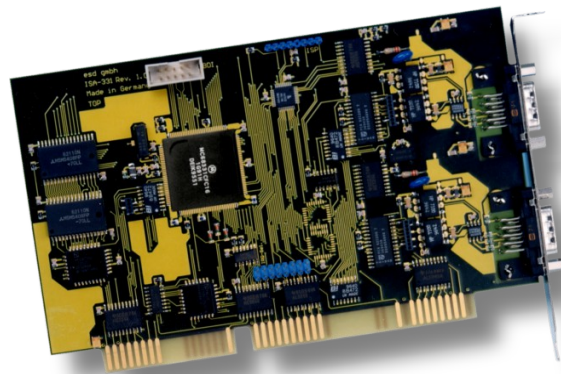




# CAN-ISA/331

**1 or 2 Channel ISA-CAN Interface  
(Layer 2, CANopen<sup>®</sup> or J1939)**



## Hardware Manual

to Products  
C.2010.02 (1x CAN)  
C.2010.04 (2x CAN)



## NOTE

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This manual contains important information and instructions on safe and efficient handling of the CAN-ISA/331. 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.

| <b>Rev.</b> | <b>Chapter</b> | <b>Changes versus previous version</b> | <b>Date</b> |
|-------------|----------------|--|-------------|
| 1.7         | -              | Order information revised.             | 2015-12-07  |
|             |                |  |             |

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

Depending on the hazard level the signal word DANGER is 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.

### 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-ISA/331 follow the instructions below and read the manual carefully to protect yourself from injury and the CAN-ISA/331 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-ISA/331 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-ISA/331 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 PC before commissioning.
- Protect the CAN-ISA/331 from dust, moisture and steam.
- Protect the CAN-ISA/331 from shocks and vibrations.
- The CAN-ISA/331 may become warm during normal use. Always allow adequate ventilation around the CAN-ISA/331 and use care when handling.
- Do not operate the CAN-ISA/331 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-ISA/331 is to be integrated.

Disconnect all hazardous voltages (mains voltage) before opening the system.



### NOTICE

**Electrostatic discharges may cause damage to electronic components.**

To avoid this, perform the steps described on page 10 *before* you touch the CAN-ISA/331, 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.

## Conformity

The CAN-ISA/331 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-ISA/331 may cause radio interferences in which case the user may be required to take adequate measures.

## Safety Instructions

---

### Intended Use

The intended use of the CAN-ISA/331 is the operation as an ISA-CAN interface board for PCs. 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-ISA/331 is intended for installation in a PC.
- The operation of the CAN-ISA/331 in hazardous areas, or areas exposed to potentially explosive materials is not permitted.
- The operation of the CAN-ISA/331 for medical purposes is prohibited.

### Service Note

The CAN-ISA/331 does not contain any parts that require maintenance by the user.

### 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                 |
| SDK | Software Development Kit          |

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# 1. Overview

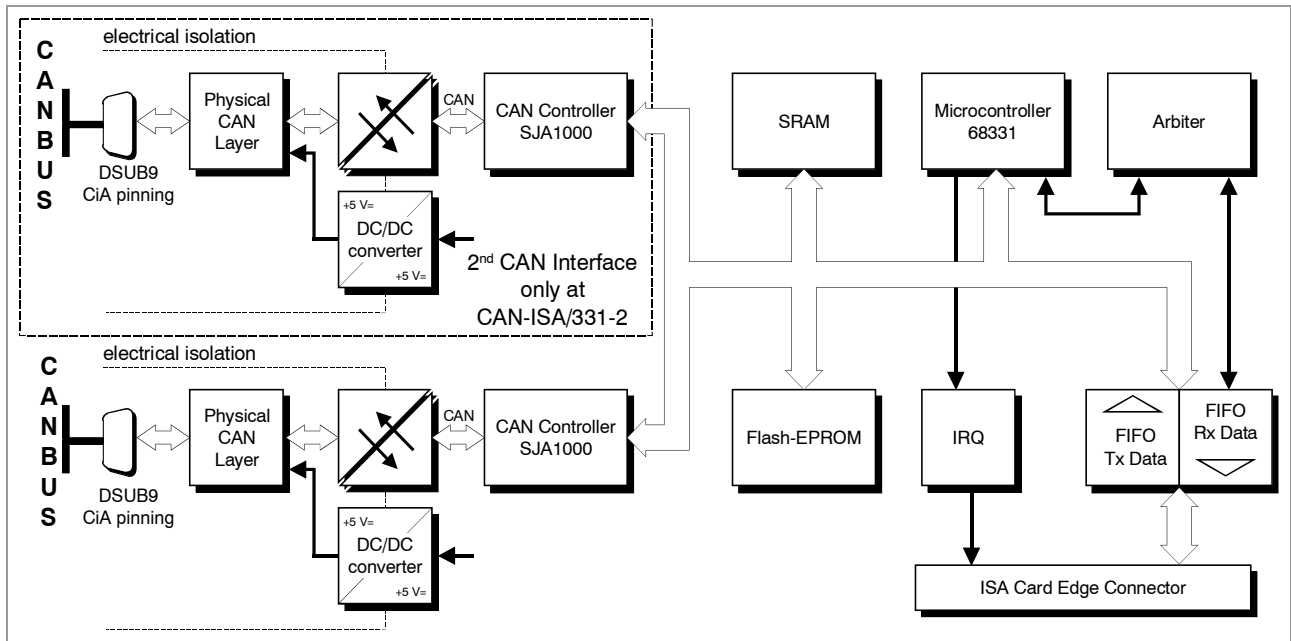


Figure 1: Block circuit diagram

The module CAN-ISA/331 is a PC board designed for the ISA bus (ISA 16 bit) with electrically isolated high-speed CAN interfaces. It uses a 68331 micro controller, which cares for the local CAN data management. The CAN data is stored in the local SRAM. Security and consistency of data is guaranteed up to 1 Mbit/s.

The ISO 11898-2 compliant CAN interfaces allow a data transfer rate of 1 Mbit/s. The CAN interface is electrically isolated from the other potentials by optocouplers and DC/DC converters.

CAN layer 2 (NTCAN-API) software drivers are available for Windows, Linux, VxWorks and QNX. The CANopen software package is available for Windows, Linux, VxWorks and QNX.



## 2. PCB View with Position of Jumper and Connectors

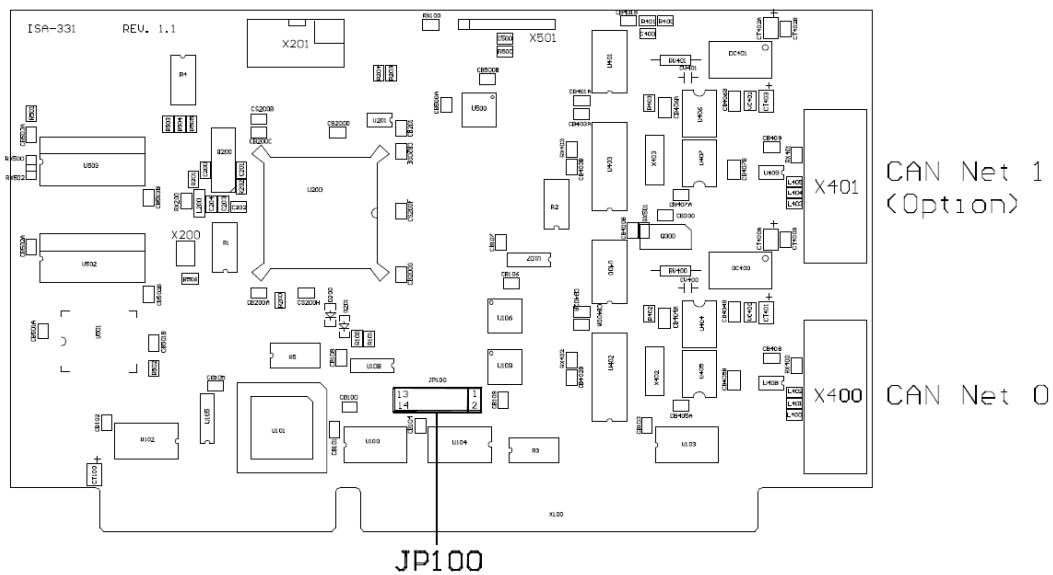


Figure 2: PCB top view



**NOTICE**

Read chapter “3.1 Before Starting Hardware Installation” on page 10, before you start with the installation of the hardware!

### 3. Hardware Installation

To put the CAN-ISA/331 into operation, please follow the installation notes.

#### 3.1 Before Starting Hardware Installation



**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-ISA/331 is to be integrated. Disconnect all hazardous voltages (mains voltage) before opening the system.



**NOTICE**

**Electrostatic discharges may cause damage to electronic components.**

- To avoid this, please discharge the static electricity from your body by touching the metal case of the PC *before* you touch the CAN-ISA/331.
- Furthermore, you should prevent your clothes from touching the CAN-ISA/331, because your clothes might be electrostatically charged as well.



**NOTICE**

During the installation it is necessary to set the **interrupt** line and it may be necessary to change the ISA I/O port address of the board. The address is default factory set to 1E0...1E7 HEX at the jumper field JP100. The CAN-ISA/331 covers 8 data bytes.

Make sure, that there will be no address conflict with other ISA boards in the PC and make sure, that there will be no conflict with other interrupts!



**NOTICE**

Make sure, that there will be no **address** conflict with other ISA boards in the PC and make sure, that there will be no conflict with other interrupts!

#### Windows NT Users:


To avoid system conflicts, you can control the used address ranges and the used interrupt lines of your system. This can be done in Windows NT 4.0 by selecting *Programs* and then selecting the folders *Administrative Tools(Common)* and *WindowsNT Diagnostics*. In the dialogue box *WindowsNT Diagnostics* call *Resources* and there select *I/O Port*.

A list with the used addresses appears. Make sure that the default value of the CAN module's address is placed in a free memory area. If it is not, compare the selectable address ranges of the module (shown in fig. 4) with the free memory areas. Note one selectable address area, and change the jumper settings during the hardware installation of the CAN module afterwards.

In the same dialogue box call *Interrupts*. A list with the used interrupt lines appears. Note a free interrupt, because you have to select an interrupt for the CAN module during the software installation. The complete software installation sequence is described in the software manual 'NTCAN-API, Installation Guide'.

### 3.2 Procedure

1. Switch off your system and all connected peripheral devices (monitor, printer, etc.). Switch off the connected CAN devices.
2. Discharge your body as described above.
3. Disconnect the power supply of the PC from the mains.

 **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-ISA/331 is to be integrated.

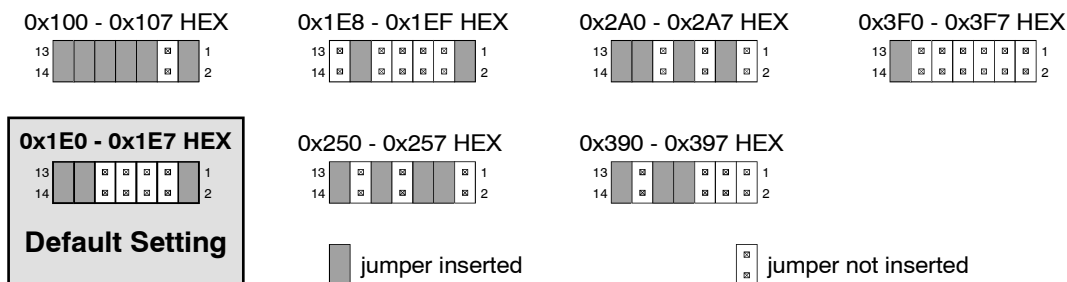
- Disconnect all hazardous voltages (mains voltage) before opening the system.
- If the system does not have a flexible mains cable, but is directly connected to mains, disconnect the power supply via the safety fuse and make sure that the fuse cannot switch on again unintentionally (i.e. with caution label).

4. Open the case.
5. Select an open ISA slot and remove the slot cover at the back of the PC.  
The board can be inserted into every ISA slot.
6. Have you made sure that there will be no address conflict with other ISA boards?  
(See chapter '3.1 Before Starting Hardware Installation' above)  
If you have to change the boards address go on with step 7 otherwise go on with step 8.
7. Changing the ISA bus I/O port address.  
To change the ISA bus address, you have to change the jumpers at the jumper field JP100.  
The location of the jumper field at the PCB is shown in figure 2 at page 9.  
If a jumper is inserted, the according address is decoded as '0'.

|             |    |    |    |    |    |    |    |
|-------------|----|----|----|----|----|----|----|
| Jumper Pin: | 13 | 11 | 9  | 7  | 5  | 3  | 1  |
|             | O  | O  | O  | O  | O  | O  | O  |
| Address:    | A3 | A4 | A5 | A6 | A7 | A8 | A9 |
|             | O  | O  | O  | O  | O  | O  | O  |
| Jumper Pin: | 14 | 12 | 10 | 8  | 6  | 4  | 2  |

**Figure 3:** Jumper JP100 (view from top layer, orientation with X400 and X401 at the right side of the board)

During the software installation you have to notify the jumpered address to the software driver. The selection box of Windows NT proposes e.g. the following alternative I/O port addresses:



**Figure 4:** Default jumper setting and settings that are supported by the Windows NT installation program

All other jumper settings are not supported by the Windows NT installation software.

If you use a Windows 95 operating system, you have to set the address jumpers according to the proposal of the Windows 95 hardware assistant.

For the installing instructions of other operating system drivers please refer the manual 'NTCAN-API, Installation Guide'.

8. Insert the CAN-ISA/331 board into the selected ISA slot. Carefully push the board down until it snaps into place.
9. Attach the board.
10. Close the system's case again.
11. Connect the CAN wires.

### **CAN-ISA/331-2:**

The first CAN interface (CAN 0) has to be connected via the lower DSUB connector (X400) and the second CAN interface (CAN 1) has to be connected via the upper DSUB connector (X410). You will find a figure showing the connectors on page 9.



#### **INFORMATION**

Please note that the CAN bus has to be terminated at both ends!

For external termination esd offers suitable termination connectors for the CAN bus. Additionally the CAN\_GND signal has to be connected to earth at exactly one point. A CAN participant with electrical connection to earth potential acts as an earth connection.



#### **INFORMATION**

Make sure that an external connection to the same earth potential is installed as near as possible to the connector in the front panel before you go on with the installation. Together with the internal earth connection this acts as a single earthing point.

12. Connect the system to mains again (mains connector or fuse).
13. Switch on the system and the peripheral devices.
14. End of hardware installation.

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

## 4. Technical Data

### 4.1 General Technical Data

|                      |  |
|----------------------|--|
| Power supply voltage | supplied by ISA bus,<br>nominal voltage: 5 V $\pm$ 5%,<br>1x CAN: $I_{5V MPMAX} = 550$ mA<br>2x CAN: $I_{5V MPMAX} = 700$ mA |
| Connectors           | X100 (card edge) - ISA bus   |
|                      | X400 (DSUB9/male) - CAN interface 1 (net 0)  |
|                      | X410 (DSUB9/male) - CAN interface 2 (net 1)  |
|                      | Only for test- and programming purposes:<br>X200 (4-pole female connector) - CPU interface (serial, TTL)                     |
|                      | X201 (10-pole male connector) - BDM interface  |
|                      | X501 (5-pole male connector) - ISP programming   |
| Temperature range    | 0...50 °C ambient temperature  |
| Humidity             | max. 90%, non-condensing   |
| Dimensions           | 174,57 mm x 106,68 mm  |
| Weight               | < 300 g  |

**Table 1:** General data of the module

### 4.2 ISA Bus Interface

|                 |  |
|-----------------|--|
| Host bus        | ISA  |
| ISA data bus    | 16 bit   |
| Interface       | IN/OUT FIFOs (512 bytes each)                                    |
| Interrupt       | 1 of 12  |
| Slot position   | no restrictions for the position of the CAN board on the ISA bus |
| Board dimension | 'short' ISA board  |
| Connector       | ISA card edge connector  |

**Table 2:** ISA Bus Interface

### 4.3 CAN Interface

|   |   |
|---|---|
| Number of CAN interfaces  | 1,<br>option: 2 CAN interfaces  |
| CAN controller  | SJA1000   |
| CAN protocol  | according to ISO 11898-1  |
| Physical layer  | High-speed CAN interface according to ISO 11898-2,<br>bit rate up to 1 Mbit/s |
| Electrical isolation of CAN interfaces from other units and from each other | separation by means of optocouplers and DC/DC converters                      |
| Bus termination   | terminating resistor has to be set externally, if required                    |
| Connector   | 2x DSUB9 (male)   |

**Table 3:** Data of the CAN interface

### 4.4 Software Support

CAN layer 2 (NTCAN-API) software drivers are available for Windows®, VxWorks®, QNX® and Linux®.

The CANopen® software package is available for Windows, Linux, VxWorks, and QNX. Drivers for other operating systems are available on request.

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

The CAN layer 2 (NTCAN-API) software installation and the software drivers are described in the manual:

“NTCAN-API Part 1: Structure, Function and C/C++ API” Application Developers Manual and  
 “NTCAN-API Part 2: Installation, Configuration and Firmware Update” Installation Guide  
 esd-order No.: C.2001.21

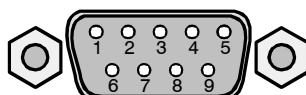
## 5. Connector Assignments

### 5.1 CAN

The assignment of the signals to the connector pins of the first CAN interface (X400) is equal to the assignment of the optional second CAN interface X401. Both connectors are 9-pole DSUBs with male contacts.

**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 ...       | shielding (connected with the case of the 9-pin DSUB connector) |
| 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 met.

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

### 6.2.1 General Rules



#### NOTICE

esd only grants the compliance with directive 2014/30/EU, if the CAN wiring is carried out with single shielded **double twisted** pair cables that match the requirements of ISO 11898-2.

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 $120\ \Omega \pm 10\%$ with an adequate conductor cross-section ( $\geq 0.22\ \text{mm}^2$ ) 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.<br>Connect <ul style="list-style-type: none"> <li>• two twisted wires to the data signals (CAN_H, CAN_L) and</li> <li>• the other two twisted wires to the reference potential (CAN_GND) and</li> <li>• the cable shield to functional earth (FE) at least at one point.</li> </ul> |
| 3 | The reference potential CAN_GND has to be connected to the functional earth (FE) at exactly <b>one</b> 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 $120\ \Omega \pm 10\%$ ) at both ends (between the signals CAN_L and CAN_H and <b>not</b> to CAN_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 CAN cables from disturbing sources. If this can not be avoided, double shielded cables are recommended.   |

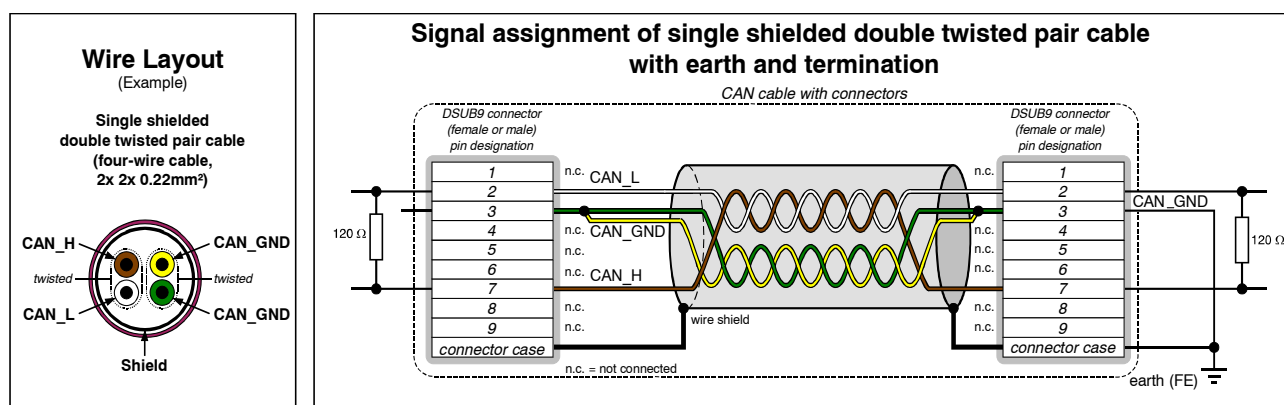


Figure 5: CAN wiring for heavy industrial environment

### 6.2.2 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!

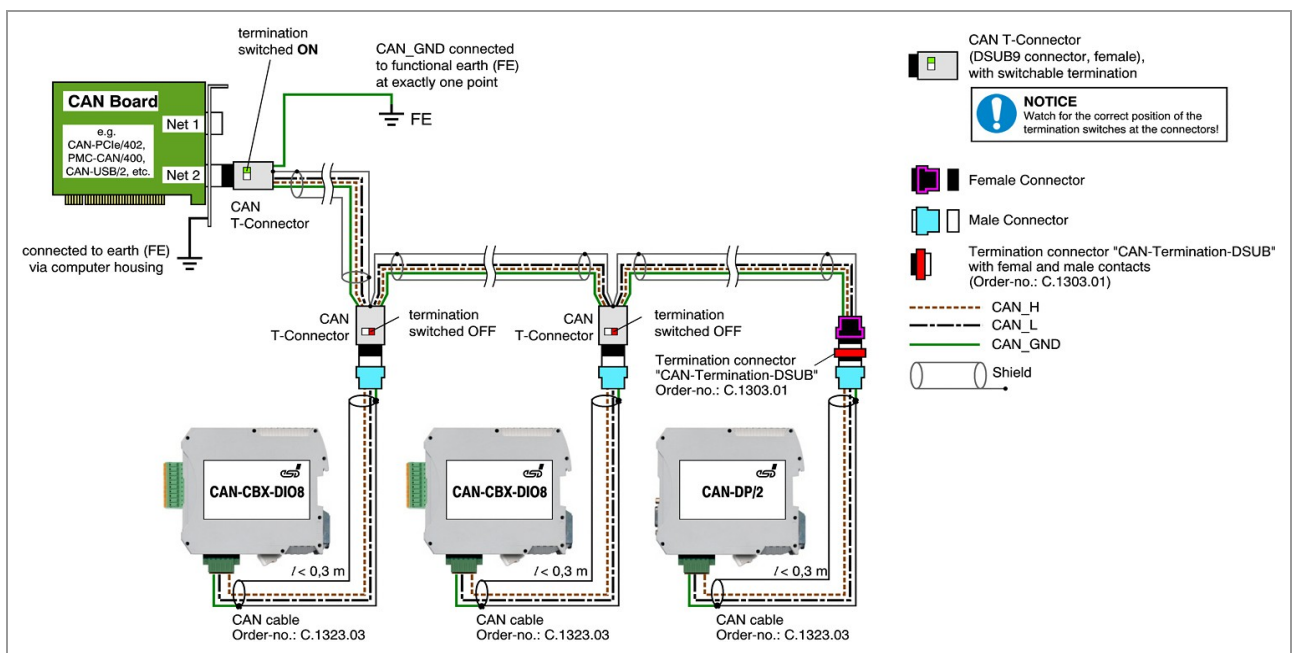


Figure 6: Example of proper wiring with single shielded double twisted pair cables

### 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).
- 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).

## 6.3 Light Industrial Environment (*Single Twisted Pair Cable*)

### 6.3.1 General Rules



#### NOTICE

esd only grants the compliance with directive 2014/30/EU, if the CAN wiring is carried out with single shielded **double twisted** pair cables that match the requirements of ISO 11898-2. See previous chapter: 'Heavy Industrial Environment (Double Twisted Pair Cable)'.

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 $120 \Omega \pm 10\%$ with an adequate conductor cross-section ( $\geq 0.22 \text{ mm}^2$ ) 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.<br>Connect <ul style="list-style-type: none"> <li>the two twisted wires to the data signals (CAN_H, CAN_L) and</li> <li>the cable shield to the reference potential (CAN_GND).</li> </ul> |
| 3 | The reference potential CAN_GND has to be connected to the functional earth (FE) at exactly <b>one</b> 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 $120 \Omega \pm 10\%$ ) at both ends (between the signals CAN_L and CAN_H and <b>not</b> at CAN_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.   |

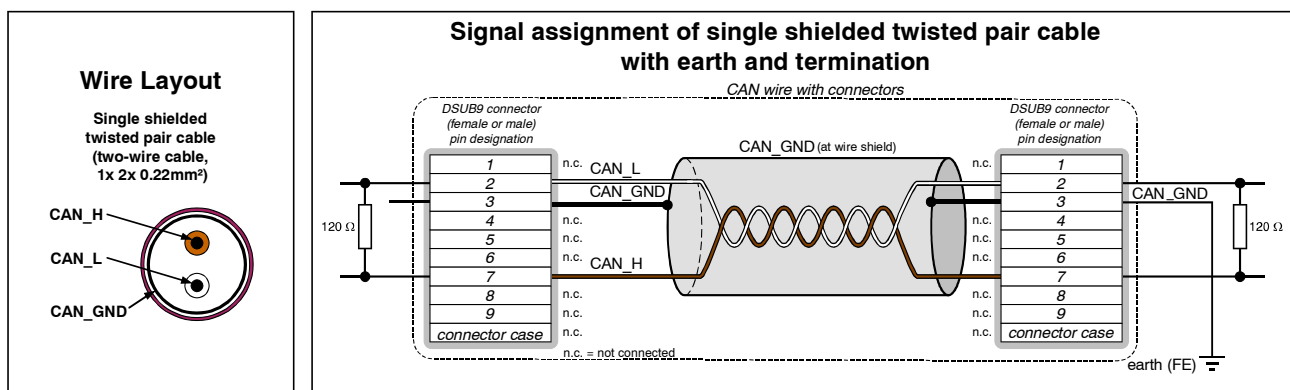


Figure 7: CAN wiring for light industrial environment

### 6.3.2 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.

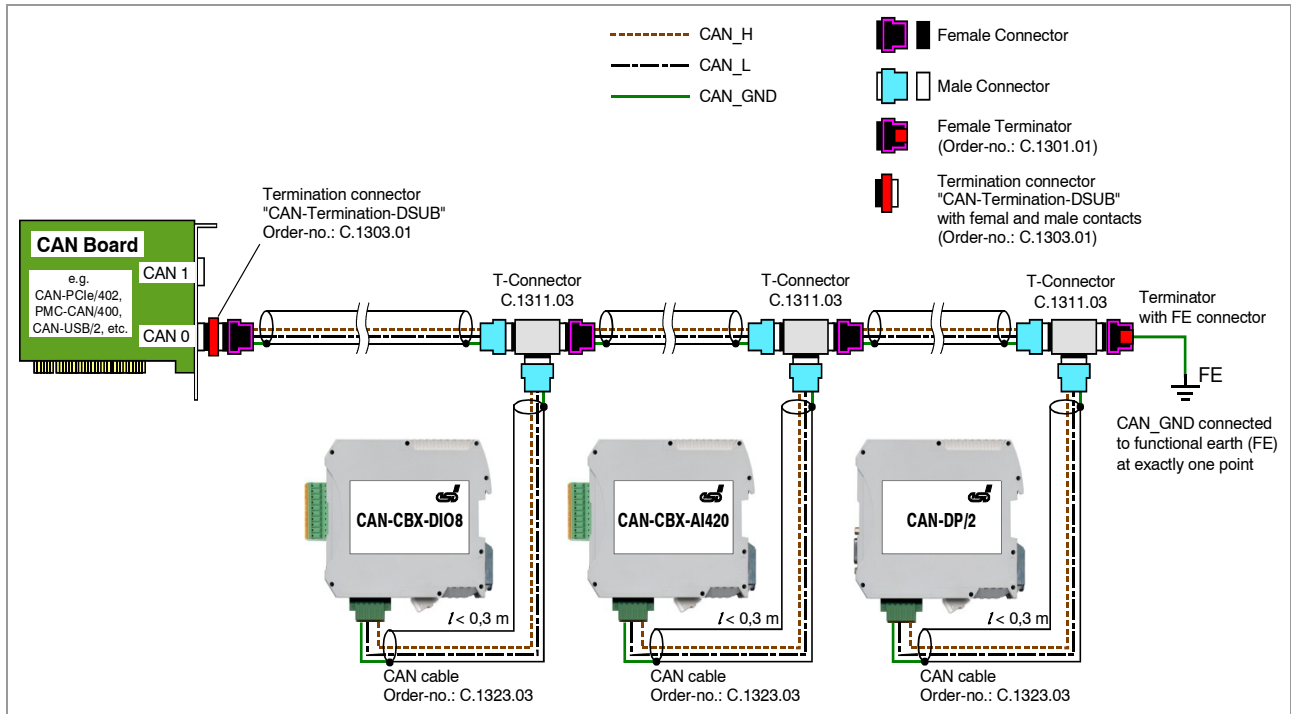


Figure 8: Example for proper wiring with single shielded single twisted pair wires

### 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).
- 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.

## 6.4 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<br>[Kbit/s] | Typical values of reachable<br>wire length<br>with esd interface $l_{\max}$<br>[m] | CiA recommendations<br>(07/95) for reachable<br>wire lengths $l_{\min}$<br>[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  |
| 83.3                 | 850  | -  |
| 66.6                 | 1000   | -  |
| 50                   | 1400   | 1000   |
| 33.3                 | 2000   | -  |
| 20                   | 3600   | 2500   |
| 12.5                 | 5400   | -  |
| 10                   | 7300   | 5000   |

**Table 4:** 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<br>Schulze-Delitzsch-Straße 25<br>70565 Stuttgart<br>Germany<br><a href="http://www.lappkabel.com">www.lappkabel.com</a> | e.g.<br>UNITRONIC ®-BUS CAN UL/CSA (1x 2x 0.22)<br>(UL/CSA approved) Part No.: 2170260 |
|   | UNITRONIC ®-BUS-FD P CAN UL/CSA (1x 2x 0.25)<br>(UL/CSA approved) Part No.: 2170272    |
| ConCab GmbH<br>Äußerer Eichwald<br>74535 Mainhardt<br>Germany<br><a href="http://www.concab.de">www.concab.de</a>                       | e. g.<br>BUS-PVC-C (1x 2x 0.22 mm <sup>2</sup> ) Order No.: 93 022 016 (UL appr.)      |
|   | BUS-Schleppflex-PUR-C (1x 2x 0.25 mm <sup>2</sup> ) 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<br>Schulze-Delitzsch-Straße 25<br>70565 Stuttgart<br>Germany<br><a href="http://www.lappkabel.com">www.lappkabel.com</a> | e.g.<br>UNITRONIC ®-BUS CAN UL/CSA (2x 2x 0.22)<br>(UL/CSA approved) Part No.: 2170261 |
|   | UNITRONIC ®-BUS-FD P CAN UL/CSA (2x 2x 0.25)<br>(UL/CSA approved) Part No.: 2170273    |
| ConCab GmbH<br>Äußerer Eichwald<br>74535 Mainhardt<br>Germany<br><a href="http://www.concab.de">www.concab.de</a>                       | e. g.<br>BUS-PVC-C (2x 2x 0.22 mm <sup>2</sup> ) Order No.: 93 022 026 (UL appr.)      |
|   | BUS-Schleppflex-PUR-C (2x 2x 0.25 mm <sup>2</sup> ) Order No.: 94 025 026 (UL appr.)   |

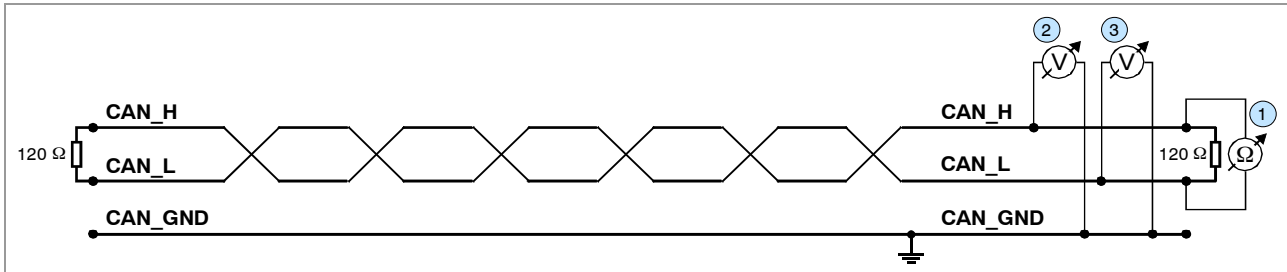


#### INFORMATION

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:

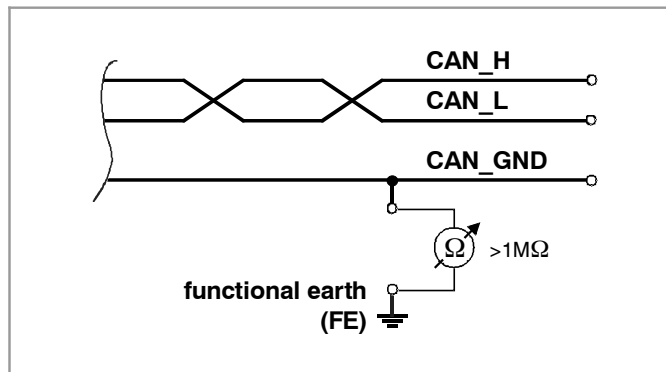
- there are no open circuits in CAN\_H or CAN\_L wiring
- your bus system has two terminating resistors (one at each end) and that they are 120 Ω each.

### 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 k $\Omega$  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 %).

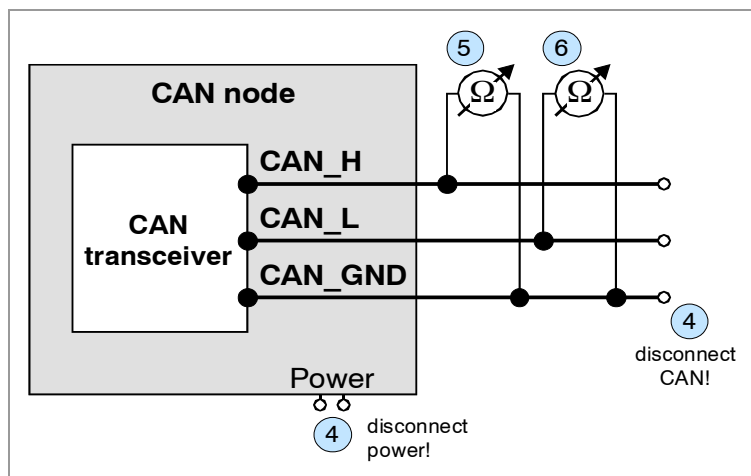


Figure 11: Measuring the internal resistance of CAN transceivers

## 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](mailto:support@esd.eu) or by phone **+40-511-37298-130**.

## 8. Declaration of Conformity

### EG-KONFORMITÄTSERKLÄRUNG DECLARATION OF CONFORMITY



Adresse  
Address

**esd electronic system design gmbh**  
**Vahrenwalder Str. 205**  
**30165 Hannover**  
**Germany**

esd erklärt, daß das Produkt  
*esd declares, that the product*

**CAN-ISA/331**

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

**C.2010.02, C.2010.04**

die Anforderungen der Normen  
*fullfills the requirements of the standards*

**DIN EN 50081-1 (03.1993)**  
**DIN EN 50082-2 (1996)**

gemäß folgendem Prüfbericht erfüllt.  
*according to test certificate.*

**1680.1407.99**

Das Produkt entspricht damit den EG-Richtlinien  
*Therefore the product corresponds to the EU-Directives*

**89/336/EWG (23.05.1989),**  
**92/31/EWG (28.04.1992)**

Diese Erklärung gilt für alle Exemplare, die das CE-Zeichen tragen und verliert ihre Gültigkeit, wenn Veränderungen am Produkt vorgenommen werden.  
*This declaration is valid for all units with the CE label on it and it lose its validity if a modification is done on the product.*

Name / Name  
Funktion / Title  
Datum / Date

Dr. Ing. Werner Schulze  
Geschäftsführer  
Hannover, den 20.06.2000

Rechtsgültige Unterschrift / *authorized Signature*

## 9. Order Information

| Type   | Properties  | Order No. |
|--|---|-----------|
| CAN-ISA/331-1  | 1x CAN 2.0A/B, ISO 11898  | C.2010.02 |
| CAN-ISA/331-2  | 2x CAN 2.0A/B, ISO 11898  | C.2010.04 |
| <i>Each CAN-ISA/331 type includes a CD-ROM with CAN layer 2 software driver for Windows and Linux, demo programs and tools as well as documentation and manuals.</i> |   |           |
| <b>Software</b>  |   |           |
| CAN-DRV-LCD CDROM+Lizenz QNX   | object licence and CD-ROM for QNX 4.x and 6.x   | C.1101.32 |
| CAN-DRV-LCD CDROM+Lizenz VxWorks   | object licence and CD-ROM for VxWorks 5.x and 6.x                                     | C.1101.55 |
| <i>Each CAN-DRV-LCD includes a CD-ROM with CAN drivers, demo programs and tools as well as documentation and manuals.</i>  |   |           |
| CANopen-LCD CDROM+Lizenz Windows/Linux   | CANopen object licence for Windows and Linux,   | C.1101.06 |
| CANopen-LCD CDROM+Lizenz QNX   | CANopen object licence for QNX  | C.1101.17 |
| CANopen-LCD CDROM+Lizenz VxWorks   | CANopen object licence for VxWorks  | C.1101.18 |
| <i>Each CANopen-LCD includes the CANopen object licence, CANopen manager and slave dll's/lib's, documentation and CAN-driver object licence.</i>                     |   |           |
| J1939 Stack for Windows (Object)   | J1939 Stack for esd CAN hardware, Windows object code, includes J1939 simulation tool | C.1130.10 |
| J1939 Stack for Linux (Object)   | J1939 Stack for esd CAN hardware, Linux object code                                   | C.1130.11 |

For detailed information about the driver availability for your special operating system, please contact our sales team.

**Table 5:** 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](http://www.esd.eu) for free.

| Manuals        |  | Order No. |
|----------------|--|-----------|
| CAN-ISA/331-ME | Hardware manual in English   | C.2010.21 |
| CAN-API-ME     | NTCAN-API: Application Developers Manual<br>NTCAN-API: Driver Installation Guide | C.2001.21 |
| CANopen-ME     | CANopen manuals in English   | C.2002.21 |
| J1939-ME       | J1939 Stack and SDK software manual in English                                   | C.1130.21 |

**Table 6:** Available manuals