PCAN-USB FD

CAN FD Interface for High-Speed USB 2.0

User Manual

Document version 1.2.1 (2015-06-10)

PEAK System

Products taken into account

Product Name	Model	Part Number
PCAN-USB FD		IPEH-004022

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Contents

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.

Device drivers and programming interfaces 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)
- 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 40 kbit/s up to 12 Mbit/s
- CAN bit rates from 40 kbit/s up to 1 Mbit/s

- Time stamp resolution 1 µs
- CAN-Bus connection via D-Sub, 9-pin (in accordance with CiA® 102)
- 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 8.1, 7, Vista (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 8.1, 7, Vista and Linux (32/64-bit)
- PCAN-View monitor software for Windows 8.1, 7, Vista (32/64-bit)
- PCAN-Basic programming interface consisting of an interface DLL, examples, and header files for all common programming languages
- 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.

Setup the driver before connecting the PCAN-USB FD adapter to the computer for the first time.

Do the following to install the driver:

1. Insert the supplied DVD into the appropriate drive of the computer. Usually a navigation program appears a few moments later. If not, start the file `Intro.exe` from the root directory of the DVD.
2. In the main menu, select **Drivers**, and then click on **Install now**.
3. Confirm the message of the User Account Control regarding the "Installer Database of PEAK Drivers".

   The setup program for the driver is started.
4. Follow the instructions of the program.

Do the following to connect the PCAN-USB FD adapter to the computer and complete the initialization:

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 PCAN-USB FD adapter to a USB port of the computer or of a connected USB hub. The computer can remain powered on.

   Windows notifies that new hardware has been detected. The drivers are found and installed by Windows.

After the initialization process is finished successfully, the LED on the PCAN-USB FD adapter is green. Furthermore, you can find the “PCAN-USB FD” entry in the “CAN-Hardware” branch of the Windows Device Manager.

3 Connecting the CAN Bus

3.1 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® 102.

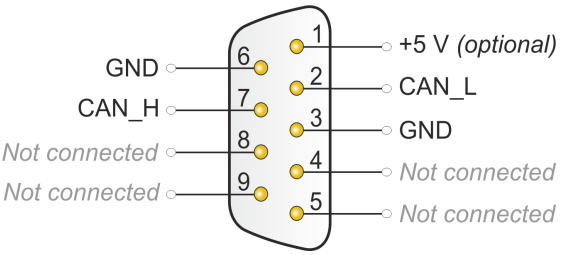

Figure 1: Pin assignment High-speed CAN
(view onto connector of the PCAN-USB FD adapter)

With the pin 1 devices with low power consumption (e.g. bus converters) can be directly supplied via the CAN connector. At delivery these pin are not assigned. You can find a detailed description about the activation in the following section 3.2.

Tip: You can connect a CAN bus with a different transmission standard via a bus converter. PEAK-System offers different bus converter modules (e.g. PCAN-TJA1054 for a Low-speed CAN bus according to ISO 11898-3).

3.2 Supplying External Devices via the CAN Connector

On the PCAN-USB FD board (casing opened) a 5-Volt supply can optionally be routed to pin 1 of the D-Sub connector. Thus devices with low power consumption (e.g. external bus converters) can be directly supplied via the CAN connector.

When using this option the 5-Volt supply is connected to the power supply of the computer and is not fused separately. A DC/DC converter is interconnected. Therefore the current output is limited to 50 mA

➡ Proceed as follows to activate the 5-Volt supply:

Attention! Electrostatic discharge (ESD) can damage or destroy components on the PCAN-USB FD board. Take precautions to avoid ESD when handling the card.

1. In order to access the board, open the casing of the PCAN-USB FD adapter by cautiously pushing in the latches on both sides, e.g. with a flat tip screwdriver.
2. Remove the board.
3. Set the solder bridge on the board of the PCAN-USB FD adapter according to the following figure.

During this procedure take especially care not to produce unwanted short circuits on the board.

Figure 2 shows the position of the solder field JP4 on board of the PCAN-USB FD.

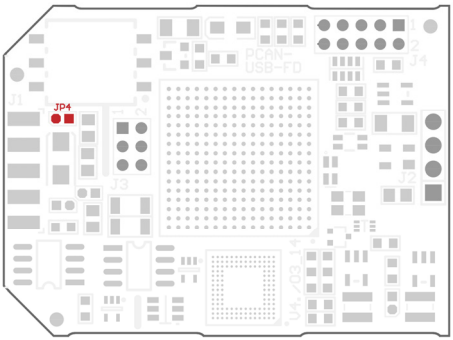

Figure 2: Top view **PCAN-USB FD board**, solder field JP4

For reassembly place the board overhead onto the top part of the casing. Ensure that the cable is lying with the strain relief in the cut-out of the casing, and that the LED is placed in the corresponding hole. Push the bottom part of the casing onto the top part (the latches click in).

Attention! Risk of short circuit! If the option described in this section is activated, you may only connect or disconnect CAN cables or peripheral systems (e.g. external bus converters) to or from the PCAN-USB FD adapter while it is de-energized (the adapter is not connected to the computer). Consider that some computers still supply the USB ports with power even when they are turned off (standby operation).

3.3 CAN Termination

The termination can be activated by solder jumpers on the board. 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. If a CAN bus is not terminated correctly, activate the internal termination.

➥ To activate the termination, the solder fields JP1 and JP2 must be soldered. Proceed as follows to activate the termination:

Attention! Electrostatic discharge (ESD) can damage or destroy components on the PCAN-USB FD board. Take precautions to avoid ESD when handling the card.

1. Open the casing of the PCAN-USB FD adapter by cautiously pushing in the latches on both sides, e.g. with a flat tip screwdriver.
2. Remove the board.
3. Set the **both** solder bridges on the board of the PCAN-USB FD adapter to activate the termination.

During this procedure take especially care not to produce unwanted short circuits on the board.

Figure 3 shows the positions of the solder fields JP1 and JP2 on board of the PCAN-USB FD.

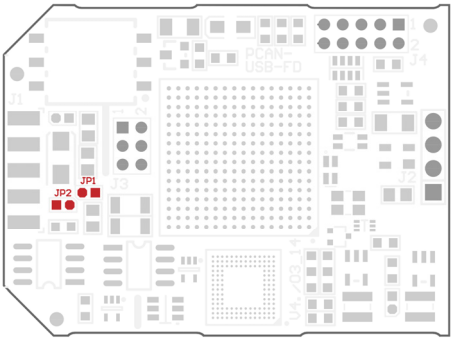

Figure 3: Top view **PCAN-USB FD board,** solder fields JP1 and JP2

For reassembly place the board overhead onto the top part of the casing. Ensure that the cable is lying with the strain relief in the cut-out of the casing, and that the LED is placed in the corresponding hole. Push the bottom part of the casing onto the top part (the latches click in).

3.4 Cabling

3.4.1 Termination

A High-speed CAN bus (ISO 11898-2) must be terminated on both ends with 120 Ohms. Otherwise, there are interfering signal reflections and the transceivers of the connected CAN nodes (CAN interface, control device) will not work.

The PCAN-USB FD adapter has a switchable internal termination (see section 3.3 on page 13). If a CAN bus is not terminated correctly, activate the internal termination.

3.4.2 Example of a Connection

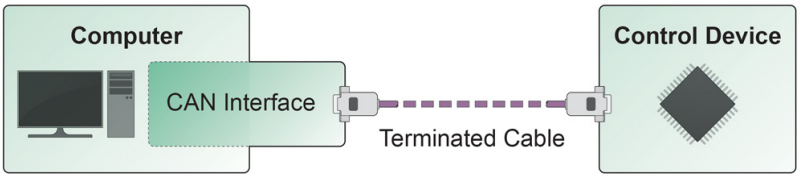

Figure 4: Simple CAN connection

In this example, the PCAN-USB FD adapter is connected with a control unit by a cable that is terminated at 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

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

The dependency of the bus length of the transmission rate is based on the arbitration phase of CAN communication. For CAN FD the transmission rate of arbitration is determined by the nominal bit rate. Through this can only take a maximum value of 1 Mbit/s, apply for CAN FD the same maximum bus lengths as for CAN, despite the higher data transfer.

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 PCAN-USB FD Tab).

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 on page 25.

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.

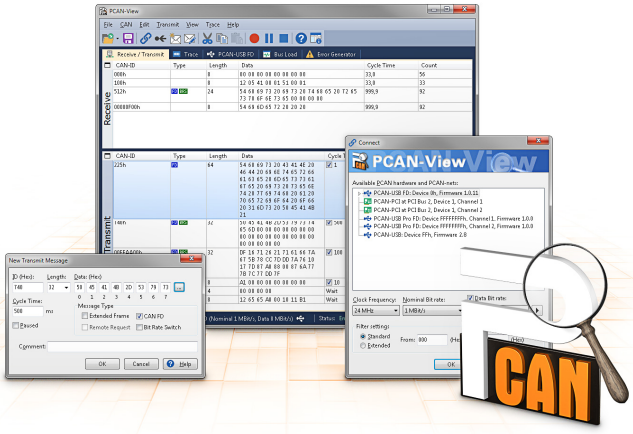

Figure 5: PCAN-View for Windows

Do the following to start and initialize PCAN-View:

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

   The dialog box for selecting the hardware and for setting the parameters appears.

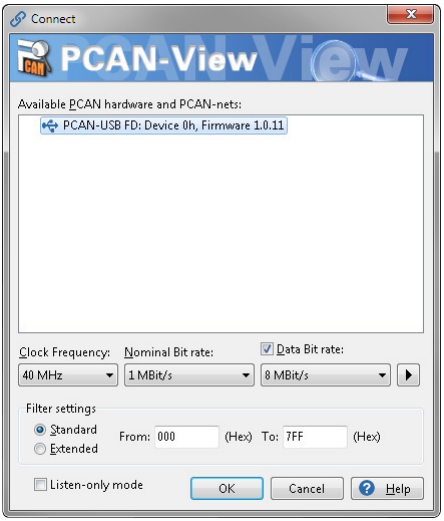

Figure 6: Selection of the specific hardware and parameters

2. From the list **Available PCAN hardware,** select the desired interface to be used.
3. Chooses the **Clock Frequency.** The selectable bit rates in the following are based on this setting.
4. Select from the drop-down list **Nominal Bit rate** the transmission rate that is used for the Arbitration phase.

   Choose from the drop-down list **Data Bit rate**, 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 frame with a higher bit rate.

Note: Both transmission rates must match those which are used by all nodes on the CAN bus. You can create user-defined transmission rates using the button to the right of the drop-down lists.

5. 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).
6. 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).
7. Finally, confirm the settings in the dialog box with **OK**. The main window of PCAN-View appears (see Figure 7).

5.1.1 Receive/Transmit Tab

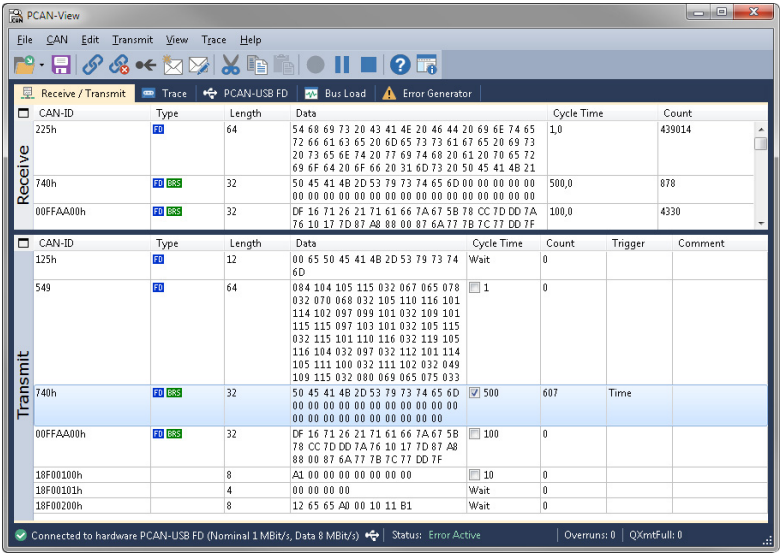

Figure 7: Receive/Transmit tab

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 representation of the data is done primarily in hexadecimal format.

- Do the following to transmit a CAN-FD message with PCAN-View:

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

     The dialog box **New Transmit Message** is shown.

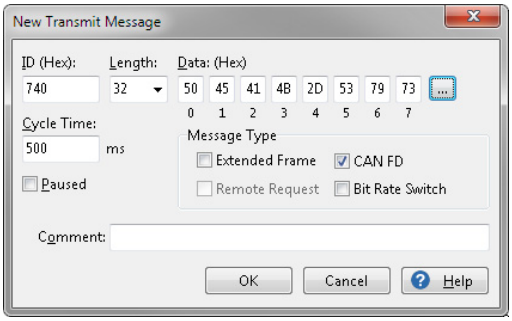

Figure 8: Dialog box new transmit message

2. Enter the ID and the data for the new CAN message. With a length of more than 8 bytes, the data on the button to the right is entered beside the eighth data field.
3. The field **Cycle Time** indicates if the message shall be transmitted manually or periodically. If you want to transmit the message periodically, you must enter a value greater than 0. For a manual-only transmission enter 0.
4. To define a CAN FD message, activate the checkbox **CAN FD**. Allows you to set a maximum length of 64 bytes of data.

Note: The values of the DLC (Data Length Code) represent a list of defined data field sizes up to 64 bytes. In the range of 9 to 15, the value of the DLC no longer matches the data field length. The "Length" indicates the resulting data field length.

5. Activate the checkbox **Bit Rate Switch** to ensures that the data of a CAN-FD-message is transmitted with the Data Bit Rate.
6. Confirm the entries with **OK**.

   The created transmit message appears on the **Receive/Transmit** tab.

7. You 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: Using the menu command **File** > **Save** the current transmit messages can be saved to a list and loaded for reuse later on.

5.1.2 Trace Tab

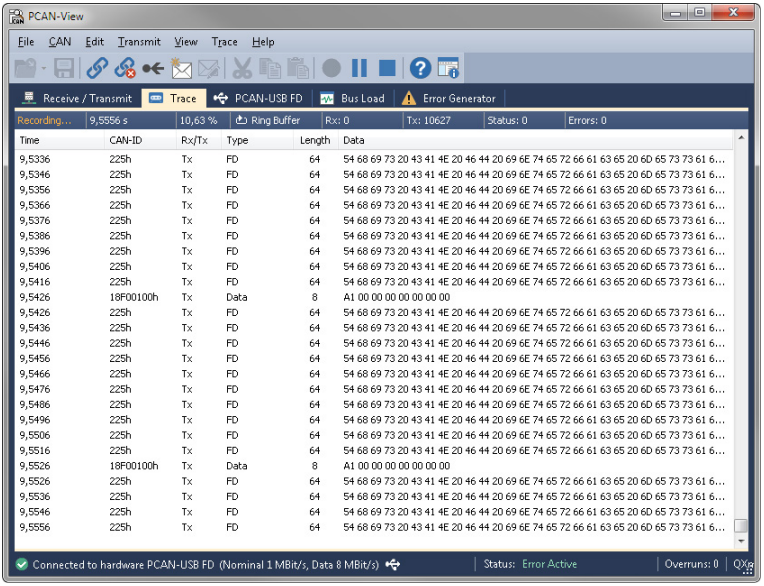

Figure 9: Trace tab

On the Trace tab the data tracer 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 can be configured to run in linear or in ring buffer mode. In linear buffer mode the logging is stopped as soon as the buffer is filled completely. In ring buffer mode the oldest messages are overwritten by incoming ones.

5.1.3 PCAN-USB FD Tab

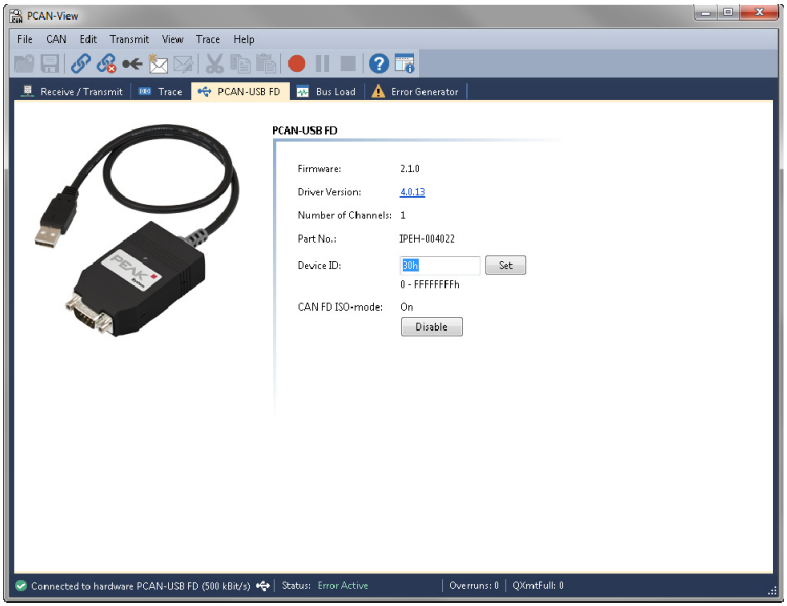

Figure 10: PCAN-USB FD tab

On the PCAN-USB FD tab various information about your hardware is displayed, like the current firmware version. 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 19). 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:

Since the first implementations of CAN FD, the protocol has been improved and is now included in the standard ISO 11898-1. The revised CAN FD 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

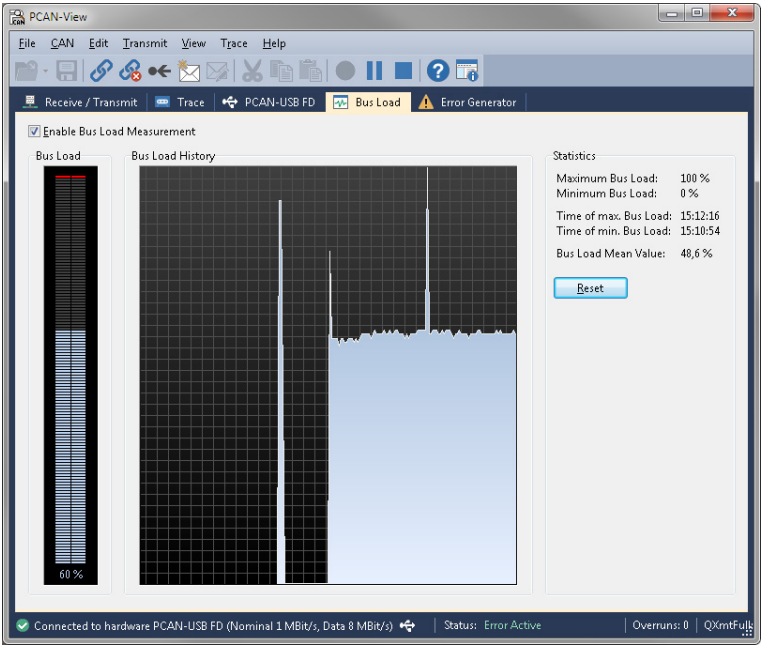

Figure 11: Bus load tab

On the Bus Load tab the current bus load of the connected CAN channel and its course over time are displayed along with statistical information. The bus load of a CAN bus reflects the utilization of transmission capacity. The more messages are transmitted on the bus, the higher is the bus load.

The current bus load on the connected bus is shown in the bar display **Bus Load** in percent. The course of the bus load over time is displayed in the progress bar **Bus Load History**. In **Statistics**, statistical information are displayed. This data shows the minimum and maximum bus load, and the bus load's arithmetic mean value. With **Reset** you can reset the statistical values.

5.1.5 Error Generator Tab

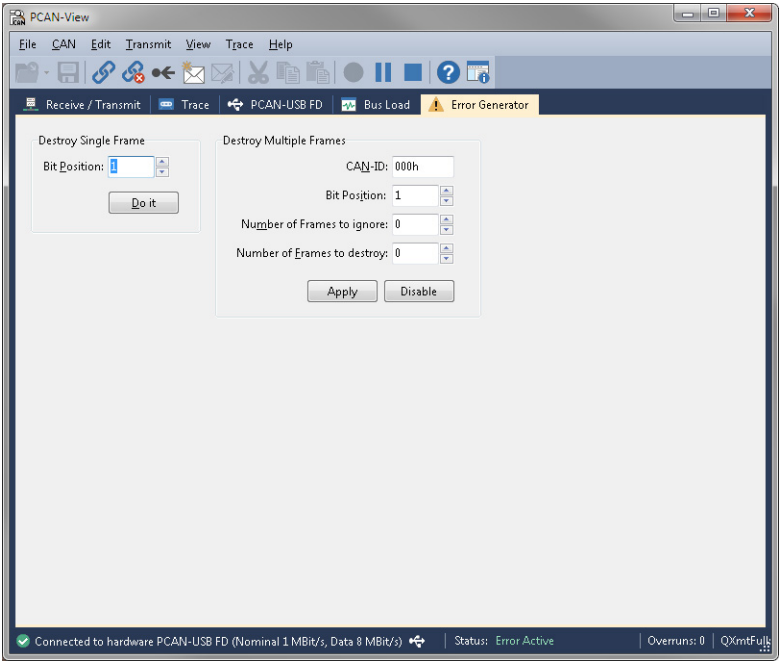

Figure 12: Error Generator tab

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 PCAN-USB FD 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. 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 menu **Help** or the F1 key.

5.2 Linking Own Programs with PCAN-Basic

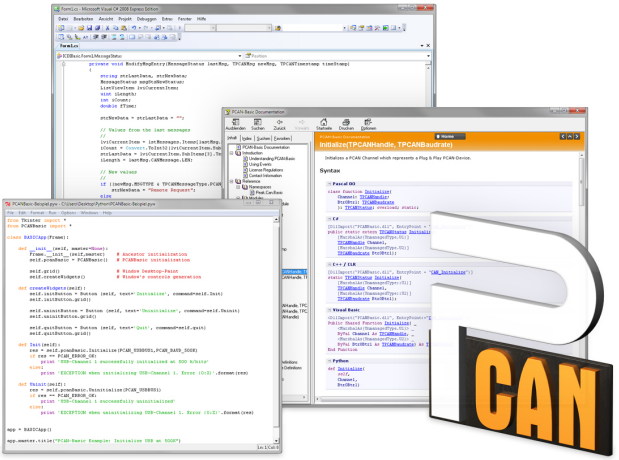

Figure 14: PCAN-Basic

On the provided DVD you can find files of the programming interface PCAN-Basic 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 8.1, 7, Vista (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 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 8.1, 7, Vista (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

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 for communication with the CAN hardware and the CAN bus. 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 to confine to specific CAN IDs or setting the CAN controller to listen-only mode.

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® 102

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

CAN	
Specification	CAN FD 1.0 (compatible with CAN 2.0)
Transmission standards	CAN FD, ISO 11898-2 (High-speed CAN)
CAN bit rates	40 kbit/s - 1 Mbit/s
CAN FD bit rates	40 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
Termination	Switchable, disabled at delivery

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

Continued on the next page

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
EMC	EN 55024: 2011-09 EN 55022: 2011-12 EC directive 2004/108/EG
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

Appendix A CE Certificate

PCAN-USB FD IPEH-004022 – EC Declaration of Conformity
PEAK-System Technik GmbH

Notes on the CE Symbol CE

The following applies to the "PCAN-USB FD" product with the item number(s) IPEH-004022.

EC Directive This product fulfills the requirements of EU EMC Directive 2004/108/EG (Electromagnetic Compatibility) and is designed for the following fields of application as for the CE marking:

Electromagnetic Immunity
DIN EN 55024, publication date 2011-09
Information technology equipment – Immunity characteristics – Limits and methods of measurement (CISPR 24:2010);
German version EN 55024:2010

Electromagnetic Emission
DIN EN 55022, publication date 2011-12
Information technology equipment – Radio disturbance characteristics – Limits and methods of measurement (CISPR 22:2008, modified);
German version EN 55022:2010

Declarations of Conformity In accordance with the above mentioned EU directives, the EC declarations of conformity and the associated documentation are held at the disposal of the competent authorities at the address below:

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Signed this 2nd day of July 2014

Appendix B Dimension Drawings

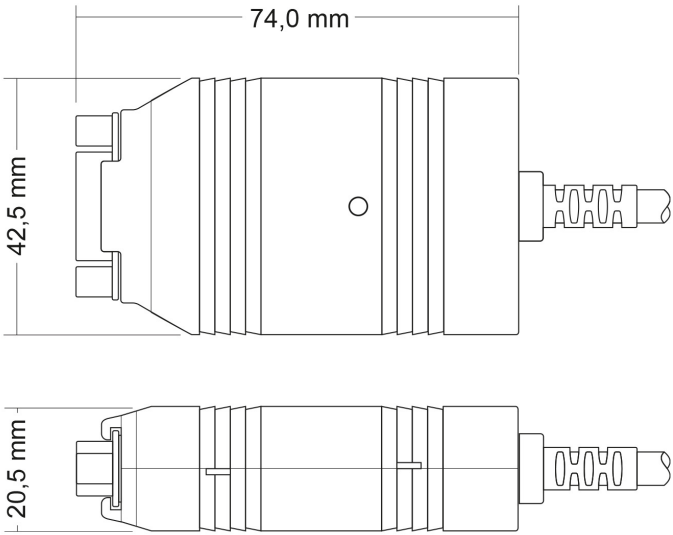

Figure 15: View PCAN-USB FD.
The figures don't show the actual size of the product.

Appendix C Quick Reference

Software/Hardware Installation under Windows

Before connecting the PCAN-USB FD adapter to the computer set up the corresponding software package from the supplied DVD (with administrator privileges). Afterwards connect the PCAN-USB FD adapter to a USB port at your computer. The adapter is recognized by Windows and the driver is initialized. After the installation process is finished successfully the red LED on the adapter is illuminated.

Getting Started under Windows

Run the CAN monitor PCAN-View from the Windows Start menu as a sample application for accessing the PCAN-USB FD adapter. For initialization of the PCAN-USB FD 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 PCAN-USB FD Tab).

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