CAN-CLOCK

Real Time Clock with CAN Interface

Hardware-Manual

to Product C.2836.xx

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Changes in the Chapters

The changes in the document listed below affect changes in the firmware as well as changes in the description of facts only.

Chapter	Changes versus previous version
-	First English version

Technical details are subject to change without further notice.

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1. Overview

1.1 Description of the Module

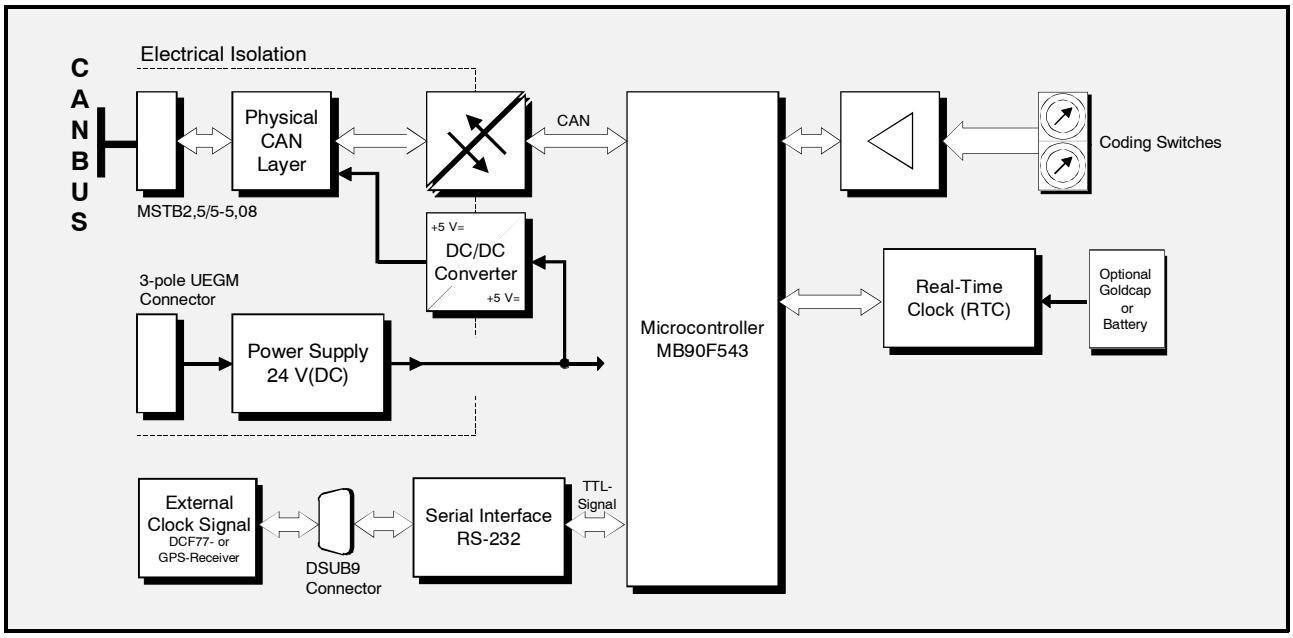


Figure 1: Block circuit diagram of the CAN-Clock module

The CAN-Clock module connects an external DCF77-receiver or an external GPS-receiver (NMEA protocol 0183-compatible) with the CAN bus. The output of the time information is made as time stamp. Furthermore the module is equipped with an internal real-time clock (RTC). The time information of the RTC can be transmitted as time stamp on the CAN bus, if the external clock signals fail to appear. The time data is given in CANopen format.

The module operates with a MB90F543 microcontroller, that buffers the CAN data in a local SRAM. The firmware is held in the flash.

The ISO 11898-compliant CAN interface allows a maximum data transfer rate of 1 Mbit/s. The CAN-interface is electrically isolated via optocoupler and DC/DC-converters. The CAN interface is connected via a 5-pin screw-/ plug connector in Combicon style.

The connection for the external time receiver is designed as serial RS232-interface with a DSUB9 connector.

1.2 View of the Module with Connectors and Coding Switches

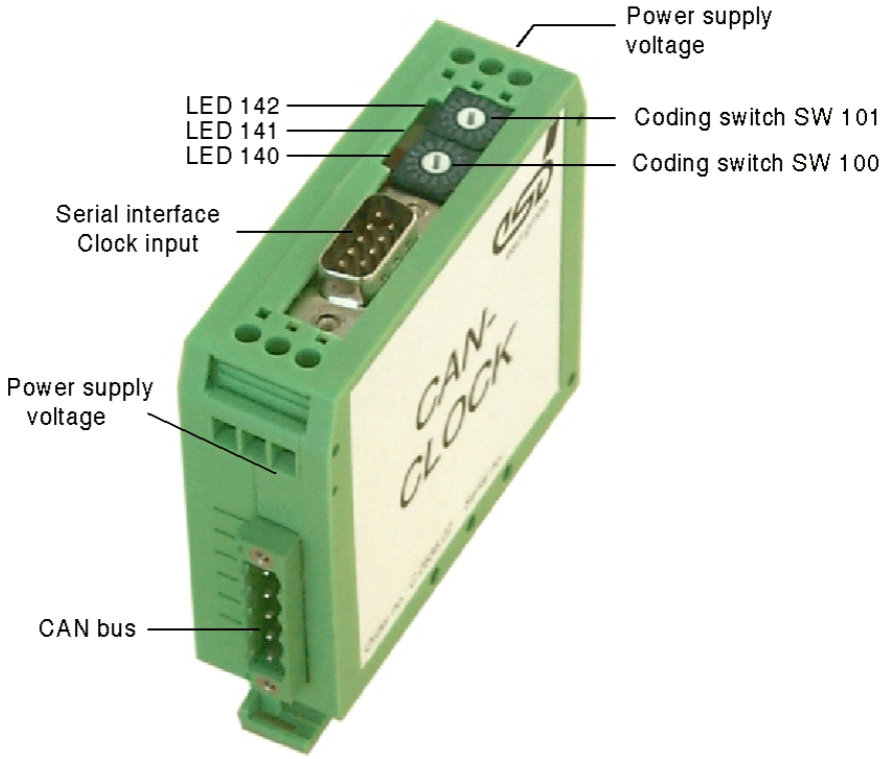


Figure 2: Position of the connectors and coding switches

1.3 Technical Data

1.3.1 General Technical Data

Power supply voltage	nominal voltage 12 V/DC ... 32 V/DC, input voltage range 24 V/DC
current consumption	50 mA (at 24 V, 20 ˚C)
Connectors	X100 (DSUB9, male) - serial interface, external clock-signal X250 (Combicon style, 5-pin MSTB2.5/5-5.08) - CAN net X300 (2x3-pin screw connector UEGM) - 24 V-power supply voltage
Temperature range	0 ... +50 ˚C ambient temperature
Humidity	max. 90 %, non-condensing
Dimensions	25 mm x 87 mm x 84 mm (W x H x D) (including mounting rail fitting and connector projection DSUB9, without CAN-connector)
Weight	approx. 120 g

Table 1: General technical data

1.3.2 Microcontroller Unit

Microcontroller	MB90F543
Memory	SRAM: integrated in MB90F543, 6 Kbyte Flash-EPROM: integrated in MB90F543, 128 Kbyte

Table 2: Microcontroller Unit

1.3.3 CAN Interface

Number of CAN interfaces	1x CAN
CAN controller	MB90F543, CAN 2.0A/B,
Electrical isolation of the CAN interfaces from other units	via optocoupler and DC/DC-converter reference voltage: 300 V_{DC}, 250 V_{AC}
Physical layer CAN	Physical Layer according to ISO 11898, transmission rate programmable from 10 Kbit/s up to 1 Mbit/s

Table 3: Data of the CAN interface

1.3.4 Serial Interface

Controller	MB90F543	
Interface	RS232, with auxiliary supply DCF77-receiver	
Connector	9-pin DSUB connector	
External receiver	GPS signal	NMEA Protocol, 0183 compatible (National Marine Electronics Association), worldwide available signal, bit rate: 4800 baud (constant), e.g.: eTrex of Gamin (NMEA 0183)
	DCF77 signal	radio signal of the time measurement standard of the Physikalisch-Technische Bundesanstalt, transmitter: Mainflingen, reach approx. 2000 km highly stable carrier frequency: 77.5 kHz e.g.: Expert mouseClock of Gude GmbH

Table 4: Data of the serial interface

1.3.5 Software

The CAN-Clock module operates with the CANopen-protocol according to CiA Draft-Standard 401.
Times are transmitted to the CAN bus in CANopen-format
coding of time: in milliseconds after midnight
coding of date: in days since January 1st, 1984
(please refer to the software manual of the CAN-Clock module)

1.4 Order Information

Type	Features	Order No.
CAN-Clock	Interface for DCF77- and GPS-receiver for CANopen	C.2836.02
CAN-Clock-ME	Manual in English [1*)]	C.2836.21
CAN-Clock-ENG	Engineering manual in English [2*)] Contents: circuit diagrams, PCB top overlay drawing, data sheets of significant components	C.2836.25

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

Table 5: Order information

2. Description of the Units

2.1 CAN Interface

2.1.1 Interface Circuit

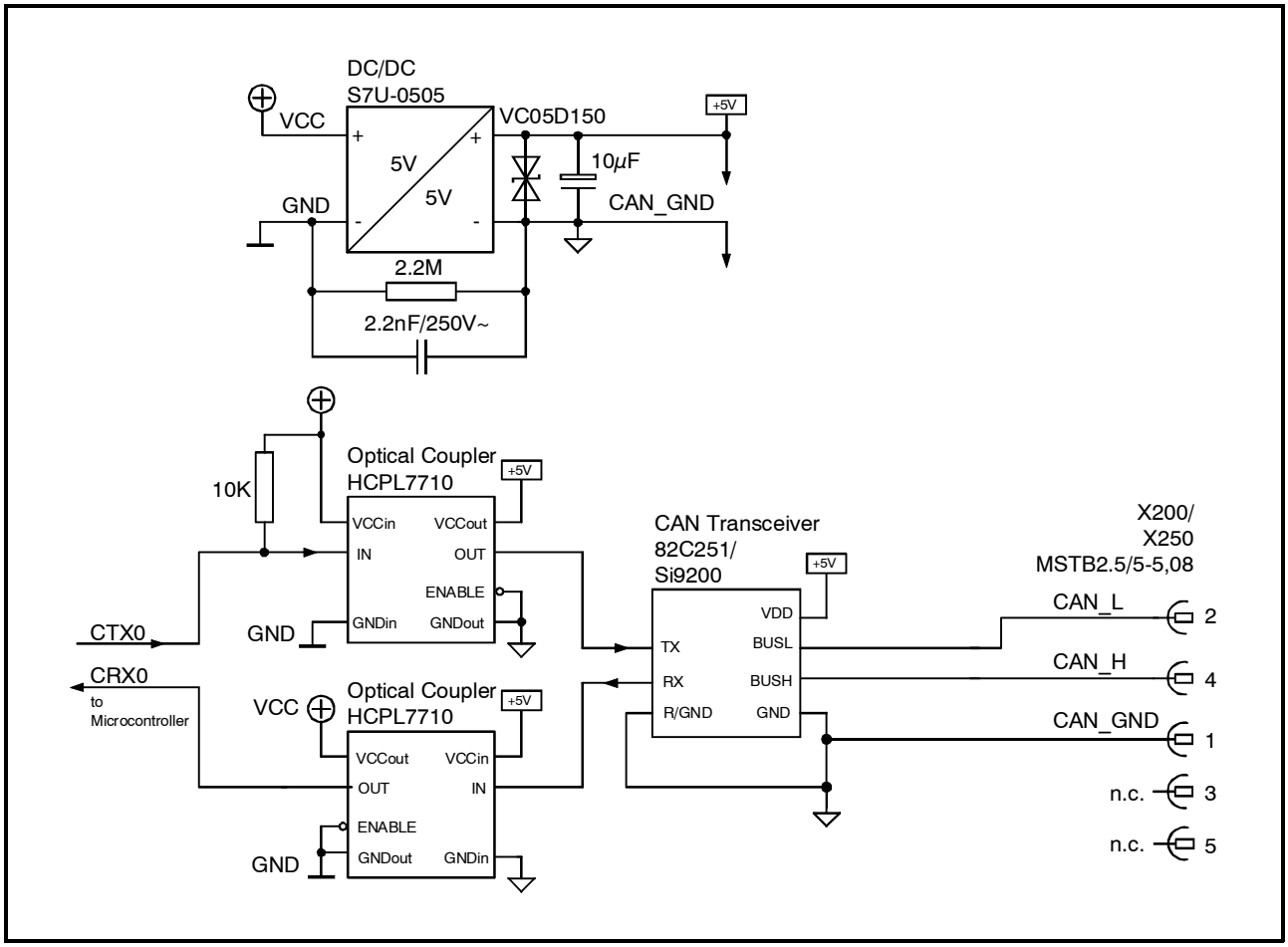


Figure 3: Circuit of the CAN interfaces

2.2 Serial Interface

2.2.1 Default Setting of the Module

Bit rate:	4800 baud
Data bits:	8
Parity:	no
Stop bits:	1
Handshake:	none

2.3 Setting Node Number and CAN Bit Rate via Coding Switch

With the coding switches the CANopen node number and the CAN bit rate can be set.

If the position of the coding switches is evaluated as bytes, the assignment is:

Coding switch SW101 (upper switch *): High-nibble
Coding switch SW100 (lower switch *): Low-nibble
* Module is mounted on the mounting rail with the LEDs up.

2.3.1 Overview of the Coding Switch Settings

Coding switch position (when switching on) [Hex]	Interpretation by the firmware
0	bit rate will be set
01...7F	setting of the CANopen node number (node-ID)
80...FE	reserved for future applications
FF	firmware update

Table 6: Index of the bit rate

2.3.2 Setting the CAN Bit Rate

To set the CAN bit rate the following steps have to be made:

1.	Switch the module off
2.	Position both coding switches to ‘0’
3.	Switch the module on; LED141 (yellow) and LED 142 (green) turn on
4.	Select the bit rate and position switch SW100 correspondingly (table of bit rates see below)
5.	To accept the new bit rate position the switch to ‘1’; LED141 turns off
6.	Switch off the module
7.	Set CANopen node number (see page 11)

2.3.3 Assignment of the Position of the Coding Switch to the CAN Bit Rates

Position of the Coding Switch SW100	Bit Rate [Kbit/s]
0	1000
1	666.6
2	500
3	333.3
4	250
5	166
6	125
7	100
8	66.6
9	50
A	33.3
B	20
C	12.5
D	10
E	reserved
F	reserved

Table 7: Index of the bit rates

2.3.4 Setting the CANopen Node Number

To set the CANopen node number (Node-ID) carry out the steps described below:

1.	Switch the module off
2.	Set the node number with the coding switches: Position 01_h...$7F_h$: CANopen node number (nibble assignment, see above)
3.	Switch the module on If the coding switches are positioned to a value between Hex 01_h...$7F_h$, this value is interpreted as node number.

2.4 LED Display

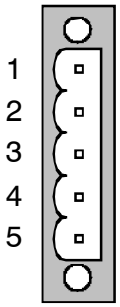
Function	Name	Colour	Indicator State	Meaning
Power	LED142	green	off	Module is off
			on	Module is on
Bit rate mode	LED141	yellow	off	Module is off or bit rate setting mode is inactive
			blinking	DCF77 Operation: LED flashes in the clock pulse of the DCF77-signal - short blinking followed by a long off phase: incorrect signal - short turning off followed by a long on phase: correct signal
				GPS Operation: Reception of a valid time telegram ($GPRMC)
			on	Bit rate setting mode is active
Failure	LED140	rot	off	Module off or no failure
			on	Failure, no bit rate is set

Table 8: Meaning of the indicator states of the LEDs

3. Connector Assignment

3.1 CAN Bus (X250, Combicon-Style)

Pin Position:

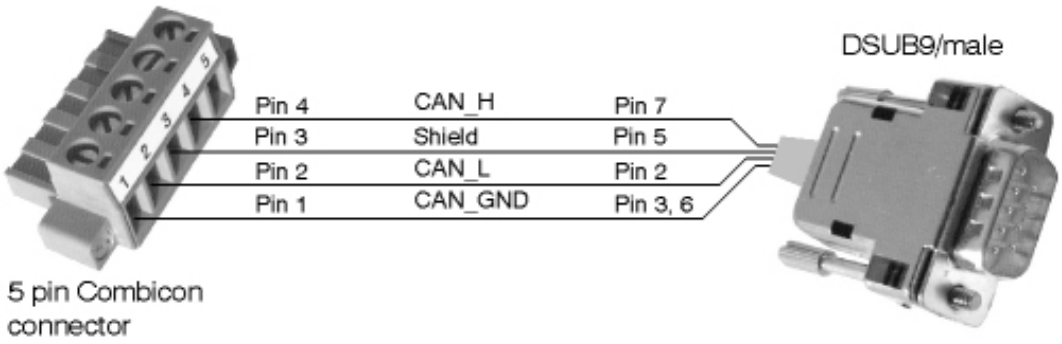


Pin Assignment:

Pin	Signal
1	CAN_GND
2	CAN_L
3	Shield
4	CAN_H
5	n.c.

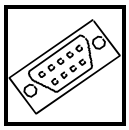
Signal description:

CAN_L, CAN_H...	CAN signal lines
CAN_GND ...	reference potential of the CAN physical layers
Shield...	shielding



The 9-pin DSUB connector is assigned in accordance with CiA DS 102.

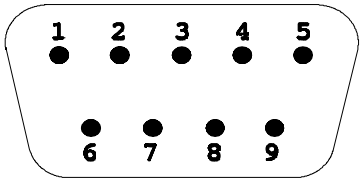
Figure 4: Adapter cable 5-pin Combicon to 9-pin DSUB



Connector Assignment

3.2 Serial Interface (X100, 9 pin DSUB, male)

Pin Assignment:

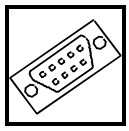


Pin Position:

Signal	Pin		Signal
n.c	6	1	n.c
		2	RxD (Input)
Vcc_help	7	3	TxD (Output)
n.c	8	4	-Vcc_help
Vcc_out	9	5	GND

9-pin DSUB connector

n.c. ... not connected
Vcc_help... 9 V output voltage
auxiliary supply for DCF77-receiver (e.g.: Expert mouseClock of Gude)
-Vcc_help... -9 V output voltage
auxiliary supply for DCF77-receiver
Vcc_ out... 5 V output voltage
power supply voltage for other DCF77- or GPS-receiver



3.3 Power Supply (X101, UEGM)

Voltage is supplied by means of the screw connector UEGM, integrated in the case. It can be connected to lines with a cross-section of up to 2.5 mm².

Assignment of the screw connectors is the same on both sides of the case. They can be used alternatively. The center contact is for +24 V and the two outer contacts are for GND.

Note: It is **not permissible** to feed-through the 24 V-supply voltage, i.e. to use one side as 24 V input and the other side as 24 V output in order to supply other devices!

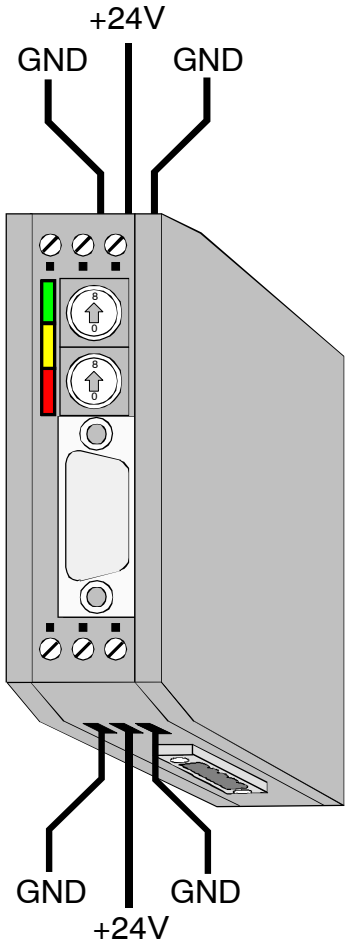


Figure 5: Voltage supply

4. Correctly Wiring Electrically Isolated CAN Networks

Generally all instructions applying for wiring regarding an electromagnetic compatible installation, wiring, cross sections of wires, material to be used, minimum distances, lightning protection, etc. have to be followed.

The following **general rules** for the CAN wiring must be followed:

1.	A CAN net must not branch (exception: short dead-end feeders) and has to be terminated by the wave impedance of the wire (generally 120 W ±10%) at both ends (between the signals CAN_L and CAN_H and **not** at GND)!
2.	A CAN data wire requires **two twisted** wires and a wire to conduct the reference potential (CAN_GND)! For this the shield of the wire should be used!
3.	The reference potential CAN_GND has to be connected to the earth potential (PE) at **one** point. Exactly **one** connection to earth has to be established!
4.	The bit rate has to be adapted to the wire length.
5.	Dead-end feeders have to kept as short as possible (l < 0.3 m)!
6.	When using double shielded wires the external shield has to be connected to the earth potential (PE) at **one** point. There must be not more than **one** connection to earth.
7.	A suitable type of wire (wave impedance ca. 120 Ω ±10%) has to be used and the voltage loss in the wire has to be considered!
8.	CAN wires should not be laid directly next to disturbing sources. If this cannot be avoided, double shielded wires are preferable.

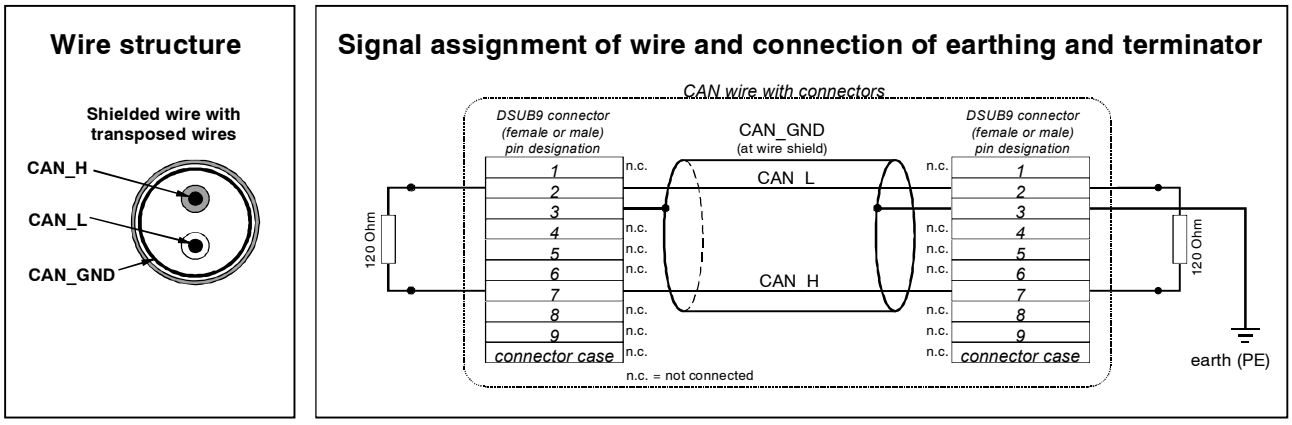


Figure: Structure and connection of wire

Cabling

- for devices which have only one CAN connector per net use T-connector and dead-end feeder (shorter than 0.3 m) (available as accessory)

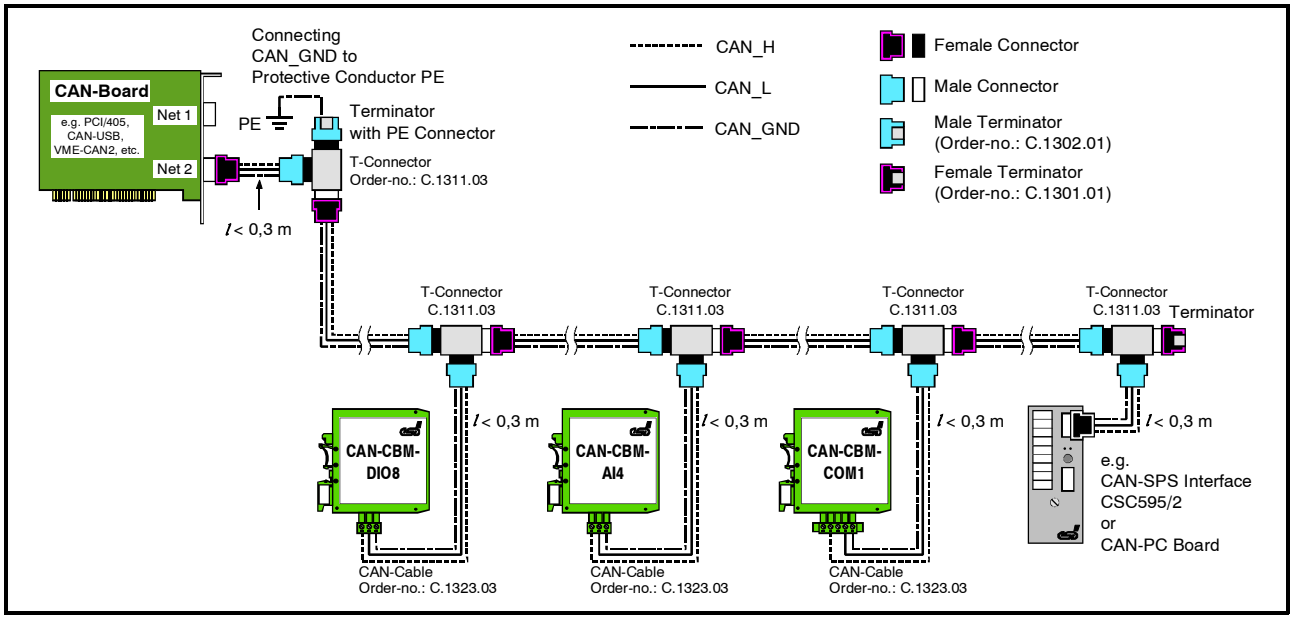


Figure: Example for correct wiring (when using single shielded wires)

Terminal Resistance

- use **external** terminator, because this can later be found again more easily!
- 9-pin DSUB-terminator with male and female contacts and earth terminal are available as accessories

Earthing

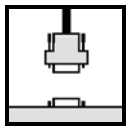
- CAN_GND has to be conducted in the CAN wire, because the individual esd modules are electrically isolated from each other!
- CAN_GND has to be connected to the earth potential (PE) at **exactly one** point in the net!
- each CAN user without electrically isolated interface works as an earthing, therefore: do not connect more than one user without potential separation!
- Earthing CAN e.g. be made at a connector

Wire Length

❍ Optical couplers are delaying the CAN signals. By using fast optical couplers and testing each board at 1 Mbit/s, however, esd CAN guarantee a reachable length of 37 m at 1 Mbit/s for most esd CAN modules within a closed net without impedance disturbances like e.g. longer dead-end feeders. (Exception: CAN-CBM-DIO8, -AI4 and AO4 (these modules work only up to 10 m with 1 Mbit/s))

Bit rate [Kbit/s]	Typical values of reachable wire length **with esd interface** l_{max} [m]	**CiA recommendations** (07/95) for reachable wire lengths l_{min} [m]
1000	37	25
800	59	50
666.6	80	-
500	130	100
333.3	180	-
250	270	250
166	420	-
125	570	500
100	710	650
66.6	1000	-
50	1400	1000
33.3	2000	-
20	3600	2500
12.5	5400	-
10	7300	5000

Table: Reachable wire lengths depending on the bit rate when using esd-CAN interfaces



Examples for CAN Wires

Manufacturer	Type of wire
U.I. LAPP GmbH Schulze-Delitzsch-Straße 25 70565 Stuttgart Germany www.lappkabel.de	e.g. UNITRONIC ®-BUS CAN UL/CSA (UL/CSA approved) UNITRONIC ®-BUS-FD P CAN UL/CSA (UL/CSA approved)
ConCab GmbH Äußerer Eichwald 74535 Mainhardt Germany www.concab.de	e.g. BUS-PVC-C (1 x 2 x 0,22 mm²) Order No.: 93 022 016 (UL appr.) BUS-Schleppflex-PUR-C (1 x 2 x 0,25 mm²) Order No.: 94 025 016 (UL appr.)
SAB Bröckskes GmbH&Co. KG Grefrather Straße 204-212b 41749 Viersen Germany www.sab-brockskes.de	e.g. SABIX® CB 620 (1 x 2 x 0,25 mm²) Order No.: 56202251 CB 627 (1 x 2 x 0,25 mm²) Order No.: 06272251 (UL appr.)

Note: Completely configured CAN wires can be ordered from **esd**.

5. CAN-Bus Troubleshooting Guide

The CAN-Bus Troubleshooting Guide is a guide to find and eliminate the most frequent hardware-error causes in the wiring of CAN-networks.

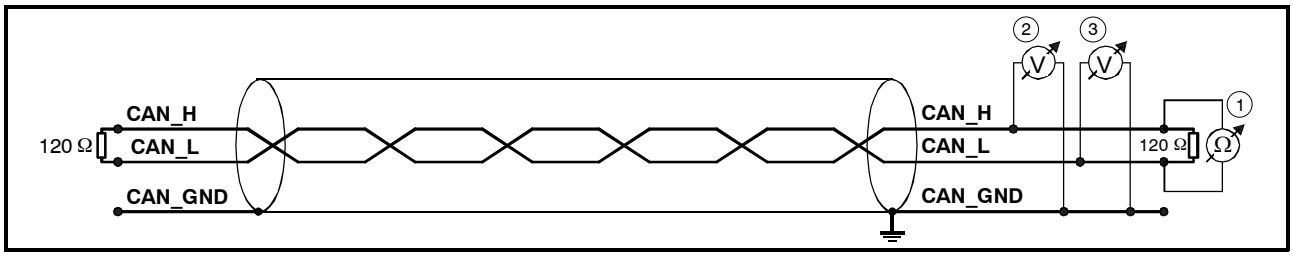


Figure: Simplified diagram of a CAN network

5.1 Termination

The termination is used to match impedance of a node to the impedance of the transmission line being used. When impedance is mismatched, the transmitted signal is not completely absorbed by the load and a portion is reflected back into the transmission line. If the source, transmission line and load impedance are equal these reflections are eliminated. This test measures the series resistance of the CAN data pair conductors and the attached terminating resistors.

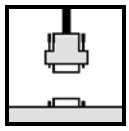
To test it, please

1. Turn off all power supplies of the attached CAN nodes.
2. Measure the DC resistance between CAN_H and CAN_L at the middle and ends of the network (1) (see figure above).

The measured value should be between 50 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
- 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.



5.2 CAN_H/CAN_L Voltage

Each node contains a CAN transceiver that outputs differential signals. When the network communication is idle the CAN_H and CAN_L voltages are approximately 2.5 volts. Faulty transceivers can cause the idle voltages to vary and disrupt network communication.

To test for faulty transceivers, please

1. Turn on all supplies.
2. Stop all network communication.
3. Measure the DC voltage between CAN_H and GND (2) (see figure above).
4. Measure the DC voltage between CAN_L and GND (3) (see figure above).

   Normally the voltage should be between 2.0 V and 4.0 V.
   If it is lower than 2.0 V or higher than 4.0 V, it is possible that one or more nodes have faulty transceivers. For a voltage lower than 2.0 V please check CAN_H and CAN_L conductors for continuity. For a voltage higher than 4.0 V, please check for excessive voltage.

To find the node with a faulty transceiver please test the CAN transceiver resistance (see next page).

5.3 Ground

The shield of the CAN network has to be grounded at only one location. This test will indicate if the shielding is grounded in several places.

To test it, please

1. Disconnect the shield wire from the ground.
2. Measure the DC resistance between Shield and ground.
3. Connect Shield wire to ground.

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

5.4 CAN Transceiver Resistance Test

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

To measure the current leakage through the CAN circuits, please use an ohm-meter and:

1. Disconnect the node from the network. Leave the node unpowered (4) (see figure below).

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

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

Normally the resistance should be between 1 M Ω and 4 M Ω. If it is not within this range, the CAN transceiver is probably faulty.

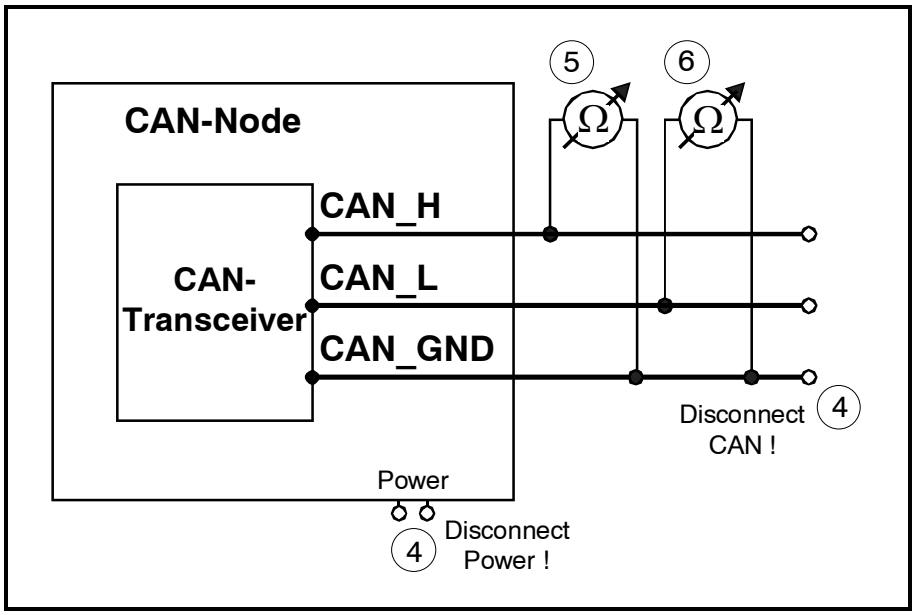


Figure: Simplified diagram of a CAN node