CAN-CBM-AI410

4 Analog Inputs

Hardware Manual

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Changes in the chapters

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

Chapter	Changes versus previous version
1.3	Order Notes supplemented
-	-

Technical details are subject to change without further notice.

N O T E

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1. Overview

1.1 Module Description

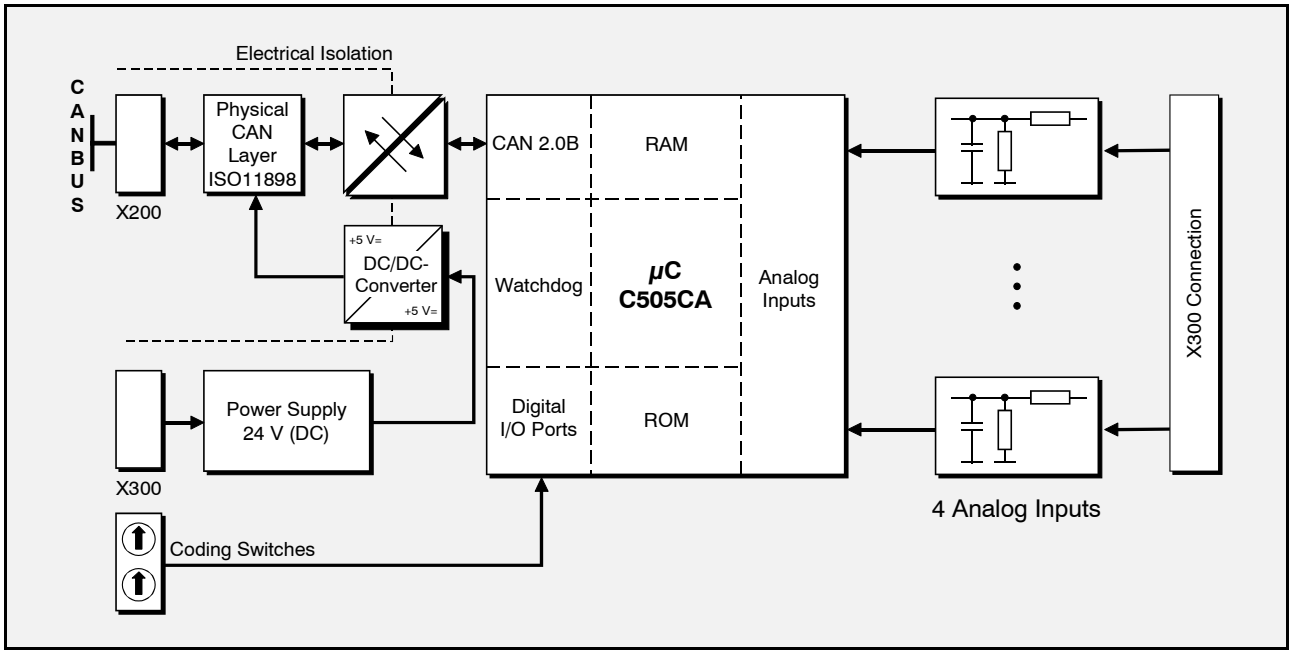


Fig. 1.1.1: Block-circuit diagram of the CAN-CBM-AI410 module

The CAN-CBM-AI410 offers four analog inputs. These are led to micro controller C505CA, which has got a resolution of 10 bit, via a low pass filter.

The bit rate of the CAN-bus and the module number (node ID) can be modified or re-programmed via the coding switches.

The CAN-interface is designed according to ISO 11898 and permits a maximum data-transfer rate of 1 Mbit/s (a maximum line length of 35 m). The CAN-interface is electrically isolated from the other potentials by optocouplers and DC/DC-converters.

An additional safety feature is the watchdog timer integrated in the microcontroller. It automatically resets the CAN-module, if the watchdog time has expired.

1.2 Summary of Technical Data

1.2.1 General Technical Data

Supply voltage	permissible voltage range: 10...30 V/DC current (at 20 ˚C): typ. 30 mA
Connectors	X300 (COMBICON design, 12-pole MSTB 2.5/12-ST-08) - 4 analog inputs, supply voltage X200 (COMBICON design, 5-pole MSTB2.5/5-5.08) - CAN-interface
Ambient temperature	0...50 ˚C (CAN-CBM-AI410), -20...+85 ˚C (CAN-CBM-AI410-T)
Humidity	max. 90%, non-condensing
Housing dimensions	width: 25 mm, hight: 88 mm, depth: 85 mm (dimensions including top hat rail and connector projection)
Weight	ca. 85 g

Table 1.2.1: General technical data

1.2.2 CAN- and Microcontroller Units

CAN-interface	physical layer in accordance with ISO 11898, electrical isolation
Transfer rate	can be selected via coding switches or programmed from 10 Kbit/s to 1 Mbit/s
CANopen module number (node ID)	can be programmed or set via coding switches
Microcontroller	C505CA, OTP
EEPROM	I²C-EEPROM for storage of parameters
LED-display	four LEDs, two of the LEDs display CANopen status

Table 1.2.2: Technical data of CAN- and micro controller units

1.2.3 Analog Inputs

Resolution	10 Bit
Input voltage	0...10 V
Input current	0...20 mA, when using an external shunt 500 Ω (not included in the scope of delivery)

Table 1.2.3: Technical data of analog inputs

1.2.4 Software Support

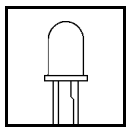
The entire EPROM-resident communication firmware to operate the CAN-CBM-AI410-module is included in the scope of delivery.

1.3 Order Notes

Type	Features	Order No.
CAN-CBM-AI410	4 analog inputs, input voltage range 0...10 V, temperature range: 0˚C ... + 50˚C	C.2835.02
CAN-CBM-AI410-T	as C.2835.02 but with extended temperature range: -20˚C ... + 85˚C	C.2835.04
CAN-CBM-Cable	Manufactured CAN cable for CAN-CBM-modules, length 0.3 m, one end DSUB9 male, one end wire-end sleeves	C.1323.03
CAN-CBM-AI410-ME	User manual in English [1*)] (this manual)	C.2835.21
CAN-CBM-AI410-ENG	Engineering manual in English [2*)], Contents: schematic diagrams, PCB top overlay drawing, data sheets of significant components	C.2835.25

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 1.3.1: Order notes for the CAN-CBM-AI410



2. View of the Housing and LED Description

2.1 Housing

The board is placed in a polyamide housing (UEGM–MSTB) made by Phoenix Contact.
The power supply and the analog inputs can be connected via a 12-pole COMBICON connector (MSTBT 2.5/12-ST-5.08) in the front panel.
Two yellow, a red and a green LED are placed next to the connector.

The two HEX-coding switches for manual configuration are placed in the top side of the housing.
The CAN-connection, a 5-pole COMBICON connector (MSTBT2.5/5-5.08), is placed in the bottom side of the housing.

The housing can be mounted on top-hat rails in accordance with EN 500 22 via the clip at its back side.

2.2 Front View with Position of LEDs and Coding Switches

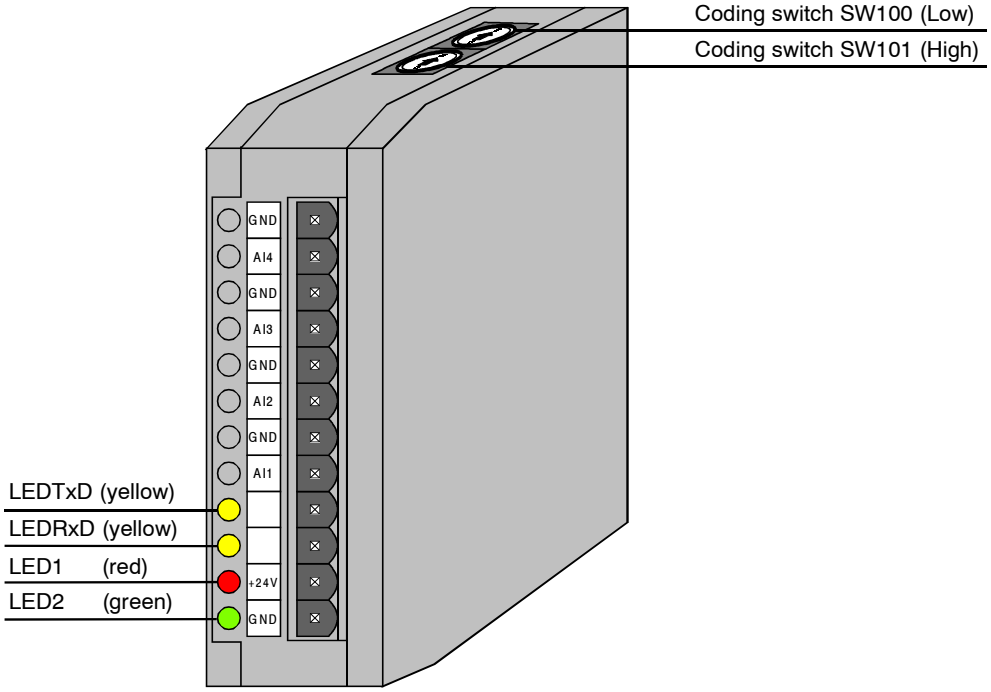


Fig. 2.2.1: Position of LEDs and coding switches

2.3 LED-Displays

The module has got two yellow, a red and a green LED (see page 7). The yellow LEDs (LED TxD, LED RxD) are not being supported yet and will always be switched off, therefore.

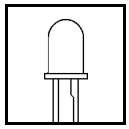
The **red and the green LED** display the CANopen-ERROR and the CANopen-RUN status. Its various signals will be explained in the following tables.

Name	Colour	LED
LED1	red	Error
LED2	green	Run

Table 2.3.1: Designation of red and green LED

Status of green CANopen-RUN-LED	RUN-status of CAN-module	Note
1 short flash of LED (200 ms on, 1 s off)	STOPPED	-
LED flashes (200 ms on, 200 ms off)	PRE-OPERATIONAL	-
LED is on permanently	OPERATIONAL	-

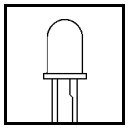
Table 2.3.2: Status of green LED



Status of red CANopen-Error-LED	Status of CAN-module	Note
LED is off	no error	- module is operational
1 short flash of LED (200 ms on, 1 s pause)	warn threshold has been reached	- at least one of the error counters of the CAN-controller has reached the warn value for error messages (too many errors)
2 successive flashes of LED (each 200 ms on, 200 ms off, 1 s pause)	NMT-error	- a 'Guard Event' or a 'Heartbeat Error' occurred.
3 successive flashes of LED (each 200 ms on, 200 ms off, 1 s pause)	Sync-error	- Sync-message has not been received within the set communication-cycle period (see object 1006_h)
4 successive flashes of LED * (each 200 ms on, 200 ms off, 1 s pause)	I²C-error	- check-sum error in I²C-EEPROM
5 successive flashes of LED * (each 200 ms on, 200 ms off, 1 s pause)	No Valid Node-ID	- module number (node ID) which has been set is not permissible
6 successive flashes of LED * (each 200 ms on, 200 ms off, 1 s pause)	No Valid Baud rate	- CAN-bit rate is not permissible

* these errors will only be displayed when the module has been configured via the coding switches

Table 2.3.3: Display of red LED



LED-Displays

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3. Hardware Configuration

3.1 PCB-View

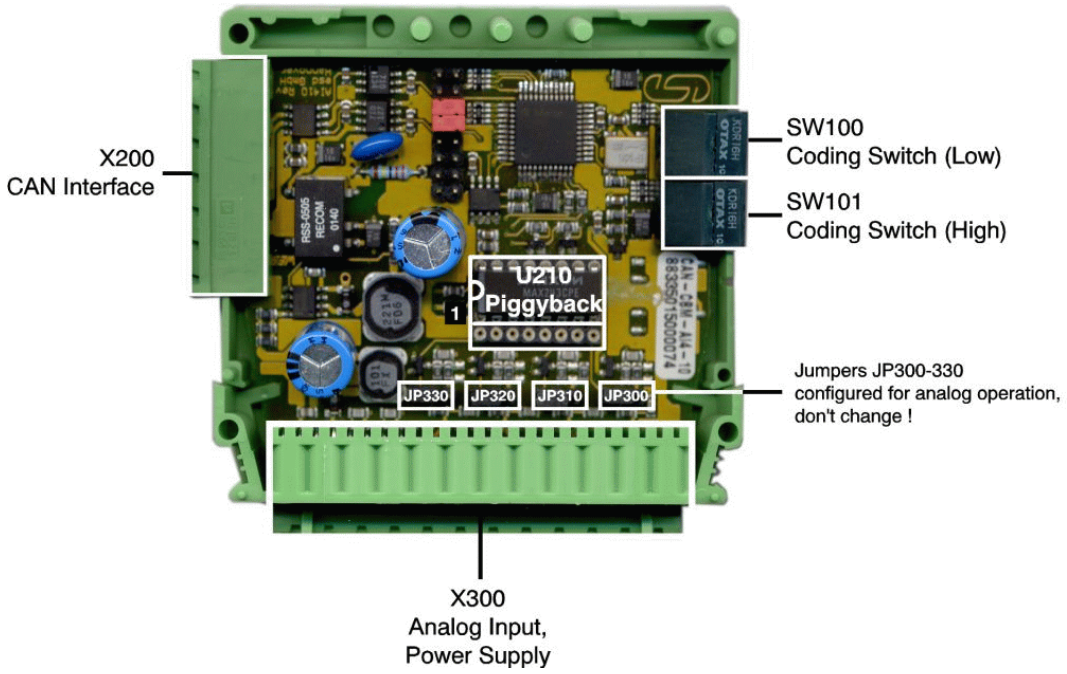


Fig. 3.1.1: PCB-view with position of coding switches and jumpers

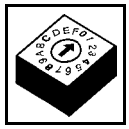
The coding switches for manual configuration and setting of identifiers (SW100, SW101) are accessible via the top side of the housing (see also page 7).

3.2 Default Setting of Bridges and Coding Switches

The respective default setting of the bridges (see following table) when leaving the manufacturer will be represented in the following figures.

Bridge/ coding switch	Function	Setting
Jumper X100	configuration	not assigned
Coding switch SW100 - LOW SW101 - HIGH	manual configuration (CAN-bit rate, node ID)	depending on the user (please refer to following chapter)
Jumpers JP300...JP330	I/O-port configuration	analog operation **These jumpers must not be changed by the user !**

Table 3.2.1: Default setting of bridges and coding switches



3.3 Manual Configuration via Coding Switches

3.3.1 Save Default Configuration in EEPROM

In default configuration the CAN-CBM-AI410 module is preconfigured with certain default values, such as a fixed bit rate. The default configuration is stored in the EEPROM.

Procedure:

1. In order to load the default configuration, both coding switches have to be set to 00_h before applying any voltage.

2. If voltage is supplied to the CAN-CBM-AI410 module, the red and the green LED start flashing (frequency about 5 Hz). After about 10 s the default configuration is stored in the EEPROM and both LEDs are turned off.

Note: If only the green LED turns off after 10 s while the red remains 'on', an error has occurred while storing the configuration in the EEPROM. This error is serious. Please contact service, if this should happen.

Parameters of default configuration:

Parameter	CANopen Object [Hex]	Default value in default configuration
CAN-bit rate	-	125 Kbit/s
COB-ID SYNC message	1005	80_h
Guard Time	100C	0
Life Time Factor	100D	0
Producer Heartbeat Time	1017	0
Configuration Date	1020	0
Configuration Time	1020	0
Analog Input Interrupt Trigger	6421	4
Analog Input Interrupt Delta	6426	0

Table 3.3.1: Default-parameter values in default configuration (see also software manual of the module)

3.3.2 Changing Parameters

Procedure:

1. Set both coding switches to FF_h before supplying power.

2. When you supply power the red LED quickly flashes (about 5 Hz) and the green LED is constantly on.

3. Now you can configure the CAN-CBM-AI410 module via both coding switches. Doing this coding switch HIGH is used to select a parameter and coding switch LOW is used to set the parameter.

Switch HIGH (type of parameter)	Switch LOW (parameter)	Description
0	0 ... 7	setting the baud rate
1 ... E	-	not defined
F	F	exit input cycle

Table 3.4.1: Permissible settings of coding switches at manual configuration

Switch LOW	Bit rate in kbit/s
0	1000
1	500
2	250
3	125
4	100
5	50
6	20
7	10
8	800

Table 3.4.2: Setting the CAN-bit rate via coding switch LOW

As soon as one of the coding switches is turned, you can start setting the parameters. The green LED now flashes more slowly (frequency about 1 Hz).

4. After about 10 s the parameter has to be set. If the setting has been successful, the green LED is constantly on again, the red LED keeps on flashing.

5. The next parameter can be set or the first configuration can be changed by turning the coding switch again.

   If the parameter has not been set within 10 s and the coding switches will be turned after these 10 s, the green LED flashes quickly (5 Hz) for 10 s while the red LED is on permanently. After these 10 s the configuration can be repeated.

6. You can leave the configuration mode by setting FF_h.
   After the configuration has successfully been stored in the EEPROM both LEDs turn off.

   Notes: If an error occurs while storing the values in the EEPROM, only the green LED turns off while the red LED flashes four successive times (see page 8). This is a serious error. Please contact service, if this should happen.

3.3.3 Setting the Module Number

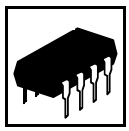
When the configuration has been successful, the module number (node ID) has to be set by means of the coding switches before the module is connected to power.
The module number can be assigned with values between 1 and 127 (01_h to $7F_h$).

The CAN-CBM-AI410-module wakes up in *preoperational* status, defined in accordance with CANopen, and shows this by transmitting the boot-up protocol to the CAN-bus.

If the CAN-CBM-AI410-module is booted-up with a module number outside the permissible range, the red LED flashes five times successively (see page 8). The green LED is off in this case.
As long as the module number is outside the defined range, the CAN-CBM-AI410 module does not get into preoperational status.

In order to correct the module number, you have to disconnect the module from power again to a new module number and then apply power again. Then the CAN-CBM-AI410 module wakes up in *preoperational* status and the green LED flashes permanently.

The default setting of the module number (node ID) is 01_h at the coding switch.



4. Description of Units

4.1 Transmit and Receive Circuit of CAN-Interface (Physical Layer)

The CAN-CBM-AI410 module has got a CAN-interface in accordance with ISO 11898.
It is connected to the bus line via a 5-pole COMBICON connector.

The power supply of the CAN-bus is electrically isolated from the applied 24 V-supply and the micro controller.
The signals are electrically isolated from the CAN-bus via optical couplers.

4.2 Analog Inputs

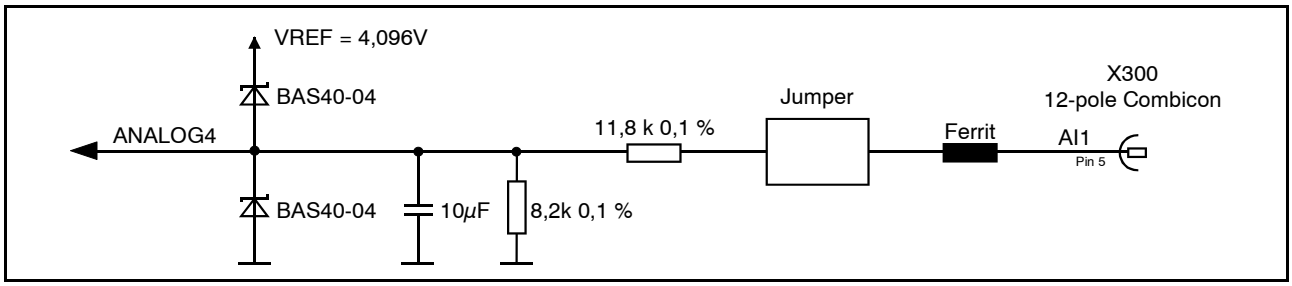


Fig. 4.2.1: Circuit of analog inputs

The analog input circuit is connected to the internal A/D converter of microcontroller C505CA. The converter has got a resolution of 10 bit. The circuit has been designed in such a way that it is possible to measure voltages from 0...10 V. If an external shunt of 500 Ω is used, it is also possible to measure current from 0...20 mA.

Attention: The position of the jumpers on the module must not be changed by the user !

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5. Connector Assignments

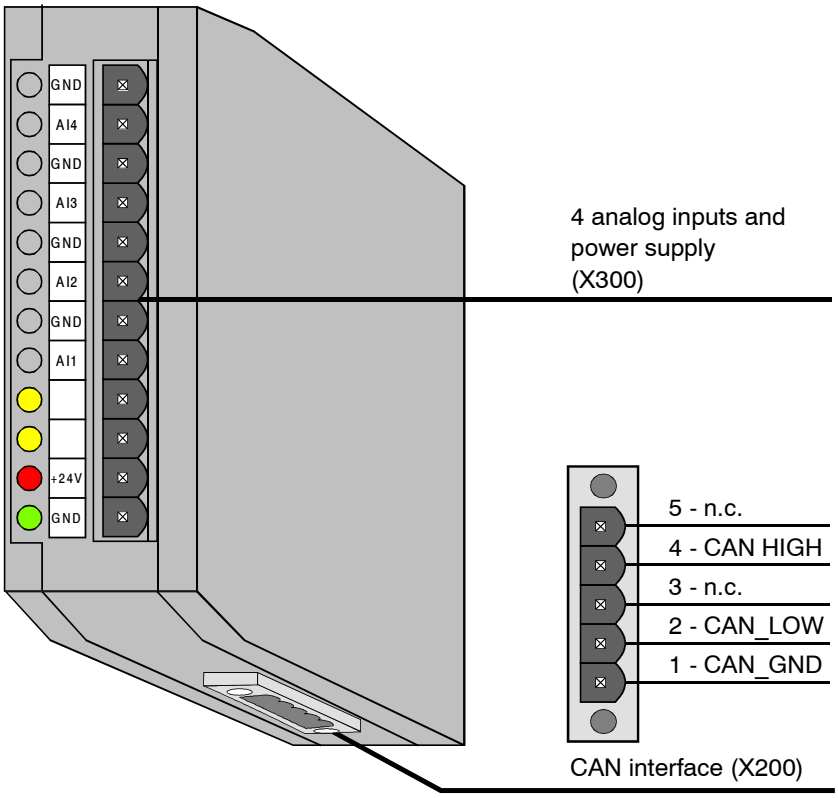
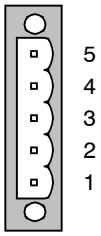


Fig. 5.1.1: Position of connectors X200 and X300

5.1 CAN-Bus (X200, 5-pole Combicon Style)

The CAN connection is on the bottom side of the housing. 5-pole COMBICON connectors (male) MSTB2.5/5-5.08 by Phoenix are used as connectors. Pins 3 and 5 are not connected.



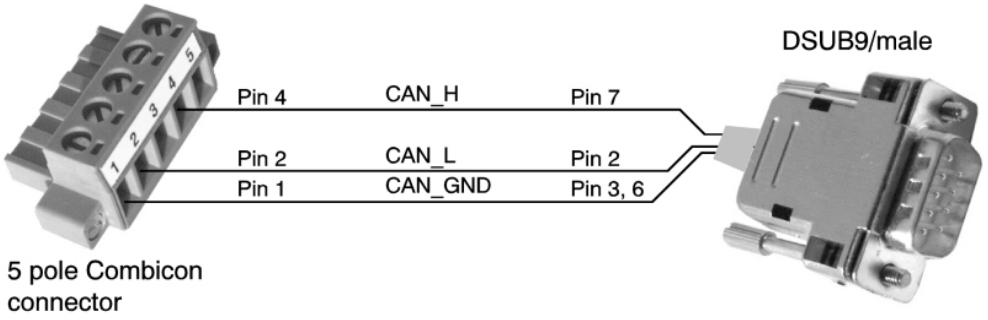
Pin	Signal
5	n.c.
4	CAN_H
3	n.c.
2	CAN_L
1	CAN_GND

Table 4.1: Pin Assignment of the Combicon socket of the module

Signal Description:

CAN_L, CAN_H ...	CAN signals
CAN_GND...	reference potential of the CAN physical layers

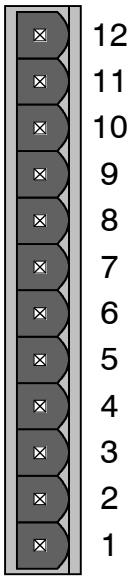
Adapter cable 5-pole Combicon to 9-pole DSUB:



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

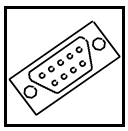
5.2 Analog Inputs and Power Supply (X300, 12-pole Combicon Style)

Pin position:



Pin assignment:

Pin	Signal
12	GND
11	AI4
10	GND
9	AI3
8	GND
7	AI2
6	GND
5	AI1
4	reserved (do not assign)
3	reserved (do not assign)
2	+24 V
1	GND



Connector Assignments

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6. Correctly Wiring Electrically Isolated CAN Networks

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

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

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

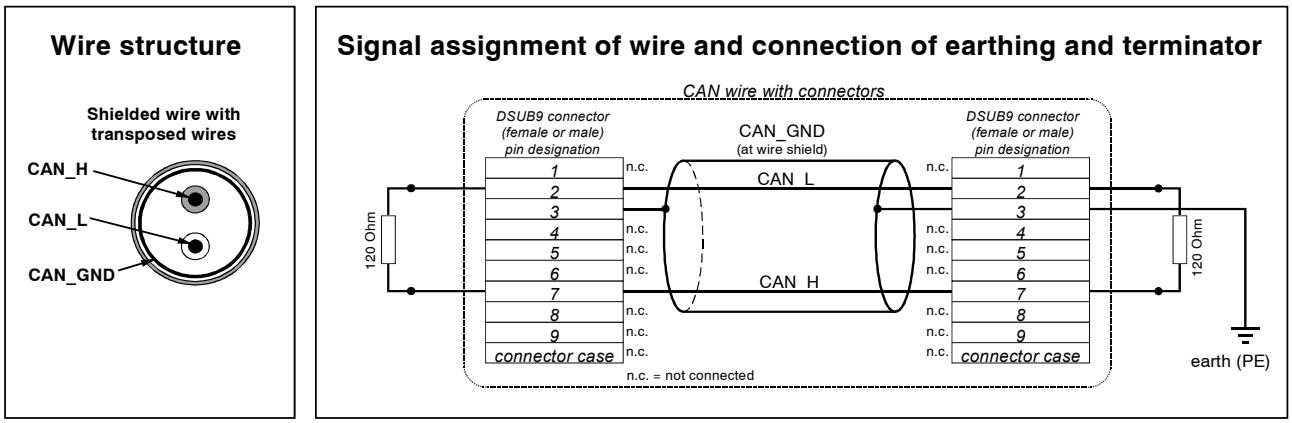


Figure: Structure and connection of wire

Cabling

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

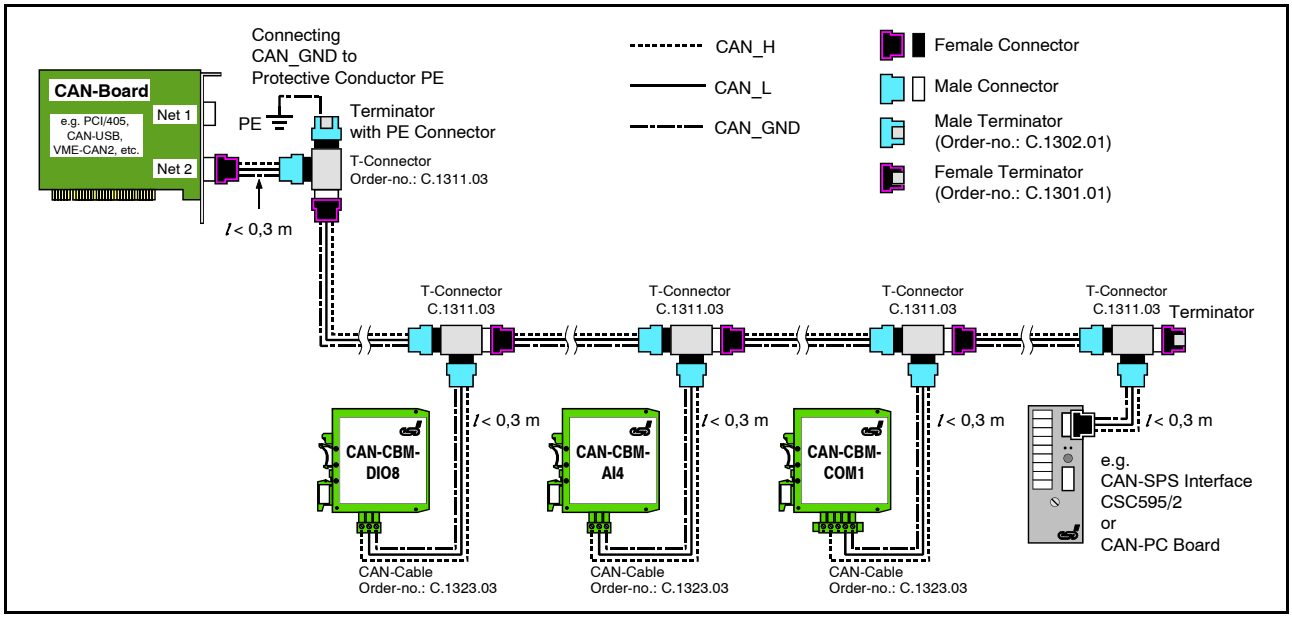


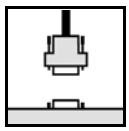
Figure: Example for correct wiring (when using single shielded wires)

Terminal Resistance

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

Earthing

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



Wire Length

❍ Optical couplers are delaying the CAN signals. By using fast optical couplers and testing each board at 1 Mbit/s, 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**.