CAN-Repeater

Passive I- and Y-Repeater for CAN

CAN-Repeater-I-Opto
(C.1330.06)

Hardware Manual

to Product C.1330.02, C.1330.03,
C.1330.06, C.1330.07

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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-Repeater. 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
1.4	-	Safety Information inserted	2016-04-28
	2.	LED colours corrected, note inserted	
	2.1, 2.2	Description of LEDs revised	
	3.	New chapter “Hardware Installation ”	
	4.	Notes inserted	
	5.	Chapter “Connector Assignments” revised	
	6.5	Chapter revised,standard values of the cross-section inserted in the table	
	8.	Declaration of Conformity new	
	9.	Order Information chapter revised and moved	
1.5	-	Note on Disposal and icon added	2022-08-04
	1	New block circuit diagram (from data sheet Rev. 1.7)	
	4.2	Description of electrical isolation added.	
	6., 7.	Chapters updated	
	8.	Declaration of Conformity updated	

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-Repeater follow the instructions below and read the manual carefully to protect yourself from injury and the CAN-Repeater from damage.
- Do not use damaged or defective cables to connect the CAN-Repeater 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-Repeater 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.

- Do not open the housing of the CAN-Repeater.
- The CAN-Repeater has to be securely installed before commissioning.
- Never let liquids get inside the CAN-Repeater. Otherwise, electric shocks or short circuits may result.
- Protect the CAN-Repeater from dust, moisture and steam.
- Protect the CAN-Repeater from shocks and vibrations.
- The CAN-Repeater may become warm during normal use. Always allow adequate ventilation around the CAN-Repeater and use care when handling.
- Do not operate the CAN-Repeater 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-Repeater is to be integrated.

→ All current circuits which are connected to the device have to be sufficiently protected against hazardous voltage (SELV according to EN 60950-1) before you start with the installation.
→ Disconnect all hazardous voltages (mains voltage) before opening the system.
→ Ensure the absence of voltage before starting any electrical work.

Qualified Personal

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

Conformity

The CAN-Repeater is an industrial product and meets the demands of the EU regulations and EMC standards printed in the conformity declaration at the end of this manual.

Warning: In a residential, commercial or light industrial environment the CAN-Repeater may cause radio interferences in which case the user may be required to take adequate measures.

Intended Use

The intended use of the CAN-Repeater is the operation as passive I- and Y-Repeater for CAN.
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-Repeater is intended for indoor use only.
- The operation of the CAN-Repeater in hazardous areas, or areas exposed to potentially explosive materials is not permitted.
- The operation of the CAN-Repeater for medical purposes is prohibited.

Service Note

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

Disposal

Products marked with a crossed-out dustbin must not be disposed of with household waste. Devices which have become defective in the long run must be disposed in an appropriate way or must be returned to the manufacturer for proper disposal. Please, contribute to environmental protection.

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1. Overview

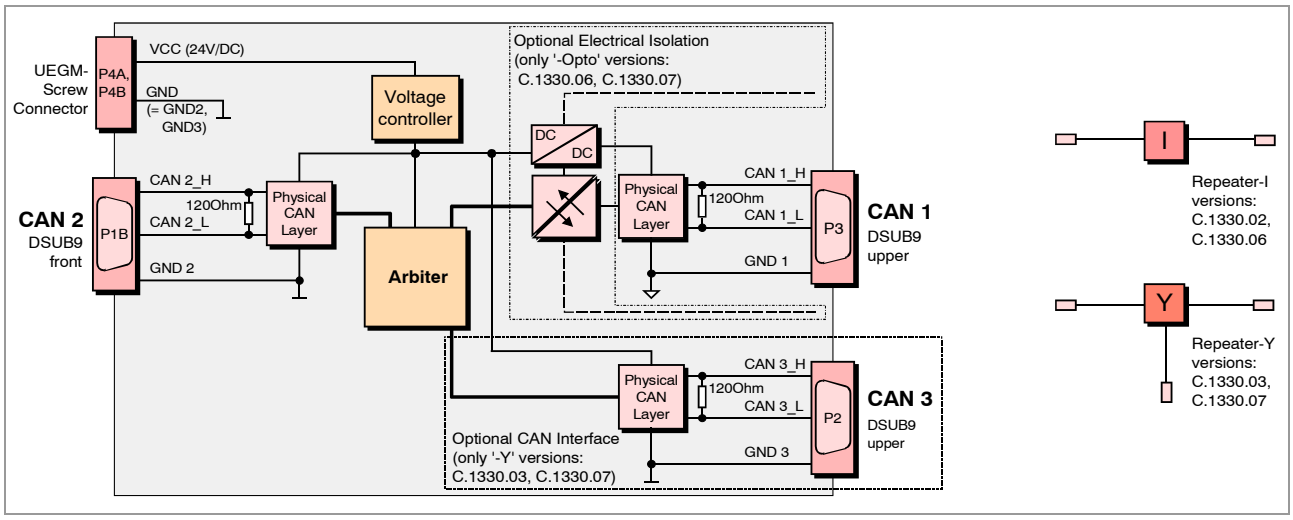


Figure 1: Block circuit diagram of CAN-Repeater

The CAN-Repeater-I can be used to increase the number of connected devices of the CAN net, or to add an electrical isolation (only with '-Opto' design). The CAN-Repeater-Y branches from one to two CAN lines.

All CAN interfaces of the repeaters are in accordance with ISO 11898. Each repeater is available without electrical isolation or with an electrically isolated CAN 1 interface.

The maximum transmission rate is 1 Mbit/s. The bit timing has to be the same for all connections. Each CAN interface has a terminating impedance of 120 Ω in the repeater.

The total extension and therefore the maximum bit rate of the complex CAN network is determined by the sum of the maximum lengths of subnetworks and the reduction of the total line length by inserting the repeater. Only one CAN-Repeater should be used per network.

The CAN-Repeater is supplied by an external voltage in the range of 8 V...30 V.

The integrated fast logic guarantees a total transparency and the perfect arbitration of CAN objects in all networks connected.

2. Front View with Connectors and LEDs

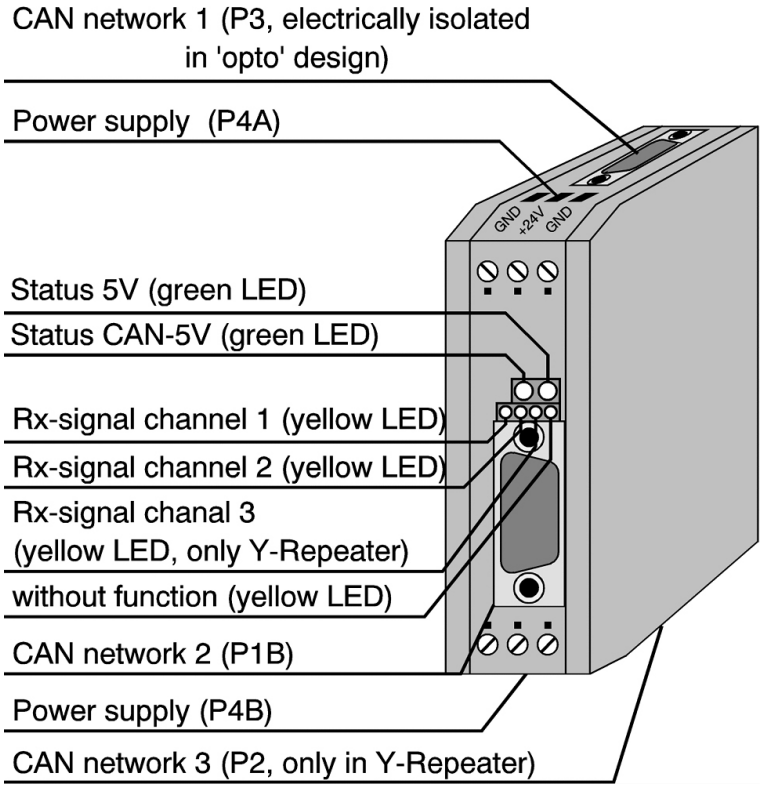


Figure 2: Front view I- and Y-Repeaters

See also chapter Connector Assignments from page 14 for signal assignment of the connectors.

NOTICE
Read chapter “Hardware Installation ” on page 11, before you start with the installation of the hardware!

2.1 Indication of Status 5 V and Status CAN-5V LEDs

2.1.1 CAN-Repeater-I and CAN-Repeater-Y

LED	Colour	Function	Indicator State	Description	LED name in schematic diagram
Status 5V	green	Power LED of all local units	off	no supply voltage	LED240A
			on	supply voltage of all local units is on	
Status CAN-5V	green	Power LED of electrically isolated CAN 1	off	always off (no electrically isolated CAN 1 interface available)	LED240B

2.1.2 CAN-Repeater-I-Opto and CAN-Repeater-Y-Opto

LED	Colour	Function	Indicator State	Description	LED name in schematic diagram
Status 5V	green	Power LED of all local units except CAN1	off	no supply voltage	LED240A
			on	supply voltage of all local units (except CAN1) is on	
Status CAN-5V	green	Power LED of electrically isolated CAN 1	off	no supply voltage on CAN1	LED240B
			on	supply voltage of electrically isolated CAN 1 interface is on	

Table 1: Description of LEDs Status 5V and Status CAN-5V

2.2 Indication of RX-Signal Channel LEDs

LED	Colour	LED Indication when LED is on	LED name in schematic diagram
Rx-signal channel 1	yellow	Rx-signal has been received on channel 1	LED150D
Rx-signal channel 2		Rx-signal has been received on channel 2	LED150C
Rx-signal channel 3		Rx-signal has been received on channel 3 (CAN-Repeater-Y and CAN-Repeater-Y-Opto only)	LED150B
No function		-	LED150A

Table 2: Description of Rx-signal channel LEDs

3. Hardware Installation

To put the CAN-Repeater into operation, please follow the installation notes.

Step	Procedure	see page
	**NOTICE** **Read the safety instructions at the beginning of this document carefully, before you start with the hardware installation!**	4
	**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-EtherCAT is to be integrated. → All current circuits which are connected to the device have to be sufficiently protected against hazardous voltage (SELV according to EN 60950-1) before you start with the installation. → Ensure the absence of voltage before starting any electrical work.	
1.	Mount the CAN-Repeater module and connect the interfaces (power supply voltage, CAN).	
2.	Please note that the CAN bus has to be terminated at both ends! **esd** offers special T-connectors. Additionally the CAN_GND signal has to be connected to earth at **exactly one** point in the CAN network. For details please read chapter “Correct Wiring of Electrically Isolated CAN Networks”	17
3.	Switch on the 24 V-power supply voltage for the CAN-Repeater.	-

4. Technical Data

4.1 General Technical Data

Supply Voltage	Nominal voltage: 24 V/DC Permissible range: 8 V ... 30 V Current (at 20°C): Ca. 50 mA/24 V (I-Repeater-Opto) Ca. 40 mA/24 V (I-Repeater) Ca. 60 mA/24 V (Y-Repeater-Opto) Ca. 40 mA/24 V (Y-Repeater)	
	NOTICE The CAN-Repeater must not be connected to a DC power supply without protection against surge voltages. → Use an external overvoltage protection → All current circuits which are connected to the CAN-Repeater have to be sufficiently protected against hazardous voltage (SELV according to EN 60950-1) before you start with the installation.	
Connectors	P1B	- CAN network 2 (DSUB9, plug)
	P2	- CAN network 3 (C.1330.03, C.1330.07 only) (DSUB9, plug)
	P3	- CAN network 1 (DSUB9, plug), (electrically isolated in '-opto' design)
	P4A, P4B	- 24V power supply (2x 3-pin connector UEGM)
Temperature range	0...50 ℃ ambient temperature	
Humidity	Max. 90%, non-condensing	
Dimensions	I- and Y-Repeater: Width: 25 mm, height: 85 mm, depth: 83 mm	
Weight	I-Repeater: approx. 100 g Y-Repeater: approx. 110 g	

Table 3: General Technical Data

4.2 CAN Interface

Number of CAN interfaces	I-Repeater: 2 Y-Repeater: 3
Electrical Isolation	CAN-Repeater-I (C.1330.02), CAN-Repeater-Y (C.1330.03): None
	CAN-Repeater-I-Opto (C.1330.06), CAN-Repeater-Y-Opto (C.1330.07): Network 1: CAN1 is electrically isolated from the other units. Separation by means of optocouplers and DC/DC-converter Isolation voltage (CAN to Host/System Ground): 1kV DC @ 1s Network 2...3: None (CAN2, CAN3 (C.1330.07 only) share potential to 24 V power supply.)
Arbiter	PLD
Physical Layer	High-speed CAN interface according to ISO 11898-2, bit rate up to 1 Mbit/s
Reduction of attainable total line length by inserting the CAN-Repeater	Approx. 14 m
CAN termination	**Integrated in CAN-Repeater, 120 Ω for each CAN interface!**

Table 4: Data of the CAN interface

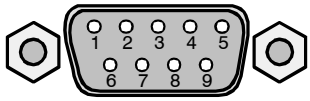
5. Connector Assignments

5.1 CAN 1 Interface with Electrical Isolation (P3)

In CAN-Repeater design '-opto' (C.1330.06, C.1330.07) the interface CAN 1 is electrically isolated from the other networks. The signal assignment for this electrically isolated CAN interface is represented below.
For modules without electrical isolation of CAN1 (C.1330.02, C.1330.03) the assignment of interface CAN 1 is described in the following chapter (see page 15).

Device connector: DSUB9, plug

Pin Position:



Pin Assignment:

Signal	Pin		Signal
CAN1 GND	6	1	-
		2	CAN1 L
CAN1 H	7	3	CAN1 GND
-	8	4	-
-	9	5	-

9-pin DSUB connector, threaded bolt with internal thread UNC 4-40

Signal Description:

CAN1_H, CAN1_L...	data lines of electrically isolated CAN network 1
CAN1_GND...	reference potential of physical interface of CAN network 1
- ...	not connected

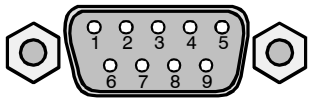
5.2 CAN-Networks without Electrical Isolation

In the following the connector pin assignment of the CAN interfaces CAN 2, CAN 3 and CAN 1 without electrical isolation is shown. CAN 1 is not electrically isolated from the other networks in the CAN-Repeater versions without “-Opto” design (C.1330.02 and C.1330.03).
CAN 3 is only available in the CAN-Repeater-Y versions (C.1330.03 and C.1330.07)

CAN interface without electrical isolation	Connector	CAN-Repeater designs
CAN 1 (without ‘-opto’ design)	P3	CAN-Repeater-I (C.1330.02), CAN-Repeater-Y (C.1330.03)
CAN 2	P1B	All CAN-Repeater versions
CAN 3	P2	CAN-Repeater-Y (C.1330.03), CAN-Repeater-Y-Opto (C.1330.07)

Device connector: 9-pin DSUB connector, plug

Pin Position:



Pin Assignment:

Signal	Pin		Signal
GND x	6	1	-
CANx H	7	2	CANx L
-	8	3	GND x
-	9	4	-
		5	-

9-pin DSUB connector, threaded bolt with internal thread UNC 4-40

Signal description:

CANx_H, CANx_L...	data lines of not electrically isolated interfaces CAN 2 , CAN 3 or CAN 1 (without electrical isolation only)
GND x...	reference potential of physical interfaces of CAN x and of the 24 V supply voltage, (x = 1, 2, 3)
-...	not connected

5.3 Power Supply (P4A, P4B, UEGM)

NOTICE
The CAN-Repeater must not be connected to a DC power supply without protection against surge voltages.

→ Use an external overvoltage protection!
→ All current circuits which are connected to the CAN-Repeater have to be sufficiently protected against hazardous voltage (SELV according to EN 60950-1) before you start with the installation.

Power is supplied by means of UEGM connectors integrated in the housing. The connectors are suitable for lines with a cross section of up to 2.5 mm².

The connectors have been assigned in the same way on both sides of the housing. They can be used alternatively. The middle contact has been designed for +24 V and the two outer contacts for GND.

NOTICE
It is **not permissible** to feed through the supply voltage, i.e. to use one side as a 24 V input and the other side as a 24 V output in order to supply further devices, for instance!

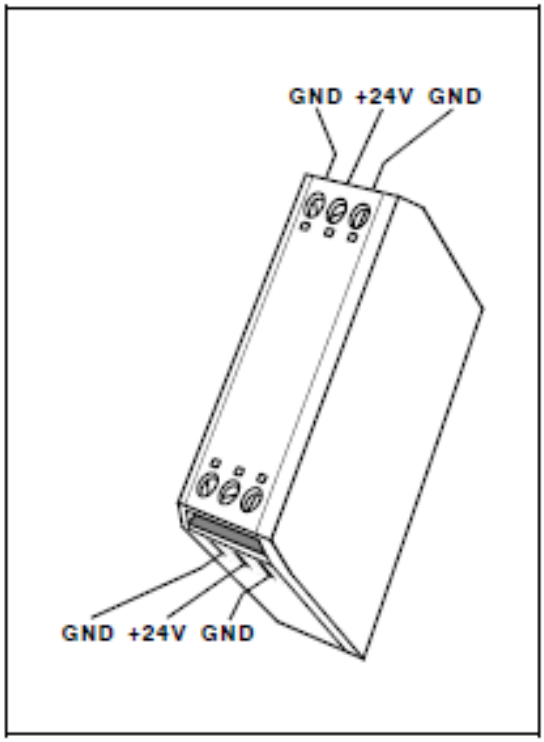


Figure 3: Power supply

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 CAN Wiring Standards

The flexibility in CAN network design is a major strength of the various extensions based on the original CAN standard ISO 11898-2, such as CANopen®, ARINC825, DeviceNet® and NMEA2000. However, taking advantage of this flexibility absolutely requires a network design that considers the interactions of all network parameters.

In some cases, the CAN organizations have adapted the scope of CAN in their specifications to enable applications outside the ISO 11898 standard. They have imposed system-level restrictions on data rate, line length and parasitic bus loads.

However, when designing CAN networks, a margin must always be planned for signal losses over the entire system and cabling, parasitic loads, network imbalances, potential differences against earth potential, and signal integrities. **Therefore, the maximum achievable number of nodes, bus lengths and stub lengths may differ from the theoretically possible number!**

esd has limited its recommendations for CAN wiring to the specifications of ISO 11898-2.
A description of the special features of the derived specifications CANopen, ARINC825, DeviceNet, and NMEA2000 is omitted here

The consistent compliance with ISO 11898-2 standard offers significant advantages:

- Reliable operation due to well proven design specifications
- Minimization of error sources due to sufficient distances to physical limits
- Easy maintenance because there are no "special cases" to consider for future network modifications and troubleshooting

Of course reliable networks can be designed according to 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

NOTICE
esd grants the EU Conformity of the product, if the CAN wiring is carried out with at least single shielded **single** twisted pair cables that match the requirements of ISO 11898-2. Single shielded *double* twisted pair cable wiring as described in chapter 6.3. ensures the EU Conformity as well.

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

1	A suitable cable type with a wave impedance of about 120 Ω ±10% with an adequate conductor cross-section (≥ 0.22 mm²) must be used. The voltage drop over the wire must be considered.
2	For light industrial environment use at least a two-wire CAN cable, the wires of which must be assigned as follows: • Two twisted wires must be assigned to the data signals (CAN_H, CAN_L). • The cable shield must be connected to the reference potential (CAN_GND).
3	The reference potential CAN_GND must be connected to the functional earth (FE) at exactly **one** point.
4	A CAN bus line must not branch (exception: short cable stubs) and must 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.

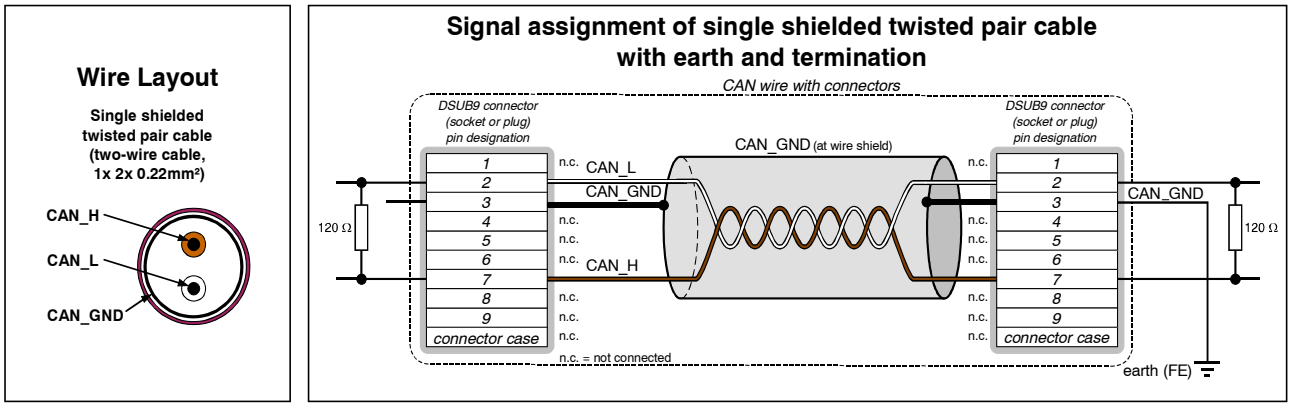


Figure 4: CAN wiring for light industrial environment

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.

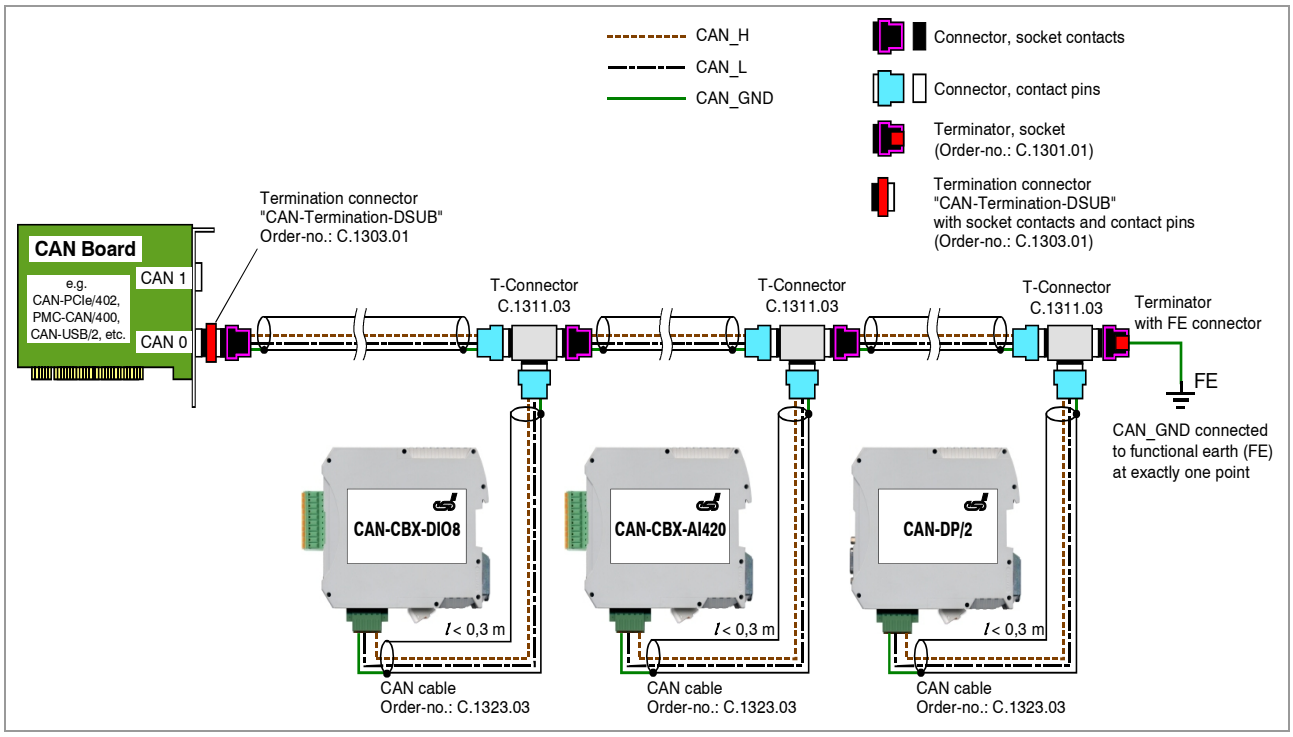


Figure 5: Example for proper wiring with single shielded single twisted pair wires

6.2.3 Branching

- In principle the CAN bus must be realized in a line. The nodes are connected to the main CAN bus line via short cable stubs. This is normally realised by so called T-connectors. esd offers the CAN-T-Connector (Order No.: C.1311.03)
- If a mixed application of single twisted and double twisted cables cannot bei avoided, ensure that the CAN_GND line is not interrupted!
- Deviations from the bus structure can be realized by the usage of repeaters.

6.2.4 Termination

- A termination resistor must be connected at both ends of the CAN bus. If an integrated CAN termination resistor is connected to the CAN interface at the end of the CAN bus, this integrated termination must be used instead of an external CAN termination resistor.
- 9-pole DSUB-termination connectors with integrated termination resistor and pin contacts and socket contacts are available from esd (order no. C.1303.01).
- For termination of the CAN bus and grounding of the CAN_GND, DSUB terminators with pin contacts (order no. C.1302.01) or socket contacts (order no. C.1301.01) and with additional functional earth contact are available.

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 suitable 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 must be considered.
2	For heavy industrial environment use a four-wire CAN cable, the wires of which must be assigned as follows: • Two twisted wires must be assigned to the data signals (CAN_H, CAN_L). • The other two twisted wires must be assigned to the reference potential (CAN_GND). • The cable shield must be connected to functional earth (FE) at least at one point.
3	The reference potential CAN_GND must be connected to the functional earth (FE) at exactly **one** point.
4	A CAN bus line must not branch (exception: short cable stubs) and must 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 cannot be avoided, double shielded cables are recommended.

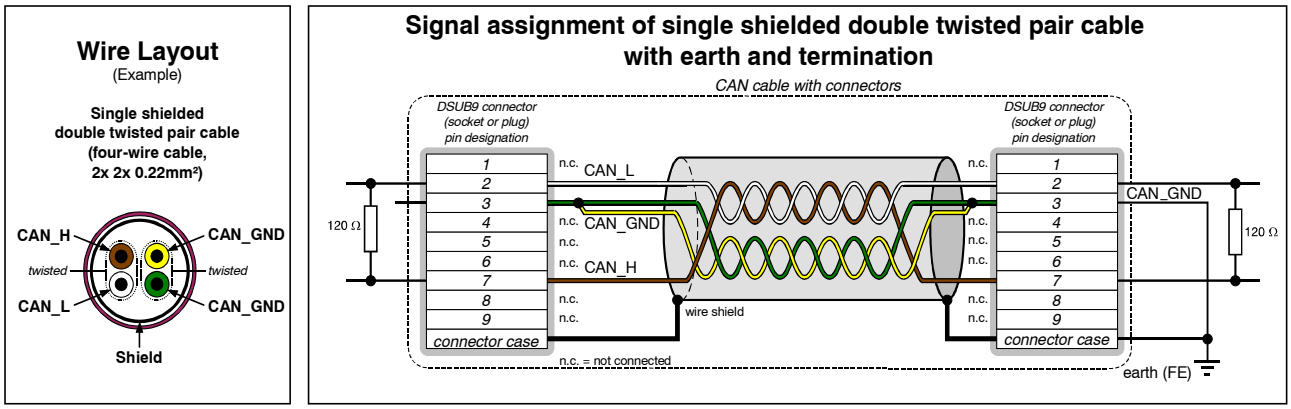


Figure 6: CAN wiring for heavy industrial environment

6.3.2 Device Cabling

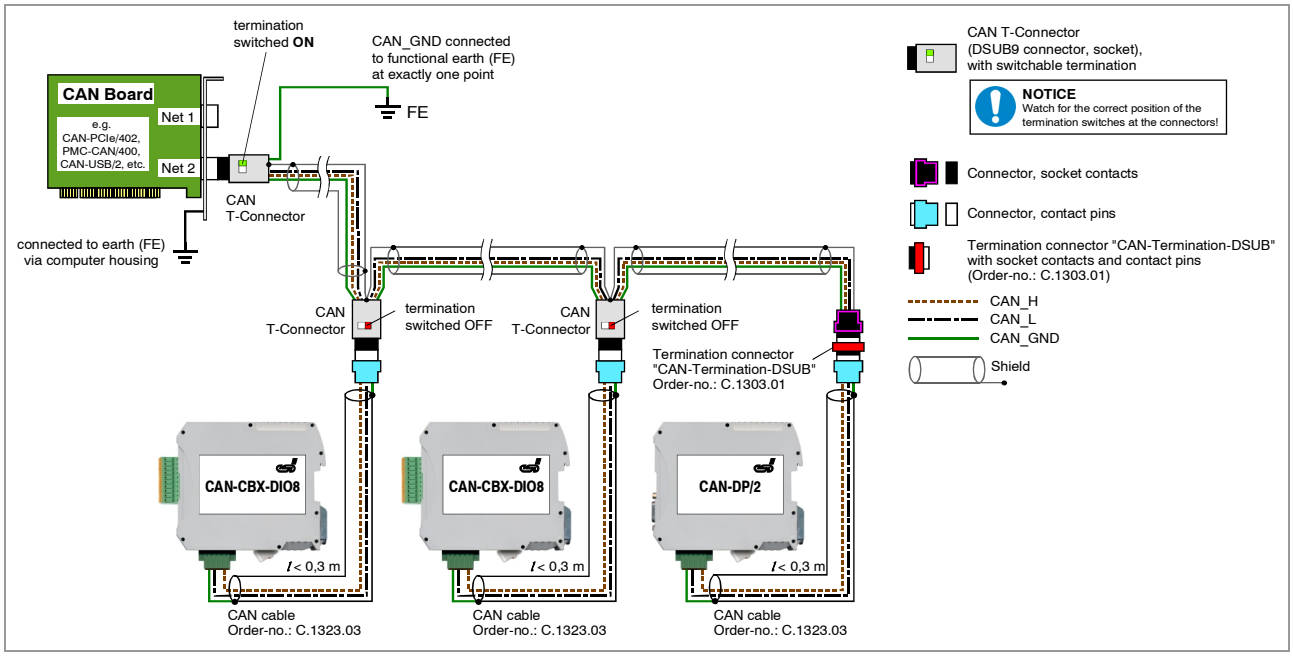


Figure 7: Example of proper wiring with single shielded double twisted pair cables

6.3.3 Branching

- In principle the CAN bus must be realized in a line. The nodes are connected to the main CAN bus line via short cable stubs. This is usually realised by so called T-connectors. When using esd's CAN-T-Connector (order no.: C.1311.03) in heavy industrial environment and with four-wire twisted cables, it must be noted that the shield potential of the conductive DSUB housing is not looped through this type of T-Connector.This interrupts the shielding. Therefore, you must take appropriate measures to connect the shield potentials, as described in the manual of the CAN-T-Connector. For further information on this, please refer to the CAN-T-Connector Manual (order no.: C.1311.21).
  Alternatively, a T-connector can be used, in which the shield potential is looped through, for example the DSUB9 connector from ERNI (ERBIC CAN BUS MAX, order no.:154039).
- If a mixed application of single twisted and double twisted cables cannot be avoided, ensure that the CAN_GND line is not interrupted!
- Deviations from the bus structure can be realized by using repeaters.

6.3.4 Termination Resistor

- A termination resistor must be connected at both ends of the CAN bus. If an integrated CAN termination resistor is connected to the CAN interface at the end of the CAN bus, this integrated termination must be used instead of an external CAN termination resistor.
- 9-pole DSUB-termination connectors with integrated termination resistor and pin contacts and socket contacts are available from esd (order no. C.1303.01).
- 9-pole DSUB-connectors with integrated switchable termination resistor can be ordered for example from ERNI (ERBIC CAN BUS MAX, socket 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

The bus length of a CAN network must be adapted to the set bit rate. The maximum values result from the fact that the time required for a bit to be transmitted in the bus system is shorter the higher the transmission rate is. However, as the line length increases, so does the time it takes for a bit to reach the other end of the bus. It should be noted that the signal is not only transmitted, but the receiver must also respond to the transmitter within a certain time. The transmitter, in turn, must detect any change in bus level from the receiver(s). Delay times on the line, the transceiver, the controller, oscillator tolerances and the set sampling time must be considered. In the following table you will find guide values for the achievable bus lengths at certain bit rates.

NOTICE
When using the CAN-Repeater the theoretical values of the achievable wire length with esd module given in table 5 are **reduced by 14 m**.

Bit-Rate [kBit/s]	Theoretical values of reachable wire length **with esd interface** l_{max} [m]	**CiA recommendations** (07/95) for reachable wire lengths l_{min} [m]	Standard values of the cross-section according to CiA 303-1 [mm²]
1000	37	25	0,25 to 0,34
800 666,6̄ 500 333,3̄ 250	59 80 130 180 270	50 - 100 - 250	0,34 to 0,6
166 125	420 570	- 500	0,5 to 0,6
100 83,3̄ 66,6̄ 50	710 850 1000 1400	650 - - 1000	0,75 to 0,8
33,3̄ 20 12,5 10	2000 3600 5400 7300	- 2500 - 5000	not defined in CiA 303-1

Table 5: Recommended cable lengths at typical bit rates (with CAN-Repeater)

- 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 that the cables, connectors and termination resistors used in CANopen networks shall meet the requirements defined in ISO11898-2.
In addition, further recommendations of the CiA, like standard values of the cross section, depending on the cable length, are described in the CiA recommendation CiA 303-1 (see CiA 303 CANopen Recommendation - Part 1: „Cabling and connector pin assignment“, Version 1.8.0, Table 2). Recommendations for pin-assignment of the connectors are described in CiA 106: “Connector pin-assignment recommendations ”.

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 finding and eliminating the most common problems and errors when setting up CAN bus networks and CAN-based systems.

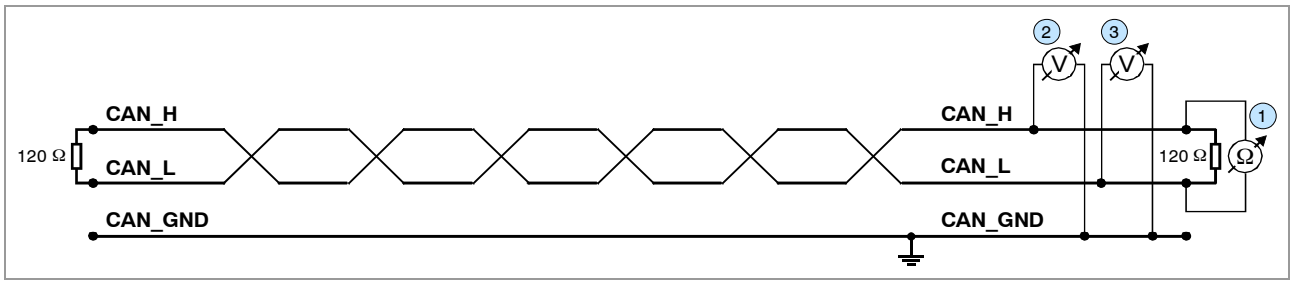


Figure 8: Simplified diagram of a CAN network

7.1 Termination

The bus termination is used to match impedance of a node to the impedance of the bus line used. If the impedance is mismatched, the transmitted signal is not completely absorbed by the load and will be partially reflected back into the transmission line.
If the impedances of the sources, transmission lines and loads are equal, the reflections are avoided. This test measures the total resistance of the two CAN data lines and the connected terminating resistors.

To test this, please proceed as follows:

1. Switch off all supply voltages of all connected CAN nodes.
2. Measure the DC resistance between CAN_H and CAN_L at one end of the network, measuring point ① (see figure above).

Expected result:
The measured value should be between 50 Ω and 70 Ω.

Possible causes of error:
▪ If the value is below 50 Ω, please make sure that:
- There is no **short circuit** between CAN_H and CAN_L wiring.
- **No more than two** terminating resistors are connected.
- The transceivers of the individual nodes are not defective.

▪ If the determined value is higher than 70 Ω, please make sure that:
- All CAN_H and CAN_L lines are correctly connected.
- Two terminating resistors of 120 Ω each are connected to your CAN network (one at each end).

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 indicates whether the CAN_GND is grounded at one or more points.

Please note that this test can only be performed with electrically isolated CAN nodes.

To test this, please proceed as follows:

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).

Do not forget to reconnect CAN_GND to earth potential after the test!

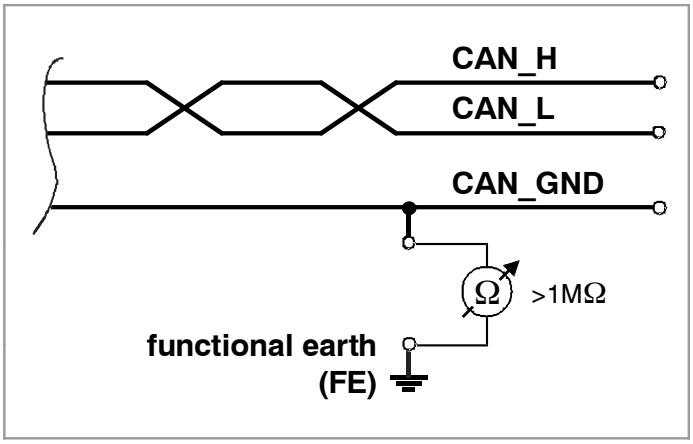


Figure 9: Simplified schematic diagram of ground test measurement

Expected result:
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 even if CAN_GND and CAN_L are short-circuited. However, this will usually cause the error rate to rise sharply.
Ensure that there is no short circuit between CAN_GND and CAN_L!

7.4 Correct Voltage Levels on CAN_H and CAN_L

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. Defective transceivers can cause the idle voltages to vary and disrupt network communication.

To test for defective transceivers, please proceed as follows:

1. Switch on all supply voltages.
2. Terminate all network communication.
3. Measure the DC voltage between CAN_H and CAN_GND, measuring point ② (see “Simplified diagram of CAN network” on previous page).
4. Measure the DC voltage between CAN_L and CAN_GND, measuring point ③ (see “Simplified diagram of CAN network” on previous page).

Expected result:
The measured voltage should be between 2.0 V and 3.0 V.

Possible causes of error:

- If it is lower than 2.0 V or higher than 3.0 V, it is possible that one or more nodes have defective transceivers.
  - If the voltage is lower than 2.0 V, please check the connections of the CAN_H and CAN_L lines.

- To find a node with a defective transceiver within a network, please check individually the resistances of the CAN transceivers of the nodes (see next section).

7.5 CAN Transceiver Resistance Test

CAN transceivers have circuits that control CAN_H and CAN_L. Experience shows 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 an ohmmeter and proceed as follows:

1. Switch **off** the node (4) and **disconnect** it from the network (see figure below).

2. Measure the DC resistance between CAN_H and CAN_GND, measuring point (5) (see figure below).

3. Measure the DC resistance between CAN_L and CAN_GND, measuring point (6) (see figure below).

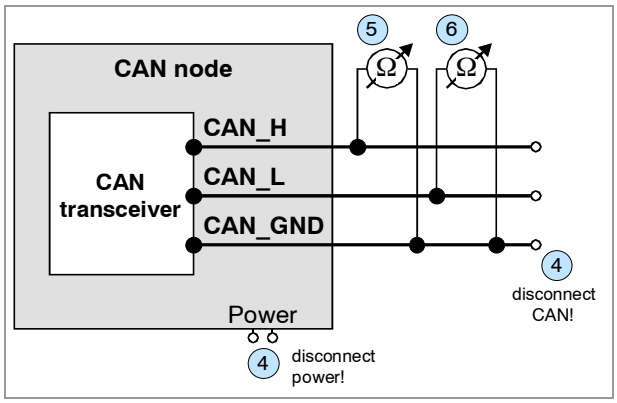


Figure 10: Measuring the internal resistance of CAN transceivers

Expected result:
The measured resistance should be greater than 10 kΩ for each measurement.

Possible causes of error:

- If the resistance is significantly lower, the CAN transceiver may be defective.
- Another indication of a defective CAN transceiver is a very high deviation of the two measured input resistances (>> 200 %).

7.6 Support by esd

If you have followed the troubleshooting steps in this troubleshooting guide and still cannot find a solution to your problem, our support team can help.
Please contact our support by email to **support@esd.eu** or by phone **+49-511-37298-130**.

8. Declaration of Conformity

EU-KONFORMITÄTSERKLÄRUNG
EU DECLARATION OF CONFORMITY

Adresse / *Address*
esd electronics gmbh
Vahrenwalder Str. 207
30165 Hannover
Germany

esd erklärt, dass das Produkt *esd declares, that the product*	Typ, Modell, Artikel-Nr. *Type, Model, Article No.*
CAN-Repeater-I	**C.1330.02**
CAN-Repeater-Y	**C.1330.03**
CAN-Repeater-I-Opto	**C.1330.06**
CAN-Repeater-Y-Opto	**C.1330.07**

die Anforderungen der Normen *fulfills the requirements of the standards*	**EN 61000-6-2:2005,** **EN 61000-6-4:2007/A1:2011**
gemäß folgendem Prüfbericht erfüllt. *according to test certificate.*	**1682.1407.99,** **H-Z00-0597-16**
Das Produkt entspricht damit der EU-Richtlinie „EMV" *Therefore the product conforms to the EU Directive 'EMC'*	**2014/30/EU**
Das Produkt entspricht den EU-Richtlinien „RoHS" *The product conforms to the EU Directives 'RoHS'*	**2011/65/EU, 2015/863/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. Bielert
Funktion / *Title* QM-Beauftragter / *QM Representative*
Datum / *Date* Hannover, 2020-01-03

Rechtsgültige Unterschrift / *authorized signature*

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9. Order Information

Type	Properties	Order No.
CAN-Repeater-I	CAN-Repeater-I with 2 CAN interfaces DSUB-9, DIN rail housing, physical layer according to ISO11898, termination resistors 120 Ohm, power supply 8 - 24 VDC	C.1330.02
CAN-Repeater-Y	CAN-Repeater-Y with 3 CAN interfaces DSUB-9, DIN rail housing, physical layer according to ISO11898, termination resistors 120 Ohm, power supply 8 - 24 VDC	C.1330.03
CAN-Repeater-I-Opto	CAN-Repeater-I-Opto with 2 CAN interfaces DSUB-9, DIN rail housing, physical layer according to ISO11898, termination resistors 120 Ohm, power supply 8-24 VDC, one CAN interface electrically isolated	C.1330.06
CAN-Repeater-Y-Opto	CAN-Repeater-Y Opto with 3 CAN interfaces DSUB-9, DIN rail housing, physical layer according to ISO11898, termination resistors 120 Ohm, power supply 8-24 VDC, one CAN interface electrically isolated	C.1330.07

Table 6: 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-Repeater-ME	Hardware manual in English	C.1330.21
CAN-Repeater-MD	Hardware manual in German	C.1330.20

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.