

PCAN-Diag FD

Mobile Diagnostic Device
for CAN and CAN FD Buses

User Manual



Document version 1.1.1 (2020-01-24)

PEAK
System

Relevant products

Product Name	Model	Part number
PCAN-Diag FD		IPEH-003069
Charging station		IPEH-003068

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1 Introduction

The PCAN-Diag FD is a handheld device for diagnosis of the communication on a CAN bus. Possibilities for diagnosis are available on the protocol layer by handling CAN 2.0 and CAN FD messages as well as on the physical layer by using the oscilloscope function and further measuring functions for voltage and resistance.

The oscilloscope function is used for a qualitative assessment of the signal course on the CAN bus. Two independent measuring channels sample both lines CAN-High and CAN-Low with up to 100 MHz. Based on the signal course, the PCAN-Diag FD decodes CAN frames and shows their elements in the scope graphics.

On the protocol layer, the incoming CAN traffic is shown in a list, optionally with symbolic representation for better interpretability. For future analysis, a tracer is implemented that records the CAN traffic. On the outgoing direction, single CAN messages or even full sequences of CAN messages can be transmitted on the connected CAN bus, e.g. in order to request diagnostic data.

Recorded CAN traces can also be played back. All functions on the protocol layer are available for CAN 2.0 as well as CAN FD.

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 PCAN-Diag FD is operated in a simple manner with a push dial and four function keys. The device is supplied either externally or by the internal batteries that are automatically charged during external

supply. With the optional charging station, the charging process can be accelerated.



Note: This manual refers to devices that are operated with firmware version 1.3.

1.1 Properties at a Glance

Hardware features

- └ High-speed CAN channel (ISO 11898-2)
 - Complies 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 (max. 64 bytes) from 25 kbit/s up to 12 Mbit/s
 - CAN bit rates from 25 kbit/s up to 1 Mbit/s
 - Microchip CAN transceiver MCP2558FD
- └ CAN bus connection via D-Sub, 9-pin (in accordance with CiA® 303-1)
- └ Display with 800 x 480 pixel resolution
- └ Portrait or landscape presentation depending on the function and device orientation
- └ Presentation on an external display via a micro HDMI interface (DVI signal with 1024 x 768 resolution)
- └ Power supply via the internal rechargeable batteries or the provided supply unit (low-voltage socket on unit)
- └ Internal memory card for saving projects; can also be used as a mass storage device during a USB connection to a PC
- └ Device operation via a push dial and 4 buttons

- Operating temperature range of 0 to 50 °C (32 to 122 °F)

Software functions

- Analysis of CAN and CAN FD networks at the physical and the protocol level
- Selection of the bit rate from a preset list or from multiple user-defined values
- Automatic bit rate detection based on a fixed value list
- Switchable listen-only mode
- Switchable silent startup function (listen-only mode at wrong bit rate)
- Symbolic representation of incoming CAN messages using symbol files, taking into account enums (lists of values), multiplexers, and ID ranges
- Symbol files can be set up using the Windows software PCAN Symbol Editor supplied with this product
- Recording of incoming CAN messages to the internal memory card, if required, with CAN ID filtering
- Playback of trace files
- Conversion of trace data to various output formats using the Windows software PEAK-Converter supplied with this product
- Transmitting individual CAN frames or CAN frame sequences
- Decimal, hexadecimal, or binary entering of CAN data; data change of a single transmission message during runtime
- Measurement of CAN bus load, displayed by means of a time diagram, switchable display of error frames
- A bus load time diagram can be saved as bitmap
- Measurement of the termination of the High-speed CAN bus, even while the system is running

- └ Switchable CAN termination for the connected bus
- └ Voltage measurement at the CAN connector (D-Sub) for pins 6 and 9
- └ Management of the device configuration, transmit lists, symbol files, and all recorded data (screenshots, traces, and CSV files) in projects
- └ Optional auto-reset on Bus Off

Oscilloscope function

- └ Two independent measurement channels, each with a maximum sample rate of 100 MHz
- └ Display of the CAN-High and the CAN-Low signal as well as the difference of both signals
- └ Trigger configuration to various properties of CAN messages:
 - Start and end of a frame
 - CAN errors
 - CAN ID
 - Bit Rate Switch of CAN FD frames
- └ External measurement devices can be triggered using the banana jack, 4 mm
- └ Depiction of raw CAN and CAN FD frames
- └ Decoding of CAN and CAN FD frames from the recorded signal course
- └ Display of various properties and of measuring data of the decoded CAN frame using the Report function
- └ Current view can be saved as bitmap screenshot
- └ Memory depth can be set to up to 1 Megasamples
- └ Saving sample data as CSV file

- └ Time measurement with a resolution of up to 10 ns

PCAN-Diag FD Editor for windows

- └ Convenient configuration of all available settings
- └ Compilation of transmit lists and sequences
- └ Configuration of multiple bitrates per project
- └ Device configuration, transmit lists, transmit sequences, and symbol files can be saved in projects
- └ Projects can be transferred to the memory card of the PCAN-Diag FD using a USB connection

1.2 Scope of supply

- └ PCAN-Diag FD with or without charging station
- └ Delivered in shockproof plastic box
- └ Configuration software PCAN-Diag FD Editor for Windows
- └ PCAN Symbol Editor for Windows
- └ Conversion software PEAK-Converter for Windows
- └ USB connection cable
- └ AC adaptor with changeable plugs for Euro, U.S., and UK
- └ Connection cable from micro HDMI to DVI
- └ Manual in PDF format
- └ Printed quick start guide

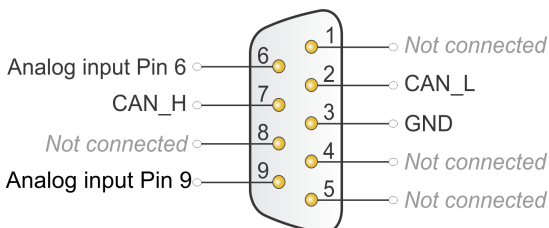
2 Putting the Device into Operation

For operation of the PCAN-Diag FD, go through the sections of this chapter in order.

2.1 CAN Connection (D-Sub)



CAN connector (D-Sub) on the rear of the device



Pin assignment D-Sub, CAN pins according to specification CiA® 303-1, analog input Pin 6 switchable to ground (GND)

The analog inputs can be used for general voltage measurements in the range of -28 to +28 Volts. The voltage measurement is described in section 5.3 on page 55.

2.1.1 Ground Connection

The D-Sub connector's shield and Pin 3 are internally connected to voltage ground (GND).

For an additional ground connection to other CAN nodes or measurement objects, a **GND ground socket** for banana plugs (4 mm diameter, 2 cm length) is available at the rear of the device.



GND socket (4 mm) on the rear of the device



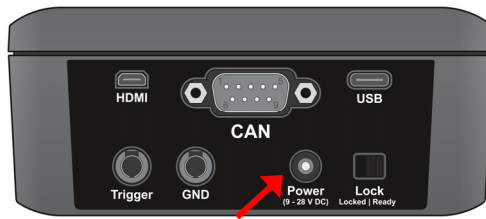
Note: The ground socket GND is only intended for banana plugs (4 mm diameter, 2 cm length).

For testing purposes, Pin 6 can also be switched to ground
(**Settings** > **Device Settings** > **Pin 6 GND connection**).

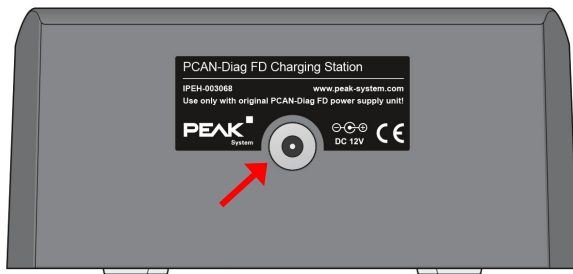
2.2 voltage Supply

The PCAN-Diag FD can be supplied in three ways:

- with the AC adaptor via the Power socket on the rear of the device
- while the device is positioned in the charging station (AC adaptor connected to the charging station)
- temporarily with the integrated batteries



Power socket on the rear of the device



Supply socket on the rear of the charging station (12 V DC only)



Supply voltage:
12 V DC (9 - 28 V possible at the Power
socket of the PCAN-Diag FD)



Diameter of barrel connector:
a = 5.5 mm, b = 2.1 mm;
minimum length: 11 mm

While operation, supply status is shown on the screen's upper status bar.

Icon	Meaning
	External power supply (AC adaptor) connected Blinking bars: integrated batteries are charged
	Supply by integrated batteries Indication of charge level (here about 60 %)



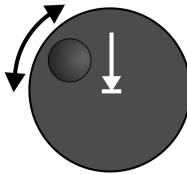
Note: The supply of the PCAN-Diag FD or the charging of the integrated batteries is not possible via a USB connection.

2.3 operation with Push Dial and Hotkeys

Operating the PCAN-Diag FD is done by the push dial and the four hotkeys.

Dial:

Move selection; alter value



Push:

Switch on device;
execute selected function

The function of the hotkeys varies and is indicated on the display in four fields beside the control panel.



Assignment of the displayed functions to the hotkeys

2.3.1 Powering On the Device

Hold down the push dial for at least half a second.

A splash screen appears for a short moment; then it's replaced by the main menu.



Tip: If the device despite existing voltage supply (external or battery) cannot be switched on, check the power-on lock (Lock switch on the rear of the device).

To **switch off** the device, select **Power Off** from the main menu. Alternatively, you can select **Power Off with Lock Switch**, in order to activate the power-on lock directly afterwards.

2.3.2 Preventing Unintentional Power-On

Powering on the device can be blocked by the Lock switch on the rear in order to prevent the batteries from accidental discharging, e.g. during transport.



Lock switch for power-on lock on the rear of the device

▶ Do the following to activate the power-on lock:

If the device is **on**:

In the main menu, select **Power Off with Lock Switch** and afterwards push the Lock switch on the rear of the device to the **Locked** position.

If the device is **off**:

Push the Lock switch on the rear of the device to the **Locked** position.

The device now cannot be powered up with the push dial.

2.4 Setting Date and Time

The PCAN-Diag FD has an integrated clock. The time stamp is used when a file is saved to the internal memory card. We recommend that you check the current date and time after the first start of the device (displayed on the upper right of the screen) and adjust them if required.

▶ Do the following to set the date and time:

1. In the main menu select **Settings**.
2. In section **Device settings**, at the entry **Date & time** click on **Set**.
3. At **Date** and at **Time** click on the digits to be adjusted and change the values by dialing.
4. When all digits are adjusted, push the Hotkey 1 **Set**.

2.5 Status Indication

When operating the device, on the upper right of the screen status of the voltage supply and the CAN bus communication is indicated.

Icon	Meaning
	External power supply (AC adaptor) connected Animated bars: integrated batteries are charged
	Supply by integrated batteries Indication of charge level (here about 60 %)
	CAN traffic: T = Transmit, R = Receive Blinking: Outgoing/incoming CAN messages Green: Regular traffic Yellow, red: Faulty traffic

Icon	Meaning
act pas off	Informs about the bus status (active, passive, bus off). When entering bus-off state, due to high (transmit) error rate, no further CAN messages are transmitted or received. In this case, after fixing the bus problem (e.g. a wrong CAN bitrate), a reset of the CAN controller should be performed. You have the following possibilities to do so: - CAN Data > CAN Message View > Reset - CAN Data > Receive Msgs. as Symbols > Rst - CAN Data > Transmit Messages > Reset - Settings > CAN Settings Auto-reset on BusOff > ☒ (autom.)
L	The device operates in observation mode (listen-only). It is automatically activated if the silent startup function detects a difference between the bitrates of the device and on the bus (Settings). The observation mode can also be enabled or disabled manually (see section 3.1.9 on page 22).

3 General Settings

➤ Main menu entry **Settings**

Here, the settings for the connection to a CAN bus and those for the use of the device are specified.

Changes at these settings can be permanently saved with **Save&OK**. If the changes are to be changed only temporarily, i.e. until switching off the device, then confirm with **OK**. A subsequent session (after an off-on cycle) uses the initial settings again.



Tip: You can adjust the device settings quickly to different applications by means of projects (see chapter 7 on page 70).

3.1 CAN

This menu section contains communications settings for CAN and CAN FD connections.

3.1.1 Silent startup

If this function is activated, at each device start the set CAN bitrate is checked in relation to the data traffic on the connected CAN bus. During this sequence the listen-only mode is active in order to avoid impact on the CAN traffic by the PCAN-Diag FD. This is indicated by the **L** in the top line.

If the device's bitrate matches, the listen-only mode is deactivated after a short period, else it stays active.



Tip: You can activate or deactivate the listen-only mode manually with the corresponding device setting **Listen-only mode**.

3.1.1.2 Detect CAN bitrate

If the bitrate of the CAN bus connected to the PCAN-Diag FD is unknown, the PCAN-Diag FD can automatically detect it. This requires data traffic on the CAN bus between at least two nodes.

Via **Detect** you get to the settings that are explained in the following. The bitrate detection is initiated by the **Start** hotkey.

CAN protocol

Three protocols are available: **CAN2.0B**, **FD iso**, and **FD non-iso**.



Note: The following settings **Allow bit rate switch**, **Use predefined sets only**, and **Force data bit rate detect** are only enabled for the protocols **FD iso** and **FD non-iso**.

Allow bit rate switch

Enables the recognition of the separate bitrate for the data part of the CAN FD frame.

Use predefined sets only

Only predefined bitrate sets are recognized that are saved in the **CAN Bit Rate Presets** list.

Force data bit rate detect

The recognition of the FD data bitrate during an established CAN FD connection is executed.

3.1.3 CAN protocol

Three protocols are available here: **CAN2.0B**, **FD iso**, and **FD non-iso**.



Note: Since the first implementation of CAN FD, the standard was refined and finally released in the specification ISO 11898-1. The revised CAN FD standard is not compatible to the original protocol. PEAK-System takes this into account by supporting both protocol versions in their CAN FD interfaces. As needed, the user can switch to the CAN FD protocol used in the environment by software.

3.1.4 Allow bit rate switch

Allows the bitrate switch for CAN FD messages so that besides the nominal bitrate also the separate one for the data part of the CAN FD frame is used.



Note: This setting must correspond to that of all other CAN FD nodes on the CAN bus.

3.1.5 Bit rate

Via **Edit** a preset or a user-defined CAN bitrate can be selected that corresponds to the bitrate on the connected CAN bus. The **CAN Bit Rate Presets** list contains saved configurations. If **None** configuration is selected, predefined frequencies and bitrates can be selected in the lists **Clock**, **Nominal Bit Rates**, and **Data Bit Rates** below.

The possible settings are derived from the selected frequency. The selected frequency in the **Clock** list has influence on the **Nom. Bit Rates** and **Data Bit Rates** lists. Depending on this, nominal

bitrates up to 1 Mbit/s are possible. The data bitrate, relevant for CAN FD connections, can be set to a maximum of 12 Mbit/s.

The **New BR** hotkey provides the option to save a custom nominal bitrate, data bitrate, or both as preset via **Add**. You can find more information on the individual parameters in the document NXP Application Note AN97076 on the internet.



Note: The submenu **New BR** gives the possibility to define higher bitrates as the standard defines as maximum. However, this leads to a warning and a non-working CAN communication.

3.1.6 CAN nominal bit rate

The nominal bitrate is indicated here which is 1 Mbit/s at maximum.

3.1.7 CAN data bit rate

The data bitrate of CAN FD frames with bitrate switch is indicated here. The data bitrate is 12 Mbit/s at maximum.

3.1.8 CAN termination

A High-speed CAN bus needs to be electrically terminated on both ends using resistors of 120 Ω . If the PCAN-Diag FD is connected to an un-terminated end of a CAN bus, the internal terminating resistor of 124 Ω can be engaged here.

3.1.9 Listen-only mode

If you want the device to not affect the traffic on the CAN bus, i.e. use it as pure monitoring tool, the Listen-only mode must be activated (**On**). Doing so, the device will neither acknowledge nor

transmit CAN (error) frames. Furthermore, active transmit lists are deactivated.

3.1.10 Auto-reset on BusOff

If the function is activated (**On**), the PCAN-Diag FD automatically performs a reset of the CAN controller when it has changed to BusOff state due to many transmission errors. This can come in handy e.g. in case of experiments with bitrates on other CAN nodes.

3.2 Display

This menu section contains screen and display settings.

3.2.1 Intro

Determines if a splash screen is shown as the device is switched on.

3.2.2 Display orientation

The orientation of the screen can be determined automatically or set to the following values: 0° (portrait view), 90° (landscape view, controls on the right), 180° (portrait view, upside down), 270° (landscape view, controls on the left).

3.2.3 HDMI output

The screen signal is routed to the Micro-HDMI output as soon as a connection to an external screen exists (DVI signal, 1024 x 768 pixels, 4:3). Meanwhile, the screen of the PCAN-Diag FD is switched off.

This option can be disabled, for example to temporarily interrupt video transmission without removing the HDMI cable.

 **Note:** Connection to a monitor is only possible with an adapter cable from Micro-HDMI to DVI.

3.2.4 Screensaver timeout

The brightness of the display will be reduced whenever the device is not operated for a certain period. This can prolong the operation time with batteries.

3.2.5 Backlight intensity

The screen brightness can be set to a value in the range of 30 to 100 percent. Default is 70 percent.

3.3 Device

This menu section contains device settings.

3.3.1 D-Sub GND connection

Pin 6 of the D-Sub connector can internally be connected to the device ground (pin 3, shield, GND socket) for testing purposes (**On**).

 **Note:** If pin 6 of the CAN cabling is used for other purposes than a ground connection, this setting must be disabled (**Off**) in order to avoid a short circuit from a powered lead to ground.

3.3.2 Beeper

The PCAN-Diag FD can give acoustic feedback to several events. Among other, a change of the CAN bus status is signaled. The **Off** setting disables the acoustic signal function of the PCAN-Diag FD.

3.3.3 Shutdown time (battery)

If the PCAN-Diag FD is run with batteries, battery sources can be preserved by switching off the device automatically after a set period, as long as the push dial hasn't been used. Setting to **Never** causes the device to stay alive all the time.

If operating the device with an external supply, for example with the enclosed AC adaptor, this setting does not have any effect.

3.3.4 Date & time

With **Set** the device date and time are adjusted. Date and time are used when saving files to the internal memory card.

3.3.5 Reset file index

File names of bitmaps or scope data to be saved get a number coming from a counter. The current count is indicated in parentheses and can be set to 0 by clicking **Reset**.

3.3.6 USB type (reboot req.)

The PCAN-Diag FD can operate as USB slave (Device) or as USB host. A changed setting is active after a restart of the device.



Note: The host functionality is not available yet.

3.3.7 USB autoconnect

Here, an automatic (**On**) or manual (**Off**) USB connection to an operating system on a connected PC can be set. For more information, see chapter 10 on page 80.

4 CAN Traffic

➤ Main menu item **CAN Data**

The PCAN-Diag FD can show the CAN data of incoming CAN messages either in a simple way in hexadecimal format (section 4.1) or with the help of symbol files that convert the CAN data into a more readable form (sections 4.2/4.3 on page 28).

The other way, it is possible to transmit prepared CAN messages periodically or manually (section 4.4 on page 44).

In addition there's the possibility to record incoming CAN traffic to files on the internal memory card. The recorded data can later be played back 1:1 or, on a PC, can be converted to various output formats and evaluated (sections 4.5/4.6/4.7 on page 46).

4.1 Displaying Incoming CAN Messages

➤ Menu item **CAN Data** > **CAN Message View**

Incoming CAN messages are shown as a list, sorted by CAN RxID (column **RxID**). The representation of the CAN data bytes (**Data D...N**) is in hexadecimal format. Each occurrence of a CAN message increments its counter (**Count**). The counting starts with the invocation of the CAN message view. The **T.Diff.** column indicates the period between the last two occurrences of a CAN message (display only at portrait view).

Red list entries indicate CAN errors that are reported by the CAN controller.

- ▶ Do the following to **change the sorting and view** in the receive list:
1. By turning, put the focus (yellow frame) onto the receive list.
 2. To move a single message or to change its representation, press the push dial and move the selection onto the desired CAN message in the receive list.
 3. Press the Hotkey 3 **Menu** and select the desired action, depending on the selection for the whole receive list or for a single message.

Reset

Clears the list of incoming CAN messages and resets the CAN controller. Latter is useful after fault maintenance on the CAN bus.

View

Switches on or off additional areas on the screen for transmission of CAN messages on each click:

- └ Transmit list
- └ Transmit list and transmit sequences
- └ Transmit sequences

The view can be permanently set under **Settings** (see the following explanation).

See section 4.4 on page 44 for further explanations about the transmit areas.

Settings

The view of the transmit areas can be configured here and be saved permanently if required.

Transmit View

View of the transmit areas as described before.

Current Tx List

Currently used transmit list (*.xmt). By clicking, another transmit list can be loaded from the internal memory card.

Save Tx List on Exit

Manual changes in the transmit list are saved **Never**, upon request (**Ask**), or **Always**.

When you have changed settings, save them permanently with **Save&OK** (Hotkey 2). If you want to use the changed settings only temporarily (during the current session), click **OK** (Hotkey 1). A subsequent session (after an off-on cycle) uses the initial settings again.

4.2 Representing CAN Messages in Symbolic Form

➤ Menu item **CAN Data** > **Receive Msgs. as Symbols**

In order to simplify the interpretation of CAN data, it can be represented in symbolic form. The representation is determined by a symbol file.



Note: Before you can represent CAN messages in symbolic form, you must have loaded a symbol file being part of a project. More in the following section 4.3 *Managing Symbol Files* on page 30.

Properties of the symbolic representation:

- └ A CAN ID is identified with a name by using a **Symbol**.
- └ Bit sequences in a CAN message representing individual quantities are given a name by **variables** or **signals**.
- └ Data can either be represented in decimal, in hexadecimal, or in binary format. The binary representation in the PCAN-Diag FD is done with a maximum of 16 digits. If more binary digits are necessary, the value is automatically represented decimally instead of binary.
- └ Variables can convert raw data transmitted via CAN and represent it as physical quantity with a unit.
- └ Specific variable values can be represented alphanumerically by using **enums** (value lists).
- └ **Multiplexers** define different symbol definitions for data output of a single CAN ID.

Name

Displays the active symbol file in the status bar at the bottom. A different symbol file can be selected with the menu command **CAN Data** > **Manage Symbol Files**. Furthermore, symbols or variables can be omitted from display there (see following section).

RESET

Clears the list of symbols and resets the CAN controller. Latter is useful after fault maintenance on the CAN bus.

SORT

Sorts the displayed symbols according to the selected element.

Selection for sorting	Meaning
Name	Symbol name
ID	CAN message ID affiliated to a symbol
Count	Number of receive events for a symbol

Changes in the list that would have influence on the sort order are not treated dynamically. To resort the list, select the sort command again.

4.3 Managing Symbol Files

➤ Menu item **CAN Data** > **Manage Symbol Files**

With a symbol file the symbolic representation of CAN messages is determined.

Using symbol files:

- One or more symbol files are made available in the PCAN-Diag FD by a project (more about projects in chapter 7 on page 70).
- For symbolic representation in the PCAN-Diag FD a single symbol file is used.
- Symbol files can be created and altered in different ways (only externally on a PC):
 - with the provided Windows program PCAN Symbol Editor (see the following section 4.3.1 on page 32)
 - in a text editor

- by importing a CANdb data base (only with licensed Windows program PCAN-Explorer 6 with CANdb Add-in, both available from PEAK-System)
- └ Any symbol files (*.sym) on a PC can be used for a project. A project is created with the windows program PCAN-Diag FD Editor (see section 7.1 on page 72).
- └ A symbol file to be used in the PCAN-Diag FD may contain a maximum number of the following elements:
 - 450 receive symbols
 - 40 variables per symbol
 - 1100 variables in all
 - 400 enums

In the PCAN-Diag FD the symbol file to be used is selected, and it is determined which elements of this symbol file are displayed.

SelectFile

Shows a list of symbol files that are provided by the current project. Select a symbol file that will be used for representation in **Receive Msgs. as Symbols**.

EditFile

Shows a preview with the current symbol file. Select the elements to be displayed in case of representing CAN messages in symbolic form. Click on an entry to alter its status. Reactivate all entries for display with **Sel.All** or vice versa with **Sel.None**.

4.3.1 Creating a Symbol File with the PCAN Symbol Editor

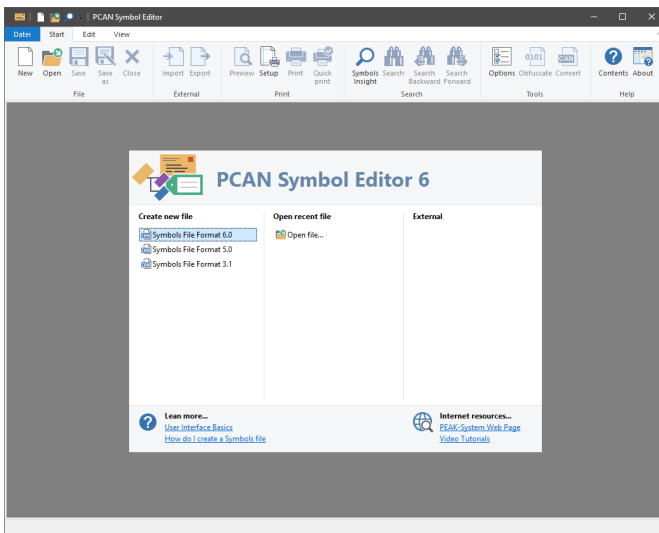
With the aid of an example, this section shows how to create a symbol file with the supplied Windows program PCAN Symbol Editor 6. The example takes the following CAN messages into account:

Symbol (data length)	CAN ID	Variable (unit)	Bits (count)	Enum
TestSymA (2 bytes)	223h	Speed (km/h)	0 - 7 (8)	
		Temperature (° C)	8 - 15 (8)	
TestSymB (1 byte)	224h	Switch1	0 (1)	Switches: 0 = Off, 1 = On

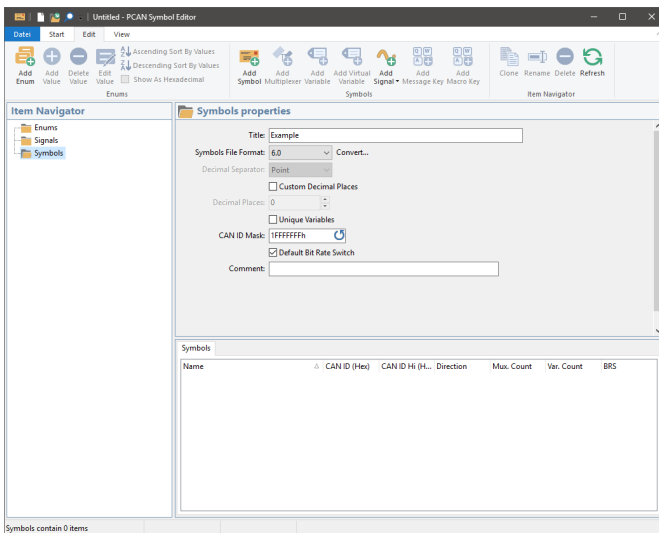
▶ Do the following to create the symbol file:

1. Start the supplied Windows program PCAN Symbol Editor (`PcanSEdt.exe`). You can find the program, for example, on the supplied DVD in the following directory:
`/Tools/PCAN-Diag FD/Tools/`

After program start, create a new symbol file by clicking on the desired symbol format. Select the **Symbols File Format 6.0** for support of the CAN FD standard.

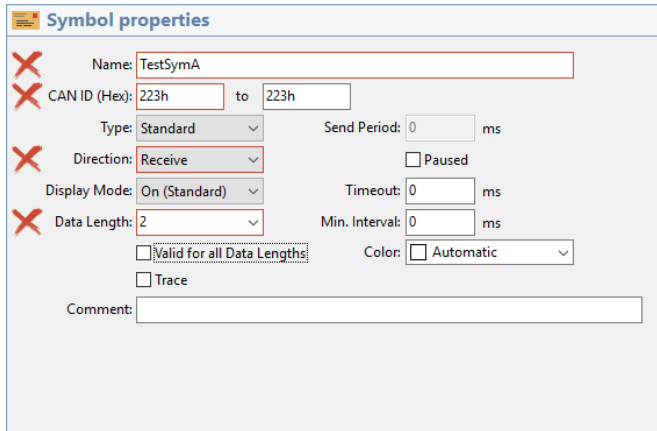


2. Afterwards, the folders in the **Item Navigator** on the left hand side are still empty. Open the **Edit** ribbon and select **Add Symbol**.



A new entry appears in the Symbols folder of the Item Navigator.

- Adjust the items in the **Symbol properties** panel according to the given values for the TestSymA symbol.



Symbol properties

Name: TestSymA

CAN ID (Hex): 223h to 223h

Type: Standard Send Period: 0 ms

Direction: Receive ☐ Paused

Display Mode: On (Standard) Timeout: 0 ms

Data Length: 2 Min. Interval: 0 ms

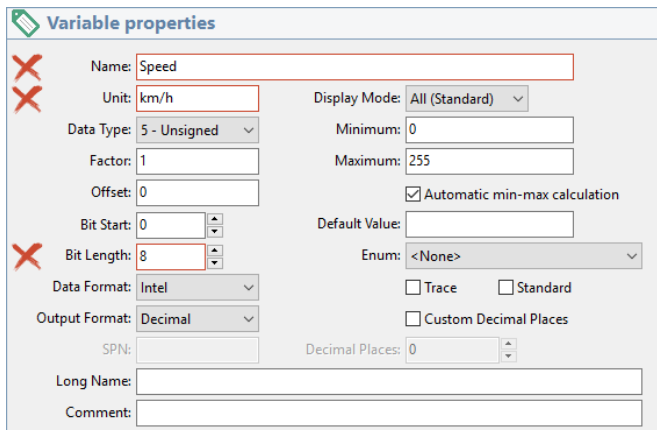
☐ Valid for all Data Lengths Color: Automatic

☐ Trace

Comment:

Adjustments are done for the marked items.

- Click on **Add Variable**. As before with the symbol, adjust the items according to the given values for the Speed variable.



Variable properties

Name: Speed

Unit: km/h Display Mode: All (Standard)

Data Type: 5 - Unsigned Minimum: 0

Factor: 1 Maximum: 255

Offset: 0 ☒ Automatic min-max calculation

Bit Start: 0 Default Value:

Bit Length: 8 Enum: <None>

Data Format: Intel ☐ Trace ☐ Standard

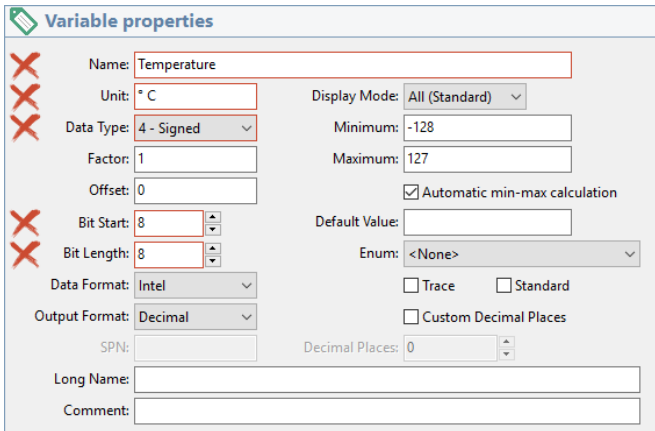
Output Format: Decimal ☐ Custom Decimal Places

SPN: Decimal Places: 0

Long Name:

Comment:

- Repeat the previous step for the Temperature variable.



Variable properties

Name: Temperature

Unit: °C

Data Type: 4 - Signed

Factor: 1

Offset: 0

Bit Start: 8

Bit Length: 8

Data Format: Intel

Output Format: Decimal

SPN:

Long Name:

Comment:

Display Mode: All (Standard)

Minimum: -128

Maximum: 127

☒ Automatic min-max calculation

Default Value:

Enum: <None>

☐ Trace ☐ Standard

☐ Custom Decimal Places

Decimal Places: 0

In order to display negative values,
Data Type must be set to **Signed**.

- With **Add Enum** create the Switches enum. Later on this is used for the Switch1 variable.

A new entry appears in the Enums folder of the Item Navigator.

- Add the two states Off (0) and On (1) to the enum with **Add Value**.
- Create the TestSymB symbol with the Switch1 variable.

Symbol properties

Name: TestSymB

CAN ID (Hex): 224h to 224h

Type: Standard Send Period: 0 ms

Direction: Receive ☐ Paused

Display Mode: On (Standard) Timeout: 0 ms

Data Length: 1 Min. Interval: 0 ms

☐ Valid for all Data Lengths Color: ☐ Automatic

☐ Trace

Comment:

Variable properties

Name: Switch1

Unit:

Display Mode: All (Standard)

Data Type: 1 - Bit Minimum: 0 Maximum: 1

Factor: 1

Offset: 0

Bit Start: 0

Bit Length: 1

Data Format: Intel

Output Format: Decimal

SPN:

Decimal Places: 0

Long Name:

Comment:

Default Value:

Enum: Switches ☐ Trace ☐ Standard

☐ Custom Decimal Places

☒ Automatic min-max calculation

The variable uses the Switches enum.

- Use **Save as** to save the symbol file with the name `SymExample.sym`.

The final symbol file has the following contents:

```
FormatVersion=6.0 // Do not edit this line!
Title="Example"

{ENUMS}
Enum=Switches(0="Off", 1="On")

{RECEIVE}

[TestSymA]
ID=223h
Len=2
Var=Speed unsigned 0,8 /u:km/h
Var=Temperature signed 8,8 /u:"° C"

[TestSymB]
ID=224h
Len=1
Var=Switch1 bit 0,1 /e:Switches
```

4.3.2 Using Multiplexers in Symbol Files

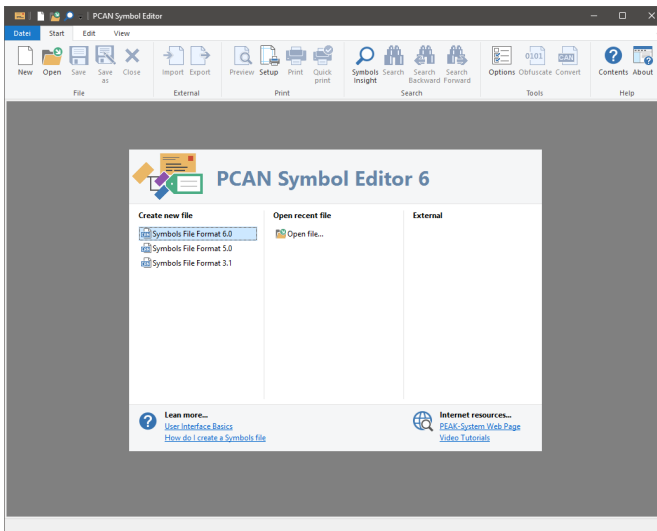
With multiplexers different symbol definitions are used for the representation of CAN data from a single message. An area of the CAN data is defined as multiplexer. The contained value indicates the symbolic representation to be used for the rest of the data in the CAN message. With the aid of an example, this section shows how to create a symbol file with multiplexers.

Symbol (CAN ID)	Multiplexer area (bit count)	Multiplexer value	Data length	Variable (unit)	Bits (count)
MuxSym (200h)	0 (1)	00h	2 bytes	Speed (km/h)	1 - 7 (7)
				Temperature (° C)	8 - 15 (8)
		01h	2 bytes	Engine (rpm)	1 - 7 (7)
				Temperature (° C)	8 - 15 (8)

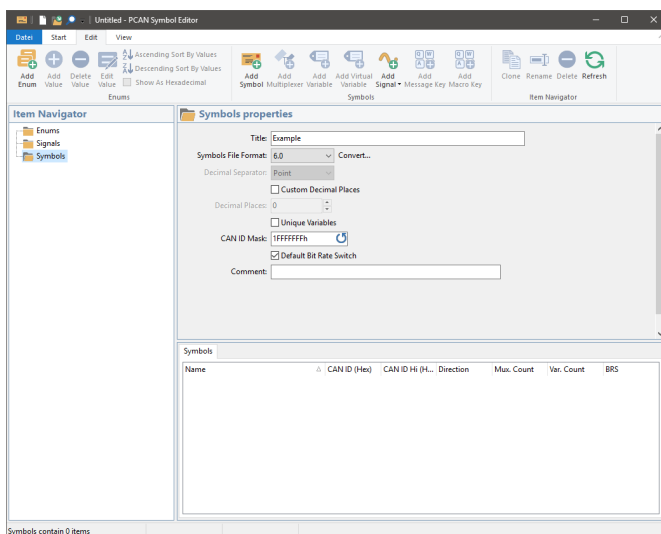
▶ Do the following to create a symbol file with multiplexers:

1. Start the supplied Windows program PCAN Symbol Editor (PcanSEdt.exe). You can find the program, for example, on the supplied DVD in the following directory:
/Tools/PCAN-Diag FD/Tools/

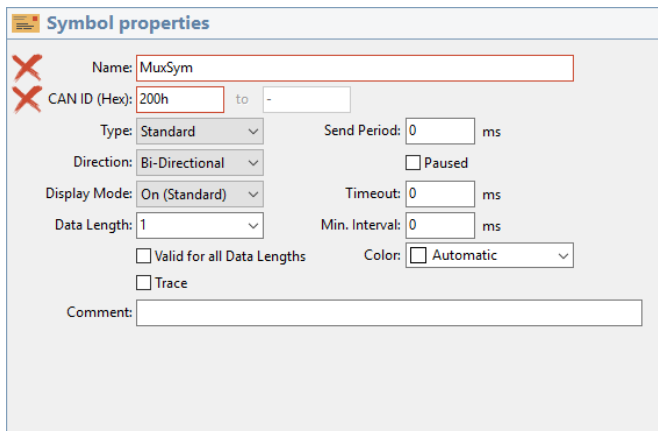
After program start, create a new symbol file by clicking on the desired symbol format. Select the **Symbols File Format 6.0** for support of the CAN FD standard.



2. Open the **Edit** ribbon and select **Add Symbol**.



- Adjust the items in the **Symbol properties** panel according to the given values for the MuxSym symbol.



The data length is not relevant at this point.
It is determined later separately for each multiplexer.

4. Add two multiplexers to the symbol by using **Add Multiplexer**.

Multiplexer properties

Name: Multiplexer1

Multiplexer Start: 0 ✗ Multiplexer Value: 00h

Multiplexer Length: 1 Send Period: 0 ms

Data Format: Intel ☐ Paused

Display Mode: All (Standard) Timeout: 0 ms

✗ Data Length: 2 Min. Interval: 0 ms

☐ Valid for all Data Lengths Color: Automatic

☐ Trace

Comment:

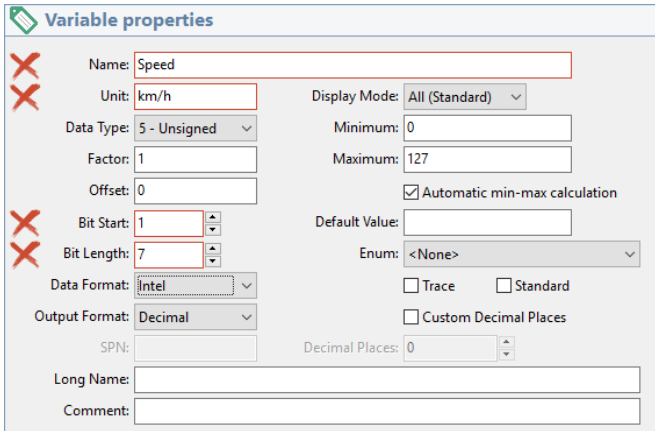
Multiplexer2 gets the value 01h (field **Multiplexer Value**).

When the symbol file is used in the PCAN-Diag FD, the multiplexers are treated as a single signal named Mux. The names given in the PCAN Symbol Editor are dismissed. Therefore, for both multiplexers only the value must be indicated, for which a multiplexer comes into effect.



Note: If a symbol contains a multiplexer with dynamic data length (setting “Valid for all Data Lengths”), only this single multiplexer is used for the PCAN-Diag FD. Further multiplexers in the corresponding symbol are ignored. The data length yields from the contained variables.

5. Add the Speed variable to Multiplexer1 by using **Add Variable** and adjust the entries according to the shown example.



Variable properties

Name: Speed

Unit: km/h

Data Type: 5 - Unsigned

Factor: 1

Offset: 0

Bit Start: 1

Bit Length: 7

Data Format: Intel

Output Format: Decimal

SPN:

Long Name:

Comment:

Display Mode: All (Standard)

Minimum: 0

Maximum: 127

☒ Automatic min-max calculation

Default Value:

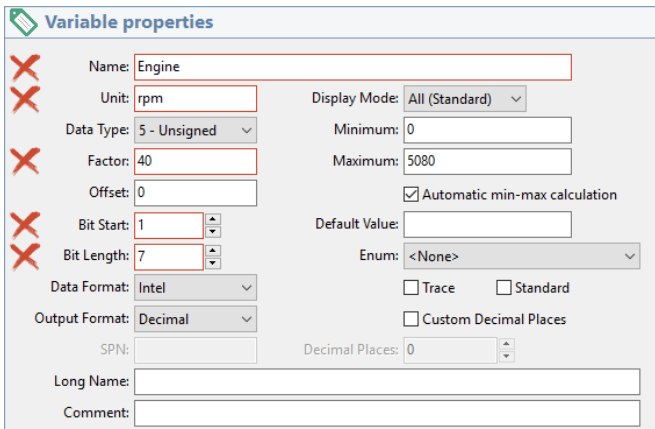
Enum: <None>

☐ Trace ☐ Standard

☐ Custom Decimal Places

Decimal Places: 0

6. Add the Engine variable to Multiplexer2 by using **Add Variable** and adjust the entries according to the shown example.



Variable properties

Name: Engine

Unit: rpm

Data Type: 5 - Unsigned

Factor: 40

Offset: 0

Bit Start: 1

Bit Length: 7

Data Format: Intel

Output Format: Decimal

SPN:

Long Name:

Comment:

Display Mode: All (Standard)

Minimum: 0

Maximum: 5080

☒ Automatic min-max calculation

Default Value:

Enum: <None>

☐ Trace ☐ Standard

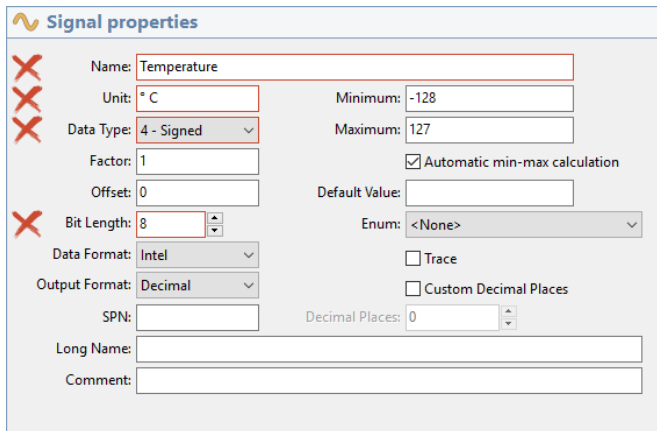
☐ Custom Decimal Places

Decimal Places: 0

7. Using the symbol format 6.0, it is possible to define signals instead of variables. Signals are defined for the whole file

independent of symbols and then can be used repeatedly afterwards. For this example a Temperature signal is created and added to both multiplexers.

Use **Add Signal** for the new Temperature signal and adjust the entries according to the shown example.



8. Assign the signal to both multiplexers by selecting each multiplexer in the Item Navigator and then **Assign Signal**, the sub item of Add Signal.
9. Use **Save as** to save the symbol file with the name `MuxSymExample.sym`.

The following figures show the two display possibilities for multiplexers on the PCAN-Diag FD screen:

In the common view, the variables of all multiplexers are shown in a single list. If the given name and all parameters of a variable are identical for all multiplexers, this variable is only listed once.

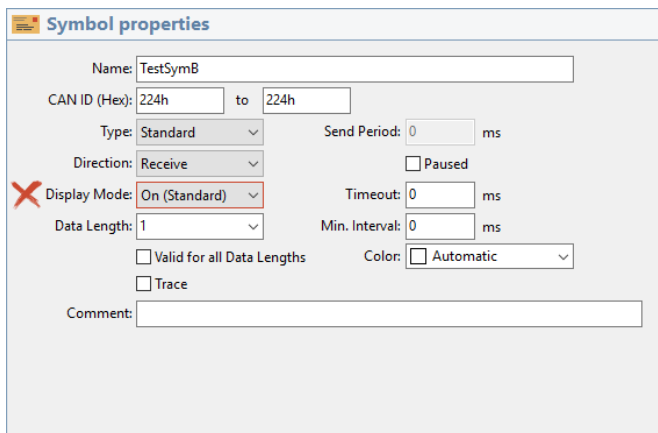
In the separate view, each multiplexer definition is shown as separate group (as known from the PCAN-Explorer).

The view is determined in the Windows program PCAN-Diag FD Editor when adding symbol files on the Symbols tab.

4.3.3 Reducing a Symbol File's Size

Because of the limited working memory in the PCAN-Diag FD, symbol files can only be read up to a specific size (see also beginning of section 4.3 on page 30). One possibility to reduce the size of a symbol file is using the Display Mode property.

You can find **Display Mode** in the properties of symbols, multiplexers, and variables.

A screenshot of the "Symbol properties" dialog box. The dialog has a title bar with a small icon and the text "Symbol properties". Inside, there are several fields and controls: "Name:" with a text box containing "TestSymB"; "CAN ID (Hex):" with two text boxes, both containing "224h"; "Type:" with a dropdown menu set to "Standard"; "Send Period:" with a text box containing "0" and a unit dropdown set to "ms"; "Direction:" with a dropdown menu set to "Receive"; "Display Mode:" with a dropdown menu set to "On (Standard)", which is highlighted with a red rectangle and a red "X" icon to its left; "Data Length:" with a dropdown menu set to "1"; "Valid for all Data Lengths" with an unchecked checkbox; "Trace" with an unchecked checkbox; "Comment:" with a text box; "Paused" with an unchecked checkbox; "Timeout:" with a text box containing "0" and a unit dropdown set to "ms"; "Min. Interval:" with a text box containing "0" and a unit dropdown set to "ms"; and "Color:" with a dropdown menu set to "Automatic".

Display Mode property in a symbol definition

The default for this property is **On**. If **Off**, the element is not processed by the PCAN-Diag FD Editor anymore. When transferring a project to the PCAN-Diag FD, elements with Display Mode Off are not compiled into the binary symbol file (*.syb).

Using this method you can reduce a symbol file's size without deleting symbols, multiplexers, or variables.

4.4 Transmitting CAN Messages

➤ Menu item **CAN Data** > **Transmit Messages**

The transmission of CAN messages is done with a transmit list and transmit sequences. Therefore, the screen contains two areas.

The transmit list contains independent CAN messages with static data. The messages are either transmitted periodically or manually. Transmit sequences contain several CAN messages that are transmitted in succession with defined intervals. Transmit sequences can be repeated periodically.

4.4.1 Setting up the Transmit List

The transmit list can either be filled from a file (*.xmt) or manually.



Tip: You can create a transmit list file, for example, with the Windows program PCAN-View which is available free of charge.

➤ To open a transmit list file from the memory card, do the following:

1. By turning, put the focus (yellow frame) onto the transmit list (upper area).
2. Press the Hotkey 3 **Menu** and click on **Load File**.

All transmit list files (*.xmt) in the directory of the current project are shown.

3. Click on the desired transmit list file.

The transmit list is filled with all CAN messages from the file. Previous entries are removed.

4. To activate the repeated transmission of the entries, press Hotkey 3 **Menu** again and click on **Start all**. As an

alternative you can activate single CAN messages by first pressing the push dial and then selecting the desired CAN message. By pressing the push dial repeatedly, the repeated transmission of the CAN message is activated or deactivated.

➤ To add a CAN message to the transmit list, do the following:

1. By turning, put the focus (yellow frame) onto the transmit list (upper area) and press the push dial.
2. Press the Hotkey 3 **Menu** and click on **Load File**.
3. Enter the parameters for the new CAN message in the transmit list.
4. Press the Hotkey 1 **OK**.

The new CAN message appears in the transmit list.



Note: Changes in the transmit list are saved according to **Settings** > **Save Tx List on Exit**.

4.4.2 Setting up Transmit Sequences

A transmit sequence is created with the help of the Windows program PCAN-View and afterwards taken over into a project with the PCAN-Diag FD Editor. It interprets a transmit list (*.xmt) after changing the file name extension to *.xms as transmit sequence.

➤ Do the following to create a transmit list:

1. Start the Windows program PCAN-View, e.g. from the internal memory card of the PCAN-Diag FD (in the directory branch /PCAN-Diag FD/Tools/).
2. Create a list of CAN messages in the Transmit window. The Cycle Time of a CAN message later determines the delay to the following message.

3. Save the transmit list (*.xmt) and rename the file name extension to *.xms.
4. In the PCAN-Diag FD Editor on the **CAN Sequence Lists** page, import the previously created transmit sequence file.
5. Transfer the project with the transmit sequence to the PCAN-Diag FD and open it there (if another project is in use).

4.5 Recording CAN Traffic

➤ Menu item **CAN Data** > **Trace Messages**

With this function, the incoming CAN traffic is recorded to a trace file on the internal memory card of the PCAN-Diag FD. Also the timing of the CAN messages is regarded.

Later, a trace file can be used for playback of the recorded CAN messages on the CAN bus (see section 4.6 on page 48). Alternatively, the file can be analyzed or played back on a PC.

Indication	Meaning
Drive	Name of the used data carrier. The MO: indicator stands for the internal memory card.
Folder	Path to the file on the data carrier. The files are saved to the Traces directory below the active project directory.
File	Name of the trace file (YYMMDD_0000.trc) that is used for the next recording. The file name is automatically put together from the current date and a consecutive number.

4.5.1 Settings for Tracing

Overwrite

Setting	Description
☒	If the given File already exists, it will be overwritten.
☐	The consecutive number in the file name is incremented with each recording. The previous file is not overwritten.

Max. Size

Maximum size a recording may have.

Packed

Setting	Description
☒	The recording is done with the memory-saving binary trace file format (*.btrc). For further use on a PC, a conversion is necessary.
☐	The recording is done with the readable trace format 2.0 by PEAK-System.

During recording, the trace file grows in 512-byte blocks, each containing 25 CAN messages. Thus, 1 MByte can hold 51200 CAN messages.

Multi file

Setting	Description
☒	If Max. Size of the trace file is reached, the recording is continued in a new file. The given File name is supplemented by a consecutive number.
☐	If Max. Size of the trace file is reached, the recording is stopped automatically.

Data

If enabled, regular CAN messages are recorded.

Errors

If enabled, error frames are recorded.

Status

If enabled, internal status messages are added to the trace of CAN messages.

Busload

If enabled, internal busload messages are added to the trace of CAN messages.

4.5.2 Perform Recording

▶ Start a recording with the hotkeys:

1. Make sure that no USB connection is present between the PCAN-Diag FD and a PC.
2. Use **START** to initiate the recording.

During the process, the size of the trace file is indicated in kByte.

3. You can **PAUSE** the recording or **STOP**. It automatically ends when reaching the maximum file size as long as the **Multi file** is not enabled.

4.6 Playing Back Recorded CAN Traffic

➤ Menu item **CAN Data** > **Play Back Trace**

The PCAN-Diag FD can play back CAN messages from a trace file (*.trc or *.btrc) onto the connected CAN bus. The timing of the

CAN messages, as it occurred originally during recording of the trace file, is maintained.

 **Note:** On the PCAN-Diag FD, transmission delays of CAN messages can occur when playing trace files in text format (*.trc). For delay-free playback, the content of the trace file should not generate a bus load higher than 30 % at 500 kbit/s. Alternatively, use the binary trace format (*.btrc).

 Do the following to play back a trace file:

1. Click on **SelectFile** and select a trace file (*.trc or *.btrc) from the project directory.
2. Set the number of repetitions of the trace file with **Loop mode**. Select **infinite** for a continuous playback of the recording.
3. Press the hotkey **PLAY** to start the playback. Afterwards, you have the following possibilities:

Function	Executed action
PAUSE	Pauses the playback. PLAY continues the playback at the point where it was interrupted before.
STOP	Ends the playback.

4.7 Using the Recorded CAN Traffic on the PC

The recorded CAN traffic can be read by a PC via a USB connection from the internal memory card of the PCAN-Diag FD. The trace files *.trc or *.btrc are in the **Traces** subdirectory of the current project.

If using the **Packed** setting, the recording is saved to a binary-coded trace file `*.btrc`. For further use, you must convert the data in an appropriate format. The Windows program PEAK-Converter is supplied on the DVD and on the internal memory card of PCAN-Diag FD for this purpose.

Possible conversion targets:

Target format	File name extension	Explanation/usage
PCAN-Trace	<code>.trc</code>	Text-based trace format by PEAK-System; viewing of the data in the PCAN-Explorer or playback of the CAN messages with the PCAN-Trace program. Tip: In connection with the trace files of the PCAN-Diag FD, we recommend to use the format version 2.0 because of the CAN FD support.
Vector ASC Trace	<code>.asc</code>	Text-based trace format by the company Vector Informatik that also can be used by some third-party programs.
Character Separated Values (CSV)	<code>.csv</code>	Common, text-based format for import into a spreadsheet (semicolon as separator).

▶ For further use of the binary-coded trace data proceed as follows:

1. Connect the PCAN-Diag FD to a PC with the provided USB cable (see also chapter 10 on page 80).
2. Under Windows, launch the `PEAK-Converter.exe` program from the internal memory card of the PCAN-Diag FD, directory `/PCAN-Diag FD/Tools`.
3. As source, select a binary-coded trace file (`*.btrc`). The trace files are located in a project directory:
`/PCAN-Diag FD/Projects/<Project name>/Traces`
4. Specify a destination file and select the desired target format (see above).

5 Measuring Functions for the CAN Bus

- Main menu item **Measurements**

This chapter describes the measurement functions of the PCAN-Diag FD. The oscilloscope function is covered in the following chapter 6 on page 57.

5.1 Bus Load

- Menu item **Measurements** > **Bus Load**



Tip: You can adjust the busload settings quickly to different applications by means of projects (see chapter 7 on page 70).

As long as no message is transmitted on the CAN bus, it is in idle state. The busload is the ratio of the durations of the idle state and CAN traffic. 0 % corresponds to no CAN traffic at all. 100 % corresponds to transmission of one CAN frame after the other without any idle state in between. The percentage utilization of the CAN bus with CAN messages is shown in a graph over a period of time and is continuously updated.

The graph is put together out of sampling intervals whose duration results from the set CAN bitrate and the given number of **Samples per bar**. Per sample value an average and a maximum value of the bus load are calculated and shown as bars and as percentage at **Current avg. bus load**.

You can counter a high bus load with the following measures:

- Raise the bitrate of all CAN nodes on the bus.

- Increase the cycle time of specific messages in the CAN net in order to reduce their emergence (less CAN messages per time).

Save as BMP

A bitmap screenshot of the busload screen is saved on the internal memory card (file name: pict000.bmp with consecutive numbers).

On the memory card the files are written to the directory of the active project (Projects > <project name>). Get the name of the active project from the lower status bar in the main menu.

Access to the saved files is achieved from a PC via a USB connection. See chapter 10 on page 80.

Menu

Via the **Menu** hotkey, you either can toggle **Errors** display or do some **Settings** for this screen.

Errors

Toggles between the view with and without the additional graph for occurring error frames (blue).

Settings

This menu contains settings for the presentation of the busload measurement.

Show Errors

Show errors.

Show Maximum

Show the maximum of the busload measurement.

Show Average

Show the average busload.

Bar Width

Determine the width of the bars shown in the graph.

Bar Separation

Determine the gap between two bars in the graph.

Max. Value Load

Determines the maximum value of the busload that is to be shown in the graph.

Max. Value Errors

Determines the maximum number of errors that are to be shown in the graph.

Samples per Bar

Determines the number of measuring values (samples) that are used for calculation of one bar of the graph.

5.2 CAN Bus Termination

➤ Menu item **Measurements** > **CAN Termination**

The function measures the resistance value between the CAN_L and CAN_H lines. While doing so the CAN traffic is not affected.

A High-speed CAN bus (ISO 11898-2) must be terminated with 120 Ω on both ends between the CAN lines CAN_L and CAN_H. This measure will prevent signal reflections at the cable ends and a

correct function of CAN transceivers attached to the CAN bus is assured.

The two termination resistors in parallel result in a total resistance of 60 Ω. The measurement of the total resistance provides information about a correct CAN bus termination.



Note: The switchable internal termination of the PCAN-Diag FD is included in the termination measurement on the CAN bus.

CAN termination

Indicates the measured resistance value.

Measurement result	Meaning
~ 60 Ω	The termination on the CAN bus is metrologically ok. Make sure that the termination resistors are present at the bus ends and not, for example, at the taps in the middle of the bus.
~ 120 Ω	Only one termination resistor is available. Install another 120 ohm resistor.
< 45 Ω	Too many termination resistors are present on the CAN bus. This can occur, for example, if both a separate termination resistor and a CAN node with internal termination are present at one bus end.
--- Ω	The measurement was not successful.
missing	No or a too large termination resistor (> 1,2 kΩ) is present on the CAN bus. Set up a <u>correct</u> termination.
shorted	Short circuit (< 10 Ω)! Check whether the PCAN-MiniDiag FD has been properly connected and terminated.
Jumping value	Check whether the PCAN-MiniDiag FD has been connected correctly. For example, the CAN lines CAN-High and CAN-Low may have been reversed.
not cal. (beside the resistance value)	The measurement facility is not calibrated, meaning that the indicated measuring value may have a larger deviation from the actual resistance value. Please contact our support about a calibration (see address Fehler! Textmarke nicht definiert.).

CAN termination

If **On**, the internal termination resistor (124 Ω) is activated.

Altering the settings at this place is only saved temporarily (until the device is switched off). The internal termination can be set permanently in the general settings (main menu item **Settings**).

START

The measurement is repeated. This can be useful during changes on the CAN bus.

STOP

The repeated measurement is stopped.

5.3 voltages on the D-Sub Connector

➤ Menu item **Measurements** > **Analog**

The voltage levels for pins 6 and 9 of the D-Sub connector are measured and shown in the graph.

Settings

Customize the view for each pin.

Show Pin 6 Voltage

Shows the voltage on pin 6 of the D-Sub connector.

Show Pin 9 Voltage

Shows the voltage on pin 9 of the D-Sub connector.

Bar Width

Determine the width of the bars shown in the graph.

Bar Height

Determine the height of the bars shown in the graph.

Bar Separation

Determine the gap between two bars in the graph.

Min. Voltage [V]

Determines the minimum value of the voltage that is to be shown in the graph.

Max. Voltage [V]

Determines the maximum value of the voltage that is to be shown in the graph.

Offset Pin 6 [digit]

Determines the offset of the voltage graph of pin 6 in digits.

Offset Pin 9 [digit]

Determines the offset of the voltage graph of pin 9 in digits.

Save as BMP

A bitmap screenshot of the busload screen is saved on the internal memory card (file name: pict000.bmp with consecutive numbers).

On the memory card the files are written to the directory of the active project (Projects > <project name>). Get the name of the active project from the lower status bar in the main menu.

Access to the saved files is achieved from a PC via a USB connection (see chapter 10 on page 80).

6 Oscilloscope Function (Scope)

- Main menu item **Scope**

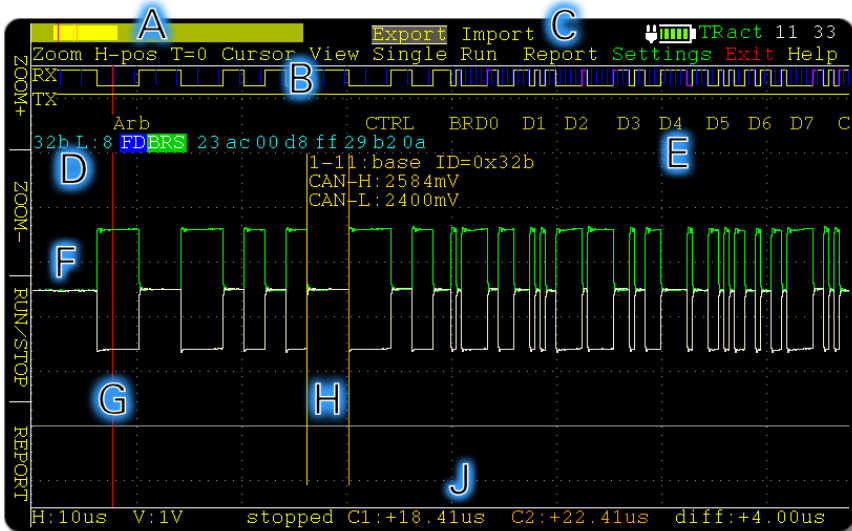
The oscilloscope function of the PCAN-Diag FD is used for in-depth diagnosis of the CAN signals on the connected lines CAN_High and CAN_Low. It is independent of the CAN communication in the PCAN-Diag FD. Therefore, it provides a further instance for troubleshooting on the CAN bus. Besides the pure display of the signal course and measuring possibilities with cursors, the oscilloscope function also shows statistical information. Handling is similar to a standard storage scope.

6.1 Properties of the Oscilloscope Function

- └ Two independent measurement channels, each with a maximum sample rate of 100 MHz
- └ Display of the CAN-High and the CAN-Low signal as well as the difference of both signals
- └ Trigger configuration to various properties of CAN messages:
 - Start and end of a frame
 - CAN errors
 - CAN ID
 - Bit Rate Switch of CAN FD frames
- └ External measurement devices can be triggered using the banana jack, 4 mm
- └ Depiction of raw CAN and CAN FD frames

- Decoding of CAN and CAN FD frames from the recorded signal course
- Display of various properties and of measuring data of the decoded CAN frame using the Report function
- Current view can be saved as bitmap screenshot
- Memory depth can be set to up to 1 Megasamples
- Saving sample data as CSV file
- Time measurement with a resolution of up to 10 ns

6.2 Elements of the Oscilloscope Screen



- A: Position bar for overview of the sample buffer (current view, trigger, measuring cursors)

- B: CAN signals for reception (**Rx**) and transmission (**Tx**) coming from the CAN transceiver, incl. bit periods (blue)
- C: Actions (see the following manual sections)
- D: CAN data decoded from the signal course
- E: CAN frame fields decoded from the signal course
- F: Signal courses CAN_High (green) and CAN_Low (white), alternatively display of the difference (blue, not shown here)
- G: Trigger position (red)
- H: Measuring cursors C1 (yellow) and C2 (orange) for time period measurement
- J: **H**: grid of time axis (horizontally)
V: grid of voltage axis (vertically)
Stopped/Waiting/Running: trigger status
C1/C2/Diff: relative time measuring values of the measuring cursors

6.3 Adjusting the View

- Functions **Zoom**, **H-pos**, and **T=0**

With the following functions the current view on the horizontal axis (time axis) is adjusted.

Element	Function
Zoom	Zooming in or out horizontally. The reference point during zooming yields from Settings > Display trigger position .
H-pos	Shifting the view horizontally.
T=0	Aligns the view to the trigger position. The trigger position is placed on the screen according to Settings > Display trigger position .

The position bar on the top of the oscilloscope screen gives an overview.

6.4 Measuring a Time Period

➤ Function **Cursor**

A section of the time axis can be marked on the screen with the two cursors C1 and C2 (vertical lines) in order to measure a time period.

➤ Do the following to measure a time period:

1. Select **Cursor** > **Cursor1 coarse**. Set the desired start point of the time period by dialing and finally pushing the button. For fine-tuning the cursor position use **Cursor** > **Cursor1 fine**.



Tip: You can measure a large time period with the highest possible time resolution by zooming in (**Zoom**) before positioning the cursor. Then the cursor can be positioned with a finer time resolution that will not be lost when zooming out afterwards.

2. Repeat the procedure with Cursor2 in order to set the end point of the time period. This must be positioned to the right of the start point.
3. In the lower status bar, read the relative position of the cursor to the trigger position (**C1**, **C2**) and the length of the **Diff** period.

6.5 Customize the view

➤ Function **View**

You can customize the view of information on the oscilloscope screen by showing selected elements. This is done by selections in the displayed menu.

OK applies the selection temporarily, **Save & OK** saves the selection throughout switching off the device. **Exit** leaves the menu without changes in the view.

Element	View	Description
CAN-H	Upper, green signal course	CAN-High of the differential CAN signal
CAN-L	Lower, white signal course	CAN-Low of the differential CAN signal
CAN-Diff	Blue signal course	Difference of CAN-High and CAN-Low
CAN_RxD	RX bar in the upper area	Bit borders and bit states of received signals
CAN_TxD	TX bar in the upper area	Bit borders and bit states of transmitted signals
Decoder	Turquoise-colored CAN frame data	Data of the CAN frame decoded from the signal course
Bit fields	Khaki-colored field descriptors	View of the fields of the decoded CAN frame

6.6 Sampling signals

➤ Functions **Single/Stop** and **Run/Stop**

The sample buffer is filled with the signal course as soon as a trigger event is detected. To sample **once**, click on **Single**. Use

Run to activate **repeated** sampling. Use **Stop** for each action to end.

You can select the **trigger event** to be used with **Settings** > **Trigger**. **Settings related to the sampling** are adjusted with **Settings** > **Pretrigger size** and **Sample buffer size**. For more information about these settings, see section 6.9.3 on page 67 and following.

6.6.1 Decoding of the Signal Course

A CAN frame detected in the signal course is automatically decoded. In the upper area of the grid, the contents of the decoded CAN frame (turquoise-colored: CAN ID, data length in bytes, payload data) and its bit fields (khaki-colored) are shown.



Tip: If this information is not shown, select **View** and check the items **Decoder** and **Bit fields**.

If more than one CAN frame is contained in the sample buffer, that one is decoded that is placed farthest to the left in the current view.

6.6.2 Fixing Decoding Problems

Decoding View	Meaning	Possible measure(s)
Red data	Faulty CAN frame	Set the device's CAN bitrate to the one on the connected CAN bus: - Main menu item Settings > CAN bitrate - As alternative: Detect CAN bitrate
	No remote CAN node transmitting an acknowledge*	- Running more than one active node on the CAN bus - Running PCAN-Diag without listen-only mode
Empty	No CAN frame detected	Shift the current view with H-pos until a CAN frame is shown.
	The Decoder element fo the oscilloscope screen is disabled	Enable the Decoder element view: View > Decoder

* If bitfields of frames are displayed at decoding, the “noack” error appears at the end of the frame.

6.7 showing a Report about the Decoded CAN Frame

➤ Function **Report**

With this function you get an overview of the properties of a decoded CAN frame.

Property	Description
Configuration	Section with the current CAN settings. They can be changed in the main menu item Settings .
Protocol	CAN protocol
Arb. Bitrate	Nominal bitrate (incl. indication of the sample point)
Data bitrate	Data bitrate at CAN FD (incl. indication of the sample point)

Property	Description
Term. Status	Status of the CAN termination:
Term. value	Measured total resistance between CAN_High and CAN_Low
Measurement	Section with measuring values that yield from the decoding of the CAN frame
Protocol	CAN protocol that the decoded CAN frame is using (BRS: bitrate switch at CAN FD)
CAN ID	CAN ID
Data length	Data length in bytes
(Data)	Data in hexadecimal format or "RTR" (Remote Transmission Request)
Total bits	Number of bits in the whole CAN frame
Dominant bits Recessive bits	Number of dominant and recessive bits in the whole CAN frame
Stuff bits	Number of stuff bits in the whole CAN frame
Fixed Stuff bits	Number of stuff bits that are predetermined by CAN FD for the CRC bitfield
Err. state ind.	Error state indicator that has been set in the CAN FD frame by the transmitting CAN node
CRC15, CRC17, CRC21	Checksum for the CAN frame; depending on the CAN frame type, another CRC algorithm is used
Stuff count	Only CAN FD frame with ISO format: Additional check information in the frame referring to the stuff bits
Bitrate	Bitrate (incl. deviation to the set bitrate)
Arb. Bitrate Data bitrate	Only CAN FD frames with BRS: nominal bitrate and data bitrate (incl. deviations to the set bitrates)
ACK field width	Actual duration of the acknowledge bit (response of all receiving CAN nodes) incl. relation to the theoretical duration of a bit timing. A greater deviation upwards may indicate a larger distance to a responding CAN node or a delayed processing of a CAN node.

6.8 Saving the Scope Screen and the Sample Buffer Contents

➤ Function **Export**

According to **Settings** > **Export**, this function saves the following data to the internal memory card:

- └ the contents of the screen as bitmap (pict000.bmp)
- └ the contents of the sample buffer as CSV file (data000.csv)
- └ a text file with information from the Report function (report000.txt)

The files are written to the directory of the active project (Projects > <project name>) and can be read later from a connected PC via USB. Get the name of the active project from the lower status bar in the main menu.

Structure of the CSV File

A CSV file contains key data with several CAN parameters and the sample data line by line in text format. As separator the semicolon (;) is used. For further use the file can be taken into an arbitrary spread sheet, for example.

6.9 Settings for the Oscilloscope Function

➤ Menu item **Scope** > **Settings**

6.9.1 Trigger

Selection of the event that triggers the sampling of the signals (trigger event).

Setting	Description
None	No trigger function
Start of Frame	Start of a recognized CAN frame
End of Frame	End of a recognized CAN frame
Error Frame	A faulty CAN frame
Free-running	Free-running sampling without trigger; the sample buffer is filled repeatedly.
CAN ID	CAN frame with the CAN ID being indicated in the following setting (item 6.9.2)
CAN Rx falling	Transition of a received CAN signal from the dominant to the recessive state
Bitrate Switch	Bitrate switch flag of a CAN FD frame

6.9.2 CAN ID

If **CAN ID** is selected as trigger event, the CAN ID indicated here is used.

Setting	Description
Frame format	Length of the CAN ID (11 bit or 29 bit)
CAN ID	Enter the CAN ID in hexadecimal format

6.9.3 Sample buffer size

Changes the buffer size and with this the sampling time. Smaller buffer sizes are useful for a faster repetition of the sampling run.

The sampling time results from the quotient of the sample buffer size and the sample rate of 100 MSamples/s.

Example: 1024 kSamples / 100 MSamples/s = 10.24 ms

6.9.4 Pretrigger size

A part of the signal course is shown before the trigger point. The percentage indicates the part of the whole course. Possible ratios: 10:90, 50:50, 90:10

6.9.5 Display trigger position

The trigger position (red vertical line) can be displayed on the left, in the middle, or on the right of the oscilloscope screen after the sampling process. Furthermore, this setting determines the reference point for zooming.

6.9.6 Hotkeys

Within the oscilloscope function, the different functions can be assigned to the four hotkeys.

Setting	Description
None	No function
Zoom+ , Zoom-	Zooming in or out horizontally.
H-pos+ , H-pos-	Shifting the view horizontally.
Frame+ , Frame-	Jumping to the next or the previous recognized CAN frame in the signal course
Single , Run/Stop	Starting the sampling, either once or repeatedly

Setting	Description
Report	Overview of the properties of a decoded CAN frame
T=0	Aligns the view to the trigger position
Save	...
Exit	Leaves the oscilloscope function
Export	Saves different data on the internal memory card
Import	...

6.9.7 View

The view of information on the oscilloscope screen can be customized by showing selected elements.

Element	View	Description
CAN-H	Upper, green signal course	CAN-High of the differential CAN signal
CAN-L	Lower, white signal course	CAN-Low of the differential CAN signal
CAN-Diff	Blue signal course	Difference of CAN-High and CAN-Low
CAN_RxD	RX bar in the upper area	Bit borders and bit states of received signals
CAN_TxD	TX bar in the upper area	Bit borders and bit states of transmitted signals
Decoder	Turquoise-colored CAN frame data	Data of the CAN frame decoded from the signal course
Bit fields	Khaki-colored field descriptors	View of the fields of the decoded CAN frame

6.9.8 Export

Here it is determined which files are written to the internal memory card when the Export function is executed:

- └ **Screendump**: the contents of the screen as bitmap
(pict000.bmp)
- └ **Report**: a text file with information from the Report function
(report000.txt)
- └ **CSV data**: the contents of the sample buffer as CSV file
(data000.csv)

7 Configuring the Device with Projects

➤ Main menu item **Projects**

With projects the PCAN-Diag FD can quickly be adapted to different applications.

A project contains the following elements:

Project element	Assigned area in the PCAN-Diag FD
General Settings	Settings
Oscilloscope settings	Scope > Settings
Settings for the view of CAN messages	CAN Data > CAN Message View > Settings CAN Data > Transmit Messages > Settings
Display settings for busload and voltage measurements	Measurements > Bus Load > Menu > Settings Measurements > Analog > Settings
CAN transmit lists	CAN Data > CAN Message View CAN Data > Transmit Messages
CAN transmit sequences	CAN Data > CAN Message View CAN Data > Transmit Messages
Symbol files	CAN Data > Manage Symbol Files
Alternative splash screen	Shown when device is started (see section 7.2 on page 75)

Using projects:

- Projects are created and altered on a PC with the provided Windows software PCAN-Diag FD Editor and then are transferred to the internal memory card of the PCAN-Diag FD.
- Any number of projects can be saved to the internal memory card (only limited by the left space on the internal memory card).

- └ During work with the PCAN-Diag FD a project can be loaded from the internal memory card.
- └ If a new version of the active project is available on the internal memory card, the project is automatically reloaded during startup of the PCAN-Diag FD.
- └ Device-internal changes of the settings or of CAN transmit lists alter the affiliated project on the internal memory card only if **Save Project** is selected (see below).

Load Project

A project is selected from the internal memory card; the project's elements are loaded into the PCAN-Diag FD. Click on the name of the desired project in order to load it.



Note: When loading a project from the memory card, all current settings, transmit lists, and symbol files in the PCAN-Diag FD are overwritten.

The **Default project** contains default settings for the PCAN-Diag FD.

Save Project

Save the current settings, transmit lists, and symbols files to the currently loaded project file.

Delete Project

Opens the list of all projects that are saved on the PCAN-Diag FD and offers the possibility to delete a project by clicking on it.

Project:

Shows the name of the active project.

At startup the PCAN-Diag FD checks if the project file on the internal memory card with the same name is newer than the initially loaded version. An updated project is automatically loaded.

7.1 Creating and Loading a Project

The procedure from creation of a project to the use in the PCAN-Diag FD is divided into three phases:

- └ Creating a project on a PC with the Windows program PCAN-Diag FD Editor.
- └ Transferring the project to the internal memory card of the PCAN-Diag FD via USB connection.
- └ Loading the project in the PCAN-Diag FD.

▶ Do the following to create a project:

1. On the PC, start the PCAN-Diag FD Editor (`PcanDiagFdEdt.exe`). You can find the program, for example, on the supplied DVD in the following directory:
`/Tools/PCAN-Diag FD/Tools/`
The elements of a project are listed on the tabs.
2. Save the created project on a data carrier with **Save**. This is required if you want to add CAN transmit lists and transmit sequences to the project. The given file name is from now on used as project name and should be unique.
3. Adjust the settings for your application on the tabs **Settings**, **Scope Settings**, **CAN Data**, and **Measurements**. See the Information column for explanations for each element.
4. If needed, add one or more **CAN Transmit Lists** on the corresponding tab. Create new lists with the Windows software PCAN-View by tabling the desired CAN messages

in the Transmit window and saving this list. Afterwards, import it into the PCAN-Diag FD Editor.

5. If you want to use transmit sequences, insert them on the **CAN Sequence Lists** tab. Import regular transmit lists created with PCAN-View. The “Cycle Time” of the CAN messages is interpreted as the “Delay” to the previous message in the list.
6. On the **Symbols** tab, select the symbol files to be available for the project.

Configure the presentation of multiplexers of all symbols files with **Target format**:

Common Multiplexer: All variables of different multiplexers are displayed in a common list.

Separate Multiplexer: Variables are listed for each multiplexer.

For adding, use the **Import** button.

7. Save the created project on a data carrier with **Save**.

▶ Do the following to transfer the project to the PCAN-Diag FD:

1. Connect the PCAN-Diag FD to a PC with the provided USB cable (see also chapter 10 on page 80).

The **Transfer to** button in the PCAN-Diag Editor is not dimmed anymore but blue indicating the possibility for transfer. A text note in the lower **Output** panel indicates that the PCAN-Diag FD has been recognized.

2. Click on **Transfer to** and check the PCAN-Diag FD device in the dialog box **Select Devices**.



Tip: You can transfer the same configuration to several PCAN-Diag devices at the same time if those are connected to the PC. Select all devices with **Select All**.

3. Click on **OK**.

The project file (*.prj) and the affiliated symbol files, transmit lists, and transmit sequences (*.sym, *.syb, *.xmt, *.xms) are transferred to the PCAN-Diag FD (progress indicator **Transfer data**). The used directory on the internal memory card is
/PCAN-Diag FD/Projects/<project name>.

4. Disconnect the USB connection between the PC and the PCAN-Diag FD.

 Do the following to load the project in the PCAN-Diag FD:

1. In the PCAN-Diag FD select **Projects** > **Load Project**.

A list with projects available on the internal memory card and the remaining memory space on the internal memory card are shown.

2. Select the project that has been transferred before.

The project is now loaded and is shown as active project.

The active project is indicated at the lower edge in the main menu.



Tip: You can get further information about the use of the PCAN-Diag FD Editor in the program's help which is invoked via **Help** or the **F1** key.

7.2 Integrating an Alternative Splash Screen

Each project can have an alternative splash screen in order to clarify already at startup which project is active. A bitmap file must be put into the corresponding project directory on the internal memory card. If it does not exist, the default splash screen is shown (Default project).

Properties of the splash screen

File name	Intro_vert.bmp
Storage path on the internal memory card	/PCAN-Diag FD/Projects/<project name>/
Format	Windows bitmap
Resolution	480 x 800 pixels
Color depth	24 bit

▶ Do the following to integrate an alternative splash screen:

1. On a PC create a bitmap file with the key features from the table.
2. Establish a USB connection between the PC and the PCAN-Diag FD.
In the PC the PCAN-Diag FD is handled as mass storage device.
3. Copy the created file `Intro_vert.bmp` into the desired project directory (see table).
4. Disconnect the USB connection.

8 Maintenance Functions for the Device

➤ Main menu item **Support**

The page gives an overview about the device's internals. The specifications are usually used for support.

In this menu, hardware functions are available for maintenance of the device. They are described briefly in the following.

 **Important note:** Misapplication of some functions can lead to the unavailability of the device.

8.1 Updating the Firmware

➤ Submenu item **Update Firmware**

Via our technical support or our website, you can obtain a current firmware file (*.bin).

➤ Do the following to update the firmware:

1. Make sure that the PCAN-Diag FD is supplied externally (plug icon at the charging level indicator on the upper right).
2. Via a USB connection from your PC (chapter 10 on page 80), copy the new firmware file (*.bin) to the internal memory card of the PCAN-Diag FD into the following directory:
/PCAN-Diag FD/Firmware/
3. On the PCAN-Diag FD, select **Support** > **Update Firmware**.

4. Select the previously copied firmware file.

The PCAN-Diag FD directly starts with the firmware update. This process takes a few seconds. Afterwards the PCAN-Diag FD is restarted automatically.

5. If a corresponding note appears on the screen, disconnect the power supply from the PCAN-Diag FD before restarting.

8.2 Starting the Bootloader

- Submenu item **Start Bootloader**

Starts the bootloader with a menu containing basic functions.

8.3 Restoring the Factory Defaults

- Submenu item **Restore Factory Defaults**

All settings are reset to their default states defined by the current firmware.

8.4 Displaying Information on Hardware and Software

- Submenu item **Show Internal Statistics**

Shows basic general information about the hardware and the firmware.

8.5 Showing Directories

- Submenu item **Browse Memory Card**

Shows the directories on the internal memory card in order to see which files exist.

8.6 Resetting the Battery Monitoring

- Submenu item **Reset Charge Level**

If the charge level of the internal batteries is not displayed plausibly anymore in the status bar on top, you can reset the monitoring function of the charge level with this entry. Afterwards, fully charge the batteries once, best of all when the device is switched off.

9 Viewing Files

- Main menu item **View Files**

You can view specific files that are saved on the internal memory card directly with the PCAN-Diag FD:

- └ `*.bmp`:
bitmaps, e.g. screenshots
- └ `*.txt, *.ini`:
text files, e.g. reports

M0: in the directory structure stands for the internal memory card.

10 USB Connection

➤ Main menu item **USB Connection**

A USB connection to a PC is used for access to the internal memory card of the PCAN-Diag FD. The PC's operating system binds the memory card into the file management, e.g. under Windows as mass storage device.

Internal memory card

Size	at least 2 GByte
File system	FAT32
Name of the USB device	PCAN-Diag FD

 **Note:** The memory card can be accessed only if the PCAN-Diag FD is switched on.

10.1 Automatic USB Connection

If **USB autoconnect** is enabled in the **Settings** (**On**), the internal memory card is automatically connected to the PC. If the PCAN-Diag FD needs the memory card to save data or to access data, the USB connection is interrupted until the operation is finished.

 **Note:** If the option is enabled, the **USB Connection** entry is not available in the main menu.

10.2 Manual USB Connection

If **USB autoconnect** is disabled in the **Settings** (**Off**), the internal memory card is connected to the PC with the main menu

item **USB Connection**. When leaving the function, the internal memory card is disconnected again.

10.3 Purposes of the USB connection

- └ Transferring projects onto the memory card of the PCAN-Diag with the provided Windows program PCAN-Diag FD Editor (7.1 on page 72)
- └ Accessing the traces, bitrate lists, bitrate frequencies, bitmaps, or CSV files created by the PCAN-Diag FD
- └ Storing an alternative splash screen in a project directory (7.2 on page 75)
- └ Placing a *.bin file for a firmware update into the directory /PCAN-Diag FD/Firmware/
- └ Storage space at your disposal

11 Technical specifications

Power supply

Supply voltage	12 V DC nominal, 9 - 28 V possible	
Rechargeable batteries	6 x AA NiMH 1.2 V 1900 mAh	
Charging periods batteries	Charging station:	about 2 h
	DC socket (unoperated):	about 4 h
	DC socket (operated):	about 11 h
Support battery clock	Button cell CR1620 3.0 V	
Current consumption	Quick-charge via charging station:	1.3 A
	Operation without charging (batteries full):	450 mA at 9 V 350 mA at 12 V 200 mA at 24 V
	Only charging (Power socket):	580 mA at 9 V 450 mA at 12 V 260 mA at 24 V
	Operation with charging (batteries empty):	550 mA max. at 12 V

D-Sub connector

Function	CAN connector
Number of pins	9
Measurement	Voltage measurement ± 28 V (10 bits resolution) at pins 6 and 9

CAN

Transmission standards	CAN FD (ISO 11898-1 and Non-ISO), CAN 2.0 A/B
CAN bitrates	10 kbit/s - 1 Mbit/s
CAN FD bitrates	10 kbit/s - 12 Mbit/s
Transceiver	High-speed CAN ISO 11898-2 (MCP2558FD)
Termination	124 Ω between CAN_L and CAN_H, switchable

Trigger output

Connection	Banana jack 4 mm
Voltage idle state	0 V
Voltage trigger event	about 3 V (rising edge)
Delay to the internal trigger	none

Oscilloscope function

Measuring channels	1: CAN_H 2: CAN_L
Sampling frequency	100 MHz
Capacity sample buffer	1 MSample max.
Trigger types	CAN frame start/end, CAN ID, CAN error, bitrate switch; alternatively free-run mode
Pretrigger	10 %, 50 %, 90 %
Resolution amplitude	10 bit, 8 mV/digit
Measuring range amplitude	-1.5 - +6.5 V
CAN-specific functions	Decoding of the recorded signal course
Data transfer	Screenshot of the current scope screen Contents of the sample buffer as CSV file

Internal memory card

Size	4 GByte
File system	FAT32
Name of the USB device	PCAN-Diag FD

USB port

Mechanics	USB socket type C
Max. transfer rate	USB 2.0 High-Speed
Function	Access to internal memory card

Screen

Display type	TFT
Resolution	480 x 800 pixels
External output	alternatively via Micro-HDMI connector, DVI signal, 1024 x 768 pixels (4:3)

Measures

Size	110 x 47 x 206 mm (W x H x D) See also dimension drawing Appendix B on page 86
Weight	680 g

Environment

Operating temperature	on external supply with charging: 0 - +40 °C (+32 - +104 °F) on operation with batteries: 0 - +50 °C (+32 - +122 °F)
Temperature for storage and transport	-20 - +50 °C (-4 - +122 °F)
Relative humidity	15 - 90 %, not condensing
Ingress protection (IEC 60529)	IP20

Conformity

EMV	Directive 2014/30/EU DIN EN 61326-1:2017-07
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-Diag FD

Item number(s): IPEH-003069/68

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 61326-1:2013-07

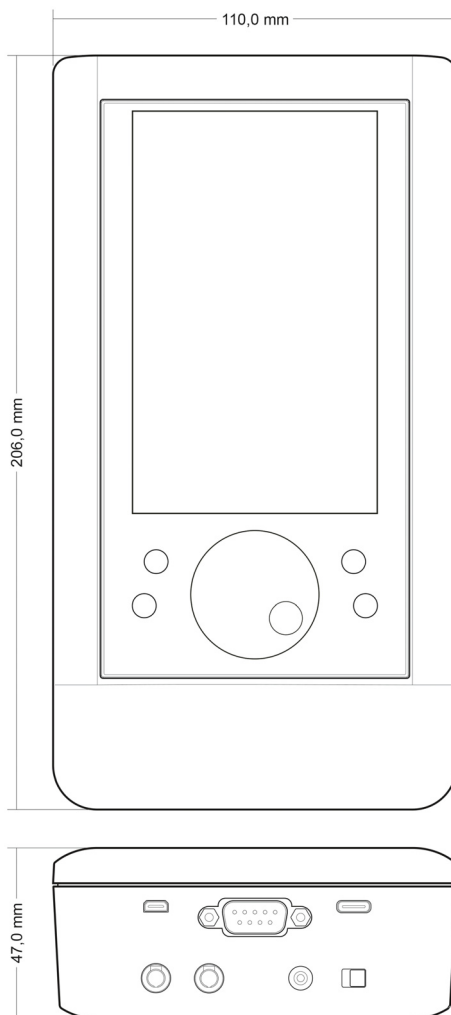
Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 1:
General requirements (IEC 61326-1:2012);
German version EN 61326-1:2013

Darmstadt, 22 February 2019

A handwritten signature in black ink, appearing to read "Uwe Wilhelm".

Uwe Wilhelm, Managing Director

Appendix B Dimension Drawing



The figure does not show the original size.

Appendix C Disposal Information (Batteries)

The device and the batteries it contains must not be disposed of with household waste. Remove the batteries from the unit for proper separate disposal.

The PCAN-Diag FD contains the following batteries:

- └ 1 x button cell CR1620 3.0 V
- └ 6 x AA 1.2 V NiMH