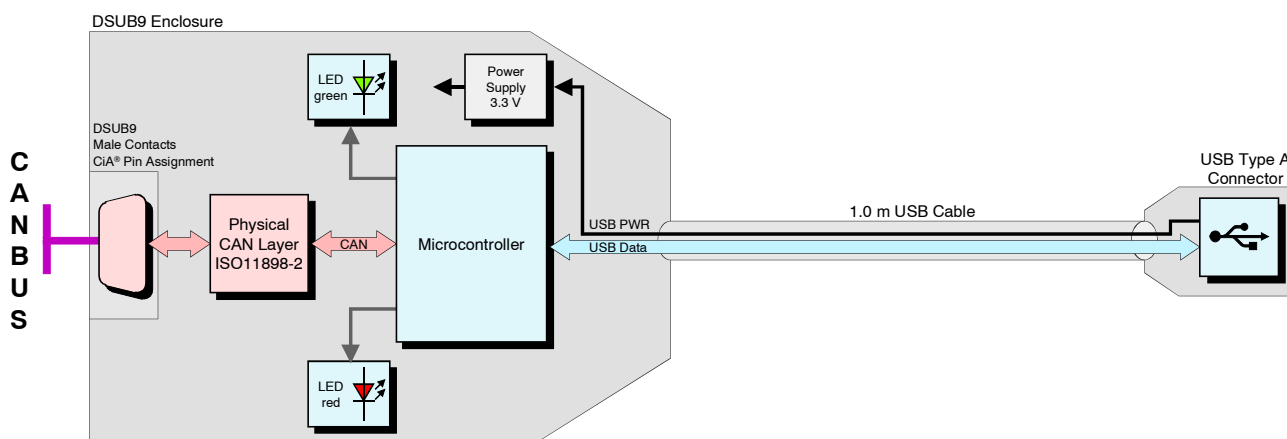


Figure 1: Block-circuit diagram of the CAN-USB/Micro

The CAN-USB/Micro is a very small, low cost CAN-USB interface for PCs, that fits into a DSUB9 enclosure. The ARM Cortex-M3 micro controller controls the CAN data. The non isolated CAN interface is powered by USB.

The CAN-USB/Micro supports the USB 2.0 full-speed interface with data rates up to 12 MBit/s.

Software drivers for Windows® are included in delivery. Linux® is supported via Linux CAN (SocketCAN) and NTCAN wrapper library. Drivers for other operating systems are available on request.

Libraries for the higher layer protocols CANopen and J1939 are available. Additional free-of-charge esd CAN tools for Windows offer efficient setup and analysis of CAN applications and networks.

The firmware can be updated from the PC.

2. View of the Connectors



Figure 2: Connectors of CAN-USB/Micro

3. Hardware Installation



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

Procedure:

1. Connect the USB connector of the CAN-USB/Micro to the USB bus of the PC.
2. Connect the 9-pin male DSUB connector to the CAN bus.
Please remember that the CAN bus has to be terminated at both ends. esd offers T-connectors and terminators. Additionally, the CAN-GND signal has to be grounded at exactly one point in the CAN network. Therefore the CAN termination connectors have got a grounding contact.
A CAN device whose CAN interface is not electrically isolated (like the CAN-USB/Micro) corresponds to the grounding of the CAN-GND.
3. End of hardware installation.
4. The software installation is described in the manual "NTCAN, Part 2: Installation, Configuration and Firmware Update, Installation Guide"

4. LED Description

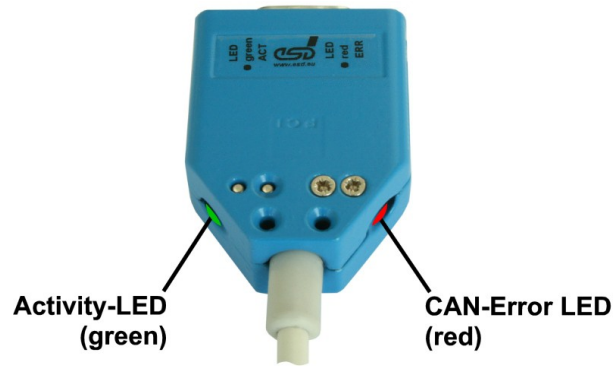


Figure 3: LEDs CAN-USB/Micro

Name	Colour	Description	
Activity	green	on	USB module is enumerated (a node address is assigned to the USB module)
		flash off	receives CAN telegrams or USB commands
		off	not working
CAN-Error	red	on	<i>CAN-Bus-off, CAN-Error-passive or CAN-Controller-Warn</i>
		off	CAN bus OK, (<i>CAN-Error-active</i>)

5. Summary of Technical Data

5.1 General Technical Data

Temperature range	0...50 °C ambient temperature
Humidity	90% non-condensing
Power supply	via USB: nominal voltage: 5 V +5 % /-12% current consumption (without CAN traffic): typical at 5 V : 50 mA
Connectors	USB - USB 2.0 interface (USB type A plug, X100) CAN - CAN interface (9-pin DSUB, male connector, X200)
Dimensions	cable length 1.0 m including connectors, DSUB9: 35 mm x 15 mm x 45 mm
IP rating	IP20
Weight	approx. 100 g

5.2 USB Interface

Number	1x USB
Controller	integrated in ARM-Cortex-M3 STM32F105, 32-bit, 72 MHz
USB interface	USB 2.0, Full-Speed, 12 Mbit/s
Connector	USB type A plug

5.3 CAN Interface

Number of CAN interfaces	1x integrated in DSUB9-enclosure
CAN controller	integrated in ARM-Cortex-M3 STM32F105, 32 bit, 72 MHz
CAN protocol	ISO 11898-1
Physical Layer	CAN High speed interface according to ISO 11898-2, bit rate up to 1 Mbit/s
Electrical isolation	none
Bus termination	has to be set externally
Connector	DSUB9, according to CiA 303-1

5.4 Software Support

Software drivers for Windows® 2K/XP/Vista/7/8 (32/64 bit) are included in delivery. Linux® kernel ≥ 2.6 is supported via Linux CAN (SocketCAN) and NTCAN wrapper library. Drivers for other operating systems are available on request.

Libraries for the higher layer protocols CANopen and J1939 are available. Additional free-of-charge esd CAN tools for Windows offer efficient setup and analysis of CAN applications and networks.

The firmware can be updated from the PC. Updates are available on the esd website www.esd.eu.

5.5 Firmware License

The CAN-USB/Micro uses the open source FreeRTOS™ (www.freertos.org) operating system.

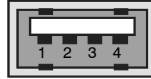
The source code of the operating system is published in terms of the GNU Public License (GPL). For the full license text please see esd's "3rd party lisensor notice" document that is part of the product's documentation on the enclosed CD.

6. Connector Assignment

6.1 USB

Device connector: USB connector type A

Pin Position:



Pin Assignment:

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

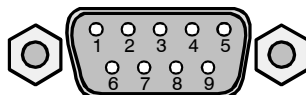
Signal Description:

V_{BUS} ... +5 V power supply voltage
D+, D-... USB signal lines Data+, Data-
GND... Reference potential

6.2 CAN

Device connector: 9-pin DSUB connector, male

Pin Position:



Pin Assignment:

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

Signal Description:

CAN_L, CAN_H ...	CAN signal lines
CAN_GND ...	reference potential of the local CAN physical layer
CAN_GND (CAN_Shield) ...	CAN_Shield is connected to shield of the USB wire and to GND
reserved ...	reserved for future applications, do not connect!

7. Correctly Wiring of 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.

7.1 General Rules

i	<p>Note: esd only grants the compliance with directive 2004/108/EC, if the CAN wiring is carried out with at least single shielded twisted pair cables that match the requirements of ISO 11898-2.</p>
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The following **general rules** for the CAN wiring must be followed:

1	A cable type with a wave impedance of about $120\ \Omega \pm 10\%$ with an adequate wire cross-section ($0.22\ \text{mm}^2$) has to be used. The voltage drop over the wire has to be considered!
2	For residential, commercial and light industrial environment use at least a two-wire CAN cable. Connect <ul style="list-style-type: none"> • the two twisted wires to the data signals (CAN_H, CAN_L) and • the cable shield to the reference potential (CAN_GND)!
3	The reference potential CAN_GND has to be connected to the functional earth (FE) at exactly one point. The CAN-USB/Micro connects CAN_GND and FE, so no further connection should be made!
4	A CAN net must not branch (exception: short cable stubs) and has to be terminated with the characteristic impedance of the line (generally $120\ \Omega \pm 10\%$) at both ends (between the signals CAN_L and CAN_H and not at GND)!
5	Keep cable stubs as short as possible ($l < 0.3\ \text{m}$)!
6	Select a working combination of bit rate and cable length.
7	Keep away cables from disturbing sources. If this cannot be avoided, double shielded wires are recommended.

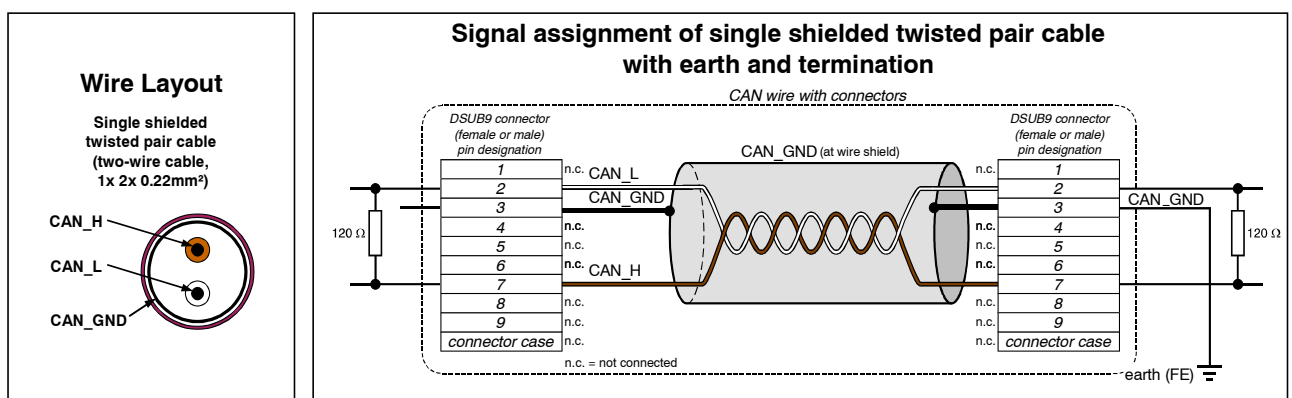


Figure. 4: CAN wiring with single shielded twisted pair cables

7.2 Cabling

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

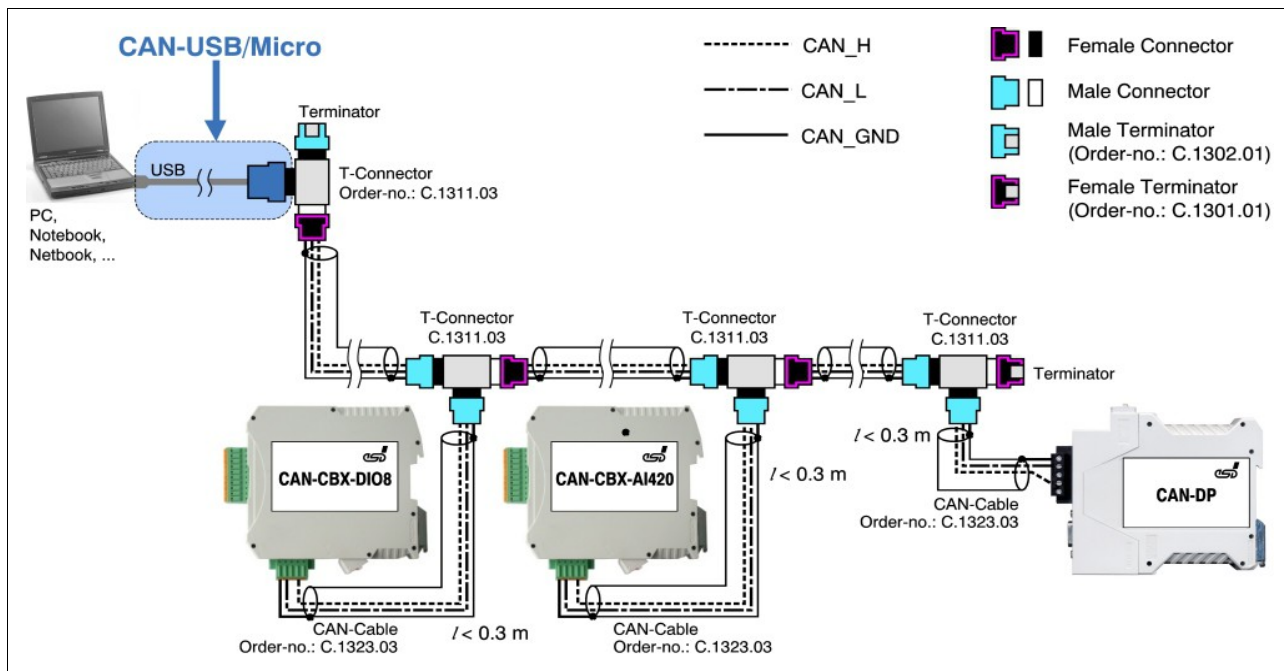


Figure. 5: Example for proper wiring with single shielded single twisted pair wires

7.3 Termination

- If the used CAN interface is not equipped with an integrated CAN termination and it is at an end of the bus, use external termination plugs.
- 9-pin DSUB-termination connectors with male and female contacts and earth terminal are available as accessories.

7.4 Earthing

- CAN_GND has to be connected to the functional earth potential (FE) at **exactly one** point of the network!
- Each *CAN interface with electrical connection to earth potential like the CAN-USB/Micro* acts as an earthing point. For this reason do not connect more than one *CAN device with electrical connection to earth potential!*
- Earthing can e.g. be made at a connector/T-connector.

7.5 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 1: 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.

7.6 Examples for CAN Cables

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 (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.)



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

8. CAN-Bus 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.

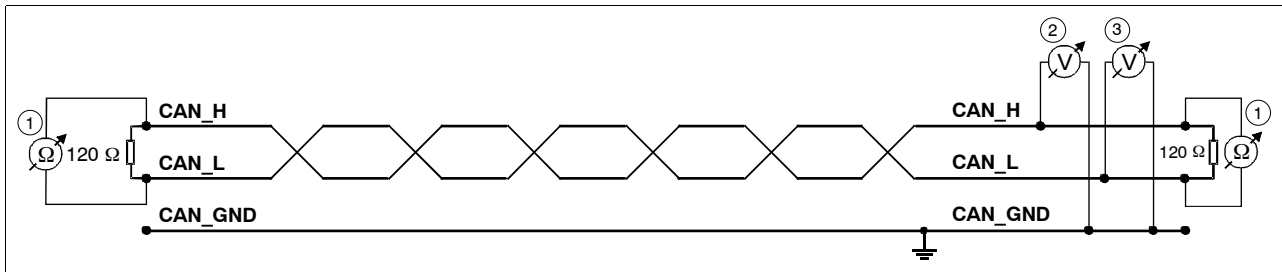


Figure 6: Simplified diagram of a CAN network

8.1 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.

8.2 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.

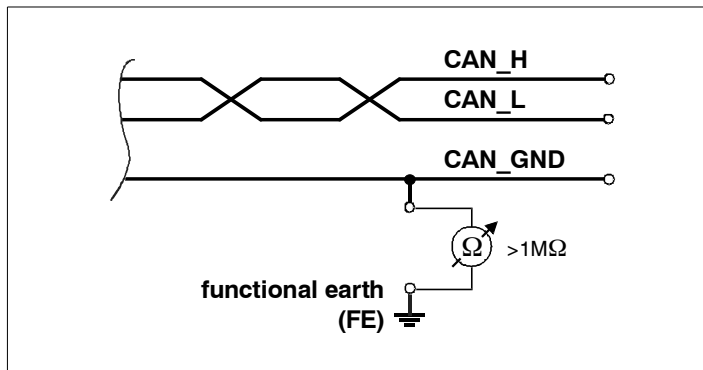


Figure 7: Simplified schematic diagram of ground test measurement

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

8.3 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!

8.4 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).

8.5 CAN Transceiver Resistance Test

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

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

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

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

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

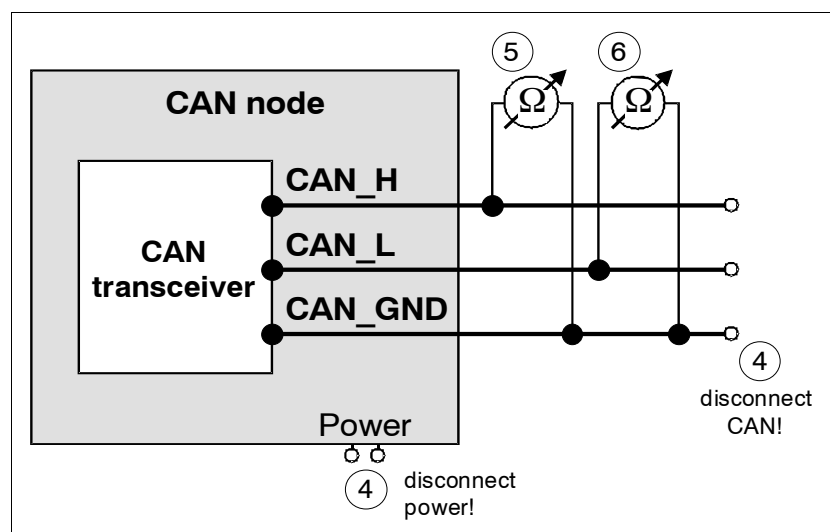


Figure 8: Measuring the internal resistance of CAN transceivers

9. Declaration of Conformity

EG-KONFORMITÄTSERKLÄRUNG EC DECLARATION OF CONFORMITY



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

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

CAN-USB/Micro

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

C.2068.02

die Anforderungen der Normen
fulfills the requirements of the standards

EN 61000-6-1:2007,
EN 61000-6-3:2007+A1:2011

gemäß folgendem Prüfbericht erfüllt.
according to test certificate.

H-K00-0397-10

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, 2014-01-17

Rechtsgültige Unterschrift / authorized signature

10. Order Information

Type	Properties	Order No.
CAN-USB/Micro	Intelligent CAN interface in DSUB9-format, including 1.0 m USB data cable with USB type-A connector, includes CAN layer 2 software driver on CD-ROM for Windows and Linux	C.2068.02
Software		
CANopen-LCD Windows/Linux	CANopen license for Linux and Windows incl. CD-ROM	C.1101.06
J1939 Stack for Windows	J1939 Stack for esd-CAN-Hardware, includes Windows-XP object code, J1939 Simulation Tool, esd CAN Windows driver license	C.1130.10
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 2: 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-USB/Micro-ME	Hardware manual in English	C.2068.21
CAN-API-ME	NTCAN, Part 1: Structure, Function and C/C++ API, Application Developers Manual (English)	C.2001.21
	NTCAN, Part 2: Installation, Configuration and Firmware Update, Installation Guide (English)	
CANopen-ME	CANopen manual in English	C.2002.21
J1939 Stack ME	J1939 stack manual in English	C.1130.21

Table 3: 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.