PCAN-Router FD

Universal, programmable Converter for CAN FD and CAN

User Manual

PEAK System

PEAK
System

Relevant products

Product Name	Model	Part number
PCAN-Router FD	2 D-Sub connectors	IPEH-002214 from SN 10000
PCAN-Router FD	Screw terminal strip (Phoenix)	IPEH-002215 from SN 1000

Contents

1 Introduction

The PCAN-Router FD has two CAN channels that support the new CAN FD standard in addition to the conventional CAN 2.0 specification. The module behavior and the data exchange between the two channels are freely programmable. Thus, for example, a conversion of CAN to CAN FD and vice versa is possible and new CAN FD applications can be integrated into existing CAN 2.0 networks.

Using the programming library and the GNU compiler for C and C++, a firmware is created and then transferred to the module via CAN. On delivery, the PCAN-Router FD is using a demo firmware whose source code is contained as example in the scope of supply.

1.1 Properties at a Glance

⌐ NXP LPC4078 microcontroller
  (ARM Cortex M4 with FPU, 120 MHz)

⌐ On-chip 4 kByte EEPROM

⌐ 8 MByte SPI flash

⌐ Two High-speed CAN channels (ISO 11898-2)

  • Comply with CAN specifications 2.0 A/B and FD

  • CAN FD support for ISO and Non-ISO standards

  • CAN FD bit rates for the data field (64 bytes max.) from 40 kbit/s up to 12 Mbit/s

  • CAN bit rates from 40 kbit/s up to 1 Mbit/s

  • NXP TJA1043T CAN transceiver with wake-up

⌐ Status signaling with two 2-color LEDs

- Connections via two 9-pin D-Sub connectors or one 10-pole screw-terminal strip (Phoenix)
- RS-232 connector for serial data transfer
- I/O-connection:
    - One digital input (low-active)
    - One digital output (Low-side switch, max. 600 mA)
- 2 additional digital inputs alternatively to RS-232 (low-active)
- Aluminum casing, optional with DIN rail fixing option available
- Voltage supply from 8 to 30 V
- Extended operating temperature range from -40 to 85 °C (-40 to 185 °F)
- New firmware can be loaded via CAN interface

1.2   Prerequisites for Operation

- Power supply in the range of 8 to 30 V DC
- For uploading a new firmware via CAN:
    - CAN interface of the PCAN series for the computer (e.g. PCAN-USB)
    - Operating system Windows 10, 8.1, 7 (32-/64-bit)

1.3   Scope of Supply

- PCAN-Router FD in aluminum casing (optionally with DIN rail mounting)
- IPEH-002215: mating connector (Phoenix)

- Windows development software (toolchain with GCC ARM Embedded, flash program)

- Library with programming examples

- Manual in PDF format

2 Connectors

Depending on the model, the PCAN-Router FD has the following connectors:

⊑ IPEH-002214: two 9-pin D-Sub connectors (m)

⊑ IPEH-002215: one 10-pole screw terminal strip

Besides the primary functions (voltage supply, CAN FD incl. CAN 2.0), there are **miscellaneous functions** that can be used as needed:

⊑ RS-232 interface for serial data transmission

⊑ 1 I/O pin: digital output, digital input

⊑ 2 additional digital inputs as an alternative to RS-232 (must be configured via hardware, see chapter 3 on page 11)

⊑ "Boot" input for activation of the CAN bootloader for firmware upload (see chapter 6 on page 20)

The following subsections describe each connector assignment.

2.1 D-Sub Connectors (IPEH-002214)

The two D-Sub connectors are used for the CAN FD channels CAN1 and CAN2. The CAN lines (CAN_H, CAN_L) are laid out corresponding to the CiA® 303-1 specification.

The power supply of the PCAN-Router FD can be done via both D-Sub connectors. The supply connections U_{b1} and U_{b2} are connected internally in a non-reactive configuration. This means that also different power sources can be connected.
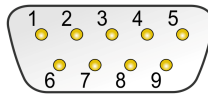
Figure 1: Pin distribution D-Sub connector

CAN1

Pin	Identifier	Function
1	+5V opt.	5-Volt supply external device (optional, see below)
2	CAN1_L	CAN FD channel 1 Low
3	GND	Ground
4	RxD (Din1)	RS-232 RxD (alternative digital input Din1[1])
5	Shield	Shield
6	Boot	Activation CAN bootloader (High level)
7	CAN1_H	CAN FD channel 1 High
8	TxD (Din2)	RS-232 TxD (alternative digital input Din2[1])
9	U_{b1}	Power supply 8 - 30 V DC

CAN2

Pin	Identifier	Function
1	+5V opt.	5-Volt supply external device (optional, see below)
2	CAN2_L	CAN FD channel 2 Low
3	GND	GND
4	-	Not used
5	Shield	Shield
6	-	Not used
7	CAN2_H	CAN FD channel 2 High
8	Din0 / Dout	Digital input Din0, digital output Dout (600 mA)
9	U_{b2}	Power supply 8 - 30 V DC

[1] For the corresponding hardware configuration, see section 3.3 on page 14.
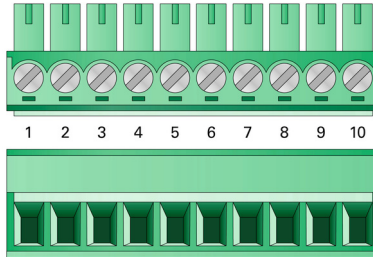
2.2   Screw terminal strip (IPEH-002215)

Figure 2: Screw terminal strip (Phoenix)

Terminal	Identifier	Function
1	U_b	Power supply 8 - 30 V DC
2	GND	Ground
3	CAN1_L	CAN FD channel 1 Low
4	CAN1_H	CAN FD channel 1 High
5	CAN2_L	CAN FD channel 2 Low
6	CAN2_H	CAN FD channel 2 High
7	Boot	Activation CAN bootloader (High level)
8	Din0 / Dout	Digital input Din0, digital output Dout (600 mA)
9	RxD (Din1)	RS-232 RxD (alternative digital input Din1[2])
10	TxD (Din2)	RS-232 TxD (alternative digital input Din2[2])

[2] For the corresponding hardware configuration, see section 3.3 on page 14.

3 Hardware Configuration

For special applications, several settings can be done on the circuit board of the PCAN-Router FD by using solder jumpers.

- 4-bit coding of the hardware for polling by the firmware

- Supply of external devices with 5 Volts via the D-Sub connector (only IPEH-002214)

- Use of two additional digital inputs (Din1, Din2) instead of the serial RS-232 interface

- Termination of the CAN buses with 120 Ω

▶ Do the following to set the solder bridge(s):

Attention! Electrostatic discharge (ESD) can damage or destroy components on the circuit board. Take precautions to avoid ESD when handling the circuit board.

1. Remove the screws from both sides of the PCAN-Router FD casing.

2. **Only for D-Sub version:**
   Additionally remove the screws from one of the two D-Sub connectors.

3. Pull the circuit board out of the casing profile.

4. Set the solder jumper(s) on the circuit board according to the desired settings.

   Only for D-Sub version: additionally remove the screws next to one of the two D-Sub connectors.

5. Afterwards, assemble the components in reverse order.

3.1   4-Bit Coding

The circuit board of the PCAN-Router FD has four coding solder fields (ID0 to ID3) in order to allocate a permanent status to the corresponding input ports of the microcontroller. A bit is set (1) if the corresponding solder field is open.
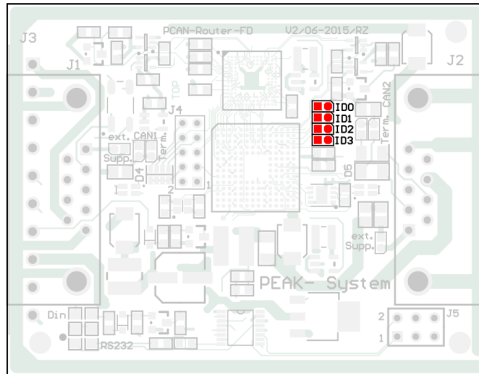

Figure 3: Position of the coding solder fields

The status of the ports is relevant in the following cases:

- The loaded firmware is programmed so that it reads the status at the corresponding ports of the microcontroller. For example, the activation of certain functions of the firmware or the coding of an ID is conceivable here.

- For a firmware upload via CAN the PCAN-Router FD is identified by a 4-bit ID which is determined by the solder jumpers (default setting: ID15, all solder fields open).

Solder field	ID0	ID1	ID2	ID3
Binary digit	0001	0010	0100	1000
Decimal equivalent	1	2	4	8

More information about the firmware upload in chapter 6 on page 20.

3.2   Supply of External Devices via the D-Sub Connector

Only product model IPEH-002214 (D-Sub connectors)

On the circuit board of the PCAN-Router FD, a 5-Volt supply can optionally be routed to each pin 1 of the D-Sub connectors CAN1 and CAN2. Thus, devices with low power consumption (e.g. bus converters) can be directly supplied via the CAN connector. The current consumption may not exceed **100 mA** per connector.
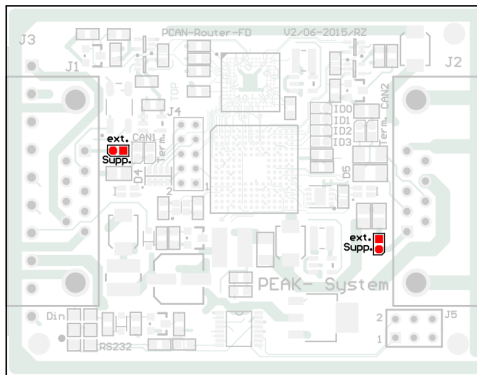

Figure 4: Position of the solder fields for the supply of external devices
(for D-Sub connector CAN1 on the left, for CAN2 on the right)

D-Sub connector	5-Volt supply	
	None (Default)	Pin 1
CAN1 (left)	ext. Supp.	ext. Supp.
CAN2 (right)	ext. Supp.	ext. Supp.

3.3 Two Additional Digital Inputs

Instead of the preset serial RS-232 interface for the serial data transmission, two additional digital inputs (Din1, Din2) can be assigned to the corresponding pins or screw terminals[3]. This is done by moving two 0-Ohm resistors (alternatively solder jumpers).
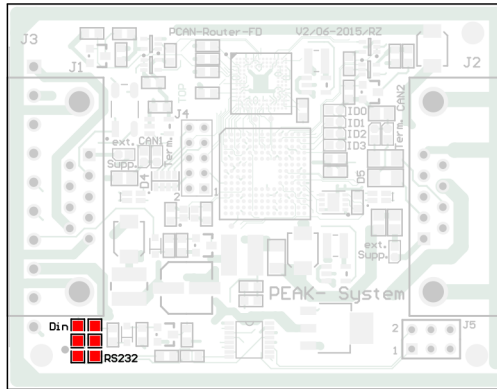

Figure 5: Position of the solder fields for switching between RS-232 and Din (pre-equipped with 0-Ohm resistors)

Function for pins/screw terminals	Positions of the solder jumpers (or 0-Ohm resistors)
RS-232 RxD, RS-232 TxD (Default)	
Din1 (Din2)	

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[3] D-Sub connectors: see section 2.1 on page 8
Screw terminal strip: see section 2.2 on page 10

3.4   Termination of the CAN Buses

If the PCAN-Router FD is connected to one end of a CAN bus and if there's no termination of the CAN bus yet, an internal termination with 120 Ω between the lines CAN_H and CAN_L can be activated. Termination is possible independently for both CAN channels.
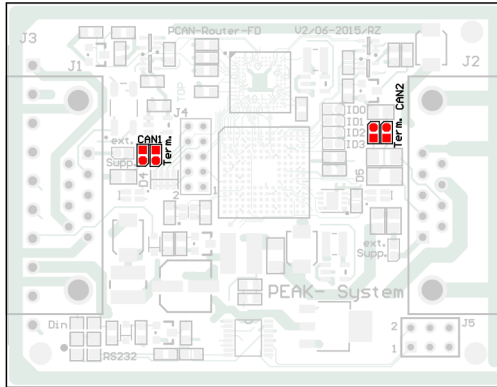

Figure 6: Position of the solder fields for the termination of the CAN bus (CAN1 on the left, CAN2 on the right)

CAN Channel	Without termination (Default)	With termination
CAN1		
CAN2		

4 Startup Procedure

The PCAN-Router FD is activated by applying the supply voltage to the respective connectors (see chapter 2 *Connectors* on page 8). The firmware in the flash memory is subsequently run.

On delivery, the PCAN-Router FD is equipped with an example firmware which forwards CAN messages 1:1 between both CAN FD channels (CAN FD ISO, 500 kbit/s nominal, 4 Mbit/s data). An incoming CAN message causes a change between green and orange of the LED status indication for the respective CAN channel.

The source code for the example firmware 1_ROUTING and further examples is included on the supplied DVD in the following directory branch:

```
/Develop/Microcontroller hardware/PCAN-Router FD/Example/
```

5 Software

This chapter covers the installation of the GNU ARM toolchain for Windows and gives notes about the software library and the firmware examples.

Software, source code, and additional information are included on the supplied DVD in the following directory branch:

`/Develop/Microcontroller hardware/PCAN-Router FD/`

5.1 Installing the GNU ARM Toolchain

To compile the code examples and the custom firmware code under Windows, install the supplied GNU ARM toolchain on your computer. The toolchain is collection of tools to develop applications for ARM processors and corresponding microcontrollers on Windows platforms. The collection includes a compiler for C and C++ as well as Make utilities.

System requirement: Windows 10, 8.1, 7 (32-/64-bit)

📦 Do the following to install the toolchain:

1. From the directory branch on the provided DVD mentioned above, change to the `Compiler` subdirectory.

2. Start the setup program for GCC ARM Embedded (`gcc-arm-none-eabi-*.exe`) and follow its instructions. Make sure that you enable the option **Add path to environment variable** on the last page.

3. Afterwards, start the setup program for PEAK-System Make Utilities (`PEAK-MakeUtils*.exe`) and follow its instructions.

In the system environment, the installation programs create search paths for the executable files. These new search paths are effective only for programs and command prompts that are started afterwards.

5.2   Library

The development of applications for the PCAN-Router FD is suppor-ted by the library `libPCAN-Router_FD_*.a` (* stands for version number), a binary file. You can access all resources of the PCAN-Router FD by means of this library. Die library is documented in the header files (`*.h`) which are located in the `inc` subdirectory of each example directory.

5.3   Firmware Examples

On the DVD, the `Example` subdirectory contains source code for several firmware examples that you can use and test directly and that you can reuse for custom firmware.

On delivery, the PCAN-Router FD is equipped with the example firmware `1_ROUTING` which forwards CAN messages 1:1 between both CAN FD channels (CAN FD ISO, 500 kbit/s nominal, 4 Mbit/s data). An incoming CAN message causes a change between green and orange of the LED status indication for the respective CAN channel.

5.3.1   Compiling a Firmware Example

➡️ Do the following to compile a firmware example under Windows:

1. From the provided DVD, copy the subdirectory of the desired example from the Example directory to the local hard disk.

2. Open a **command prompt** by using the Windows Start menu. Alternatively you can press the key combination ⊞ + R and enter cmd.exe as program to be executed.

3. At the command prompt, change to the previously copied directory.

4. Execute the following command in order to clean up the target directories (e.g. out) from files that have been generated earlier:

   make clean

5. Execute the following command to compile the firmware example:

   make all

   If the compiler has finished without errors ("Errors: none"), you can find the firmware file with the extension .bin in the subdirectory out. This file is then used for firmware upload to the PCAN-Router FD.

6 Uploading Firmware via CAN

The microcontroller in the PCAN-Router FD is equipped with new firmware via CAN. The scope of supply includes the Windows program PCAN-Flash to transfer the firmware from the computer to the PCAN-Router FD.

6.1 System Requirements

The following prerequisites must be given, so that the PCAN-Router FD can be updated with new firmware:

- CAN interface of the PCAN series for the computer (e.g. PCAN-USB FD)

- CAN cabling between the CAN interface and the PCAN-Router FD with proper termination (120 Ω on each end of the CAN bus)

- Operating system Windows 10, 8.1, 7 (32-/64-bit)

- If you want to update several PCAN-Router FD connected to the same CAN bus, you must assign a unique ID to each router. See section 3.1 *4-Bit Coding* on page 12.

6.2 Preparing Hardware and Software

For an upload of new firmware via CAN, the CAN bootloader must be activated in the PCAN-Router FD. This can only be done via CAN channel 1. Firmware transfer, on the other hand, can also be done via CAN channel 2.

◗ Do the following to prepare the hardware:

1. Switch the PCAN-Router FD off by disconnecting it from the power supply.

2. Establish a connection between "Boot" and the power supply ("U_{b1}", "U_{b2}", or "U_b") at the connectors of the PCAN-Router FD.
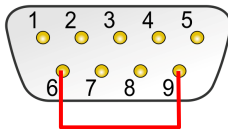

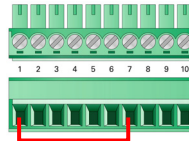Figure 7: Connection at D-Sub connector CAN1 between the pins 6 and 9

Figure 8: Connection at the screw terminal strip between terminals 1 and 7

This measure later applies the "Boot" connection with a High level.

3. Connect a CAN bus of the PCAN-Router FD with a CAN interface connected to the computer. Pay attention to the proper termination of the CAN cabling (2 x 120 Ω).

⚠ **Attention!** Risk of short circuit! A CAN cable with D-Sub connectors <u>must not</u> have a connection on pin 6, as it can be seen on 1:1 cables, for example. At other CAN nodes (e.g. a CAN interface of the PCAN series) this line may be applied to the mass. Damage or destruction of the electronics is a possible consequence.

◗ Do the following to prepare the software:

1. On the supplied DVD, change to the following directory:
   `/Develop/Microcontroller hardware/PCAN-Router FD/`

2. Copy the subdirectory `PcanFlash` to the local hard disk.

The contained Windows software that copies the Firmware via CAN (`PcanFlash.exe`) can only be started from a data carrier that is writable.

6.3 Sending the Firmware

On the PCAN-Router FD a new version of the firmware can be transferred via both CAN channels. Only the bootloader can be activated via the first CAN channel. The firmware is uploaded via a CAN bus using the supplied Windows program PCAN-Flash.

▶ Do the following to activate the bootloader via CAN FD channel 1:

1. Ensure that a connection is established between the "Boot" and "U_{b1}", "U_{b2}", or "U_b" connections of the PCAN-Router FD (see Figure 7 or Figure 8).

2. Switch on the PCAN-Router FD by applying a supply voltage.

   Due to the High level at the "Boot" connection, the PCAN-Router FD starts the CAN bootloader. This can be deter-mined by the status LEDs:

LED	State	Color
CAN1	quickly blinking	orange
CAN2	on	orange

▶ Do the following to transfer a new firmware via CAN FD channels 1 or 2:

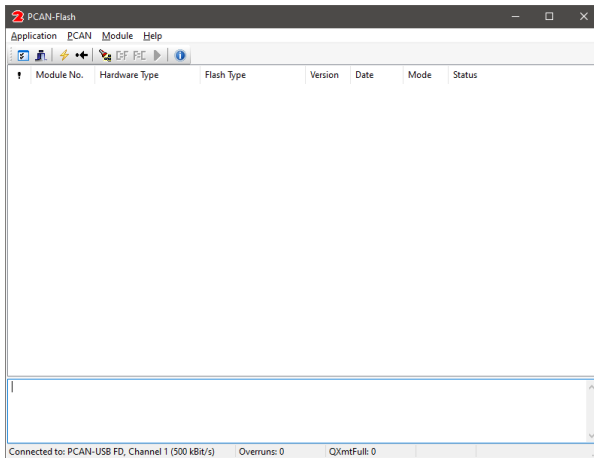1. Run the program `PcanFlash.exe` under Windows from the local hard drive.

Figure 9: Main window of PCAN-Flash

2. Click on the ⊡ (**Options**) button in order to call up the dialog box.

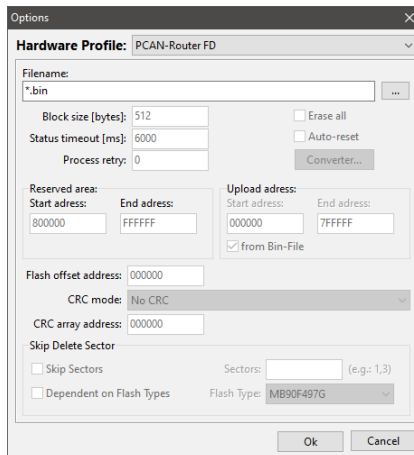3. From the **Hardware Profile** dropdown list, select the **PCAN-Router FD** entry.

Figure 10: Select PCAN-Router FD as hardware profile.

4. Click on the ... button next to the **File name** field in order to select the desired firmware file (`*.bin`) to be uploaded.

5. Click on the **OK** button.

6. Make sure that the PCAN-Flash program is connected with 500 kbit/s to the available CAN interface at the computer.

   If not, click the ⚡ (**Connect**) button in order to change the selection in the according dialog box.
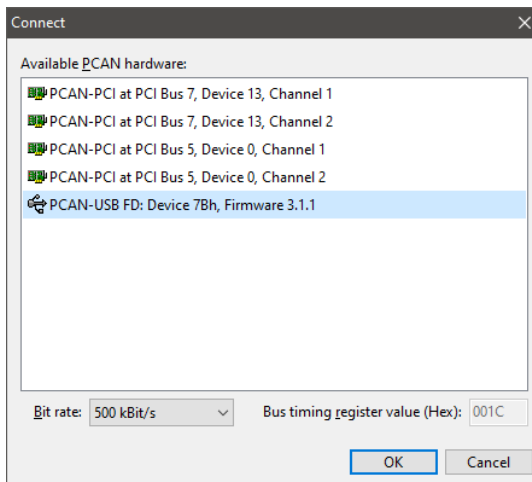

Figure 11: **Connect** dialog box

7. Click the ⚡ (**Detect**) button in order to detect the PCAN-Router FD connected to the CAN bus.

   An entry for the PCAN-Router FD appears in the main window.

8. Select the entry for the PCAN-Router FD.

9. Click the ▶ (**Program**) button in order to start uploading the new firmware to the PCAN-Router FD.

    Observe the status indication at the bottom of the window. The process was successful if the last message to appear is "**Flashing of module(s) finished!**".

10. Disconnect the power supply from the PCAN-Router FD.

11. At the PCAN-Router FD, disconnect the connection between "Boot" and the power supply ("U_{b1}", "U_{b2}", or "U_b").

You can now use the PCAN-Router FD with the new firmware.

7 Technical Specifications

Functionality	
Microcontroller	Microcontroller NXP LPC4078 (ARM Cortex M4 with FPU, 120 MHz)
Add-on memory	4 kByte On-Chip-EEPROM 8 MByte SPI Flash
CAN	2 x CAN FD (ISO, non-ISO, CAN 2.0)
CAN bit rates	Arbitration phase: 40 kbit/s - 1 Mbit/s Data field (CAN FD): 40 kbit/s - 12 Mbit/s
Transceiver	NXP TJA1043 with Wake-Up
RS-232	RxD and TxD serial connections with RS-232 levels
Digital inputs (Din)	Low-active, max. level U_b
Digital output (Dout)	Low-side, max. 600 mA
Status indication	2 duo LEDs
Connectors	IPEH-002214: 2 x D-Sub connector, 9-pin, assignment according to specification CiA® 303-1 IPEH-002215: 1 x screw terminal strip, 10-pole, pitch 3.81 mm (Phoenix Contact MC 1,5/10-ST-3,81 - 1803659)

Power supply	
Supply voltage (U_b)	8 - 30 V DC
Current consumption	max. 150 mA at 8 V max. 100 mA at 12 V max. 50 mA at 30 V
Power-down mode	40 µA

Measures	
Size (L x W x H)	IPEH-002214 (D-Sub): 58.7 x 80 x 27.7 mm (B x L x H) IPEH-002215 (Phoenix): 58.7 x 84.4 x 27.7 mm (B x L x H) Circuit board (IPEH-002214/15): 65 x 51 mm (L x W) See also dimension drawings in Appendix A on page 28
Weight	IPEH-002214 (D-Sub): 105 g IPEH-002215 (Phoenix): 94 g

Environment

Operating temperature	-40 - +85 °C (-40 - +185 °F)
Temperature for storage and transport	-40 - +100 °C (-40 - +212 °F)
Relative humidity	15 - 90 %, not condensing
Ingress protection (IEC 60529)	IP20

Conformity

EMV	Directive 2014/30/EU DIN EN 61326-1:2013-07
RoHS 2	Directive 2011/65/EU DIN EN 50581 VDE 0042-12:2013-02

Appendix A CE Certificate

EU Declaration of Conformity

This declaration applies to the following product:

Product name: PCAN-Router FD

Item number(s):   IPEH-002214/15

Manufacturer: PEAK-System Technik GmbH
Otto-Roehm-Strasse 69
64293 Darmstadt
Germany

We declare under our sole responsibility that the mentioned product is in conformity with the following directives and the affiliated harmonized standards:

EU Directive 2011/65/EU (RoHS 2)

DIN EN 50581 VDE 0042-12:2013-02
Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances;
German version EN 50581:2012

EU Directive 2014/30/EU (Electromagnetic Compatibility)
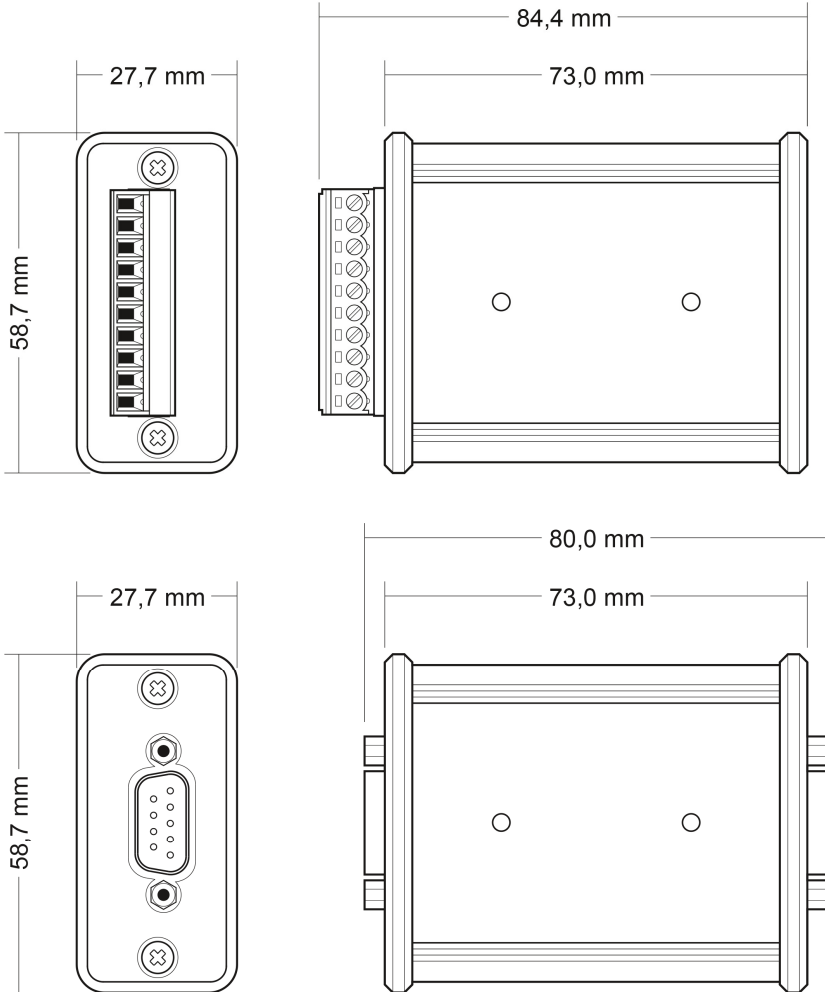
DIN EN 61326-1:2013-07
Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 1:
General requirements (IEC 61326-1:2012);
German version EN 61326-1:2013

Darmstadt, 17 December 2019

Uwe Wilhelm, Managing Director

Appendix B Dimension Drawings

The figures do not show the original size.