CAN-PC104/200

PC/104-CAN-Interface

Hardware Installation
and
Technical Data

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Changes in the Chapters

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

Chapter	Changes versus previous version
2.1	Address range corrected.
3.6	Header in code example corrected.

Further technical changes are subject to change without notice.

N O T E

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1. Overview

1.1 Module Description

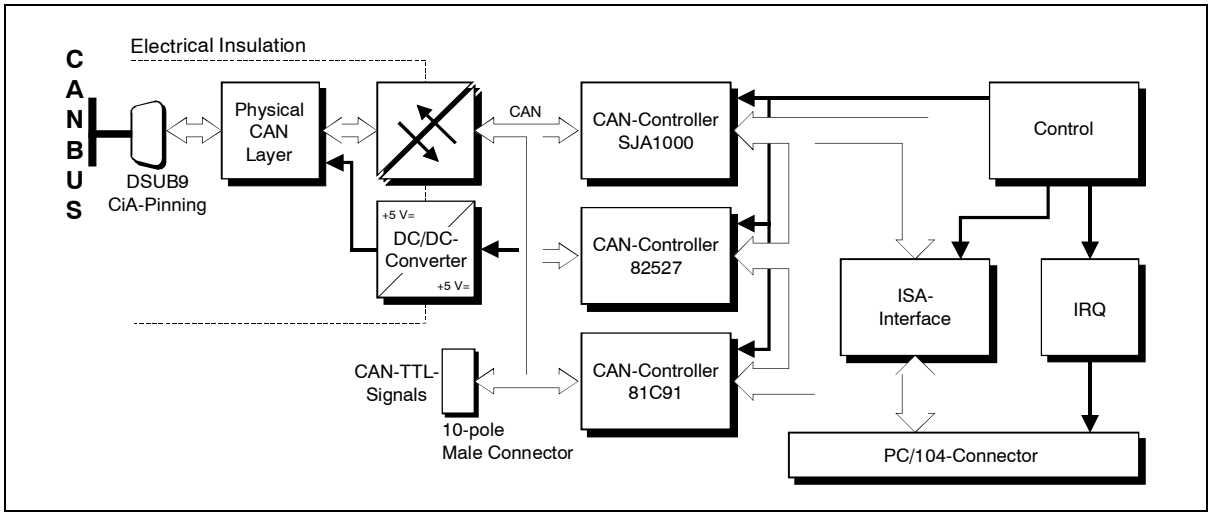


Fig. 1.1.1: Block-circuit diagram of the CAN-PC104 module

The CAN-PC104/200 board is a CAN-module for the PC/104-bus (PC/104, 8 bit). It uses the three most important CAN-controllers: Intel 8257, Siemens 81C91 and Philips SJA1000. The module can be operated in FULL- or BASIC-CAN.

Being equipped with three CAN-controllers, the PC104/200 module is ideally for development tasks or people just starting to work with CAN.

The CAN-interface is ISO11898-compliant and allows a maximum data-transfer rate of 1 Mbit/s. The bit rate, like many other properties of the CAN-interfaces, can be set by means of software.
The CAN-interface is electrically insulated from other potentials by means of optocouplers and DC/DC-converters.

1.2 PCB View with Connector Designation

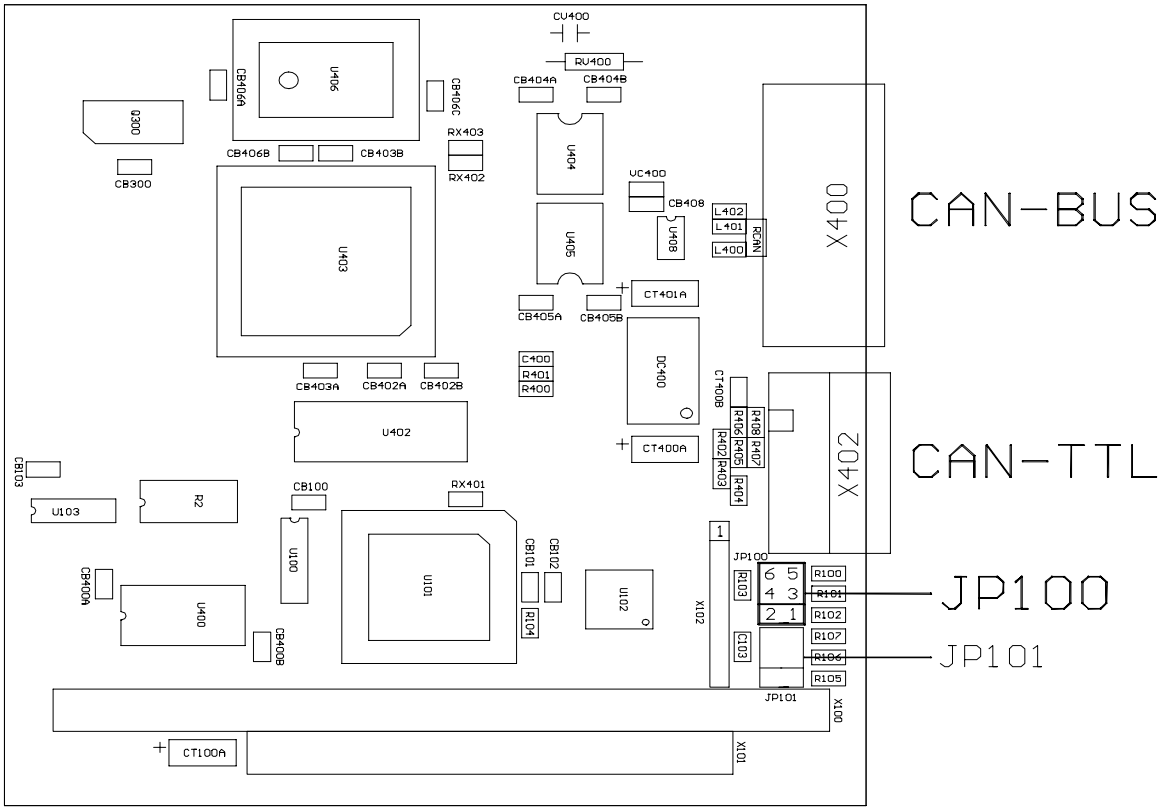
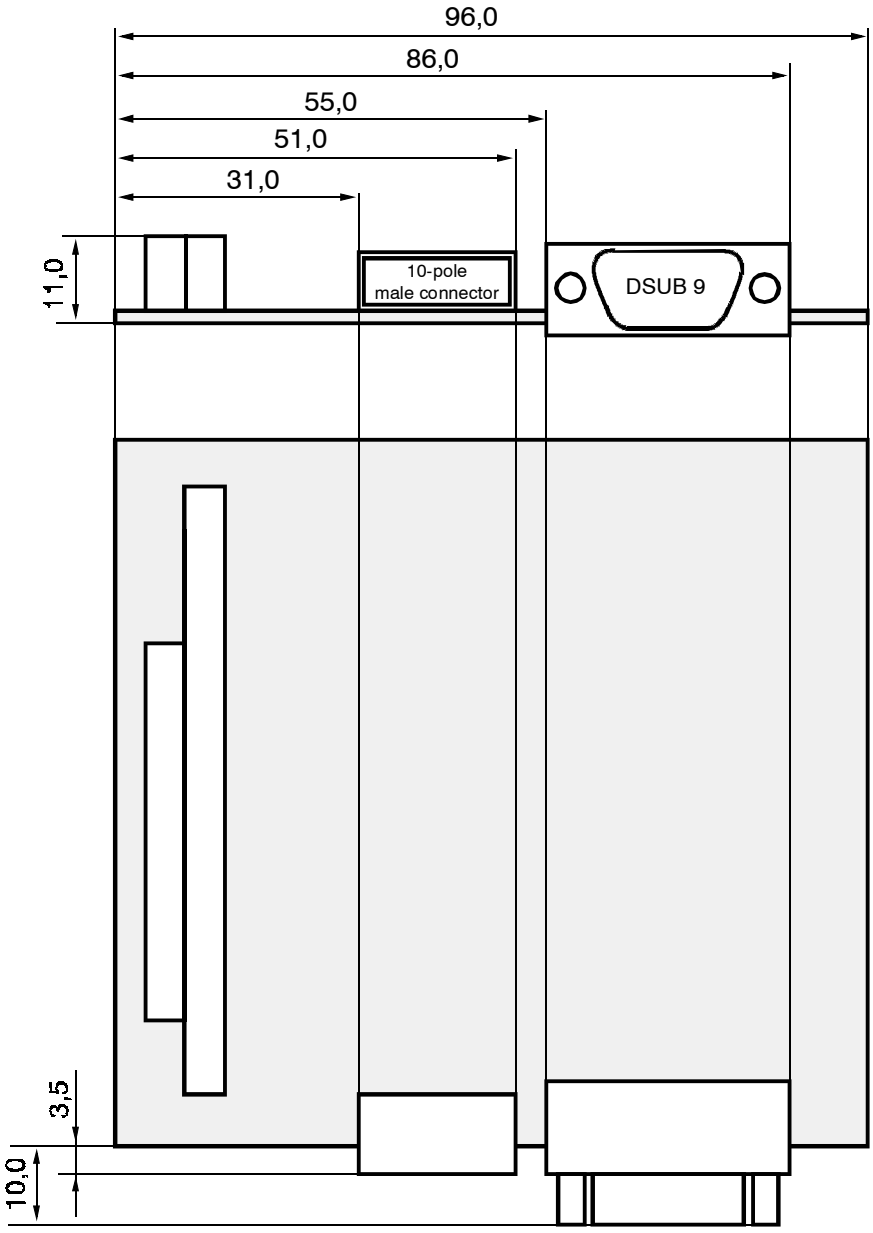


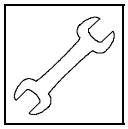
Fig. 1.2.1: View of the module

1.3 Connector Position and Board Dimensions



All listed values are in millimetres.

Fig. 1.3.1: CAN-PC104/200 technical drawing



2. Hardware Installation

2.1 Before Starting the Installation!

During the hardware installation it might be necessary to change the PC/104-I/O-port address. The address is default-set to **1E8...1EF** HEX. The CAN-module covers 8 data bytes. Furthermore, the interrupt has to be set during the following software installation.

The interrupt has to be set by software. There are no jumpers or switches to set the interrupt. The interrupt setting is described in the installation chapter in the software manual.

Please make sure to prevent address conflicts with other boards of the PC/104-system and conflicts with other interrupts!

Windows-NT/2000/XP Users:

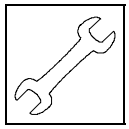
In order to avoid address and interrupt conflicts, the address assignment should be checked before starting the actual hardware installation.
In Windows NT 4.0 this can be made by selecting *Programs*/*Administrative Tools (Common)*/ *Windows NT Diagnostics* e.g. In the dialogue box *Windows NT Diagnostics* call *Resources* and there select *I/O Port*. A list with the used and available address areas appears.

Make sure that the default value of the PC104/200 is in a free memory area. If it is not, note a free memory area (which corresponds to the choices stated in fig. 2.2.2) and change the PC104/200 address by means of the jumper field during the hardware installation described below.

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 'CAN API with Software Tools and Installation Notes'.)

Windows-9x/ME Users:

If you are working with Windows 9x/ME, **first read the software installation guide** in the appendix of the manual 'CAN API with Software Tools and Installation Notes' and then start with the installation sequence!



2.2 Installing the Hardware and Setting the PC/104-Bus Address

The CAN-PC104 module can be used in all PC/104-compatible systems such as portable industry PCs or fixed control plants, therefore the carrier system will be described by the general term ‘computer’ in the following.

Attention!
Electro static discharge may cause damage to electronic devices. To avoid this, first do the following steps to discharge your personal static electricity, *before* you touch the CAN module:

- Switch off the power supply of all units but leave it connected to mains.
- Then touch the computer’s metal case to discharge the static electricity.
- Even your clothes must not touch the CAN module!

1. Switch off the computer and all connected peripheral devices (monitor, printer, ...). Switch off the CAN devices of the net to which the CAN module is to be connected.

2. Discharge yourself as described above if not yet done.

3. Disconnect the computer from mains by removing the mains connector.
   If the computer does not have a flexible mains lead but is fixed to the mains, disconnect the supply voltage via the safety fuse and protect the fuse from switching on again unintentionally.

4. Remove the computer cover

5. Select a free position in the PC/104-bus stack.
   There are no restrictions in choosing a position in the stack for this module as long as there are only 16-bit modules between it and the CPU.

6. Have you made sure that there will be no address conflict with other PC/104 boards? (See chapter '2.1 Before Starting Hardware Installation' above.)
   If you have to change the address of the board, go on with step 7 otherwise go on with step 8.

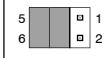
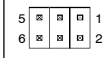
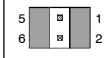
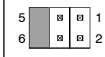
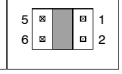
➠➠

7. Setting the PC/104-bus-I/O-port address
   The address is set via the jumper JP100. Next to it is the jumper field JP101, which is *not* being evaluated. The position of the jumper fields can be taken from figure 1.2.1 on page 4.

jumper pins:	5	3	1
	O	O	O
address selection bits:	**S2**	**S1**	**S0**
	O	O	O
jumper pins:	6	4	2

Fig. 2.2.1: Jumper field JP100
(As seen on component layer, CAN-bus connectors pointing to the top)

The hardware address has to be given to the driver during the software installation. The menu of the Windows NT installation program offers a choice of the following addresses:

Address Range	Jumper JP100
reserved	
0x100 - 0x107 HEX	
0x1E0 - 0x1E7 HEX	
0x1E8 - 0x1EF HEX (default setting)	
0x250 - 0x257 HEX	
0x2A0 - 0x2A7 HEX	
0x390 - 0x397 HEX	
0x3F0 - 0x3F7 HEX	

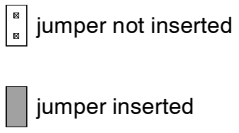
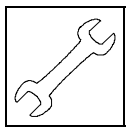


Fig. 2.2.2: Choices of addresses supported by the installation program

All other jumper combinations are not being supported by the installation program.

If you are working with Windows 9x/ME, you have to set the jumpers as proposed by the Windows-Hardware Wizard.



8. Install The CAN-module at the PC/104-stack position you have selected.

9. Close the computer case.

10. Connect the CAN or DeviceNet.
    Please note that the CAN has to be terminated at both ends. esd offers special T-connectors and terminators. Furthermore the CAN-GND signal has to be earthed at *exactly one* point in the CAN-network. Therefore the termination connectors are equipped with an earth connector. A CAN-participant without an electrically insulated interface acts as an earth connection.

    Please consult the notes on correct wiring of CAN-networks in the last chapter of this manual!

    The first CAN-interface (CAN net 0) is connected via the DSUB-connector (X400) and the second interface (CAN net 1) is connected via the DSUB-connector (X401).

11. Connect the power supply of the computer (mains connector or fuse).

12. Switch on the power supply of the computer, the peripheral devices and the other CAN-participants.

13. End of hardware installation.
    The software installation for is described in the manual 'CAN-API with Software Tools and Installation Notes'.

3. Accessing the Controllers

3.1 Introduction

This chapter describes the addresses and registers of the three CAN-controllers on the board.

> The information given here is only important for programmers who do *not* use the driver software available from esd for the module!

3.2 Address Range

The address range for the access to individual controllers is eight bytes. The basis address can be set by means of jumpers. Access to individual controllers is controlled by different offsets for this basis address. The following functions have been assigned to the individual offsets:

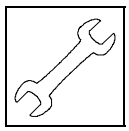
- 0 : (CS-C0) generating the chip-select signal for controller 0 (SJA1000)
- 1 : (ALE) generating the address-latch signal for controllers 0 and 2
- 2 : not assigned
- 3 : (IRQ) setting the IRQ
- 4 : (CS-C1) generating the chip-select signal for controller 1 (82527)
- 5 : (CS-C2) generating the chip-select signal for controller 2 (SAE81C91)
- 6 : not assigned
- 7 : (ALE+Hold) generating the address-latch signal for controller 1 (82527)

3.3 Access Sequence

All controllers have the register access split into two cycles in common. This can be seen in an I/O-action which is generally divided into two (output: write twice / input: write read) operations.

When accessing the controllers for the first time, the register address has to be specified as date in the controller. By writing this date in a certain offset for the basis address of the board, ‘ALE’ is signalled to the controllers and the data is therefore stored as address in the controller.

During the second access the register contents are transferred as date. This, again, is made via a certain controller-specific offset for the basis address of the board. This offset accesses one of the controllers via its ‘CS’ signal.



3.4 Special Features

The special feature of controller 82527 regarding its address-latch signal has to be considered. Because of the separate timing it is necessary to prolong the address-latch signal of this controller until the chip-select signal has been activated. A separate offset is available, therefore.

3.5 Setting the Board Interrupt

Another special feature is the selection of the board interrupt to be used. By means of offset '3' information about the IRQ-number and activation or deactivation of the IRQs can be stored in a latch on the board. This latch has got a bit-by-bit access. With a fictitious write date on the latch bits 0...2 and bit 7 are important. Bits 0...2 in the date select one of the bits in the latch. Bit 7 in the date contains the value of the selected bit in the latch. The bits in the latch have got the following meaning:

- 0 : (L0) *selection nibble for IRQ*
- 1 : (L1) "
- 2 : (L2) "
- 3 : (L3) "
- 4 : not used
- 5 : not used
- 6 : activate selection
- 7 : change IRQ-output from Tri-state into driven status

By means of *Selection nibble* one from ten IRQs within the PC104 PC can be selected:

L3	L2	L1	L0	IRQ
0	0	0	0	free
0	0	0	1	free
0	0	1	0	free
0	0	1	1	3
0	1	0	0	4
0	1	0	1	5
0	1	1	0	free
0	1	1	1	7
1	0	0	0	free
1	0	0	1	9
1	0	1	0	10
1	0	1	1	11
1	1	0	0	12
1	1	0	1	free
1	1	1	0	14
1	1	1	1	15

Table 3.5.1: Selecting the interrupt

3.6 Examples

The C-code extracts shown below represent examples for write or read accesses and IRQ-settings:

SJA1000:

```
void canOut
    (
    int reg,
    int value
    )
    {
    outp(canIoPort+1,reg);
    outp(canIoPort+0,value);
    }


int canInp
    (
    int reg
    )
    {
    outp(canIoPort+1,reg);
    return(inp(canIoPort+0));
    }
```

SAE81C91:

```
void canOut
        (
        int reg,
        int value
        )
        {
        outp(canIoPort+1,reg);
        outp(canIoPort+5,value);
        }


int canInp
        (
        int reg
        )
        {
        outp(canIoPort+1,reg);
        return(inp(canIoPort+5));
        }
```

82527:

```
void canOut
   (
   int reg,
   int value
   )
   {
   outp(canIoPort+7,reg);
   outp(canIoPort+4,value);
   }


int canInp
   (
   int reg
   )
   {
   outp(canIoPort+7,reg);
           return(inp(canIoPort+4));
   }
```

Activate IRQ:

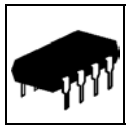
```
i1       = level;
    for (i=0;i<4;i++)
        {
        stat=i;
        if (i1 & 0x01)
            {
            stat |= 0x80;
            }

   outp(canIoPort+3,stat);
        i1=i1>>1;
        }
    outp(canIoPort+3,0x87);
    outp(canIoPort+3,0x86);
```

Deactivate IRQ :
(delete selection completely)

```
outp(canIoPort+3,0x07);
outp(canIoPort+3,0x06);

for (i=0;i<4;i++)
    outp(canIoPort+3,i);
```



4. Summary of Technical Data

4.1 General Technical Data

Ambient temperature	0...50 ˚C
Humidity	max. 90%, non-condensing
Supply voltage	via PC/104-bus, nominal voltage: 5 V ±5% power consumption (20 ˚C, all CAN controllers equipped): 250 mA (typical)
Connectors	X100 (64-pole PC/104-PCB connector) - PC/104-bus X101 (40-pole PC/104-PCB connector) - PC/104-bus X400 (DSUB9/male) - CAN-interface (ISO11898) X402 (10-pole male connector) - CAN-TTL signals The following connector is only equipped for programming and service: X102 (8-pole male connector) - ISP-programming
Dimensions	95.9 mm x 90.2 mm
Weight	< 150 g

Table 4.1.1: General module data

4.2 PC/104 Bus

Host bus	PC/104
PC/104-data bus	8 bit
Interrupt	1 out of 12
Connectors	PC/104-PCB connectors, 40-pole and 64-pole

Table 4.2.1: PC/104-bus data

4.3 CAN-Interface

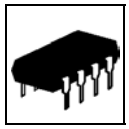
Number	1
CAN-controller	Intel 8257, Siemens 81C91 and Philips SJA1000 (selectable via software)
CAN-protocol	Basic- or Full-CAN
Physical interface	ISO 11898-compliant physical layer, transfer rate programmable from 10 kbit/s to 1 Mbit/s
Bus termination	has to be set externally
Electrical insulation of CAN-interfaces from other units	insulation of CAN-interfaces from other PC/104-bus potentials by optocouplers and DC/DC-converters

Table 4.3.1: Data of the CAN-interface

4.4 Software Support

The module has got layer-2 drivers for the operating system VxWorks for all three controllers.
A few basic C-program codes are contained for initialization, setting the bit rate and for CAN-read and write accesses.

Also contained are software examples for DOS and Windows 3.11. Furthermore, software drivers for Windows NT and Windows 9x/ME are available. The Windows NT driver is written in kernel mode and is multiprocessor-conform. The Windows 9x/ME driver is realized as VxD.



4.5 Order Notes

Type	Features	Order No.
CAN-PC104/200-1	1x CAN, 3 controllers	C.2013.02
CAN-PC104/200-1-MM	1x CAN 2.0A/B with 3 CAN controllers, with AMD Micromatch connector instead of DSUB9 for CAN	C.2013.09
Options:		
CAN-Kabel-MB	adapter cable DSUB9 (male) to 10-pol. Micromatch (male), 15 cm ribbon cable, only for C.2013.09 necessary	C.1323.015
CAN-PC104/200-95	Windows 95/98/ME VxD-driver	C.2013.10
CAN-PC104/200-NT	Windows NT Device-driver (can also be used under windows 2000/XP)	C.2013.11
CAN-PC104/200-Linux	Linux driver	C.2013.19
CAN-PC104/200-QNX	QNX4 driver	C.2013.32
CAN-PC104/200-VxW	VxWorks-CAN-API, object code	C.2013.55
CAN-PC104/200-Co	CANopen-object licence	C.2013.12
CAN-PC104/200-ME *)	English manual for C.2013.02 and C.2013.09	C.2013.21
CAN-API-ME *)	English software manual	C.2001.21
CAL/CANopen-ME *)	Additional English software manual for C.2013.12	C.2002.21

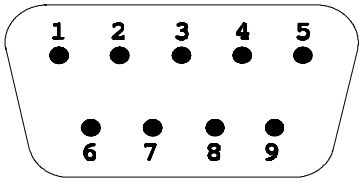
*) If order together with the module, the manual will be delivered free of charge.

Table 4.5.1: Order notes

5. Connector Assignment

5.1 CAN-Interface (X400)

Pin Location:



Pin Assignment:

Signal	Pin		Signal
		1	reserved
CAN_GND	6	2	CAN_L
CAN_H	7	3	CAN_GND
reserved	8	4	reserved
reserved	9	5	shield

9-pole DSUB male

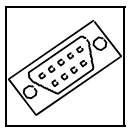
Signal Description:

CAN_L, CAN_H... CAN-signal lines

CAN_GND ... reference potential of the local CAN-physical layer

shield ... potential of the connector cover

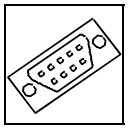
reserved ... reserved for future applications



5.2 CAN-TTL Signals (X402)

Connector X402 carries the Rx/Tx signals of the CAN-controller. The signals are on TTL-level and are not electrically insulated from the other micro controller units!

Signal name	Pin		Signal name
+5V	1	2	Tx00*
Tx01*	3	4	Rx00*
Rx01*	5	6	-
-	7	8	-
-	9	10	GND

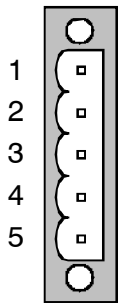


5.3 Option: DeviceNet Adapter Boards

By means of connector X402 a DeviceNet adapter board can be connected. The adapter board is available either with a DeviceNet interface with Phoenix Combicon connector MSTB 2.5/-GF-5.08 (or equivalent) or with a CAN-interface with a DSUB9-connector. The assignment of this DSUB9-connector is the same as that of X400.

The DeviceNet interface is designed in accordance with the specification 'DeviceNet Communication Model and Protocol, Rel. 2.0'. The power supply of the CAN-driver is externally supported.

Pin Assignment:



Pin	Signal
1	V-
2	CAN-
3	shield
4	CAN+
5	V+

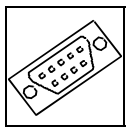
Signal Description:

V+... power supply for CAN-interface (U_{VCC} = 24 V ± 4%)

V-... reference potential for V+ and CAN+/CAN-

CAN+, CAN-... CAN-signal lines

shield... shielding
(via highly resistive RC-combination connected to earth (shield panel))



The DeviceNet option includes the CAN-PC104/200 module, the DeviceNet adapter board, the ribbon cable, the fixing brackets and all necessary bolds, screws and washers.
The connector labelled 'OUT' does not have any function on the adapter board. It is only required for CAN-modules with TTL-outputs for two CAN-networks.

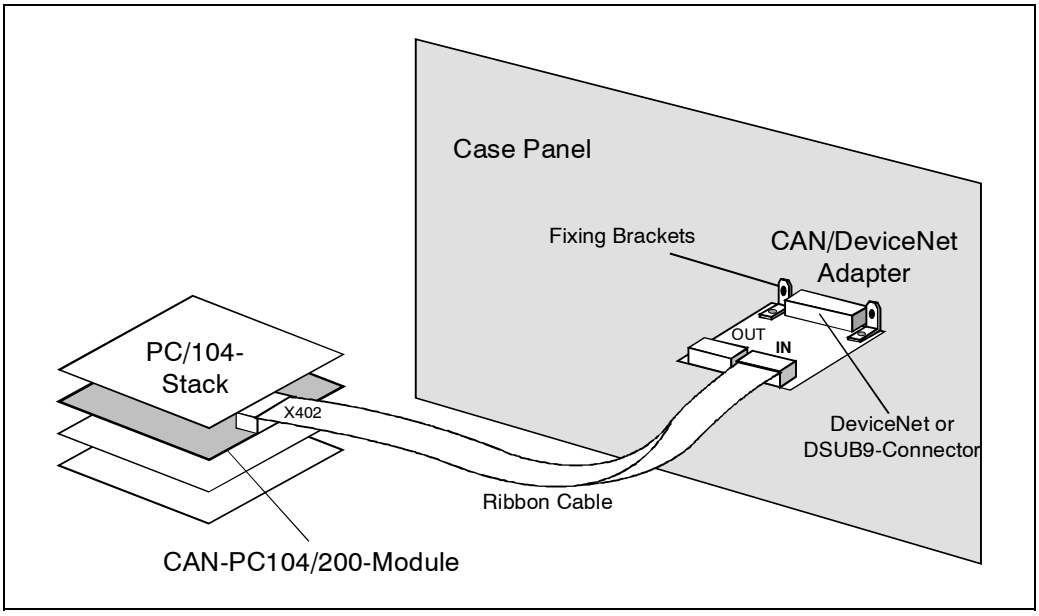


Fig. 5.3.1: Connection of the adapter board

All dimensions specified in the following drawings are in millimetres.

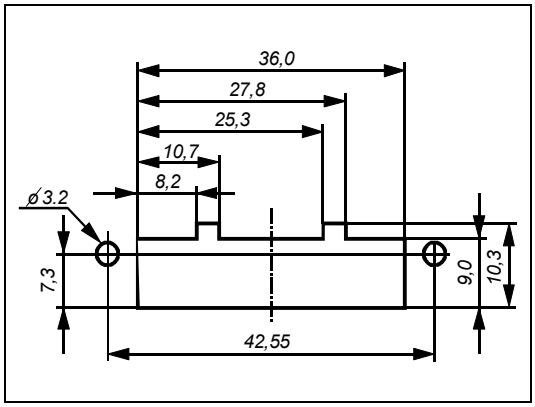


Fig. 5.3.2: Recess in case panel for adapter boards with DeviceNet connector

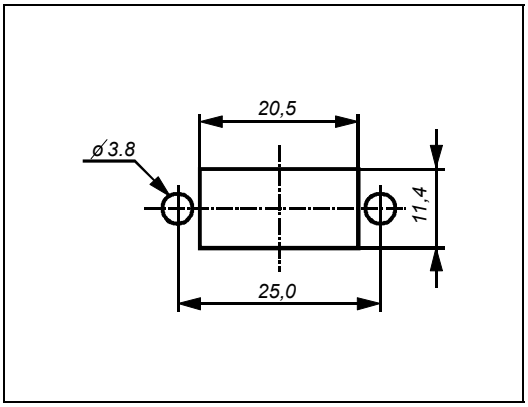


Fig. 5.3.3: Recess in case panel for adapter boards with DSUB9-connector

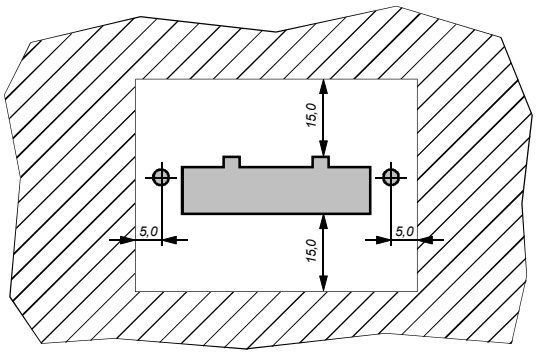


Fig. 5.3.4: Required free space outside the case for adapter boards with DeviceNet connector (space considers e.g. the following Phoenix Combicon connector types:
MSTB, MSTBP, MVSTBR, MVSTBW, TMSTBP)

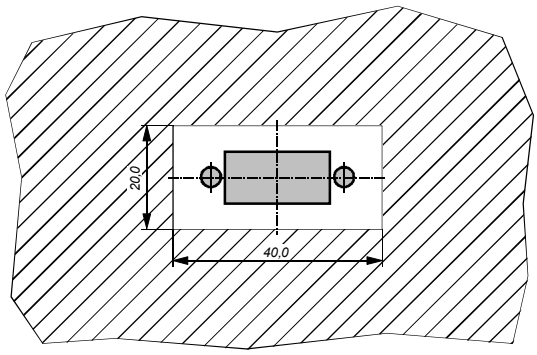


Fig. 5.3.5: Required free space outside the case for adapter boards with DSUB9-connector

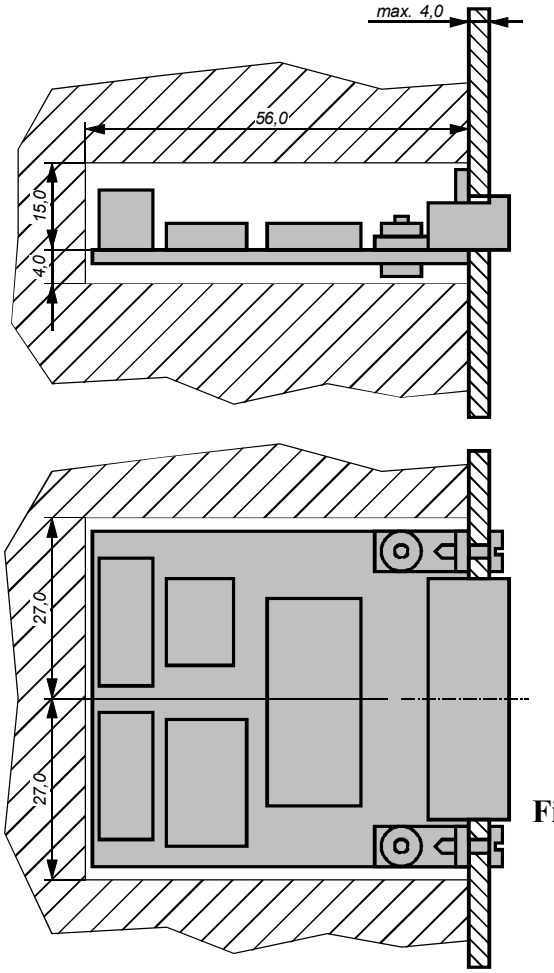


Fig. 5.3.6: Required free space inside the case for adapter boards with DeviceNet or DSUB9-connector

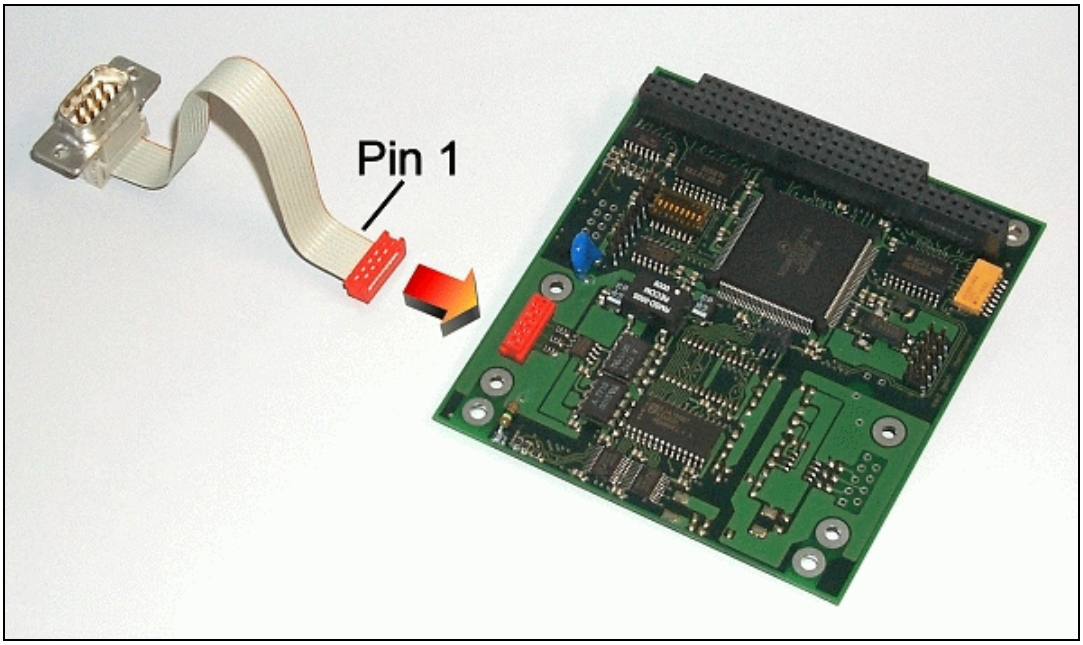
6. Version CAN-PC104/xxx-Micromatch

6.1 Overview

This version of the PC104-module has got an AMP-Micromatch socket instead of a DSUB9-CAN-connector. The socket is so small that it does not protrude the PCB, even if it is connected to a plug. This is of great advantage, if the module is to be used in a narrow case.

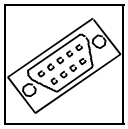
esd offers the adapter cable 'CAN-Cable-MB' (Order No. C.1323.015) with a length of 15 cm to convert from micromatch connector to DSUB9. The DSUB-connector of the adapter cable corresponds to the standard assignment of a 9-pin DSUB-connector for CAN (see DSUB9-CAN-connectors). The adapter cable has to be ordered in addition to the PC104-module.

Attention:	The micromatch connector is **not protected against wrong polarity**!! The connecting cable must always be connected as shown in the figure below!



If you want to make the adapter cable yourself, you require the following information:

The AMP-socket used on the board has got the following designation:
AMP Micromatch, FL, 10-pin, No. 8-215079-0



Connector Assignment

The plug required, designed for use with standard flat-ribbon cables and crimp connection, has got the following designation:
AMP Micromatch, FRC, 10-pin, No. 8-215083-0
(available, e.g. from Farnell under order number 149-081)

The maximum length of the adapter cable including the externally connected cable to the T-piece must not exceed 30 cm (ISO11898)!

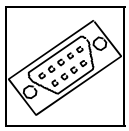
6.2 Pin Assignment Micromatch Socket

The following table shows the assignment of the micromatch socket on the board. Pin 6 of the socket is not assigned.

Pin Assignment (View from Top Layer onto Connector):

Signal	Pin		Signal
reserved	1	6	not connected
CAN_L	2	7	CAN_GND
CAN_GND	3	8	CAN_H
reserved	4	9	reserved
shield	5	10	reserved

10-pin AMD-micromatch socket



6.3 Adapter Cable Micromatch (male) to DSUB9(male)

The adapter cable 'CAN-Cable-MB' (Order No. C.1323.015) consists of the two connectors and one flat-ribbon cable with 9 wires which is crimped with wire 1 to pin 1 of the DSUB-connector at one end and with wire 1 to pin 1 of the micromatch connector at the other end. The highest pin of the micromatch connector (pin 6) is not assigned.

DSUB9-connector (male) Pin	**Flat-ribbon cable signal**	**Micromatch connector** (male) Pin
1	reserved	1
2	CAN_L	2
3	CAN_GND	3
4	reserved	4
5	shield	5
		6
6	CAN_GND	7
7	CAN_H	8
8	reserved	9
9	reserved	10

7. 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.

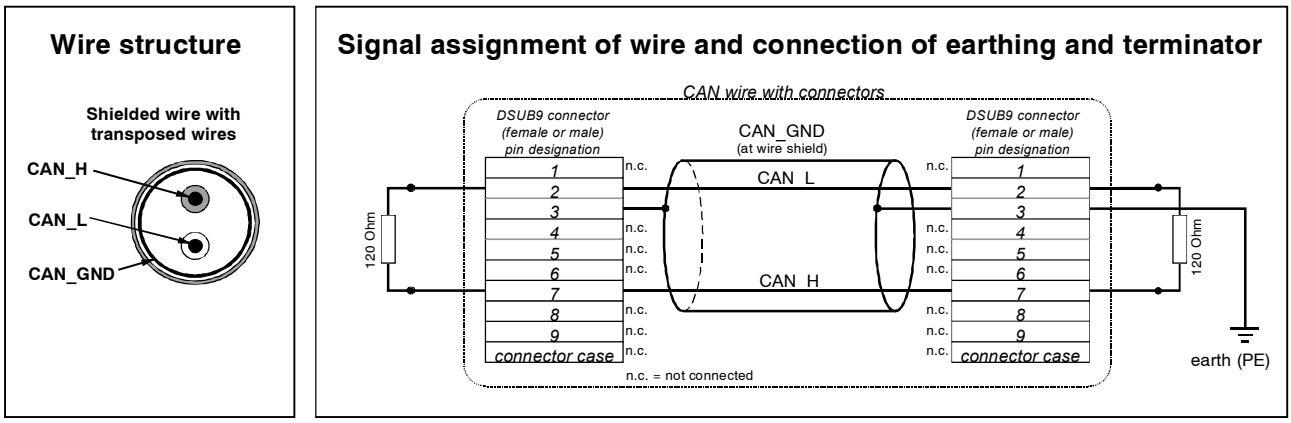


Figure: Structure and connection of wire

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)

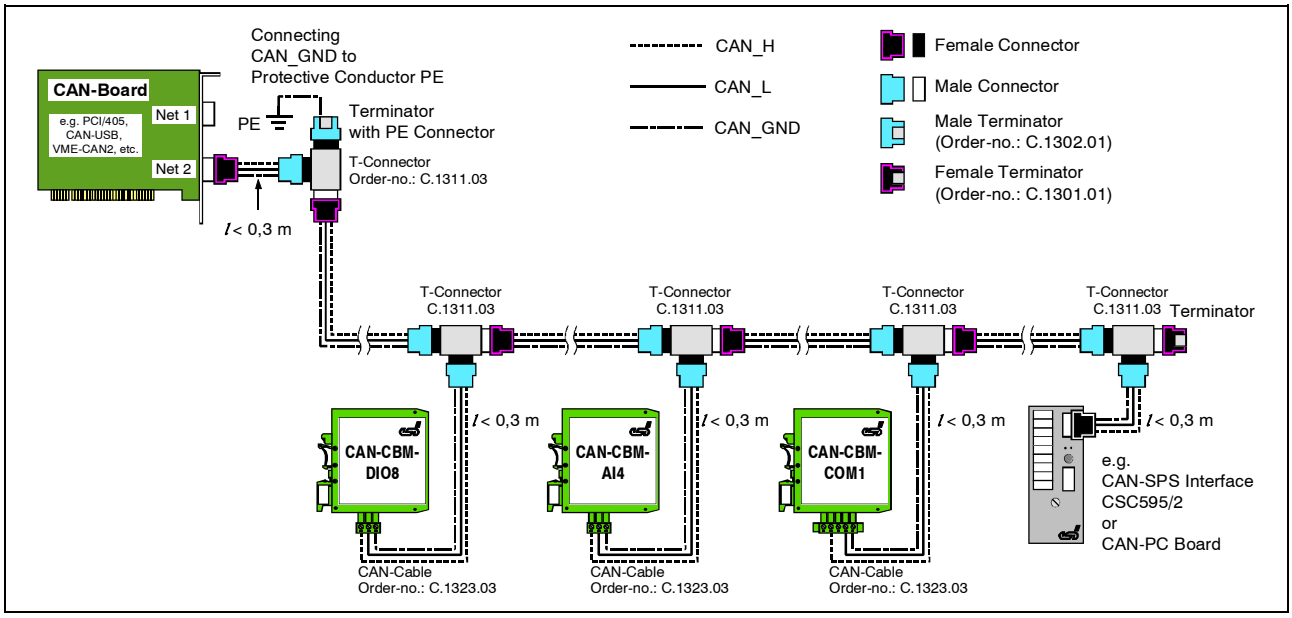


Figure: Example for correct wiring (when using single shielded wires)

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

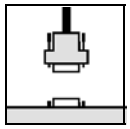
- CAN_GND has to be conducted in the CAN wire, because the individual esd modules are electrically isolated from each other!
- CAN_GND has to be connected to the earth potential (PE) at **exactly one** point in the net!
- each CAN user without electrically isolated interface works as an earthing, therefore: 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**.