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PCAN-USB FD

CAN FD Interface for High-Speed USB 2.0

User Manual



Document version 1.4.0 (2019-03-19)

PEAK System

Relevant products

Product name	Model	Part number
PCAN-USB FD		IPEH-004022

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

Phone: +49 (0)6151 8173-20
Fax: +49 (0)6151 8173-29

www.peak-system.com
info@peak-system.com

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1 Introduction

The CAN FD adapter PCAN-USB FD allows the connection of CAN FD and CAN networks to a computer via USB. A galvanic isolation of up to 500 Volts decouples the PC from the CAN bus. The simple handling and its compact plastic casing make the adapter suitable for mobile applications.

The new CAN FD standard (CAN with Flexible Data rate) is primarily characterized by higher bandwidth for data transfer. The maximum of 64 data bytes per CAN FD frame (instead of 8 so far) can be transmitted with bit rates up to 12 Mbit/s. CAN FD is downward-compatible to the CAN 2.0 A/B standard, thus CAN FD nodes can be used in existing CAN networks. However, in this case the CAN FD extensions are not applicable.

The monitor software PCAN-View and the programming interface PCAN-Basic for the development of applications with CAN connection are included in the scope of supply and support the new standard CAN FD.

Device drivers exist for different operating systems, so programs can easily access a connected CAN bus.



Tip: At the end of this manual (Appendix C) you can find a Quick Reference with brief information about the installation and operation of the PCAN-USB FD adapter.

1.1 Properties at a Glance

- Adapter for High-speed USB 2.0
  (compatible to USB 1.1 and USB 3.0)
- High-speed CAN connection (ISO 11898-2)

- Complies with CAN specifications 2.0 A/B and FD
- CAN FD support for ISO and Non-ISO standard switchable
- CAN FD bit rates for the data field (64 bytes max.) from 25 kbit/s up to 12 Mbit/s
- CAN bit rates from 25 kbit/s up to 1 Mbit/s
- Time stamp resolution 1 µs
- CAN bus connection via D-Sub, 9-pin
  (in accordance with CiA® 303-1)
- FPGA implementation of the CAN FD controller
- NXP TJA1044GT CAN transceiver
- Galvanic isolation up to 500 V
- CAN termination can be activated through a solder jumper
- Measurement of bus load including error frames and overload frames on the physical bus
- Induced error generation for incoming and outgoing CAN messages
- 5-Volt supply to the CAN connection can be connected through a solder jumper, e.g. for external bus converter
- Voltage supply via USB
- Extended operating temperature range from -40 to 85 °C
  (-40 to 185 °F)

Note: This manual describes the use of PCAN-USB FD adapter with **Windows**. You can find device drivers for **Linux** and the corresponding application information on the provided DVD in the directory branch `Develop` and on our website under www.peak-system.com/linux.

1.2 System Requirements

- A vacant USB port (USB 1.1, USB 2.0 or USB 3.0) at the computer or at a self-powered USB hub connected to the computer
- Operating system Windows 10, 8.1, 7 (32/64-bit)
  or Linux (32/64-bit)

Note: Do not use a USB extension cable to connect the PCAN-USB FD adapter to the computer. The use of an extension cable does not comply with the USB specification and can lead to malfunction of the adapter.

1.3 Scope of Supply

- PCAN-USB FD in plastic casing
- Device drivers for Windows 10, 8.1, 7 and Linux (32/64-bit)
- CAN monitor PCAN-View for Windows
- Programming interface PCAN-Basic for developing applications with CAN connection
- Programming interfaces for standardized protocols from the automotive sector
- Manual in PDF format

2 Installing the Software and the Adapter

This chapter covers the software setup for the PCAN-USB FD adapter under Windows and the connection of the adapter to the computer.

Install the driver before you connect the adapter to the computer.

- Do the following to install the driver:

1. Start `Intro.exe` from the supplied DVD.

   The navigation program starts.

2. Select in the main menu **Drivers** and click on **Install now**.
3. Confirm the message of the User Account Control related to "Installer database of PEAK Drivers".

   The driver setup starts.

4. Follow the program instructions.

- Do the following to connect the adapter:

Note: Do not use a USB extension cable to connect the PCAN-USB FD adapter to the computer. The use of an extension cable does not comply with the USB specification and can lead to malfunction of the adapter.

1. Connect the adapter to a USB port of the computer or of a connected USB hub. The computer can remain powered on.

   Windows detects the new hardware and completes the driver installation.

2. Check the LED on the adapter. If the LED is green, then the driver was initialized successfully.

3 Connecting the CAN Bus

3.1 Connection over D-Sub Connector

A High-speed CAN bus (ISO 11898-2) is connected to the 9-pin D-Sub connector. The pin assignment for CAN corresponds to the specification CiA® 303-1.

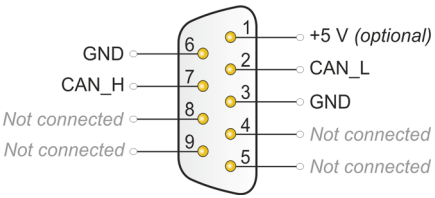


Figure 1: Pin assignment High-speed CAN
(view onto connector of the PCAN-USB FD adapter)

Low power devices (e.g. bus converters) can be supplied directly with 5 volts over pin 1 of the CAN connector. Pin 1 is not in use at the delivery state. For more information see the next section 3.2.

Tip: Connect a CAN bus with a different transmission standard via a bus converter. PEAK-System offers different bus converter modules like the PCAN-TJA1054 for a Low-speed CAN bus according to ISO 11898-3.

3.2 Voltage Supply of External Devices

External devices with low power consumption (e.g. bus converters) can be directly supplied via the CAN connector. With a solder bridge for the one CAN channel on the PCAN-USB FD board (casing opened), a 5-Volt supply can optionally be routed to pin 1 of the D-Sub connector. The current output is limited to 50 mA.

Do the following to activate the voltage supply:

Risk of short circuit! Solder with great care to avoid unwanted short circuits on the card.

Attention! Electrostatic discharge (ESD) can damage or destroy components on the card. Take precautions to avoid ESD.

1. Open the adapter casing. Push the latches on both sides cautiously, e.g. with a flat tip screwdriver.
2. Remove the board.
3. Set the solder bridge.

   Figure 2 shows the position of the solder field.
4. Close the case. Place the board overhead onto the top part of the casing.

Note: The cable must lie with the strain relief in the cut-out of the casing and the LED must be in the corresponding hole.

5. Push the bottom part of the casing onto the top part until the latches click in.

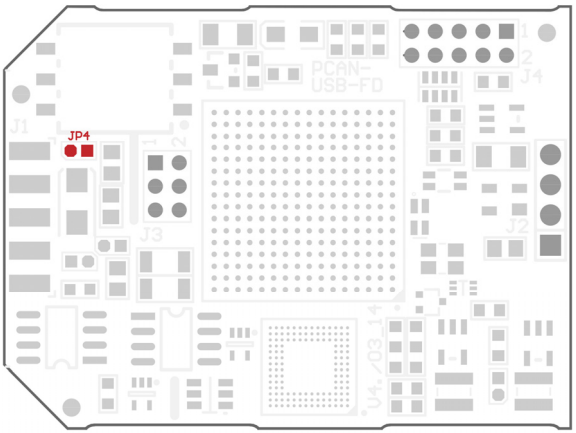


Figure 2: Top view **PCAN-USB FD board**, solder field JP4

Risk of short circuit! The 5-Volt supply is not protected separately. Therefore, turn off the computer before you connect and disconnect CAN cables or peripheral systems.

Consider that some computers still supply the USB ports with power even when they are turned off (standby operation).

3.3 Activating the Internal Termination

The internal termination can be activated by solder jumpers on the board to terminate one end of the CAN bus with 120 Ohms. At delivery the termination is not activated. A High-speed CAN bus (ISO 11898-2) must be terminated on both ends with 120 Ohms. Otherwise disturbances may arise.

➡ Do the following to activate the internal termination:

⚠ **Risk of short circuit!** Solder with great care to avoid unwanted short circuits on the card.

Attention! Electrostatic discharge (ESD) can damage or destroy components on the card. Take precautions to avoid ESD.

1. Open the adapter casing. Push the latches on both sides cautiously, e.g. with a flat tip screwdriver.
2. Remove the board.
3. Set both solder bridges on the board.

   Figure 3 shows the positions of the solder fields.
4. Close the case. Place the board overhead onto the top part of the casing.

Note: The cable must lie with the strain relief in the cut-out of the casing and the LED must be in the corresponding hole.

5. Push the bottom part of the casing onto the top part until the latches click in.

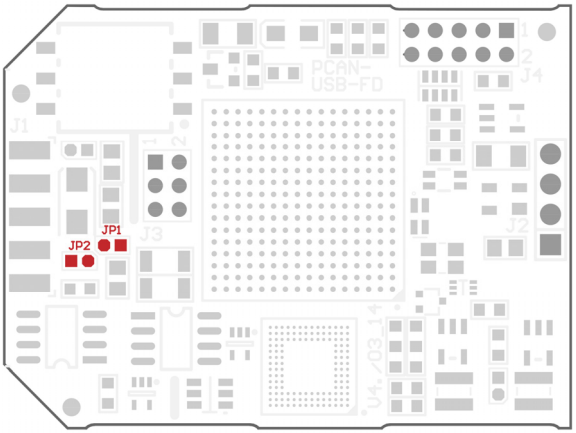


Figure 3: Top view **PCAN-USB FD board,** solder fields JP1 and JP2

3.4 Cabling

3.4.1 Termination

The High-speed CAN bus (ISO 11898-2) must be terminated with 120 ohms on both ends. The termination prevents interfering signal reflections and ensures the proper operation of the transceivers of the connected CAN nodes (CAN interfaces, control devices).

The PCAN-USB FD adapter has an optional internal termination with 120 ohms. For more information, see chapter 3.3.

3.4.2 Example of a Connection

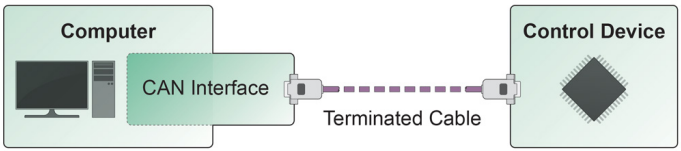


Figure 4: Simple CAN connection

This example shows a connection between the PCAN-USB FD adapter and a control unit. The connection cable is terminated with 120 ohms on both ends.

3.4.3 Maximum Bus Length

High-Speed CAN networks may have bit rates of up to 1 Mbit/s. The maximum bus length depends primarily on the bit rate.

The following table shows the maximum possible CAN bus length at different bit rates:

Bit rate	Bus length
1 Mbit/s	40 m
500 kbit/s	110 m
250 kbit/s	240 m
125 kbit/s	500 m
50 kbit/s	1.3 km
25 kbit/s	2.5 km

The listed values have been calculated on the basis of an idealized system and can differ from reality.

Note: For CAN FD, the same maximum bus lengths apply as for CAN, despite the higher data bit rate of CAN FD.
The dependency is based on the bit rate during the arbitration, called nominal bit rate. The nominal bite rate at CAN FD can be up to 1 Mbit/s.

4 Operation

4.1 Status LED

The PCAN-USB FD adapter has a status LED which can be in one of the following conditions:

Status	Meaning
Green on	There's a connection to a driver of the operating system.
Green slow blinking	A software application is connected to the adapter.
Green quick blinking	Data is transmitted via the connected CAN bus.
Red blinking	An error is occurring during the transmission of CAN data.
Orange quick blinking	Identification of an adapter when multiple adapters are plugged (see chapter 5.1.3 page 23).

4.2 Unplugging the USB Connection

On Windows, the icon for removing hardware safely is not used with the PCAN-USB FD adapter. You can unplug the adapter from the computer without any preparation.

4.3 Distinguishing Several PCAN-USB FD Adapters

You can operate several PCAN-USB FD adapters on a single computer at the same time. The supplied program PCAN-View allows the assignment of device IDs in order to distinguish the adapters in a software environment. For more information see section 5.1.3.

5 Software and API

This chapter covers the provided software PCAN-View and the programming interface PCAN-Basic.

5.1 Monitor Software PCAN-View

PCAN-View is simple Windows software for viewing, transmitting, and logging CAN- and CAN FD messages.

Note: This chapter describes the use of PCAN-View with a CAN-FD adapter.

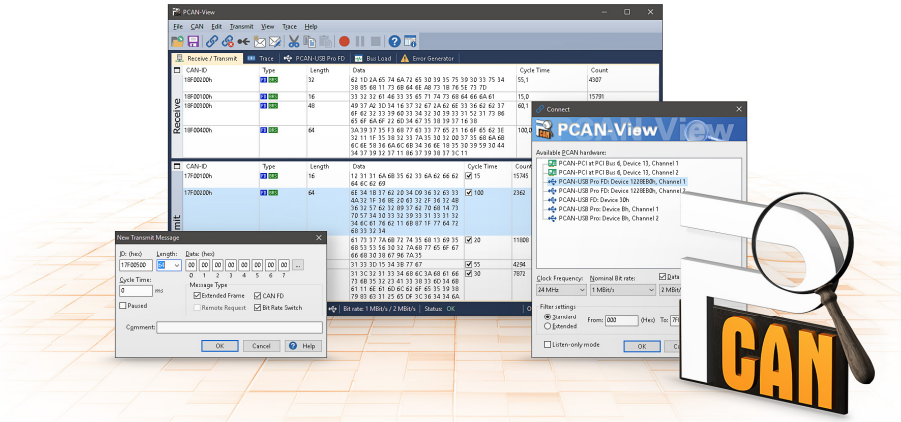


Figure 5: PCAN-View for Windows

Do the following to start and initialize PCAN-View:

1. Open the Windows Start menu and select **PCAN-View**.

   The **Connect** dialog box appears.

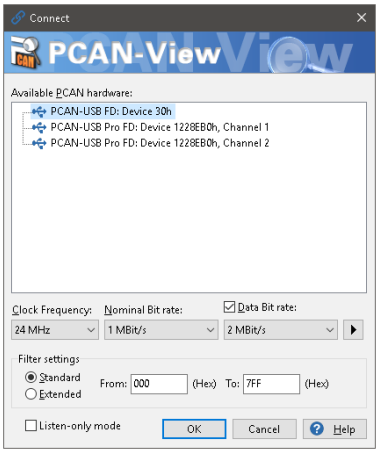


Figure 6: Selection of the specific hardware and parameters

2. Select an interface from the list.
3. From the drop-down menu, choose a **Clock Frequency**. The selectable bit rates in the following are based on this setting.
4. From the drop-down list, select a **Nominal Bit rate**, which is used for the arbitration phase (max. 1Mbit/s).
5. Enable the **Data Bit rate** checkbox.
6. From the drop-down menu, choose an additional **Data Bit rate** for the CAN FD bus. The bit rate selected here is used to transfer the data fields of a CAN FD frame with a higher bit rate.

Note: Both transmission rates must match those which are used by all nodes on the CAN bus.



Tip: You can create custom bit rates by using the button (▸).

7. Under **Filter settings** you can limit the range of CAN IDs to be received, either for standard frames (11-bit IDs) or for extended frames (29-bit IDs).
8. Activate the **Listen-only mode** if you do not actively participate in the CAN traffic and just want to observe. This also avoids an unintended disruption of an unknown CAN environment (e.g. due to different bit rates).
9. Confirm the settings in the dialog box with **OK**. The main window of PCAN-View appears (see 5.1.1).

5.1.1 Receive/Transmit Tab

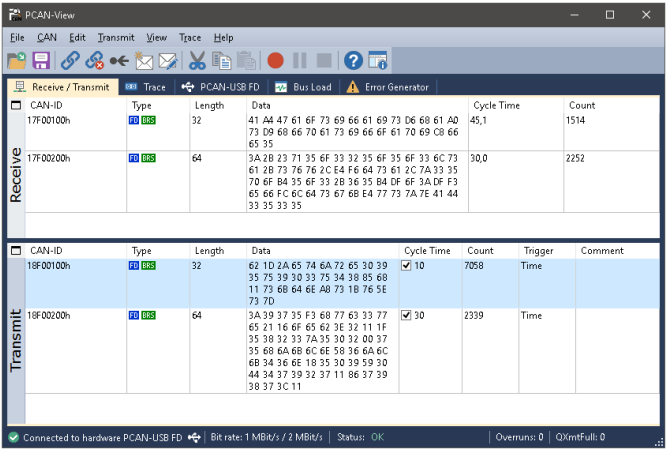


Figure 7: Receive/Transmit tab

The **Receive/Transmit** tab is the main element of PCAN-View. It contains two lists, one for received messages and one for the transmit messages. The CAN data format is hexadecimal by default.

Do the following to transmit a CAN FD message:

1. Select the menu command **Transmit** > **New Message** (alternatively or Ins).

   The **New Transmit Message** dialog box appears.

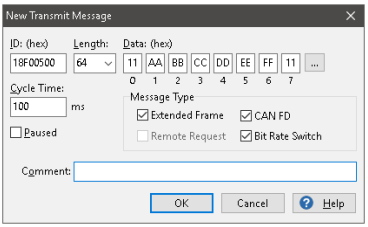


Figure 8: Dialog box new transmit message

2. Enable the **CAN FD** checkbox to define a CAN FD message with maximum **Length** of 64 data bytes.
3. Enter the **ID**, the data **Length** and the CAN message **Data**. With a length of more than 8 bytes, click on [...] and enter the data bytes into the editor.

Note: With the program version 4 of PCAN-View, the DLC field was renamed to **Length**. Latter reflects the actual data length.

4. Enter a value into the **Cycle Time** field to choose manually or periodically message transmission. Enter a value greater than 0 to transmit periodically. Enter the value 0 to transmit only manually.
5. Enable the **Bit Rate Switch** checkbox, that the data of a CAN FD message is transmitted with the selected **Data Bit rate**.
6. Confirm the entries with **OK**.

   The created transmit message appears on the **Receive/Transmit** tab.
7. Trigger selected transmit messages manually with the menu command **Transmit** > **Send** (alternatively [Space] bar). The manual transmission for messages being transmitted periodically is carried out additionally.

Tip: Under the menu command **File > Save,** you can save the current transmit messages into a transmit list. Saved transmit lists are available for reuse.

5.1.2 Trace Tab

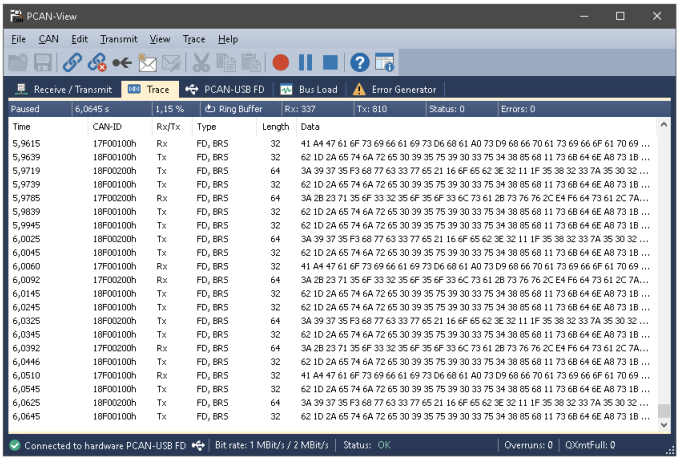


Figure 9: Trace tab

On the **Trace** tab, the data tracer (data logger) of PCAN-View is used for logging the communication on a CAN bus. During this process the messages are cached in the working memory of the PC. Afterwards, they can be saved to a file.

The Tracer runs either in linear or in ring buffer mode. The linear buffer mode stops the Tracer as soon as the buffer is full. The ring buffer mode overwrites the oldest messages by new ones as soon as the buffer is full.

5.1.3 PCAN-USB FD Tab

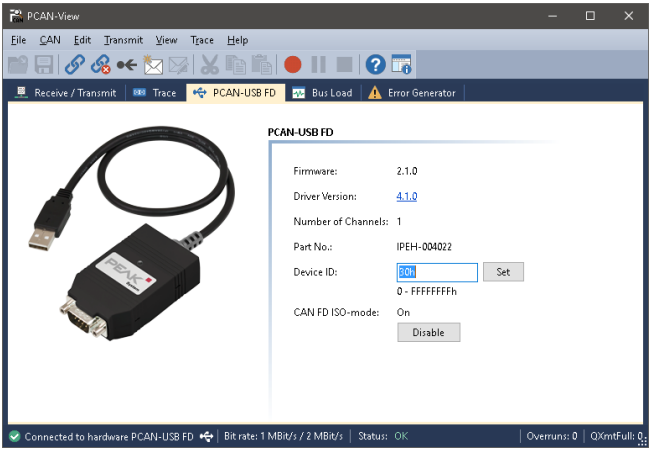


Figure 10: PCAN-USB FD tab

The **PCAN-USB FD** tab contains some detailed information about the hardware and driver.

In addition, you can assign a **Device ID** to the adapter. Thus, it can be uniquely identified while operating several PCAN-USB FD adapters on a computer at the same time.

To identify a PCAN-USB FD adapter, you first go to the dialog box for selecting the hardware of PCAN-View (Figure 6 on page 18). In the list “Available PCAN hardware and PCAN-nets”, you can perform a right-click on every USB adapter and execute the command "identify". Thereby, the LED of the corresponding adapter flashes shortly.

CAN FD ISO-mode

The defined in the ISO 11898-standard is not compatible with the original protocol. PEAK-System takes this into account by supporting both protocol versions with their CAN FD interfaces.

If required, the user can switch to the CAN FD protocol used in the environment with the **Enable** / **Disable** button („Non-ISO“ and „ISO“).

5.1.4 Bus Load Tab

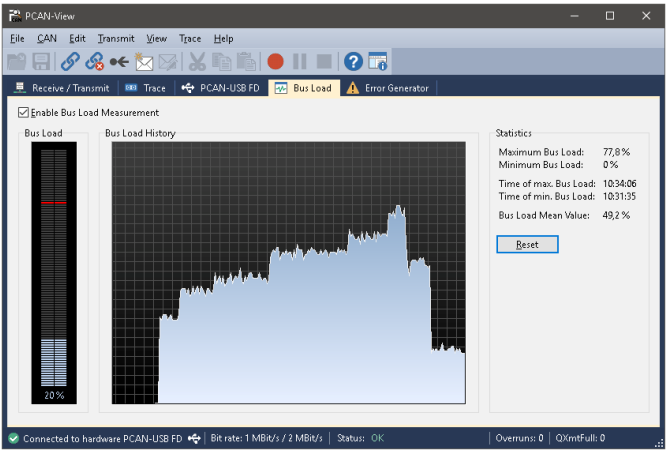


Figure 11: Bus Load tab

On the **Bus Load** tab, the current bus load, time course, and statistical information of the CAN channel are displayed. The CAN bus load reflects the utilization of transmission capacity.

5.1.5 Error Generator Tab

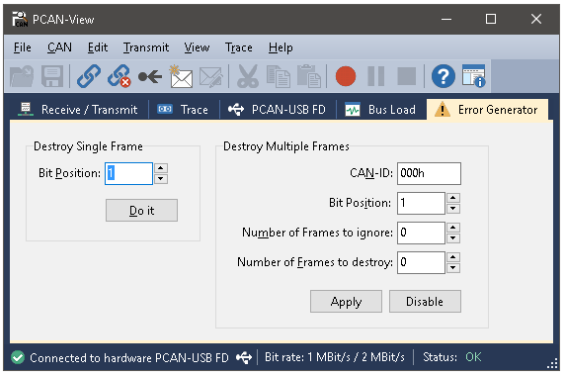


Figure 12: Error Generator tab

Via the **Error Generator** tab, the communication on the CAN bus can be disturbed for testing purposes by 6 consecutive dominant bits. This is a violation of the CAN protocol on the CAN bus which must be recognized as an error by the connected CAN nodes.

You can destroy CAN frames with the error generator by one of two methods:

- once after activation
- repeatedly at specific intervals related to a CAN ID

The **Destroy Single Frame** area refers to the next CAN frame that is recognized by the adapter after activation.

Do the following to destroy a single CAN frame:

1. Enter the **Bit Position** where in the CAN frame the error is to be generated. The count includes the stuff bits.
2. Execute the destroy action with **Do it**.

   The next received or transmitted CAN frame will be destroyed at the selected bit position.

The **Destroy Multiple Frames** area refers to a CAN ID whose frames are to be destroyed in specific intervals.

Do the following to destroy multiple CAN frames:

1. Enter the **CAN ID** of the frame to be destroyed.
2. Enter the **Bit Position** where in the CAN frame the error is to be generated. The count includes the stuff bits.
3. The **Number of Frames to ignore** field specifies the number of CAN frames with the given ID that are ignored before a frame is destroyed.
4. The **Number of Frames to destroy** field specifies the number of CAN frames with the given ID that are destroyed consecutively.
5. Confirm the entries with **Apply** to activate the error generator.
6. Stop destroying further CAN frames with **Disable**.

5.1.6 Status Bar



Figure 13: Display of the status bar

The status bar shows information about the current CAN connection, about error counters (Overruns, QXmtFull) and shows error messages.

You can find further information about the use of PCAN-View in the help which you can invoke in the program via the **Help** menu or with the F1 key.

5.2 Linking Own Programs with PCAN-Basic Version 4 or Higher

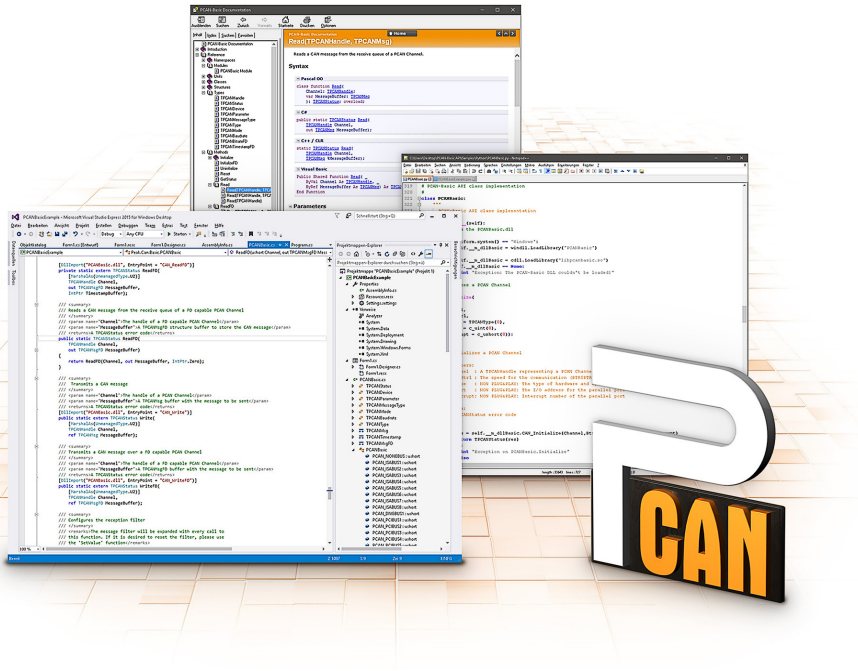


Figure 14: PCAN-Basic

On the provided DVD, you can find files of the PCAN-Basic programming interface in the directory branch `Develop`. This API provides basic functions for linking own programs to CAN and CAN FD interfaces by PEAK-System and can be used for the following operating systems:

- Windows 10, 8.1, 7 (32/64-bit)
- Windows CE 6.x (x86/ARMv4)
- Linux (32/64-bit)

The API is designed for cross-platform use. Therefore, software projects can easily be ported between platforms with low efforts. For all common programming languages, examples are available.

Beginning with version 4, PCAN-Basic supports the new CAN FD standard (CAN with Flexible Data Rate) which is primarily characterized by higher bandwidth for data transfer.

5.2.1 Features of PCAN-Basic

- API for developing applications with CAN and CAN FD connection
- Access to the CAN channels of a PCAN-Gateway via the new PCAN-LAN device type
- Supports the operating systems Windows 10, 8.1, 7 (32/64-bit), Windows CE 6.x, and Linux (32/64-bit)
- Multiple PEAK-System applications and your own can be operated on a physical channel at the same time
- Use of a single DLL for all supported hardware types
- Use of up to 16 channels for each hardware unit (depending on the PEAK CAN interface used)
- Simple switching between the channels of a PEAK CAN interface
- Driver-internal buffer for 32,768 messages per CAN channel
- Precision of time stamps on received messages up to 1 µs (depending on the PEAK CAN interface used)
- Supports PEAK-System's trace formats version 1.1 and 2.0 (for CAN FD applications)
- Access to specific hardware parameters, such as listen-only mode
- Notification of the application through Windows events when a message is received

- Extended system for debugging operations
- Multilingual debugging output
- Output language depends on operating systems
- Debugging information can be defined individually
- Thread-safe API



Tip: An overview of the API functions is located in the header files. You can find detailed information about the PCAN-Basic API on the provided DVD in the text and help files (file name extensions `.txt` and `.chm`).

5.2.2 Principle Description of the API

The PCAN-Basic API is the interface between the user application and device driver. In Windows operating systems this is a DLL (Dynamic Link Library).

The sequence of accessing the CAN interface is divided into three phases:

1. Initialization
2. Interaction
3. Completion

Initialization

A channel must be initialized before using it. This is done by the simple call of the function `CAN_Initialize` for CAN and `CAN_InitializeFD` for CAN FD. Depending on the type of the CAN hardware, up to 16 CAN channels can be opened at the same time. After a successful initialization the CAN channel is ready. No further configuration steps are required.

Interaction

For receiving and transmitting messages, the functions `CAN_Read` and `CAN_Write` as well as `CAN_ReadFD` and `CAN_WriteFD` are available. Additional settings can be made, e.g. setting up message filters for specific CAN IDs or the listen-only mode for the CAN controller.

When receiving CAN messages, events are used for an automatic notification of an application (client). This offers the following advantages:

- The application no longer needs to check for received messages periodically (no polling).
- The response time at reception is reduced.

Completion

To end the communication, the function `CAN_Uninitialize` is called in order to release the reserved resources for the CAN channel, among others. In addition the CAN channel is marked as "Free" and is available to other applications.

5.2.3 Notes about the License

Device drivers, the interface DLL, and further files needed for linking are property of the PEAK-System Technik GmbH and may be used only in connection with a hardware component purchased from PEAK-System or one of its partners. If a CAN hardware component of third-party suppliers should be compatible to one of PEAK-System, then you are not allowed to use or to pass on the driver software of PEAK-System.

If a third-party supplier develops software based on the PCAN-Basic and problems occur during the use of this software, consult the software provider.

6 Technical Specifications

Connectors	
Computer	USB plug type A
CAN	D-Sub (m), 9 pins Pin assignment according to specification CiA® 303-1

USB	
Type	High-speed USB 2.0 (compatible with USB 1.1 and USB 3.0)

CAN	
Protocols	CAN FD ISO 11898-1:2015, CAN FD non-ISO, CAN 2.0 A/B
Physical transmission	ISO 11898-2 (High-speed CAN)
CAN bit rates	25 kbit/s - 1 Mbit/s
CAN FD bit rates	25 kbit/s - 12 Mbit/s
Controller	FPGA implementation
Time stamp resolution	1 µs
Transceiver	NXP TJA1044GT
Galvanic isolation	up to 500 V
Supplying external devices	D-Sub pin 1; 5 V, max. 50 mA Not assigned at delivery
Internal Termination	via solder bridges, disabled at delivery

Power supply	
Supply voltage	+5 V DC (via USB port)
Power consumption	Max. 170 mA

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

Measures	
Size (w/o cable)	75 x 43 x 22 mm
Cable length	about 0.75 m
Weight (with cable)	68 g

Conformity	
EMV	Directive 2014/30/EU DIN EN 55024:2016-05 DIN EN 55032:2016-02
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-USB FD**

Item number(s): **IPEH-004022**

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

CE 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 55024:2016-05
Information technology equipment – Immunity characteristics – Limits and methods of measurement (CISPR 24:2010 + Cor.:2011 + A1:2015);
German version EN 55024:2010 + A1:2015

DIN EN 55032:2016-02
Electromagnetic compatibility of multimedia equipment - Emission Requirements (CISPR 32:2015);
German version EN 55032:2015

Darmstadt, 11 January 2019

Uwe Wilhelm, Managing Director

Appendix B Dimension Drawings

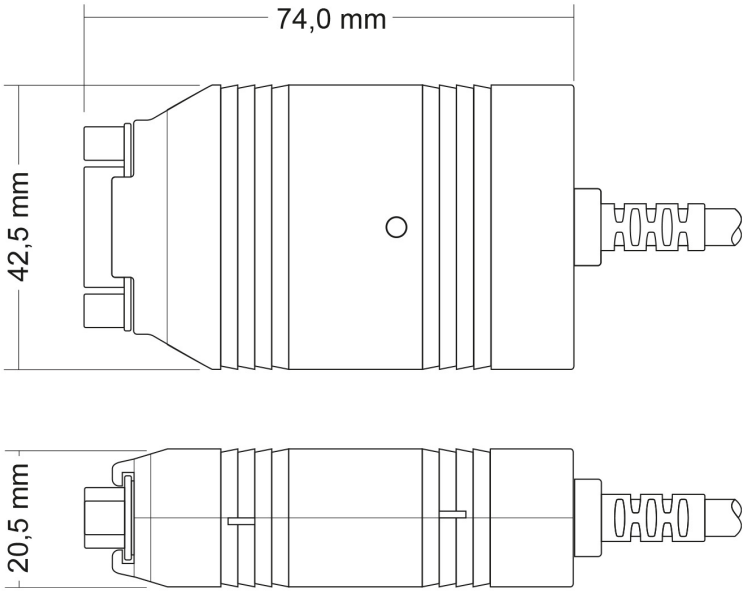


Figure 15: View PCAN-USB FD.
The figures don't show the actual size of the product.

Appendix C Quick Reference

Software/Hardware Installation under Windows

Install the driver from DVD, before you connect the PCAN-USB FD adapter to the computer. After that, you connect the adapter to a USB port of the computer or of a connected USB hub. The computer can remain powered on. The LED must light green.

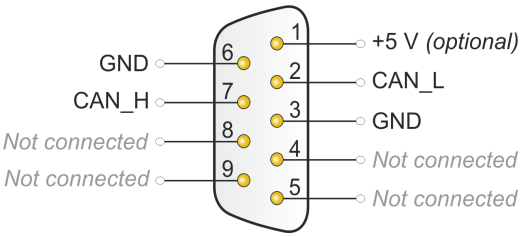
Note: Do not use a USB extension cable to connect the PCAN-USB FD adapter to the computer.

Getting Started under Windows

Run the CAN monitor PCAN-View from the Windows Start menu as a sample application for accessing the adapter. For initialization of the adapter select the desired CAN interface and the CAN bit rate.

Status	Meaning
Green on	There's a connection to a driver of the operating system.
Green slow blinking	A software application is connected to the adapter.
Green quick blinking	Data is transmitted via the connected CAN bus.
Red blinking	An error is occurring during the transmission of CAN data.
Orange quick blinking	Identification of an adapter when multiple adapters are plugged (see chapter 5.1.3 page 23).

High-speed CAN connector (D-Sub, 9 pins)



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