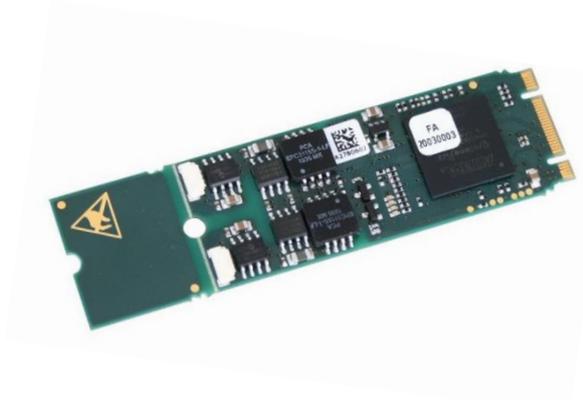




# CAN-M.2/402

M.2 Card with 2 or 4 CAN FD<sup>®</sup> Ports



CAN-M.2/402-2-FD



CAN-M.2/402-4-FD

## Hardware Manual

to Product C.2074.64,  
C.2074.68, C.2074.69

## Notes

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This manual contains important information and instructions on safe and efficient handling of the CAN-M.2/402. Carefully read this manual before commencing any work and follow the instructions.  
The manual is a product component, please retain it for future use.

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## Document History

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

Rev.	Chapter	Changes versus previous version	Date
1.0	-	First English manual of CAN-M.2/402-2-FD	2020-08-27
1.1	all	Description of CAN-M.2/402-4 variants added. Description of CAN-M.2/402-2-FD revised.	2025-04-08

Technical details are subject to change without further notice.

## Classification of Warning Messages and Safety Instructions

This manual contains noticeable descriptions, warning messages and safety instructions, which you must follow to avoid personal injuries or death and property damage.



This is the safety alert symbol.

It is used to alert you to potential personal injury hazards. Obey all safety messages and instructions that follow this symbol to avoid possible injury or death.

### DANGER, WARNING, CAUTION

Depending on the hazard level the signal words DANGER, WARNING or CAUTION are used to highlight safety instructions and warning messages. These messages may also include a warning relating to property damage.



#### DANGER

Danger statements indicate a hazardous situation which, if not avoided, will result in death or serious injury.



#### WARNING

Warning statements indicate a hazardous situation that, if not avoided, could result in death or serious injury.



#### CAUTION

Caution statements indicate a hazardous situation that, if not avoided, could result in minor or moderate injury.

### NOTICE

Notice statements are used to notify people on hazards that could result in things other than personal injury, like property damage.



#### NOTICE

This NOTICE statement indicates that the device contains components sensitive to electrostatic discharge.



#### NOTICE

This NOTICE statement contains the general mandatory sign and gives information that must be heeded and complied with for a safe use.

### INFORMATION



#### INFORMATION

Notes to point out something important or useful.



## Safety Instructions

- When working with the CAN-M.2/402 follow the instructions below and read the manual carefully to protect yourself from injury and the CAN-M.2/402 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-M.2/402 and follow the CAN wiring hints in chapter: "Correct Wiring of Galvanically 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.
- The galvanic isolation of the CAN-M.2/402 or adapters has only functional tasks and is not protected against hazardous electrical voltage.
- The CAN-M.2/402 may only be operated on supply circuits that provide sufficient protection against dangerous voltages.
- External circuits connected to the ports of the CAN-M.2/402 must be sufficiently protected against dangerous voltage.
- The user is responsible for compliance with the applicable national safety regulations.
  
- The device has to be securely installed in the control cabinet before commissioning.
- Protect the CAN-M.2/402 from dust, moisture and steam.
- Protect the CAN-M.2/402 from shocks and vibrations.
- The CAN-M.2/402 may become warm during normal use. Always allow adequate ventilation around the CAN-M.2/402 and use care when handling.
- Do not operate the CAN-M.2/402 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-M.2/402 is to be integrated.

- Disconnect all hazardous voltages (mains voltage) before opening the system.
- Ensure the absence of voltage before starting any electrical work



### NOTICE

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

- Take the appropriate precautions for handling electrostatic discharge sensitive devices.
- Discharge the static electricity from your body before touching the CAN-M.2/402.
- Transport and store the CAN-M.2/402 only in an electrostatically safe bag, as when delivered.
- Furthermore, you should prevent your clothes from touching the CAN-M.2/402, because your clothes might be electrostatically charged as well.

### Qualified Personnel

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

## Conformity

The CAN-M.2/402 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-M.2/402 may cause radio interferences in which case the user may be required to take adequate measures.

The CAN-M.2/402 is a sub-assembly intended for incorporation into an apparatus by a manufacturer and NOT by the end user. The manufacturer of the final system must decide whether additional EMC or EMI protection requirements are necessary.

## Intended Use

The intended use of the CAN-M.2/402 is the operation as CAN FD interface for Embedded 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-M.2/402 is intended for installation in an Embedded System or PC, with indoor use only.
- The operation of the CAN-M.2/402 in hazardous areas, or areas exposed to potentially explosive materials is not permitted.
- The operation of the CAN-M.2/402 for medical purposes is prohibited.

## Service Note

The CAN-M.2/402 does not contain any parts that require maintenance by the user. The CAN-M.2/402 does not require any manual configuration of the hardware. Unauthorized intervention in the device voids warranty claims.

## Disposal

Devices which have become defective in the long run have to be disposed in an appropriate way or must be returned to the manufacturer for proper disposal. Please, contribute to environmental protection.

---

## Typographical Conventions

Throughout this manual the following typographical conventions are used to distinguish technical terms.

Convention	Example
File and path names	<code>/dev/null</code> or <code>&lt;stdio.h&gt;</code>
Function names	<code><b>open()</b></code>
Programming constants	<code>NULL</code>
Programming data types	<code>uint32_t</code>
Variable names	<code><i>Count</i></code>

## Number Representation

All numbers in this document are base 10 unless designated otherwise. Hexadecimal numbers have a prefix of 0x, and binary numbers have a prefix of 0b. For example, 42 is represented as 0x2A in hexadecimal and 0b101010 in binary.

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# 1 Overview

## 1.1 About this Manual

This manual describes the hardware variants of the CAN-M.2/402. The product is available in different variants, which differ in the number of CAN ports and the supported temperature range.

- CAN-M.2/402-2-FD – Variant with two CAN ports
- CAN-M.2/402-4-FD, CAN-M.2/402-4-FD-T – Variants with four CAN ports

The variants with four CAN ports, collectively referred to as CAN-M.2/402-4, differ only in the supported temperature range.

All specific differences between the variants of the CAN-M.2/402 are explicitly noted in this manual. Functional features, available options, and included components may differ depending on the selected CAN-M.2/402 variant.

	<p><b>NOTICE</b></p> <p>To avoid damage to the CAN-M.2/402 card or adapter and to ensure EU conformity, ensure that you only use the associated adapter for your CAN-M.2/402 card! See Table 1.</p>
---	---

### Short Overview

Variant	Specification			Use with Adapter		
	Number of CAN FD ports	Galvanic isolation of the CAN port	Ext. Temp. Range	CAN-Mini/402-DSUB9-15cm or -30cm	CAN-Mini/402-DSUB9-ISOL with galvanic isolation of CAN	CAN termination via adapter
CAN-M.2/402-2-FD (C.2074.64)	2x	✓	-	✓	Not compatible!	✓
CAN-M.2/402-4-FD (C.2074.68)	4x (TTL-level)	- (use adapter →)	-	Not compatible!	✓	✓
CAN-M.2/402-4-FD-T (C.2018.69)	4x (TTL-level)	- (use adapter →)	✓	Not compatible!	✓	✓

Table 1: Product overview

## 1.2 Description

### 1.2.1 2x CAN Variant CAN-M.2/402-2-FD

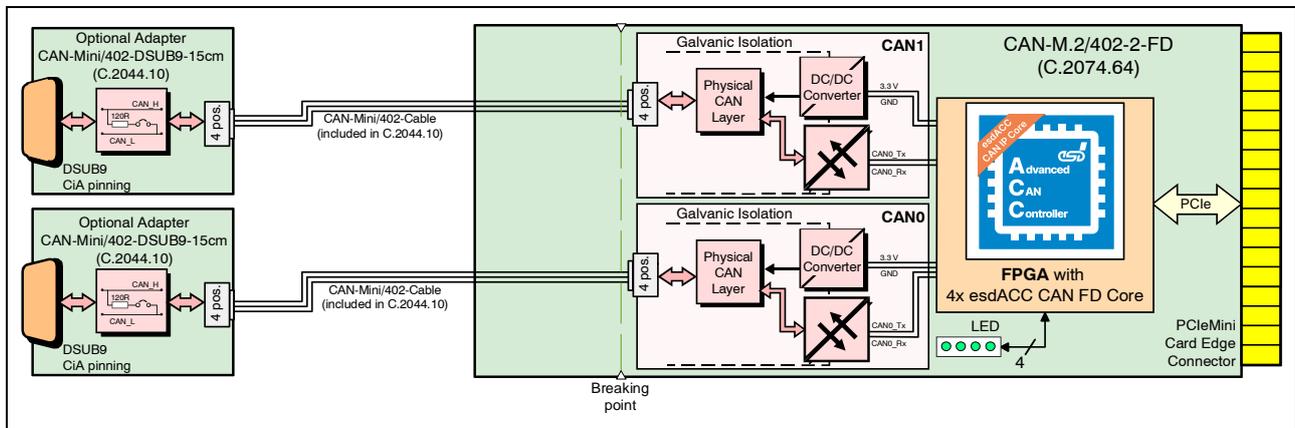


Figure 1: Block circuit diagram of CAN-M.2/402-2-FD

The CAN-M.2/402-2-FD is an M.2 card, that features two galvanically isolated CAN FD ports. The optional adapters CAN-Mini/402-DSUB9-15cm and CAN-Mini/402-DSUB9-30cm come with a DSUB9 connector, selectable on-board CAN termination and an adapter cable of 15 cm or 30 cm length.

### 1.2.2 4x CAN Variants CAN-M.2/402-4

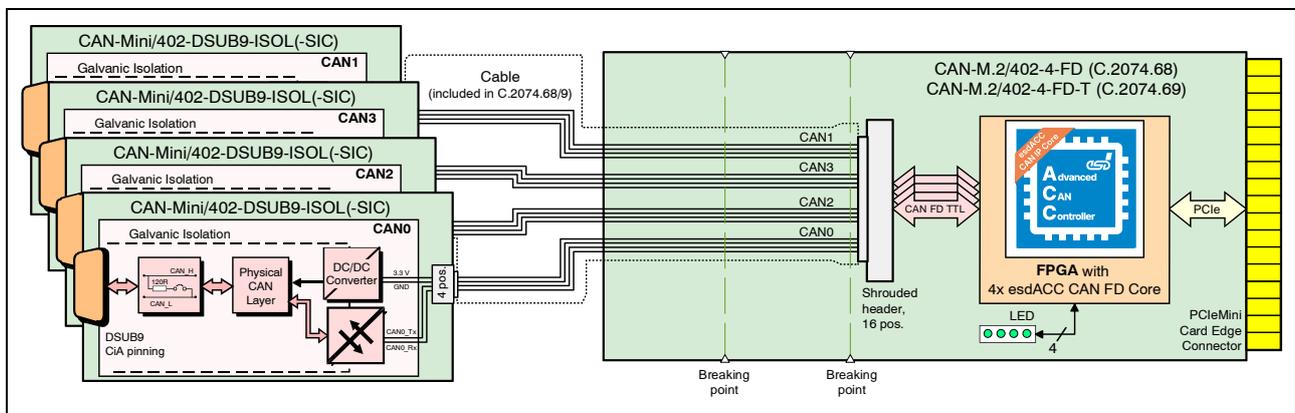


Figure 2: Block circuit diagram of CAN-M.2/402-4 variants

The CAN-M.2/402-4-FD is an M.2 Card, that features four CAN FD ports (TTL level). The adapter cable is included in delivery. The card length can be easily reduced. The CAN-M.2/402-4-FD-T variant is functionally identical to the CAN-M.2/402-4-FD but features components designed for an extended temperature range.

Each port can be connected to the CAN-Mini/402-DSUB9-ISOL, a bi-directional TTL-to-CAN level adapter available as an accessory, using the supplied cable. The adapter provides galvanic isolation and implements the physical CAN FD layer.

It has a jumper-selectable onboard CAN termination and a DSUB9 connector for integration into a CAN FD network. The CAN FD ports are fully backward compatible with CAN CC environments.

The adapter variant CAN-Mini/402-DSUB9-ISOL-SIC is almost identical in construction but uses a CAN FD SIC transceiver with signal improvement capability.

### 1.2.3 CAN Data Management

The ISO 11898-2-compatible CAN FD ports allow each a maximum data transfer rate of 8 Mbit/s, or 1 Mbit/s for CAN CC applications. The CAN FD ports are fully backwards compatible and can also be used in CAN classic (CAN CC) applications.

The CAN FD ports are controlled by the esdACC (esd Advanced CAN Controller) developed by esd and certified according to ISO 16845:2004, which is implemented in an FPGA.

The FPGA supports bus mastering (first-party DMA) to transfer data to the host memory. This results in a reduction of overall latency on servicing I/O transactions, in particular at higher data rates and a reduced host CPU load.

Due to the support of MSI (Message Signalled Interrupts) CAN-M.2/402 can be operated for example in Hypervisor environments. The CAN-M.2/402 supports high resolution 64-bit hardware timestamps to enable highly accurate reception and transmission of CAN messages.

The CAN layer 2 (NTCAN-API) drivers for Windows® and Linux® are included in the scope of delivery. See “Order Information” on page 44 for availability of other drivers.

Customized options are available for customized series production in reasonable quantities. Please contact our sales team for detailed information.

Additional free-of-charge esd CAN tools for Windows are downloadable from our website. The tools offer efficient setup and analysis of CAN CC applications and networks.

## 1.3 Glossary

### Abbreviations

Abbreviation	Term
API	Application Programming Interface
CAN	Controller Area Network
CAN CC	CAN classic
CAN FD	CAN flexible data-rate
CPU	Central Processing Unit
CiA	CAN in Automation
esd	esd electronics gmbh
HW	Hardware
I/O	Input/Output
n.a.	not applicable
OS	Operating System
SDK	Software Development Kit
PCI	Peripheral Component Interconnect
PCIe	PCI Express
IDC	Insulation Displacement Connector

## 2 PCB View with Connectors and LEDs

### 2.1 CAN-M.2/402-2-FD

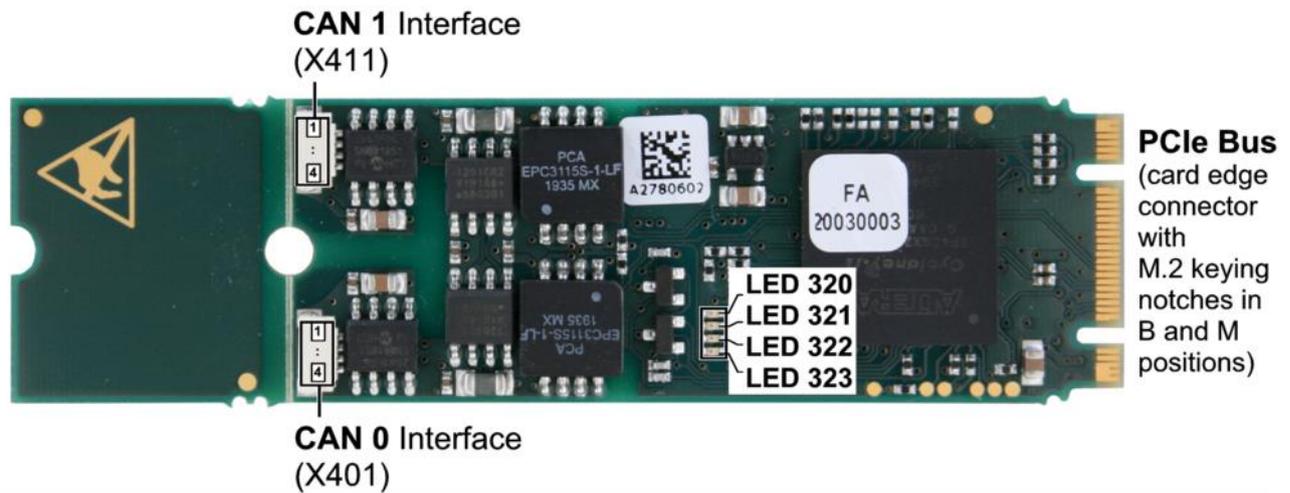


Figure 3: PCB view CAN-M.2/402-2-FD



#### NOTICE

Read chapter "Hardware Installation" on page 23, before you start with the installation of the hardware!

#### 2.1.1 LED Description

The CAN-M.2/402-2-FD comes with four green LEDs, which are equipped on the top layer, see Figure 3.

LED name in schematic diagram	Name	Indicator State	Description
LED320	Power	Off	Power supply voltage off / FPGA not booted
		On	Power supply voltage on / FPGA ready
LED321	reserved	-	-
LED322	Activity CAN1	Off	No CAN bus connection and/or no data transfer on CAN1
		On	Connected to CAN bus 1 and CAN data transfer on CAN1
LED323	Activity CAN0	Off	No CAN bus connection and/or no data transfer on CAN0
		On	Connected to CAN bus 0 and CAN data transfer on CAN0

Table 2: LEDs of CAN.M.2/402-2-FD

## 2.2 CAN-M.2/402-4 Variants

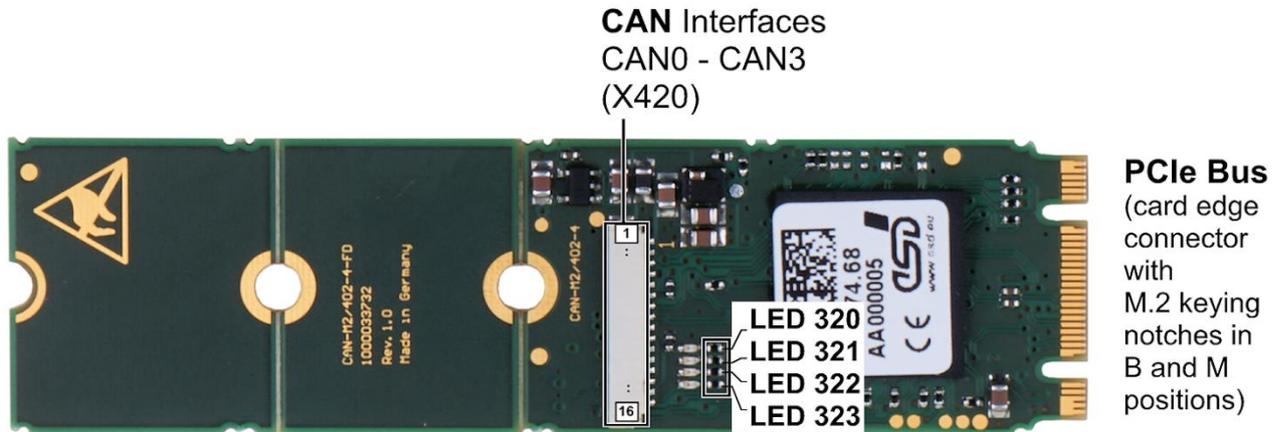


Figure 4: PCB view of CAN-M.2/402-4-FD

**NOTICE**  
 Read chapter “Hardware Installation” on page 23, before you start with the installation of the hardware!

### 2.2.1 LED Description

The CAN-M.2/402-4 variants come with four green LEDs, which are equipped on the top layer, see Figure 4.

LED name in schematic diagram	Function	Indicator State	Description
LED320	Activity CAN0	Off	No CAN bus connection and/or no data transfer on CAN0
		On	Connected to CAN bus 0 and CAN data transfer on CAN0
LED321	Activity CAN1	Off	No CAN bus connection and/or no data transfer on CAN1
		On	Connected to CAN bus 1 and CAN data transfer on CAN1
LED322	Activity CAN2	Off	No CAN bus connection and/or no data transfer on CAN2
		On	Connected to CAN bus 2 and CAN data transfer on CAN2
LED323	Activity CAN3	Off	No CAN bus connection and/or no data transfer on CAN3
		On	Connected to CAN bus 3 and CAN data transfer on CAN3

Table 3: LEDs of CAN-M.2/402-4

## 2.3 Product Label

The product label is stuck on the top side of the CAN-M.2/402. It is described using the example of the CAN-M.2/402-4-FD product label.

esd Product Label Example	esd Product Label shows	Example:
	- Data matrix code (top row)	-
	- <b>esd order number</b>	C.2074.68 (Order No. of CAN-M.2/402-4-FD)
	- <b>Batch (first two letters) and serial number (following six digits)</b>	AA00005 ( <b>AA</b> 000005 <b>Batch</b> <b>Serial number</b> )
	- CE mark	
	- esd logo (www.esd.eu)	-

Table 4: Example product label

## 2.4 DSUB Adapters and Adapter Cables

CAN-M.2/402 Variant	Galvanic isolation of CAN port	Use with Adapter	Read chapter
CAN-M.2/402-2-FD	On the board	CAN-Mini/402-DSUB9-15cm or CAN-Mini/402-DSUB9-30cm	2.4.1
CAN-M.2/402-4-FD CAN-M.2/402-4-FD-T	Via adapter	CAN-Mini/402-DSUB9-ISOL or CAN-Mini/402-DSUB9-ISOL-SIC	2.4.2

Table 5: Suitable adapters

### 2.4.1 Adapter CAN-Mini/402-DSUB9-15cm/-30cm

#### 2.4.1.1 Description

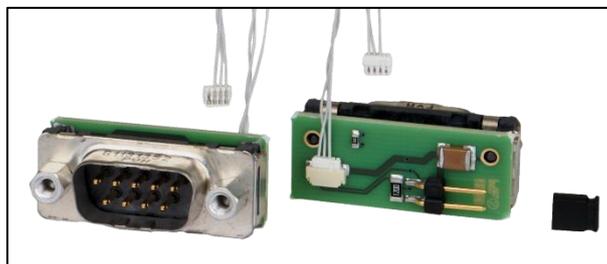


Figure 5: CAN-Mini/402-DSUB9-15cm adapter views with cable

With the adapters CAN-Mini/402-DSUB9-15cm and CAN-Mini/402-DSUB9-30cm you can connect the CAN ports of CAN-M.2/402-2-FD via DSUB9 connectors (see Figure 6). These adapters differ only in the length of the adapter cable (15cm or 30cm).

The CAN cable connector and the termination jumper are equipped on the bottom layer of the adapter, see Figure 7. The pin assignment of the cable connector is the same as described for CAN-M.2/402-2-FD, see chapter 3.1, page 19.

The adapters are not contained in the scope of delivery of CAN-M.2/402-2-FD and can be individually ordered, see “Order Information” on page 44.

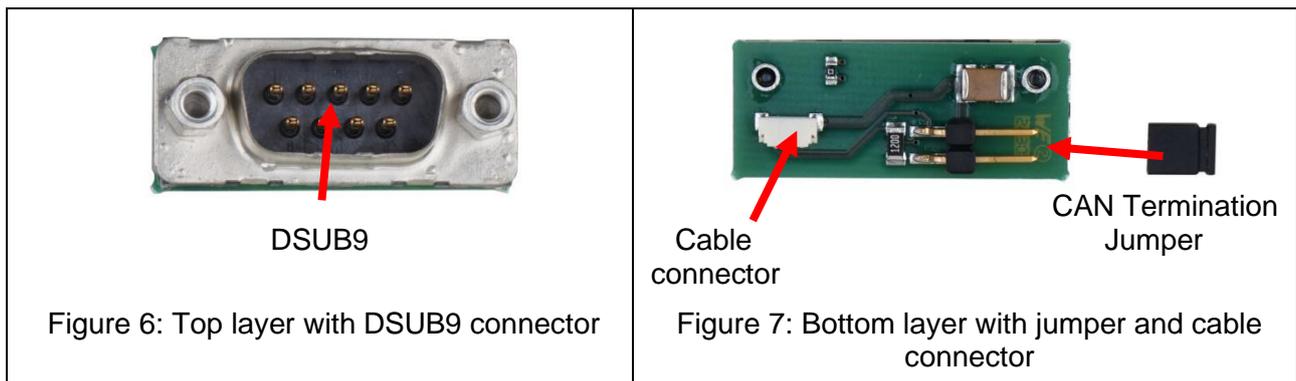
The 1-to-1 adapter cable CAN-Mini/402-Cable with 15 cm length (C.2044.14) and two UNC 4-40 DSUB bolts is included in the scope of delivery of CAN-Mini/402-DSUB9-15cm.

The bolts are intended to be used with a front panel!



**NOTICE**  
Read chapter “Hardware Installation” on page 23, before you start with the installation of the CAN-M.2/402-2-FD!

#### 2.4.1.2 Adapter View



## 2.4.2 Adapter CAN-Mini/402-DSUB9-ISOL(-SIC)

### 2.4.2.1 Description

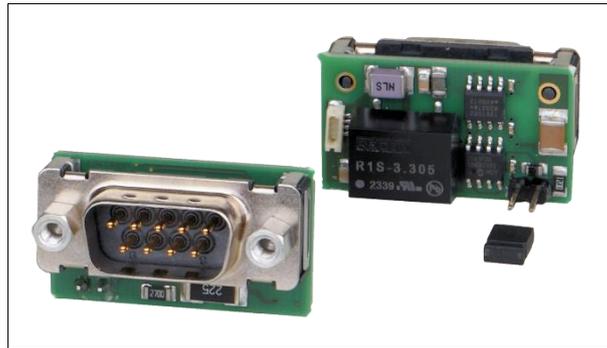


Figure 8: CAN-Mini/402-DSUB9-ISOL adapter views

With the adapter CAN-Mini/402-DSUB9-ISOL you can connect the individual CAN TTL-level signals of the CAN-M.2/402-4 variants via DSUB9 connectors.

The adapter converts the TTL-level signals to CAN signal level, or vice versa. It uses a high-speed CAN FD transceiver and provides galvanic isolation of the CAN FD port.

It is equipped with a DSUB9 plug on one side of the board (Figure 9), and the CAN cable connector and a jumper for selectable CAN termination on the other side of the board (Figure 10). The pin assignment of the cable connector is described in chapter 3.2.2. The fixing bolts are included in the scope of delivery of the adapter. The bolts are intended to be used with a front panel!

The CAN-Mini/402-DSUB9-ISOL-SIC variant uses a CAN FD SIC transceiver that provides signal improvement capability (SIC). This can reduce signal ringing effects in a network. Both adapter variants only differ in the CAN transceiver used.

The 1-to-4 adapter cable is in the scope of delivery of the CAN-M./402-4 variants.

The optional adapters have to be ordered individually as accessories, see “Order Information” on page 44.



#### NOTICE

Read chapter “Hardware Installation” on page 23, before you start with the installation of the CAN-M.2/402!

### 2.4.2.2 Adapter View

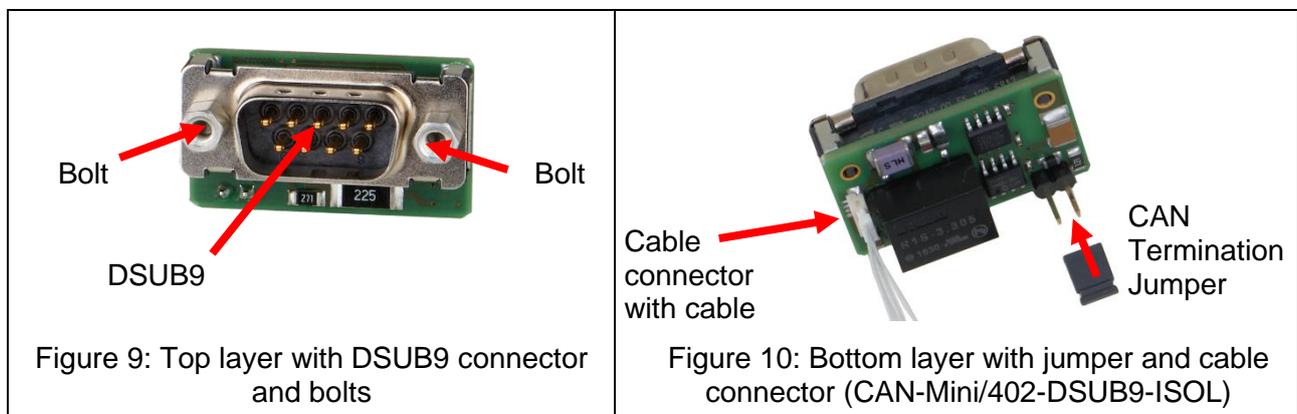


Figure 9: Top layer with DSUB9 connector and bolts

Figure 10: Bottom layer with jumper and cable connector (CAN-Mini/402-DSUB9-ISOL)

### 2.4.3 CAN Termination Jumper

The CAN termination of the connected CAN channel can be set internally via the jumper. The jumper is located on the bottom layer of the adapters CAN-Mini/402-DSUB9-15cm/-30cm (see Figure 7) or CAN-Mini/402-DSUB9-ISOL(-SIC) (see Figure 10).

JumperJP400	
Jumper set	Internal termination (120Ω) of the connected CAN net.
Jumper not set	The connected CAN channel must be terminated externally.

Table 6: Jumper

# 3 Connector Assignments

## 3.1 CAN-M.2/402-2-FD

### 3.1.1 4-pin CAN Connector

The CAN-M.2/402-2-FD comes with two 4-pin wire-to-board connectors equipped on the PCB top layer. The connector is also equipped on the adapters CAN-Mini/402-DSUB9-15cm/-30cm.

**Device connector:** 4-pin wire-to-board connector, receptacle, side entry shrouded header (JST, SM04B-SURS-TF)

**Pin Position:**



1 2 3 4

**Pin Assignment:**

Pin	Signal
1	reserved
2	CANx_GND
3	CANx_H
4	CANx_L

**Signal Description:**

CANx\_L, CANx\_H ... CAN signals of the CAN net x (x... 0, 1)  
 CANx\_GND... Reference potential of the local CAN physical layer of CAN net x (x... 0, 1)  
 reserved ... Reserved for future applications, do not connect!



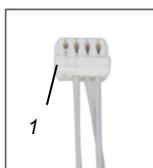
**NOTICE**

Please note that the connector assignment of the 4-pin CAN connector of the CAN-Mini/402-DSUB9-ISOL(-SIC) adapter differs and is described in chapter 3.2.2.1

See chapter 2.4.1 for further information about the adapters.

#### 3.1.1.1 4-Pin Mating Connector Plug of Adapter Cable CAN-Mini/402-Cable

**Pin Position:**



Use the 1-to-1 adapter cable CAN-Mini/402-Cable to connect CAN-M.2/402-2-FD and the adapter CAN-Mini/402-DSUB9-15cm. Connect the 4-pin connector plugs (JST, 04SUR-32S) of the respective CAN port with the 4-pin CAN connector receptacles (JST, SM04B-SURS-TF) on the board of the CAN-M.2/402-2-FD and on the adapter. The pin assignment of the cable connector is as described in 3.1.1.

Figure 11: 4-pin connector plug of 1-to-1 adapter cable (detail)

### 3.2 CAN-M.2/402-4 Variants

#### 3.2.1 16-pin CAN Connector (CAN TTL-Level)

The CAN-M.2/402-4-FD and CAN-M.2/402-4-FD-T come with a wire-to-board connector for the connection of up to four CAN channels. The connector is equipped on the PCB top layer.

**Device connector:** 16-pin wire-to-board connector, receptacle, side entry shrouded header (JST, SM16B-SURS-TF)

#### Pin Position:



1 ... 16

#### Pin Assignment:

Pin	Signal
1	3.3V
2	GND
3	CAN1_Tx
4	CAN1_Rx
5	3.3V
6	GND
7	CAN3_Tx
8	CAN3_Rx
9	3.3V
10	GND
11	CAN2_Tx
12	CAN2_Rx
13	3.3V
14	GND
15	CAN0_Tx
16	CAN0_Rx

#### Signal Description:

CANx\_Rx, CANx\_Tx ...

3.3V

GND...

CAN signals (TTL-level) of the CAN net x (x... 0, 1, 2, 3)

3.3 V supply voltage for adapter

Reference potential (System GND)

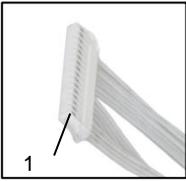


#### NOTICE

esd grants the EU conformity of the product if the wiring of CAN-M.2/402-4-FD and CAN-M.2/402-4-FD-T is carried out with the adapters CAN-Mini/402-DSUB9-ISOL or CAN-Mini/402-DSUB9-ISOL-SIC.

### 3.2.1.1 16-Pin Mating Connector Plug (CAN-TTL Level)

**Pin Position:**



Use the 1-to-4 adapter cable to connect the CAN-M.2/402-4 variants with the CAN-Mini/402-DSUB9-ISOL(-SIC) adapters.

Connect the 16-pin connector plug (JST, 16SUR-32S) of the 1-to-4 adapter cable with the 16-pin CAN connector receptacle (JST, SM16B-SURS-TF) on the board of the CAN-M.2/402-4 variant.

The pin assignment of the 16-pin cable connector plug is as described in 3.2.1.

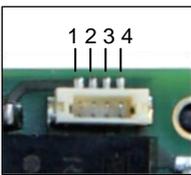
Figure 12: 16-pin connector plug of 1-to-4 adapter cable (detail)

### 3.2.2 CAN TTL-Level Signals via Cable Connector on the Adapter

The 4-pin wire-to-board connector is equipped on the bottom layer of the adapter CAN-Mini/402-DSUB9-ISOL(-SIC), see Figure 10 page 17.

**Device connector:** 4-pin wire-to-board connector, receptacle, top entry shrouded header (JST, BM04B-SURS-TF)

**Pin Position:**



**Pin Assignment:**

Pin	Signal
1	3.3V
2	GND
3	CANx_Tx
4	CANx_Rx

**Signal Description:**

CANx\_Rx, CANx\_Tx ... CAN signals (TTL-level) of the CAN net x (x... 0, 1, 2, 3)  
 3.3 V ... 3.3 V supply voltage from CAN-M.2/402  
 GND ... Reference potential (System GND)

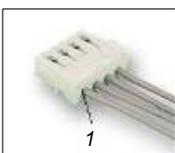


**NOTICE**

Please note that the connector assignment of the 4-pin CAN connector of the CAN-M.2/402-2-FD board and adapter differ and are described in chapter 3.1.

### 3.2.2.1 4-Pin Mating Connector Plug (CAN-TTL Level)

**Pin Position:**



Use the 1-to-4 adapter cable to connect CAN-M.2/402-4 variants with the CAN-Mini/402-DSUB9-ISOL(-SIC) adapters.

Connect the 4-pin connector plug (JST, 04SUR-32S) of the 1-to-4 adapter cable of the respective CAN port with the 4-pin CAN connector receptacles (JST, BM04B-SURS-TF) on the CAN-Mini/402-DSUB9-ISOL(-SIC) adapters.

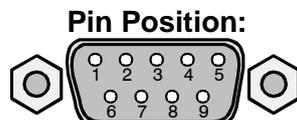
The pin assignment of the cable connector is as described in 3.2.2

Figure 13: 4-pin connector plug of 1-to-4 adapter cable (detail)

### 3.3 CAN via DSUB9 Connectors on the Adapters

Using the adapters the CAN channels can be connected via DSUB9 connectors

**Device connector:** 9-pin DSUB connector, pin-contacts, on adapters



**Pin Assignment:**

Signal	Pin	Signal
CANx_GND	6	1
		2
CANx_H	7	CANx_L
Reserved	8	CANx_GND
Reserved	9	4
		5

**Signal Description:**

CANx_L, CANx_H	CAN signal lines (x = number of the connected CAN port CAN-M.2/402-2-FD: x = 0 or 1, CAN-M.2/402-4-FD, CAN-M.2/402-4-FD-T: x = 0, 1, 2, or 3,
CANx_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!

## 4 Hardware Installation



### NOTICE

Read the safety instructions at the beginning of this document carefully, before you start with the hardware installation!



### WARNING

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-M.2/402 is to be integrated.

- The CAN-M.2/402 may only be operated on supply circuits that provide sufficient protection against dangerous voltages.
- External circuits connected to the ports of the CAN-M.2/402 must be sufficiently protected against dangerous voltage.
- The user is responsible for compliance with the applicable national safety regulations.
- Disconnect all hazardous voltages (mains voltage) before opening the system. Never carry out work while power supply voltage is switched on!
- Ensure the absence of voltage before starting any electrical work.



### NOTICE

Electrostatic discharges may cause damage to electronic components.

- Take the appropriate precautions for handling electrostatic discharge sensitive devices.
- Discharge the static electricity from your body before touching the CAN-M.2/402.
- Transport and store the CAN-M.2/402 only in an electrostatically safe bag, as when delivered.

### 4.1 Preparation

#### 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. If applicable, connect the adapters:

CAN-M.2/402-2-FD:  
Connect up to 2 CAN-Mini/402-DSUB9-15cm adapters via the 1-to-1 adapter cables.

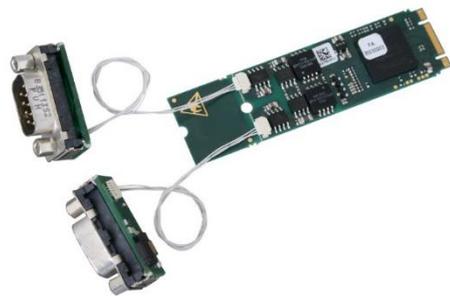


Figure 14: CAN-M.2/402-2-FD (+2 adapters)

CAN-M.2/402-4 variants:  
Connect up to 4 CAN-Mini/402-DSUB9-ISOL adapters via the 1-to-4 adapter cable

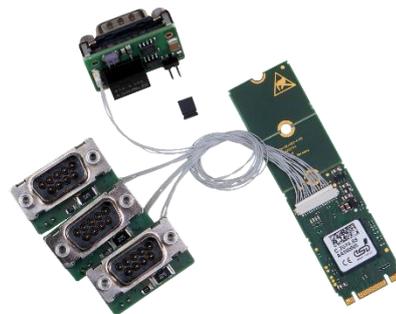


Figure 15: CAN-M.2/402-4-FD (+4 adapters)

## Hardware Installation

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Set or remove the CAN termination jumpers on the adapters according to your needs.  
See 2.4.3

4. Disconnect the system from the mains.  
Make sure that no risk arises from the system into which the CAN-M.2/402 shall be inserted.  
Read the manual of the system used and follow the instructions of the system manufacturer.



### **WARNING**

#### **Hazardous Voltage**

Risk of electric shock due to unintentional contact with uninsulated live parts with high voltages.

- 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).
- Ensure the absence of voltage before starting any electrical work.
- Cover or block off adjacent live parts.

5. Open the case if necessary.

To install CAN-M.2/402, continue as described in chapter 4.2 ‘Installing the Hardware’.

To uninstall, continue as described in chapter 4.3 ‘Uninstalling the Hardware’.

## 4.2 Installing the Hardware

1. Read and follow the safety instructions at the beginning of chapter 4 and execute steps 1 to 4 of the preparation procedure as described in chapter 4.1 if not already done.
2. Select a free PCIe Mini or M.2 slot. Please note that an adapter may be required when using a PCIe Mini slot. Insert the board into the selected slot and gently push the board into the slot.
3. If applicable, mount the CAN-Mini/402-DSUB9-adapter in your system. Use the enclosed bolts to fix the DSUB9 adapters, for example in a front panel.



### **NOTICE**

To avoid damage to the adapters, please note that the thread of the bolts reaching into the body of the DSUB should not be longer than 6 mm!

8. Close the system's case again.

Connect the CAN bus.

Please note:

- The CAN bus must be terminated at both ends! esd offers special T-connectors and termination connectors for external termination. Additionally, the CAN\_GND signal must be connected to earth at exactly one point in the CAN network.
- If you use a CAN-M.2/402-4 variant without the CAN-Mini/402-DSUB9-ISOL(-SIC) adapters, the CAN signals are not galvanically isolated and are TTL-level only!
- If you use the CAN-M.2/402 variant with the CAN-Mini/402-DSUB9-adapters the CAN channels might be already terminated, depending on the CAN termination jumper settings on the adapter boards (see 2.4.3).

For further details, please read chapter 6 “Correct Wiring Galvanically Isolated CAN Networks” from page 32.

11. Connect the system to mains again (mains connector or safety fuse).

12. Before you switch on the supply voltage, check that all plug connectors are correctly seated. Switch on the system and the peripheral devices.
13. End of hardware installation.
14. Continue with the software installation as described in the manual 'NTCAN, Installation Guide' (see chapter "Manuals", page 45).

### 4.3 Uninstalling the Hardware

1. Read and follow the safety instructions at the beginning of chapter 4 and execute steps 1 to 4 of the preparation procedure as described in chapter 4.1 if not already done.
2. Make sure that all connected interfaces and power supply are switched off.
3. Disconnect the CAN-M.2/402 and the adapters from the connected interfaces.
4. Loosen the fastening of the CAN-M.2/402 and of the adapters.
5. Carefully pull the CAN-M.2/402 and the adapters out of the slots.
6. If necessary, close the housing cover again.

# 5 Technical Data

## 5.1 General Technical Data

Power supply voltage	<p>Nominal voltage: 3.3 V</p> <p>Nominal current:            CAN-M.2/402-2-FD: <math>I_{3.3VMPMAX} = 320 \text{ mA}</math>, <math>I_{3.3VTYPICAL} = 270 \text{ mA}</math></p> <p>CAN-M.2/402-4:            3.3 V, with power/current consumption (under load):            - 2 DSUB9 adapters: <math>1.7 \text{ W}</math> / <math>I_{3.3V\_2xCAN} = 550 \text{ mA}</math>            - 4 DSUB9 adapters: <math>2.6 \text{ W}</math> / <math>I_{3.3V\_4xCAN} = 800 \text{ mA}</math></p>
Temperature range	<p>CAN-M.2/402-2-FD (C.2074.64):            Ambient temperature (Standard range): 0°C ... 75°C</p> <p>CAN-M.2/402-4-FD (C.2054.68):            Ambient temperature (Standard range): 0°C ... 70°C</p> <p>CAN-M.2/402-4-FD-T (C.2054.69):            Ambient temperature (Extended range): -40°C ... 85°C</p>
Humidity	Operation: max. 90%, non-condensing
Dimensions	<p>22 mm x 80 mm x 4.4 mm</p> <p>The printed circuit boards can be shortened by simply breaking off, to:            22 mm x 60 mm x 4.4 mm</p> <p>The printed circuit boards of the CAN-M.2/402-4 variants can be reduced further to: 22 mm x 42 mm x 4.4 mm</p>
Weight	<p>CAN-M.2/402-2-FD: Board: approximately 8 g;            Adapter: approximately 8 g each</p> <p>CAN-M.2/402-4: Board: approximately 6 g;            Adapter: approximately 10 g each</p>

Table 7: General Data of the module

## 5.2 PCI Express Mini Interface

PCIe interface	PCI Express Spec. R1.1, Link width 1x
Form factor	2280, can be reduced to 2260 The CAN-M.2/402-4 variants can also be reduced to 2242. The component heights on the PCB top side exceed the requirements of the PCI Express M.2 specification. The maximum component height is 2.24 mm instead of 1.5 mm.

Table 8: PCIe Mini interface

	<b>INFORMATION</b> The optional CAN-M.2-80/402-2-FD comes with a maximum component height of 1.5 mm, as required in the M.2 specification. Form factor is 2280 only! Contact our Sales Team ( <a href="mailto:sales@esd.eu">sales@esd.eu</a> ) for further information.
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## 5.3 Connectors

### 5.3.1 CAN-M.2/402 Connectors

Name	Function, Ports	Type
M.2	Mini PCI Express interface	Card edge connector with M.2 keying notches in B and M positions
CAN-M.2/402-4 variants only:		
CAN	CAN ports CAN0 - CAN3	1x Wire-to-board IDE connector (JST SM16B-SURS-TF), shrouded header (16-pos.), side entry type, (4x CAN FD), Optional adapters with DSUB9 connectors (pin contacts) can be connected (1 adapter per CAN channel) via the 1-to-4 adapter cable. The cable is included in delivery of CAN-M.2/402.
CAN-M.2/402-2-FD only:		
CAN0, CAN1	CAN ports CAN0, CAN1	2x Wire-to-board IDE connector (JST SM04B-SURS-TF), shrouded header (4-pos.), side entry type, (1x CAN FD) Optional adapters with DSUB9 connectors (pin contacts) can be connected (1 adapter per CAN channel) via the 1-to-1 adapter cables. The cable is included in delivery of the CAN-Mini/402-DSUB9-15cm adapter.

Table 9: CAN-M.2/402 Connectors

### 5.3.2 Connectors on the Adapters

The technical data of the connectors on the adapters are described in the corresponding chapters:

- CAN-Mini/402-DSUB9-15cm Adapter for CAN-M.2/402-2-FD: See chapter 5.5.1.
- CAN-Mini/402-DSUB9-ISOL Adapter for CAN-M.2/402-4: See chapter 5.5.2.

## 5.4 CAN Ports

Number of CAN ports	CAN-M.2/402-2-FD: 2 CAN-M.2/402-4: 4 (TTL-level)
CAN controller	esdACC integrated in FPGA, acc. to ISO 11898-1 (CAN 2.0 A/B)
CAN protocol	According to ISO 11898-1
Physical CAN Layer	CAN FD transceiver conforms with ISO 11898-2, CAN FD bit rates: up to 8 Mbit/s CAN CC bit rates: 10 kbit/s up to 1 Mbit/s  CAN-M.2/402-4: The CAN signals of these cards are TTL-level only! The described properties are realized via the adapters CAN-/402-DSUB9-ISOL(-SIC) with CAN FD transceivers 5.5.2
Galvanic isolation	Separation by means of optocouplers and DC/DC-converters voltage over CAN isolation (CAN to slot bracket/Earth CAN to Host/System Ground; CAN to CAN): 1kV DC @ 1s ( $I < 1 \text{ mA}$ )  CAN-M.2/402-4: The CAN signals of these cards are TTL-level signals only! The described properties are realized via the adapters CAN-/402-DSUB9-ISOL(-SIC) with galvanic isolation, see 5.5.2.
Bus termination	Terminating resistor can be switched on the optional CAN-Mini/402-DSUB9-adapter, if required
Connector	DSUB9 connector if a CAN-Mini/402-DSUB9-adapter is used

Table 10: Data of the CAN port

## 5.5 Adapter

### 5.5.1 CAN-Mini/402-DSUB9-15cm/-30cm Adapter

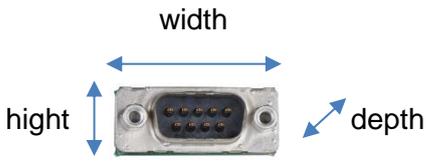
Description	Adapter for 1 CAN channel of CAN-M.2/402-2-FD
Physical CAN Layer	As described in chapter 5.4, realized via CAN-M.2/402-2-FD
Galvanic isolation	As described in chapter 5.4, realized via CAN-M.2/402-2-FD
Dimensions	 <p>width: 31.5 mm,  height: 13 mm,  depth: 16.5 mm  (10 mm behind front panel)</p> <p>(adapter only, without cables)</p>
Weight	ca. 8 g per adapter
Connector	1x DSUB9 (pin contacts), 1x 4-pin Wire-to-Board connector, pin contacts (JST, SM04B-SURS-TF), side entry type
Cable	1-to-1 adapter cable, included in the scope of delivery of the adapter 2x IDE cable plug, 4 positions (JST, 04SUR-32S to JST, 04SUR-32S)
Cable length	CAN-Mini/402-DSUB9-15cm: 150 mm CAN-Mini/402-DSUB9-30cm: 300 mm
Bolts	2x DSUB bolts (UNC 4-40 x 5 mm hex nuts with UNC 4-40 x 6 mm thread)

Table 11: Technical data of the DSUB9 adapter



#### NOTICE

The adapter is intended to be used with a front panel with 0,8 mm to 1,2 mm thickness! Don't mount the bolts into the DSUB without a front panel or additional spacers like washers, because otherwise the bolt thread might damage the DSUB.

### 5.5.2 CAN-Mini/402-DSUB9-ISOL(-SIC) Adapter

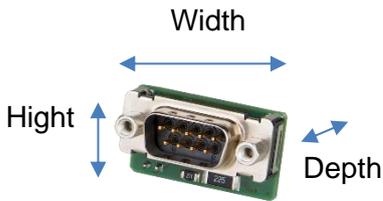
Description	Adapter for 1 CAN channel of the CAN-M.2/402-4 variants	
Transceiver	CAN FD transceiver according to ISO 11898-2 CAN-Mini/402-DSUB9-ISOL: High-speed CAN FD transceiver CAN-Mini/402-DSUB9-ISOL-SIC: SIC transceiver acc. to CiA 601-4	
Physical CAN Layer	As described in chapter 5.4, realized via this adapter	
Galvanic isolation	As described in chapter 5.4, realized via this adapter	
Dimensions Adapter board	 <p>Width: 31.5 mm, Height: 18 mm, Depth: 22,5 mm (10 mm behind front panel)</p> <p>(adapter only, without cable)</p>	
Weight	ca. 10 g	
Connector	1x DSUB9 (pin contacts) 1x Wire-to-Board connector 4 positions, pin contacts (JST, BM04B-SURS-TF), top entry type	
Cable:	1-to-4 adapter cable, included in the scope of delivery of CAN-M.2/402-4. 1x IDE cable plug 16-pin (JST, 16SUR-32S) to 4x IDE cable plug (JST, 04SUR-32S)	
Bolts	2x fixing bolts are needed per adapter board. The bolts are included in the scope of delivery of the adapter. (Use e.g. UNC 4-40 x 5 mm hex nuts with UNC 4-40 x 6 mm thread)	

Table 12: Technical data of the DSUB9 adapter

	<p><b>NOTICE</b></p> <p>To avoid damage to the CAN-Mini/402-DSUB9-ISOL(-SIC) adapter, please note that the thread of the bolts, reaching into the body of the DSUB, should not be longer than 6 mm!</p>
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## 5.6 Software Support

Device drivers for Windows® and Linux® are included in delivery. Drivers for real-time operating systems, are available for QNX®, RTX64®, VxWorks® and INtime®.

Higher layer protocols (CANopen®, J1939, ARINC825) are supported for Classical CAN applications on CAN-M.2/402 only. See Order Information on page 44 for the availability of the drivers.

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 (CAN-API) software installation and the software drivers are described in the manual:

“NTCAN Part 1: C/C++ Software Design Guide” Application Developers Manual and  
 “NTCAN Part 2: Installation, Configuration and Firmware Update” Installation Guide

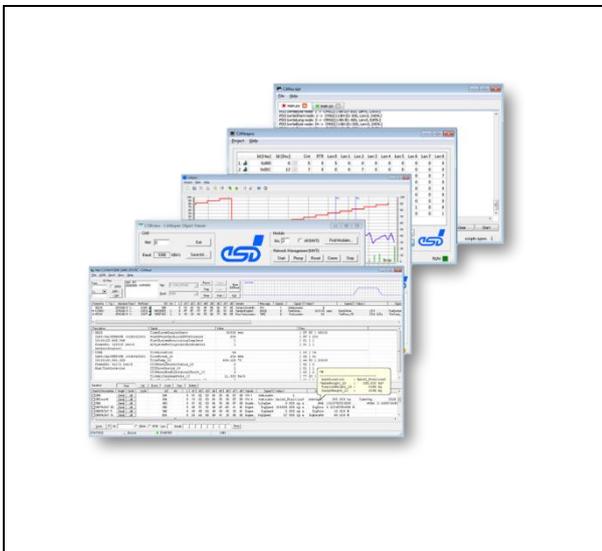
(esd-order No.: C.2001.21)

### CAN Tools for Classical CAN

esd offers additional free-of-charge tools which support efficient setup and analysis of Classical CAN applications and networks.

The CAN Tools are operational with all esd PC-CAN interfaces (e.g. PCIe, USB, EtherCAN/2 ...)

The following CAN Tools are available:



<b>CANreal</b>	Display and record of CAN message frames
<b>CANplot</b>	Graphical display of CAN data
<b>CANrepro</b>	Replay of pre-recorded CAN messages
<b>CANscript</b>	Python based scripting tool
<b>COBview</b>	Analysis and diagnostics of CANopen® nodes

**System Requirements:**

- Windows 32-bit or 64-bit system
- 30 MB free HD drive space
- esd CAN driver installed

As part of the esd software development kit (CAN SDK) of the NTCAN-API the CAN Tools are included in delivery of the CAN-CD.

The CAN SDK can also be downloaded free-of-charge from the esd website.

# 6 Correct Wiring of Galvanically Isolated CAN Networks



## NOTICE

This chapter applies to CAN networks with bit rates up to 1 Mbit/s.

If you work with higher bit rates, as for example used for CAN FD, the information given in this chapter must be examined for applicability in each individual case.

For further information refer to the CiA® CAN FD guidelines and recommendations (<https://www.can-cia.org/>).

For the CAN wiring all applicable rules and regulations (EU, DIN), such as regarding electromagnetic compatibility, security distances, cable cross-section or material, must be observed.

## 6.1 CAN Wiring Standards

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

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

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

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

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

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

Of course, reliable networks can be designed according to the specifications of CANopen, ARINC825, DeviceNet and NMEA2000, **however it must be observed that it is strictly not recommended to mix the wiring guidelines of the various specifications!**

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

### 6.2.1 General Rules

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

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

1	A suitable cable type with a wave impedance of about $120\ \Omega \pm 10\%$ with an adequate conductor cross-section ( $\geq 0.22\ \text{mm}^2$ ) must be used. The voltage drop over the wire must be considered.
2	For light industrial environment use at least a two-wire CAN cable, the wires of which must be assigned as follows: <ul style="list-style-type: none"> <li>• Two twisted wires must be assigned to the data signals (CAN_H, CAN_L).</li> <li>• The cable shield must be connected to the reference potential (CAN_GND).</li> </ul>
3	The reference potential CAN_GND must 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 must 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.

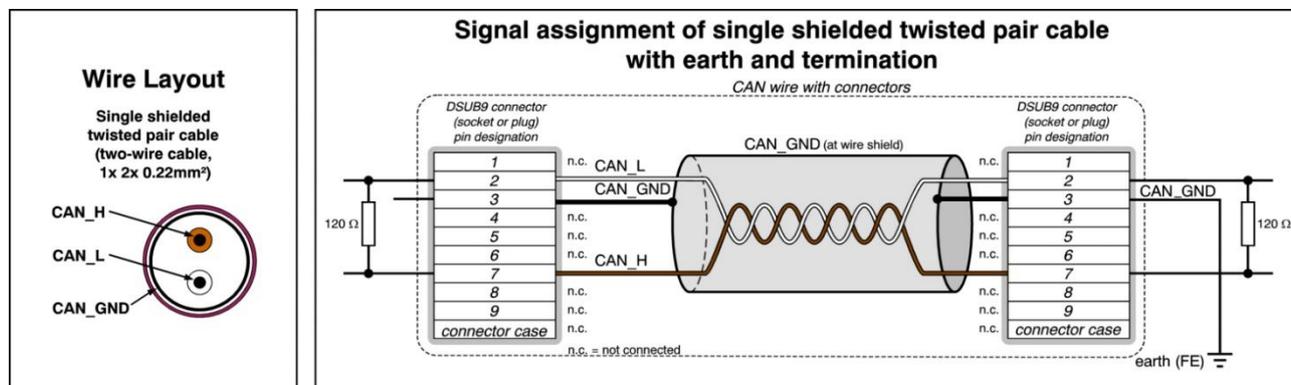


Figure 16: CAN wiring for light industrial environment

### 6.2.2 Cabling

- To connect CAN devices with just one CAN connector per net use a short stub ( $< 0.3$  m) and a T-connector (available as accessory). If these devices are located at the end of the CAN network, the CAN terminator “CAN-Termination-DSUB9” can be used.

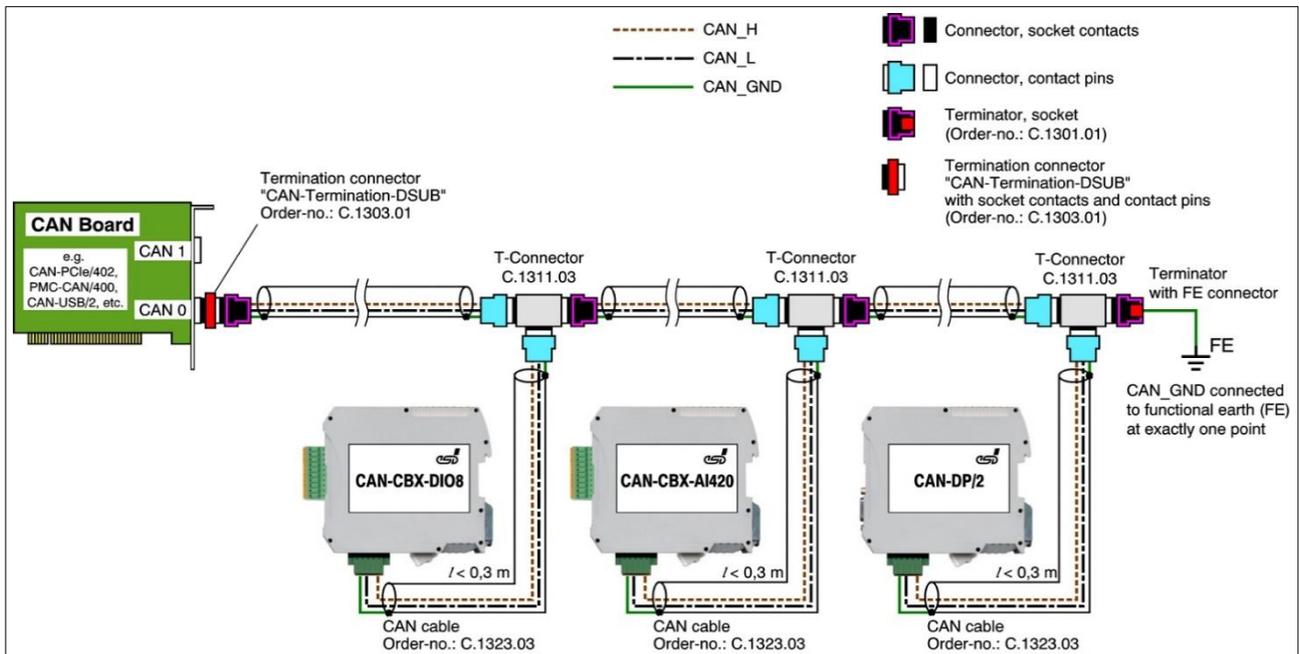


Figure 17: Example for proper wiring with single shielded single twisted pair wires

### 6.2.3 Branching

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

### 6.2.4 Termination Resistor

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

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

### 6.3.1 General Rules

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

1	A suitable cable type with a wave impedance of about $120 \Omega \pm 10\%$ with an adequate conductor cross-section ( $\geq 0.22 \text{ mm}^2$ ) must be used. The voltage drop over the wire must be considered.
2	For heavy industrial environment use a four-wire CAN cable, the wires of which must be assigned as follows: <ul style="list-style-type: none"> <li>• Two twisted wires must be assigned to the data signals (CAN_H, CAN_L) and</li> <li>• The other two twisted wires must be assigned to the reference potential (CAN_GND).</li> <li>• The cable shield must be connected to functional earth (FE) at least at one point.</li> </ul>
3	The reference potential CAN_GND must 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 must 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 cannot be avoided, double shielded cables are recommended.

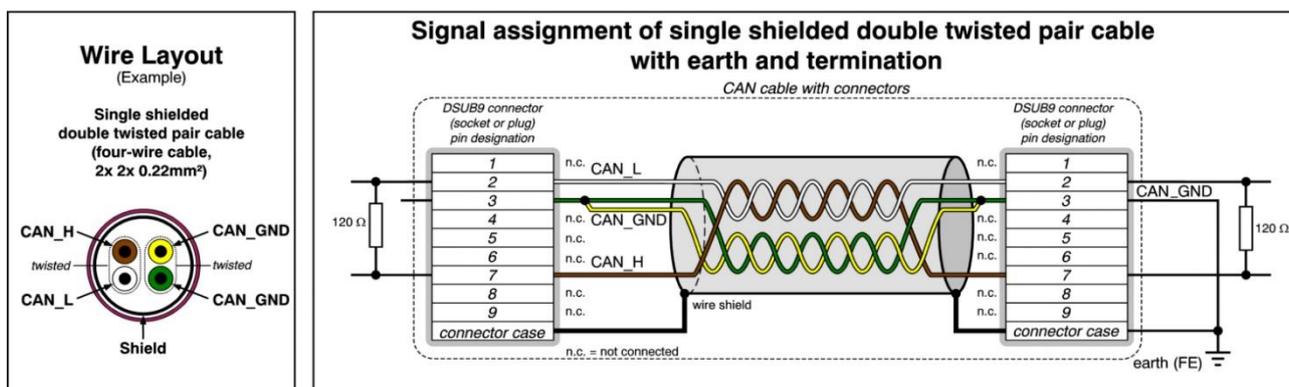


Figure 18: CAN wiring for heavy industrial environment

## 6.3.2 Device Cabling

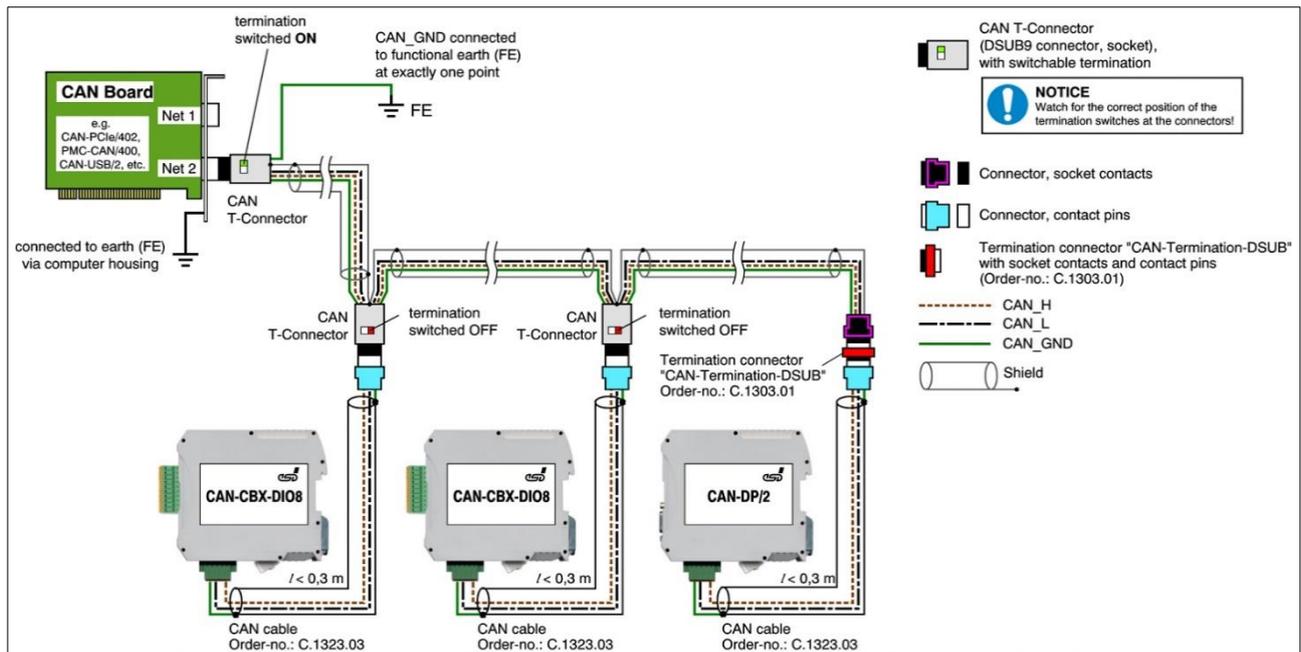


Figure 19: Example of proper wiring with single shielded double twisted pair cables

## 6.3.3 Branching

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

## 6.3.4 Termination Resistor

- A termination resistor must be connected at both ends of the CAN bus. If an integrated CAN termination resistor is connected to the CAN interface at the end of the CAN bus, this integrated termination must be used instead of an external CAN termination resistor.
- 9-pole DSUB-termination connectors with integrated termination resistor and pin contacts and socket contacts are available from esd (order no. C.1303.01).
- 9-pole DSUB-connectors with integrated switchable termination resistor can be ordered for example from ERNI (ERBIC CAN BUS MAX, socket contacts, order no.:154039).

## 6.4 Electrical Grounding

- For CAN devices with electrical isolation the CAN\_GND must be connected between the CAN devices.
- CAN\_GND should be connected to the earth potential (FE) at **exactly one** point of the network.
- Each *CAN interface with electrical connection to earth potential* acts as a grounding point. For this reason, it is recommended not to connect more than one *CAN device with electrical connection to earth potential*.
- Grounding can be done for example at a termination connector (e.g. order no. C.1302.01 or C.1301.01).

## 6.5 Bus Length

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

In the following table you will find guide values for the achievable bus lengths at certain bit rates.

Bit Rate [kbit/s]	Theoretical values of reachable wire length with esd interface $l_{\max}$ [m]	CiA recommendations (07/95) for reachable wire lengths $l_{\min}$ [m]	Standard values of the cross-section according to CiA 303-1 [mm <sup>2</sup> ]
1000	37	25	0.25 to 0.34
800	59	50	0.34 to 0.6
666. $\bar{6}$	80	-	
500	130	100	
333. $\bar{3}$	180	-	
250	270	250	
166	420	-	0.5 to 0.6
125	570	500	
100	710	650	0.75 to 0.8
83. $\bar{3}$	850	-	
66. $\bar{6}$	1000	-	
50	1400	1000	
33. $\bar{3}$	2000	-	not defined in CiA 303-1
20	3600	2500	
12.5	5400	-	
10	7300	5000	

Table 13: Recommended cable lengths at typical bit rates (with esd-CAN interfaces)

Optical couplers are delaying the CAN signals. esd modules typically achieve a wire length of 37 m at 1 Mbit/s within a proper terminated CAN network without impedance disturbances, such as those caused by cable stubs > 0.3 m.



### NOTICE

Please note that the cables, connectors, and termination resistors used in CANopen networks shall meet the requirements defined in ISO 11898-2. In addition, further recommendations of the CiA, like standard values of the cross section, depending on the cable length, are described in the CiA recommendation CiA 303-1 (see CiA 303 CANopen Recommendation - Part 1: “Cabling and connector pin assignment,” Version 1.9.0, Table 2). Recommendations for pin-assignment of the connectors are described in CiA 106: “Connector pin-assignment recommendations”.

## 6.6 Examples for CAN Cables

esd recommends the following two-wire and four-wire cable types for CAN network design. These cable types are used by esd for ready-made CAN cables, too.

### 6.6.1 Cable for Light Industrial Environment Applications (Two-Wire)

Manufacturer	Cable Type
U.I. LAPP GmbH Schulze-Delitzsch-Straße 25 70565 Stuttgart Germany <a href="http://www.lappkabel.com">www.lappkabel.com</a>	e.g. UNITRONIC ®-BUS CAN UL/CSA (1x 2x 0.22) (UL/CSA approved) Part No.: 2170260
	UNITRONIC ®-BUS-FD P CAN UL/CSA (1x 2x 0.25) (UL/CSA approved) Part No.: 2170272
ConCab GmbH Äußerer Eichwald 74535 Mainhardt Germany <a href="http://www.concab.de">www.concab.de</a>	e. g. 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 Schulze-Delitzsch-Straße 25 70565 Stuttgart Germany <a href="http://www.lappkabel.com">www.lappkabel.com</a>	e.g. UNITRONIC ®-BUS CAN UL/CSA (2x 2x 0.22) (UL/CSA approved) Part No.: 2170261
	UNITRONIC ®-BUS-FD P CAN UL/CSA (2x 2x 0.25) (UL/CSA approved) Part No.: 2170273
ConCab GmbH Äußerer Eichwald 74535 Mainhardt Germany <a href="http://www.concab.de">www.concab.de</a>	e. g. 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 finding and eliminating the most common problems and errors when setting up CAN bus networks and CAN-based systems.

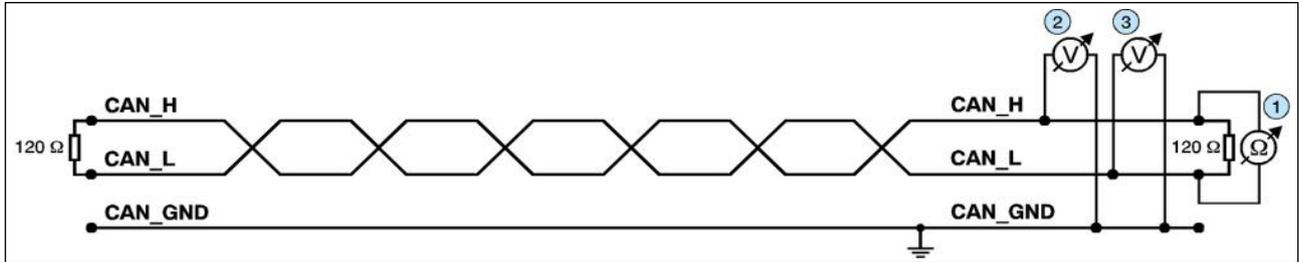


Figure 20: Simplified diagram of a CAN network

## Termination

The bus termination is used to match impedance of a node to the impedance of the bus line used. If the impedance is mismatched, the transmitted signal is not completely absorbed by the load and will be partially reflected back into the transmission line.

If the impedances of the sources, transmission lines and loads are equal, the reflections are avoided. This test measures the total resistance of the two CAN data lines and the connected terminating resistors.

To **test this**, please proceed as follows:

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

## Expected result:

The measured value should be between 50 Ω and 70 Ω.

## Possible causes of error:

- If the determined value is below 50 Ω, please make sure that:
  - There is no **short circuit** between CAN\_H and CAN\_L wiring.
  - **No more than two** terminating resistors are connected.
  - The transceivers of the individual nodes are not defective.
- If the determined value is higher than 70 Ω, please make sure that:
  - All CAN\_H and CAN\_L lines are correctly connected.
  - Two terminating resistors of 120 Ω each are connected to your CAN network (one at each end).

### 7.1 Electrical Grounding

The CAN\_GND of the CAN network should be connected to the functional earth potential (FE) at only **one** point. This test indicates whether the CAN\_GND is grounded at one or more points.

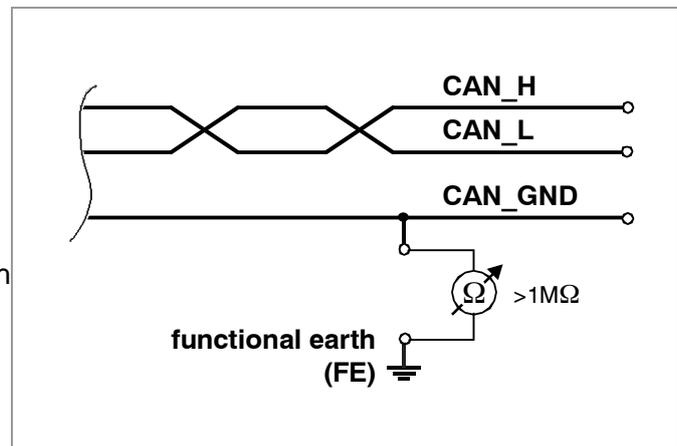
Please note that this test can only be performed with electrically isolated CAN nodes.

**To test this, please proceed as follows:**

1. Disconnect the CAN\_GND from the earth potential (FE).
2. Measure the DC resistance between CAN\_GND and earth potential (see figure on the right).

Do not forget to reconnect CAN\_GND to earth potential after the test!

Figure 21: Simplified schematic diagram of ground test measurement



**Expected result:**

The measured resistance should be greater than 1 M $\Omega$ . If it is smaller, please search for additional grounding of the CAN\_GND wires.

### 7.2 Short Circuit in CAN Wiring

A CAN bus might possibly still be able to transmit data even if CAN\_GND and CAN\_L are short-circuited. However, this will usually cause the error rate to rise sharply. Ensure that there is no short circuit between CAN\_GND and CAN\_L!

### 7.3 Correct Voltage Levels on CAN\_H and CAN\_L

Each node contains a CAN transceiver that outputs differential signals. When the network communication is idle the CAN\_H and CAN\_L voltages are approximately 2.5 V measured to CAN\_GND. Defective transceivers can cause the idle voltages to vary and disrupt network communication.

**To test for defective transceivers, please proceed as follows:**

1. Switch on all supply voltages.
2. Terminate all network communication.
3. Measure the DC voltage between CAN\_H and CAN\_GND, measuring point ②. (See “Simplified diagram of a CAN network” on previous page).
4. Measure the DC voltage between CAN\_L and CAN\_GND, measuring point ③. (See “Simplified diagram of a CAN network” on previous page).

**Expected result:**

The measured voltage should be between 2.0 V and 3.0 V.

**Possible causes of error:**

- If the voltage is lower than 2.0 V or higher than 3.0 V, it is possible that one or more nodes have defective transceivers.
  - If the voltage is lower than 2.0 V, please check the connections of the CAN\_H and CAN\_L lines.
- To find a node with a defective transceiver within a network, please check individually the resistances of the CAN transceivers of the nodes (see next section).

## 7.4 CAN Transceiver Resistance Test

CAN transceivers have circuits that control CAN\_H and CAN\_L. Experience shows that electrical damage can increase the leakage current in these circuits.

**To measure the current leakage through the CAN circuits, please use an ohmmeter and proceed as follows:**

1. Switch **off** the node ④ and **disconnect** it from the CAN network. (See figure below.)
2. Measure the DC resistance between CAN\_H and CAN\_GND, measuring point ⑤ (See figure below.)
3. Measure the DC resistance between CAN\_L and CAN\_GND, measuring point ⑥ (See figure below.)

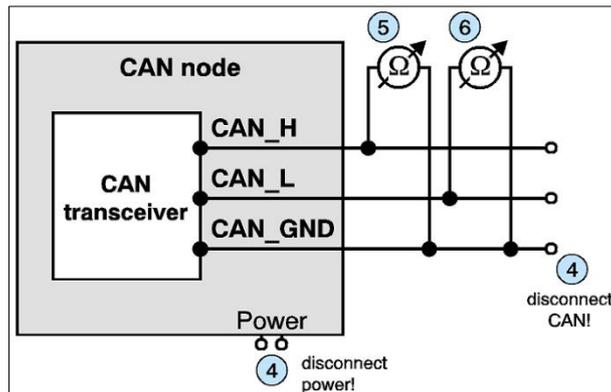


Figure 22: Measuring the internal resistance of CAN transceivers

**Expected result:**

The measured resistance should be greater than 10 k $\Omega$  for each measurement.

**Possible causes of error:**

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

## 7.5 Support by esd

If you have followed the troubleshooting steps in this troubleshooting guide and still cannot find a solution to your problem, our support team can help.

Please contact our support by email to [support@esd.eu](mailto:support@esd.eu) or by phone **+49-511-37298-130**.

# 8 Declaration of Conformity

## 8.1 CAN-M.2-2-FD

### EU-KONFORMITÄTSERKLÄRUNG EU DECLARATION OF CONFORMITY



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

esd erklärt, dass das Produkt      Typ, Modell,      Mit den Adaptern,      Type, Model,  
*esd declares, that the product*      *Artikel-Nr.*      *with the adapters*      *Article No.*

<b>CAN-M.2/402-2-FD</b>	<b>C.2074.64</b>	<b>CAN-PCleMini/402-DSUB9-15cm</b> <b>C.2044.10</b> <b>CAN-PCleMini/402-DSUB9-30cm</b> <b>C.2044.11</b>
-------------------------	------------------	--

die Anforderungen der Normen      EN 61000-6-2:2005,  
*fulfills the requirements of the standards*      EN 61000-6-3:2007/A1:2011

gemäß folgendem Prüfberichte erfüllt.      H-K00-0760-20  
*according to test certificate.*

Das Produkt entspricht damit der EU-Richtlinie „EMV“      2014/30/EU  
*Therefore the product conforms to the EU Directive 'EMC'*

Das Produkt entspricht den EU-Richtlinien „RoHS“      2011/65/EU, 2015/863/EU  
*The product conforms to the EU Directives 'RoHS'*

Diese Erklärung verliert ihre Gültigkeit, wenn das Produkt nicht den Herstellerunterlagen  
entsprechend eingesetzt und betrieben wird, oder das Produkt abweichend modifiziert wird.  
*This declaration loses its validity if the product is not used or run according to the manufacturer's  
documentation or if non-compliant modifications are made.*

Name / Name      T. Bielert  
Funktion / Title      QM-Beauftragter / QM Representative  
Datum / Date      Hannover, 2025-01-29

Rechtsgültige Unterschrift / authorized signature

## 8.2 CAN-M.2/402-4 Variants

### EU-KONFORMITÄTSERKLÄRUNG EU DECLARATION OF CONFORMITY



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

esd erklärt, dass das Produkt      Typ, Modell,      Mit den Adaptern,      Type, Model,  
*esd declares, that the product*      *Artikel-Nr.*      *with the adapters*      *Article No.*

<b>CAN-M.2/402-4-FD</b>	<b>C.2074.68</b>	<b>CAN-Mini/402-DSUB9-ISOL</b>	<b>C.2054.10</b>
<b>CAN-M.2/402-4-FD-T</b>	<b>C.2074.69</b>	<b>CAN-Mini/402-DSUB9-ISOL-SIC</b>	<b>C.2054.11</b>
		<b>CAN-Mini/402-M12-ISOL</b>	<b>C.2054.13</b>
		<b>CAN-Mini/402-M12-ISOL-SIC</b>	<b>C.2054.15</b>

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

**EN 61000-6-2:2005,**  
**EN 61000-6-3:2007/A1:2011**

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

**EMVP No.: 0256-202409**

Das Produkt entspricht damit der EU-Richtlinie „EMV“  
*Therefore the product conforms to the EU Directive 'EMC'*

**2014/30/EU**

Das Produkt entspricht den EU-Richtlinien „RoHS“  
*The product conforms to the EU Directives 'RoHS'*

**2011/65/EU, 2015/863/EU**

Diese Erklärung verliert ihre Gültigkeit, wenn das Produkt nicht den Herstellerunterlagen  
entsprechend eingesetzt und betrieben wird, oder das Produkt abweichend modifiziert wird.  
*This declaration loses its validity if the product is not used or run according to the manufacturer's  
documentation or if non-compliant modifications are made.*

Name / Name  
Funktion / Title  
Datum / Date

T. Bielert  
QM-Beauftragter / QM Representative  
Hannover, 2024-11-27

Rechtsgültige Unterschrift / *authorized signature*

## 9 Order Information

### 9.1 CAN-M.2/402-2-FD Hardware

Type	Properties	Order No.
CAN-M.2/402-2-FD	Active CAN interface board with 2 CAN ports for M.2 slot as B&M Key (PCI Express) for type 2280 or 2260. - 2,24 mm maximum component height - esd Advanced CAN Controller (esdACC) in FPGA - CAN FD capable according to ISO 11898-1:2015 - Physical Layer according to ISO 11898, galvanic isolation - 3x LEDs for CAN- and board status Drivers, tools and documentation for Windows & Linux on CD-ROM Adapters must be ordered separately as required.	C.2074.64
<b>Accessories:</b>		
CAN-Mini/402-DSUB9-15 cm	Adapter to 1x DSUB9 connector (pin contacts), 1x 4-pin wire-to-board connector (SM04B-SURS-TF), 2x DSUB bolts, Mini/402-Cable (150 mm, C.2044.14) included	C.2044.10
CAN-Mini/402-DSUB9-30 cm	As C.2044.10 but with 300 mm connection cable	C.2044.11
CAN-Mini/402-Cable	Adapter Cable, 4 positions, length: 150 mm, wire size: 32AWG (for SM04B-SUR-TF to SM04B-SUR-TF, JST),	C.2044.14

Table 14: Order information CAN-M.2/402-2-FD hardware

### 9.2 CAN-M.2/402-4 Hardware

Type	Properties	Order No.
CAN-M.2/402-4-FD	Active CAN interface board with 4 CAN ports for M.2 slot as B&M Key (PCI Express) for type 2280, 2260, or 2242. - 2,24 mm maximum component height - esd Advanced CAN Controller (esdACC) in FPGA - CAN FD capable according to ISO 11898-1:2015 - Physical Layer according to ISO 11898, galvanic isolation via adapter - 3x LEDs for CAN- and board status - 1-to-4 adapter cable included Drivers, tools and documentation for Windows & Linux on CD-ROM Adapters must be ordered separately as required.	C.2074.68
CAN-M.2/402-4-FD-T	As C.2074.68, but for extended temperature range: -40 °C ... +85 °C	C.2074.69
<b>Accessories:</b>		
CAN-Mini/402-DSUB9-ISOL	Adapter to 1x DSUB9 connector (pin contacts) with galvanic isolation, 1x 4-pin wire-to-board connector (SM04B-SURS-TF), 2x DSUB bolts	C.2054.10
CAN-Mini/402-DSUB9-ISOL-SIC	As C.2054.10 but with SIC transceiver	C.2054.11

Table 15: Order information CAN-M.2/402-4 hardware

## 9.3 Software

Type		Order No.
Device drivers for Windows and Linux on CD-ROM to CAN-M.2/402 are included in delivery.		
Additional CAN object licences including CD-ROM with CAN driver:		
CAN-DRV-LCD CDROM+Lizenz QNX	Object Licence and CD-ROM for QNX 6.x and 7.x	C.1101.32
CAN-DRV-LCD CDROM+Lizenz RTX	Object Licence and CD-ROM for RTX64	C.1101.35
CAN-DRV-LCD CDROM+Lizenz VxWorks	Object Licence and CD-ROM for VxWorks	C.1101.55
CAN-DRV-LCD CDROM+Lizenz INtime	Object Licence and CD-ROM for INtime 6 and 7	C.1101.65
Higher-Layer Protocols including CD-ROM for CAN CC Applications:		
CANopen-Software Stack Windows/Linux	Single user runtime license for CANopen Software Stack for Windows and Linux	C.1101.06
CANopen-LCD CDROM + Lizenz QNX	Single user runtime license for CANopen Software Stack for QNX	C.1101.17
CANopen-LCD CDROM + Lizenz RTX	Single user runtime license for CANopen Software Stack for RTX/RTX64	C.1101.16
CANopen-LCD CDROM + Lizenz VxWorks	Single user runtime license for CANopen Software Stack for VxWorks	C.1101.18
J1939 Stack for Windows (Object)	Single-user runtime license for J1939 Software Stack and J1939 Device Simulator & Monitor	C.1130.10
J1939 Stack for Linux (Object)	Single-user runtime license for Linux Software Stack	C.1130.11
J1939 Stack for RTX (Object)	Single-user runtime license for RTX/RTX64 Software Stack	C.1130.12
ARINC 825-LCD Windows/Linux/LabVIEW	Licence and CD for Windows, Linux and LabVIEW (Windows)	C.1140.06
ARINC 825-LCD QNX	Licence and CD for QNX	C.1140.17
ARINC 825-LCD RTX	Licence and CD for RTX/RTX64	C.1140.16
ARINC 825-LCD VxWorks	Licence and CD for VxWorks	C.1140.18
For detailed information about the driver availability for your special operating system, please contact our sales team.		

Table 16: Order information software

## 9.4 Manuals

### PDF Manuals

For the availability of the manuals see table below.

Please download the manuals as PDF documents from our esd website <https://www.esd.eu> for free.

Manuals		Order No.
CAN-M.2/402-ME	Hardware manual in English	C.2074.21
CAN-API-ME	NTCAN Part 1: Application Developers Manual NTCAN Part 2: Driver Installation Guide	C.2001.21
CANopen-API-ME	CANopen Manuals in English	C.2002.21

Table 17: Available Manuals

### Printed Manuals

If you need a printout of the manual additionally, please contact our sales team ([sales@esd.eu](mailto:sales@esd.eu)) for a quotation. Printed manuals may be ordered for a fee.