VH6501 CAN Disturbance Interface
Manual

Version 1.2 | English

Imprint

Vector Informatik GmbH
Ingersheimer Straße 24
D-70499 Stuttgart

Contents

1 Introduction

In this chapter you find the following information:

1.1 About this User Manual

Conventions

In the two following charts you will find the conventions used in the user manual regarding utilized spellings and symbols.

Style	Utilization
bold	Blocks, surface elements, window- and dialog names of the software. Accentuation of warnings and advices. **[OK]** Push buttons in brackets **File|Save** Notation for menus and menu entries
Microsoft	Legally protected proper names and side notes.
`Source Code`	File name and source code.
Hyperlink	Hyperlinks and references.
<CTRL>+<S>	Notation for shortcuts.

Symbol	Utilization
	This symbol calls your attention to warnings.
	Here you can obtain supplemental information.
	Here you can find additional information.
	Here is an example that has been prepared for you.
	Step-by-step instructions provide assistance at these points.
	Instructions on editing files are found at these points.
	This symbol warns you not to edit the specified file.

1.1.1 Certification

Certified Quality Management System

Vector Informatik GmbH has ISO 9001:2008 certification. The ISO standard is a globally recognized standard.

1.1.2 Warranty

Restriction of warranty

We reserve the right to change the contents of the documentation and the software without notice. Vector Informatik GmbH assumes no liability for correct contents or damages which are resulted from the usage of the documentation. We are grateful for references to mistakes or for suggestions for improvement to be able to offer you even more efficient products in the future.

1.1.3 Registered Trademarks

Registered trademarks

All trademarks mentioned in this documentation and if necessary third party registered are absolutely subject to the conditions of each valid label right and the rights of particular registered proprietor. All trademarks, trade names or company names are or can be trademarks or registered trademarks of their particular proprietors. All rights which are not expressly allowed are reserved. If an explicit label of trademarks, which are used in this documentation, fails, should not mean that a name is free of third party rights.

> Windows, Windows 7, Windows 8.1, Windows 10
> are trademarks of the Microsoft Corporation.

1.2 Important Notes

1.2.1 Safety Instructions and Hazard Warnings

Caution!
In order to avoid personal injuries and damage to property, you have to read and understand the following safety instructions and hazard warnings prior to installation and use of this interface. Keep this documentation (manual) always near the interface.

1.2.1.1 Proper Use and Intended Purpose

Caution!
The interface is designed for analyzing, controlling and otherwise influencing control systems and electronic control units. This includes, inter alia, bus systems like CAN, LIN, K-Line, MOST, FlexRay, Ethernet, BroadR-Reach and/or ARINC 429.

The interface may only be operated in a closed state. In particular, printed circuits must not be visible. The interface may only be operated (i) according to the instructions and descriptions of this manual; (ii) with the electric power supply designed for the interface, e.g. USB-powered power supply; and (iii) with accessories manufactured or approved by Vector.

The interface is exclusively designed for use by skilled personnel as its operation may result in serious personal injuries and damage to property. Therefore, only those persons may operate the interface who (i) have understood the possible effects of the actions which may be caused by the interface; (ii) are specifically trained in the handling with the interface, bus systems and the system intended to be influenced; and (iii) have sufficient experience in using the interface safely.

The knowledge necessary for the operation of the interface can be acquired in workshops and internal or external seminars offered by Vector. Additional and interface specific information, such as „Known Issues“, are available in the „Vector KnowledgeBase“ on Vector´s website at www.vector.com. Please consult the „Vector KnowledgeBase“ for updated information prior to the operation of the interface.

1.2.1.2 Hazards

Caution!
The interface may control and/or otherwise influence the behavior of control systems and electronic control units. Serious hazards for life, body and property may arise, in particular, without limitation, by interventions in safety relevant systems (e.g. by deactivating or otherwise manipulating the engine management, steering, airbag and/or braking system) and/or if the interface is operated in public areas (e.g. public traffic, airspace). Therefore, you must always ensure that the interface is used in a safe manner. This includes, inter alia, the ability to put the system in which the interface is used into a safe state at any time (e.g. by „emergency shutdown“), in particular, without limitation, in the event of errors or hazards.

Comply with all safety standards and public regulations which are relevant for the operation of the system. Before you operate the system in public areas, it should be tested on a site which is not accessible to the public and specifically prepared for performing test drives in order to reduce hazards.

1.2.1.3 Disclaimer

Caution!
Claims based on defects and liability claims against Vector are excluded to the extent damages or errors are caused by improper use of the interface or use not according to its intended purpose. The same applies to damages or errors arising from insufficient training or lack of experience of personnel using the interface.

2 Device Description

In this chapter you find the following information:

2.1 Scope of Delivery

Contents

The delivery includes:

- VH6501 Interface
- Vector Power Supply 12 V / 1.25 A (part number 05024)
- USB2.0 cable (part number 05011)

2.2 Introduction

About the VH6501

With the VH6501, you can cause specific and reproducible disturbances on the CAN bus, its physical properties and the logical level (recessive or dominant).

The VH6501 offers the following capabilities:

- Forcing freely definable sequences of recessive or dominant disturbance pulses
- Disturbance of specific frames via trigger
- Manipulation of the bit fields of CAN/CAN FD frames

Figure 1: VH6501

The main features of the VH6501 interface are:

- Full-featured CAN network interface
  (can be used by several applications at the same time)
- Disturbance functionalities for CAN/CAN FD
  (CANoe only)
- External trigger
- Second channel for dedicated digital-analog input/output tasks
- 5x LED indicating activities and status
- Software time sync
- Hardware time sync (via SYNCcableXL)

2.3 Accessories

Reference
Information on available accessories can be found in the separate accessories manual on the Vector Driver Disk in `\Documentation\Accessories`.

2.4 Connectors Bus Side

Front side

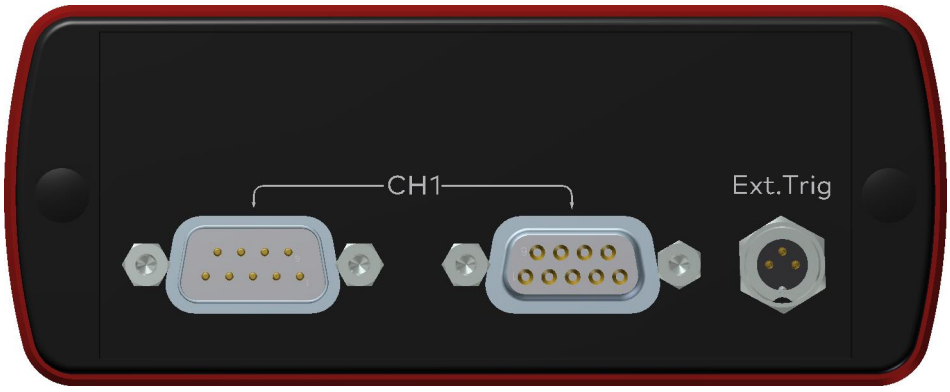
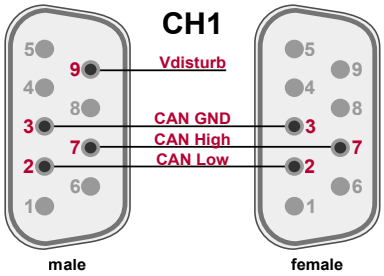


Figure 2: VH6501 with D-SUB9 connectors

> **CH1 (2x D-SUB9)**
The VH6501 has a female and a male D-SUB9 connector. The pin assignment of both connectors is identical. Both connectors are interconnected.

Pin	Assignment
1	Not connected
2	CAN Low CAN High*
3	CAN GND
4	Not connected
5	Not connected
6	Not connected
7	CAN High CAN Low*
8	Not connected
9	$V_{disturb}$ -27 V…+27 V (male only)



* CAN High and CAN Low can be electronically swapped at the female connector

Note
$V_{disturb}$ can be used to simulate external disturbances and electrical shorts by applying voltage between -27 V…+27 V against CAN GND (pin 3). If not required, pin 9 can be left unconnected. Further information can be found in section Technical Data on page 19.

By connecting the device via both terminals, you can use the VH6501 as a bypass interface that does not change the topology of the existing CAN network:

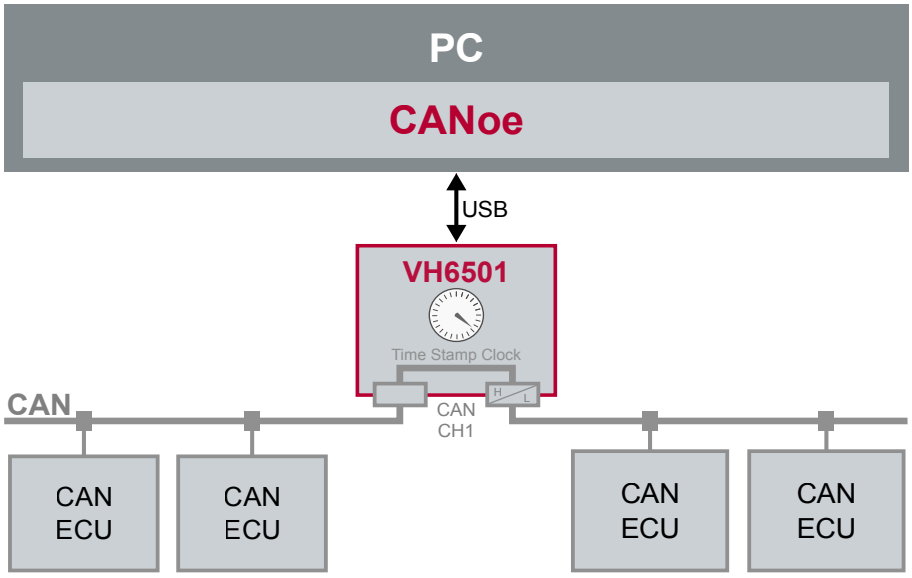


Figure 3: VH6501 as bypass interface

Note
The female and male connector are not split or isolated by the device, i. e. disturbances and triggers on the bus always affect both sides. The VH6501 cannot be used as a gateway.

By connecting the device to an existing CAN network via one terminal, you can use the VH6501 as network interface. This setup adds a new stub to the existing CAN network.

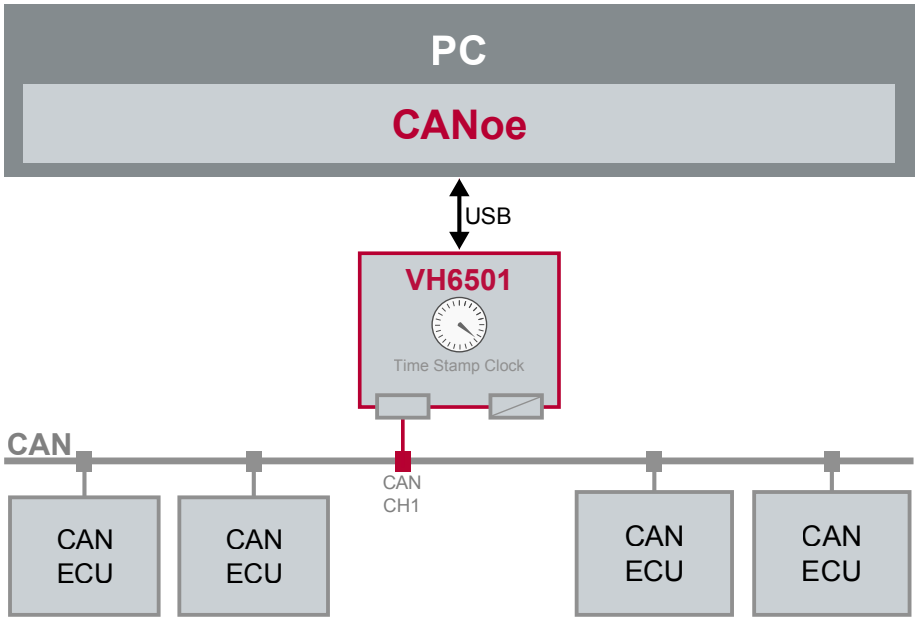


Figure 4: VH6501 as network interface

> **External Trigger**

This connector (Binder type 711) can be used to trigger other devices, e. g. an oscilloscope.

Pin	Assignment
1	Not connected
2	Trigger output - 0V (low) - 5V (high) - 50 Ohm - adjustable edge and pulse duration via CANoe
3	GND

2.5 Connectors USB Side

Back side

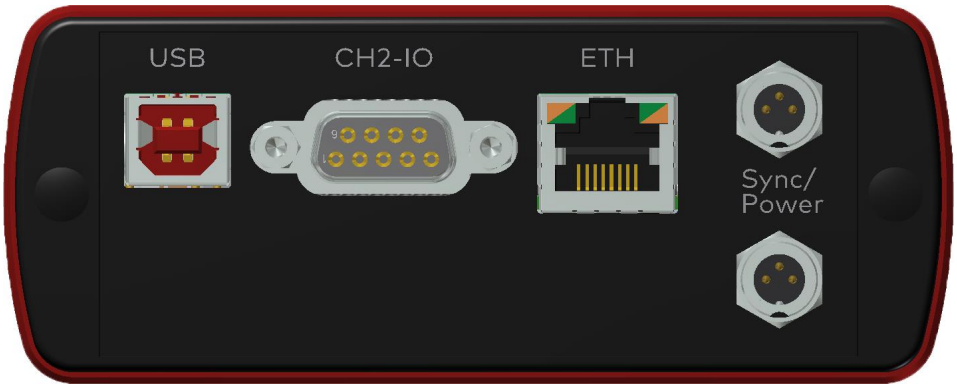


Figure 5: Connectors on the USB side

Device connectors

> **USB**

Connect your PC and the VH6501 via USB to install and to use the device. Use the USB2.0 compliant cable found in the delivery (USB extension cables may generate faults between the PC and the device).

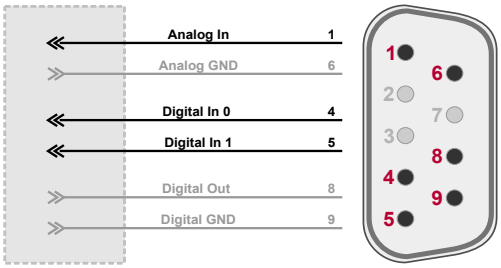
Note

On USB connection, the powered device executes a calibration process as well as a self diagnosis on the transceiver and the digital disturbance unit. This process takes approx. 1 second.

> **CH2-IO (D-SUB9)**

Use this D-SUB9 connector for dedicated digital-analog input/output tasks. The pin assignment for CH2 is as follows:

Pin	Assignment
1	Analog In
2	Not connected
3	Not connected
4	Digital In 0 / Trigger In*
5	Digital In 1 / Trigger In*
6	Analog GND
7	Not connected
8	Digital Out
9	Digital GND



* You can use these pins as external trigger to send user-defined or frame-based sequences. Furthermore, it is possible to use the digital inputs as additional trigger enable for CANoe trigger conditions. An external trigger cannot be used if a trigger enable is configured. Use either Digital In 0 or Digital In 1 as trigger/trigger enable. Parallel usage of both inputs is not supported.

Reference

Details on the internal interconnection of the input/ouput pins can be found on the next page.

Details on CH2

The internal interconnection of the input/ouput pins is as follows:

Internal interconnection of digital input 0/1

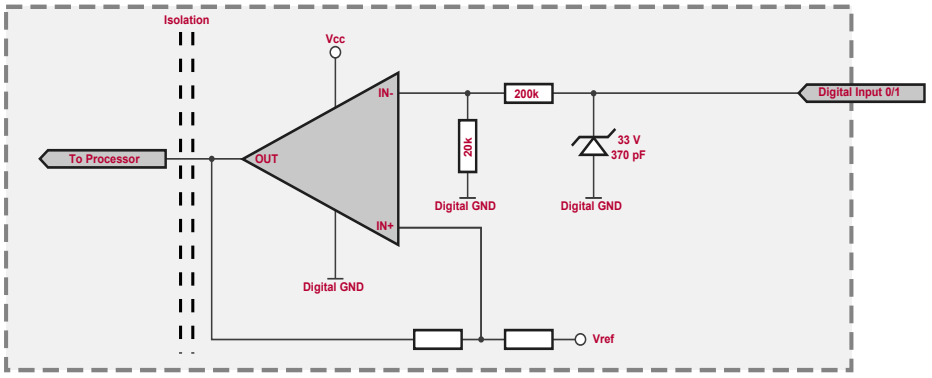


Figure 6: Digital input 0/1

Internal interconnection of digital output

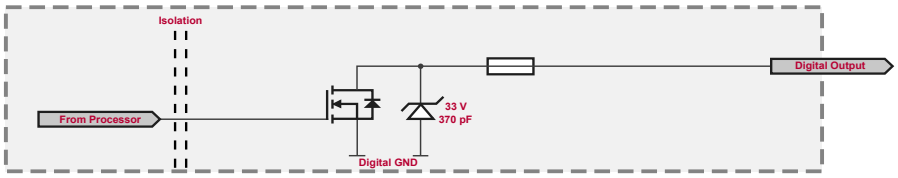


Figure 7: Digital output

Internal interconnection of analog input

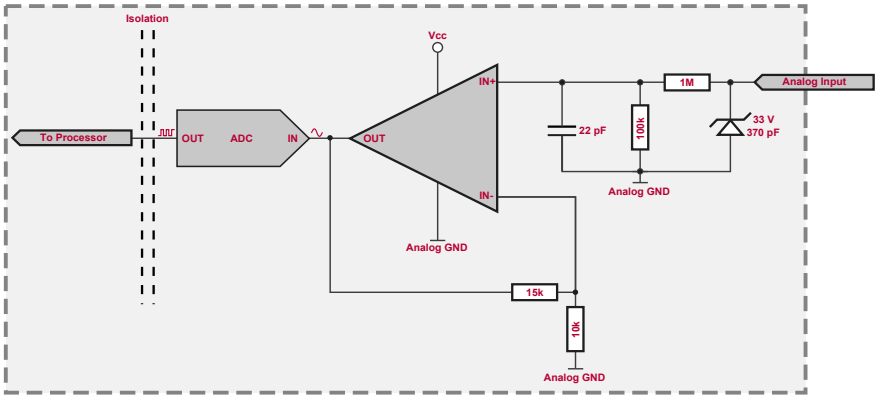


Figure 8: Analog input

Extended measuring range of the analog input

In normal operation, voltages up to 18 V can be applied and measured at the analog input. The cutoff frequency f_c (-3 dB) for AC voltages is approx. 7.2 kHz.

For measurements above 18 V (max. 50 V), an external series resistor has to be applied to the analog input. The series resistor R_{ext} depends on the maximum input voltage U_{input} to be measured and can be calculated as follows:

$$R_{ext}\,[kOhm] = [(U_{input} * 0.61111) - 11] * 100$$
$$with\ 18\,V < U_{input} \leq 50\,V$$

The cutoff frequency for AC voltages is also affected by the external series resistor:

$$f_c\left[Hz\right] = \frac{1}{2.33 * 10^{-6} * R_{ext}\,[kOhm]}$$

Examples

	24 V	32 V	36 V	48 V
R_{ext}	367 kΩ	856 kΩ	1100 kΩ	1833 kΩ
R_{ext} (E96)	374 kΩ (24.12 V)	866 kΩ (32.17 V)	1100 kΩ (36.00 V)	1870 kΩ (48.60 V)
f_c (-3 dB)	1148 Hz	496 Hz	390 Hz	230 Hz

Device connectors (continued)

> **Host (Ethernet)**
Host connector (100BASE-TX and 1000BASE-T). Reserved for future purposes.

> **2x Power/Sync (Binder connectors)**
The VH6501 has two power/sync connectors (Binder type 711) which can be used for time synchronization of different Vector devices (see section Time Synchronization on page 32) or for power. It does not matter which connector is used to supply the device.

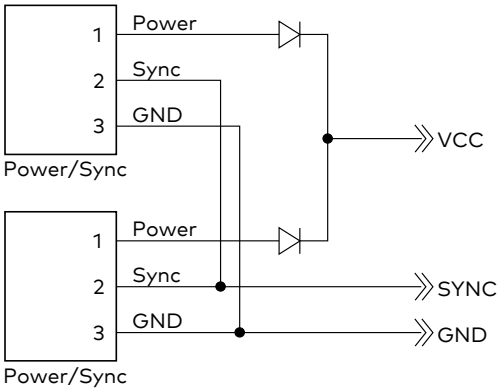


Figure 9: Internal wiring of the power/sync connector

Pin	Assignment
1	Power supply (6 V … < 60 V DC, typ. 12 V)
2	Synchronization line
3	Ground

2.6 LEDs

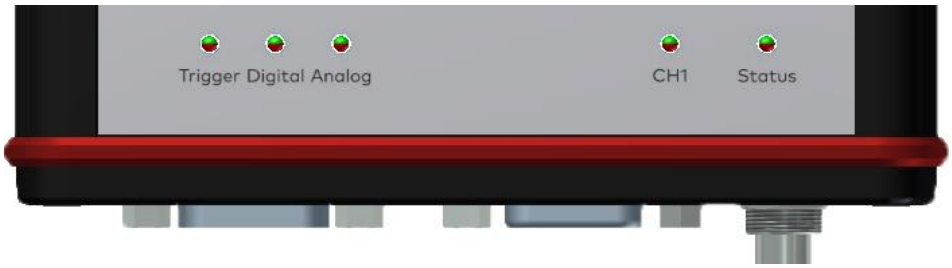


Figure 10: Top LEDs on VH6501

> **Trigger**
Multicolored LED which indicates the trigger state.

Color	Description
Off	No active trigger.
Green	Waiting for (multiple) trigger. This state remains until the last trigger has been released in the application.
Red	Self test error. Please try to reboot the device. If the error still remains, please contact our support.

> **Digital**
Multicolored LED which indicates the state of the digital disturbances.

Color	Description
Off	No digital disturbance/sequence transmission.
Green	Digital output in progress. For short sequences, this state remains at least for 0.5 s. For long sequences, this state remains as long as the output is in progress.
Red	At start-up: Calibration error. Please try to reboot the device. If the error still remains, please contact our support. At runtime: Error in digital disturbance/sequence transmission. Transmission is stopped due to high current, electrical short or overvoltage of the transceiver. Please check your hardware setup and your CANoe configuration.

> **Analog**
Multicolored LED which indicates the state of the analog disturbances.

Color	Description
Off	No analog disturbances.
Green	Analog output in progress.
Red	Error while analog disturbances selected. Possible reasons: high current at electrical shorts or overvoltage at transceiver/resistors. Affected resistors and electrical shorts will be automatically removed. Please check your hardware setup and your CANoe configuration.

> **CH1**

Multicolored channel LEDs which indicates the bus activity for CAN.

Color	Description
Green	Data frames have been transmitted or received correctly.
Orange	CAN: Error frames have been transmitted or received.
Red	CAN: Bus off.

CAN: The flashing frequency depends on the bus load.

> **Status**

Multicolored LED indicating the device status.

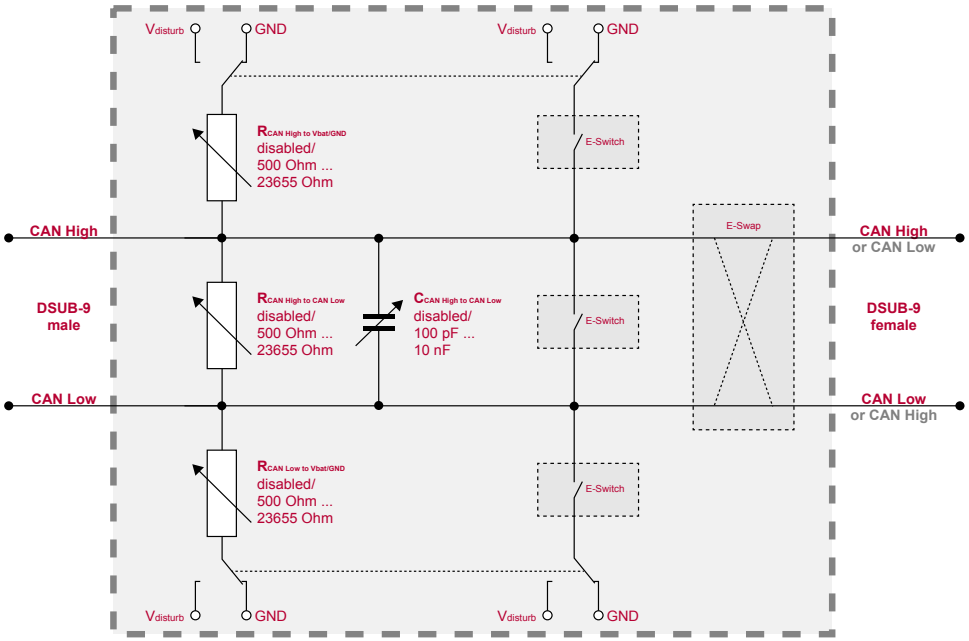
Color	Description
Green	On: Running measurement. Flashing: Device is ready for operation.
Orange	On: Device executes update. Flashing: Device start up.
Red	Error. Device not working.

2.7 Technical Data

CAN/CAN FD channel	1x D-SUB9 (TJA1057 Piggyback) CAN2.0: 2 MBit/s CAN FD: up to 8 MBit/s
Analog input	10 bit Input 0 V...18 V Voltage tolerance up to 50 V (with series resistor) Sampling rate up to 1 kHz
Digital input	Range 0 V...32 V Schmitt trigger high 2.7 V, low 2.2 V Hysteresis 0.5 V Input frequencies up to 1 kHz
Digital output	Open Drain External supply up to 32 V Current max. 500 mA Short circuit / over voltage protected
Time stamps	Resolution: 8 ns Accuracy (in device): 1 µs Accuracy software sync: typ. 50 µs Accuracy hardware sync: typ. 1 µs
PC interface	USB 2.0
External power supply	6 V... < 60 V DC Power-up: 9 V DC
Power consumption	Typical 7 W
Temperature range (ambient temp. of the device)	Operation: -40 °C ... +60 °C Storage: -40 °C ... +85 °C
Relative humidity of ambient air	15 %...95 %, non-condensing
Dimensions (LxWxH)	Approx. 155 mm x 111 mm x 45 mm
Weight	Approx. 600 g
Operating system requirements	Windows 7 SP1 (32 bit / 64 bit) Windows 8.1 (32 bit / 64 bit) Windows 10 (64 bit)
Software requirements	CANoe version 10.0 SP2 (SP3 or higher recommended)

Changeable resistors and capacitor

The following block diagram depicts the resistors and the capacitor which can be controlled via CANoe. In addition, CAN High and CAN Low can be swapped at the female connector if required.



Resistor values

Ohm					
500	525	570	605	735	800
905	1000	1495	1660	1965	2260
2485	3240	3720	4130	4945	9180
14505	23655				

Capacitor values

pF					
100	126	133	223	440	460
485	510	566	600	643	688
762	825	909	1000	1303	1499
1803	2200	3197	4700	10000	

Caution!
The VH6501 has an internal protection against incorrect resistor/voltage combination that could lead to electronic damages. If $V_{disturb}$ is >30 V and the value of a resistor is <=1 kOhm, the affected resistor will be disabled .

Note
Due to technical reasons, it is currently not possible to change the variable resistors $R_{CAN\ High\ to\ Vbat/GND}$ and $R_{CAN\ Low\ to\ Vbat/GND}$ together with a digital sequence output.

The variable resistor $R_{CAN\ High\ to\ CAN\ Low}$ and the capacitor $C_{CAN\ High\ to\ CAN\ Low}$ as well as short circuites are not affected.

Note
The internal protection does work as long as CAN High and CAN Low are not externally fed.

Note
According to the technical specification of the TJA1057 transceiver, the range of the voltage difference of CAN High and CAN Low is -27 V ... 27 V.

3 Getting Started

In this chapter you find the following information:

3.1 Driver Installation

General information

The Vector Driver Disk offers a driver setup which allows the installation or the removal of Vector devices.

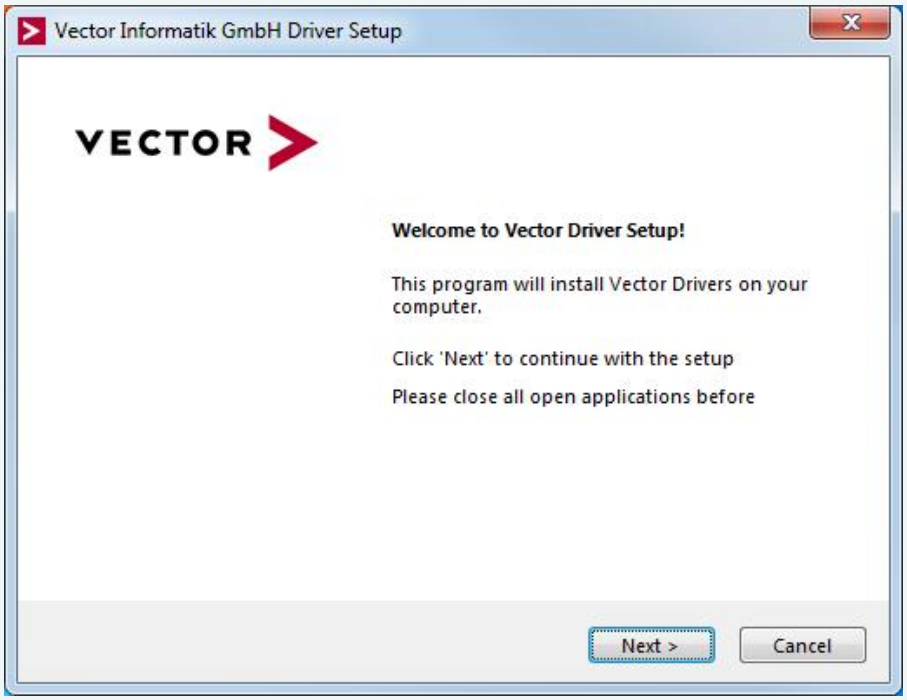
Note

Please note that you will need **Administrator Rights** for the following steps.

Step by Step Procedure

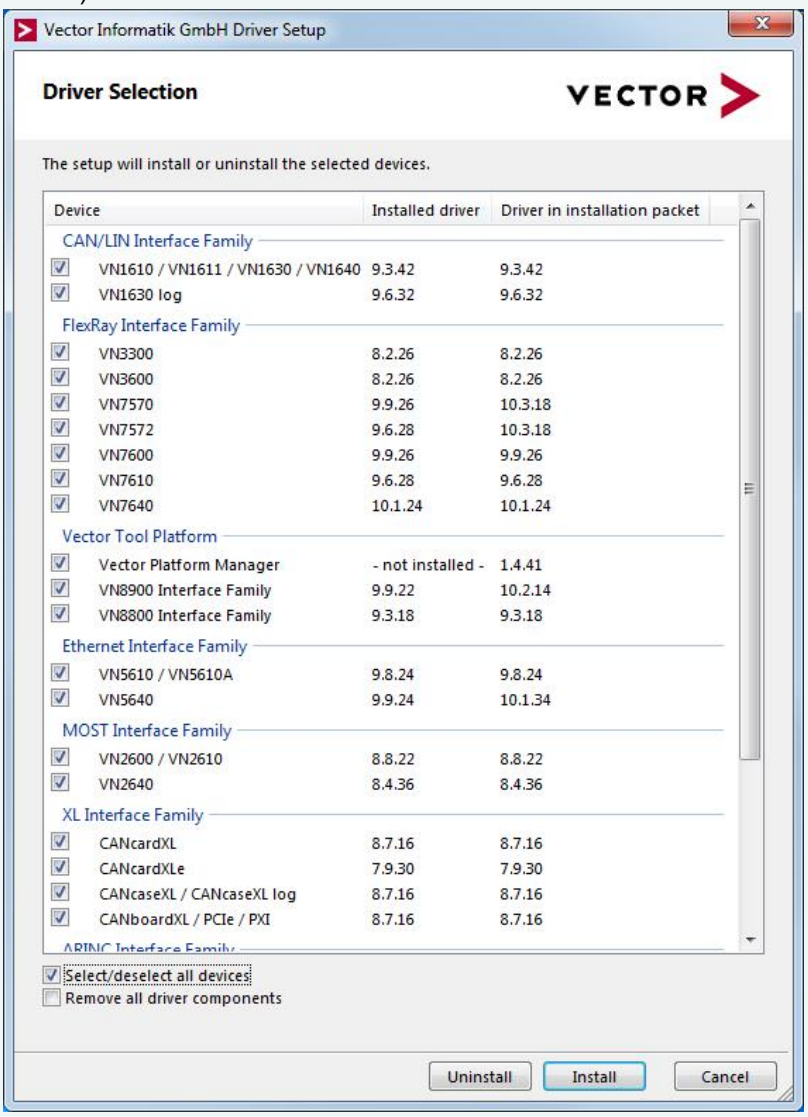
1. Execute the driver setup from the autostart menu or directly from `\Drivers\Setup.exe` before the device is connected to the PC with the included USB cable.

   If you have already connected the device to the PC, the **Windows found new Hardware** wizard appears. Close this wizard and then execute the driver setup.



2. Click **[Next]** in the driver setup dialog. The initialization process starts.

3. In the driver selection dialog, select your devices to be installed (or to be uninstalled).



4. Click **[Install]** to execute the driver installation, or **[Uninstall]** to remove existing drivers.
5. A confirmation dialog appears. Click **[Close]** to exit. After successful installation, the device is ready for operation and can be connected to the PC with the included USB cable and powered by supplying external voltage (e. g. with an appropriate cable offered by Vector).
6. Install or update your CANoe to version 10.0 SP2 or higher.

3.2 Device Configuration

Configuration

Before the installed device can be used in an application, it must be properly configured for the needed use case. This configuration is done with the **Vector Hardware Config** tool which comes with the driver installation. The tool can be found in **Windows | Start | Settings | Control Panel | Vector Hardware** and manages all installed Vector devices.

Reference
Further details on **Vector Hardware Config** can be found in the installation instructions (see section Vector Hardware Configuration on page 26).

Reference
Further details on the configuration with CANoe can be found in the according online help.

4 Vector Hardware Configuration

In this chapter you find the following information:

4.1 General Information

Executing Vector Hardware Config

After the successful driver installation you will find the configuration application **Vector Hardware** in the Control Panel (see below). The tool gives you information about the connected and installed Vector devices. There are also several settings that can be changed.

Figure 11: Icon in Control Panel

Control Panel Windows 7

> Category view
Windows Start | Control Panel | Hardware and Sound,
click **Vector Hardware** in the list.

> Symbols view
Windows Start | Control Panel,
click **Vector Hardware** in the list.

Control Panel Windows 8.1

> Category view
<Windows key>+<X> | Control Panel | Hardware and Sound,
click **Vector Hardware** in the list.

> Symbols view
<Windows key>+<X> | Control Panel,
click **Vector Hardware** in the list.

Control Panel Windows 10

> Category view
<Windows key>+<X> | Control Panel | Hardware and Sound,
click **Vector Hardware** in the list.

> Symbols view
<Windows key>+<X> | Control Panel,
click **Vector Hardware** in the list.

4.2 Tool Description

4.2.1 Introduction

Vector Hardware Config

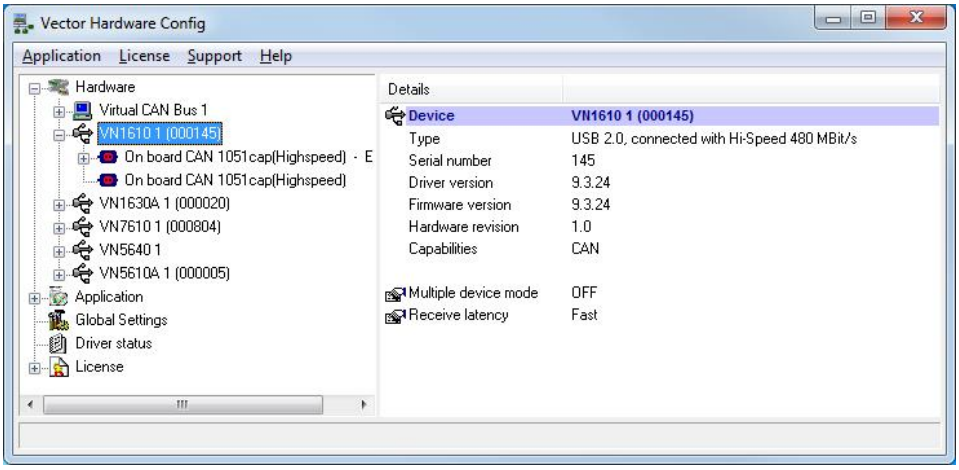


Figure 12: General view of Vector Hardware Config

Logical and physical channels

Vector Hardware Config enables the channel configuration between installed Vector devices and applications. Applications use so-called logical channels which are hardware independent and have to be assigned to real hardware channels.

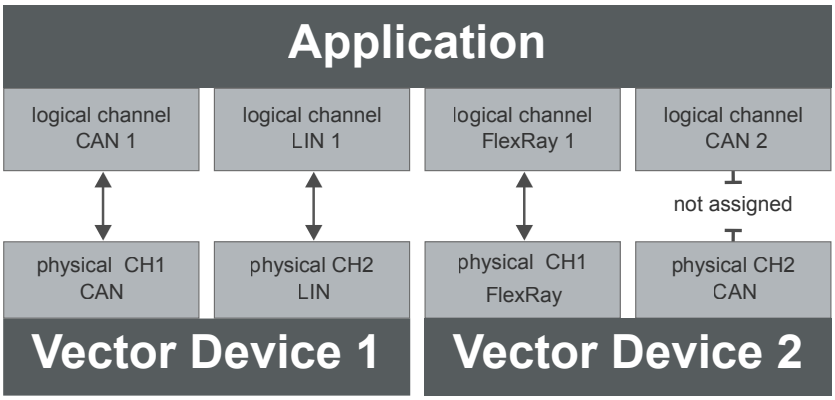


Figure 13: Concept of channel assignments

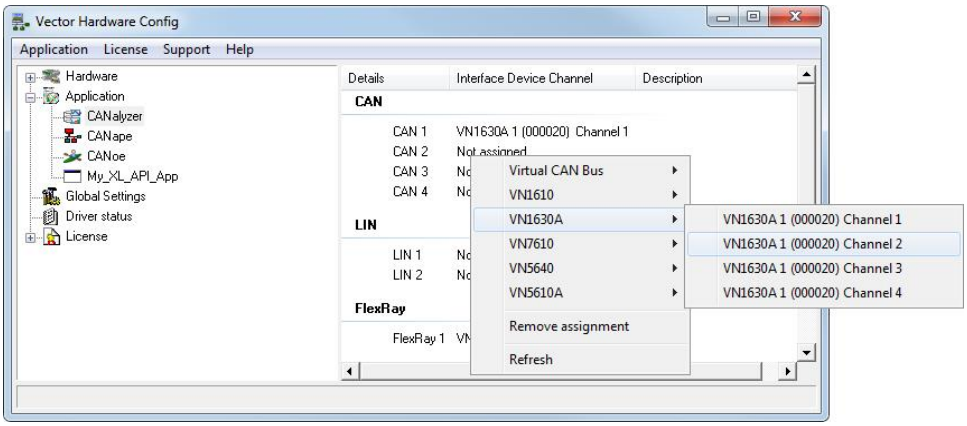


Figure 14: Channel assignment in Vector Hardware Config

4.2.2 Tree View

Accessing Vector devices

The tool is split into two windows. The left window has a tree view and lets you access the installed Vector devices, the right window displays the details of the selection. The following nodes are available in the tree view:

Hardware

The **Hardware** section lists the installed Vector devices. Each device item has physical channels which can be assigned to any number of logical channels (e. g. CANalyzer CAN 1). A logical channel can be assigned to only one physical channel.

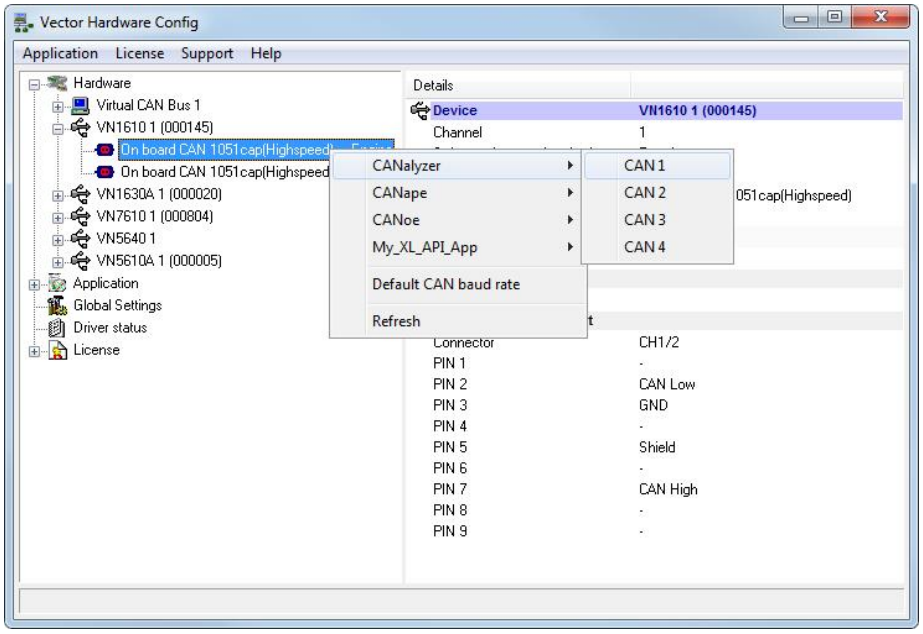


Figure 15: Hardware

Application

In **Application**, all available applications are displayed in a tree view. According to each application, the assignments of logical and physical channels are displayed in the right part of the window. If no assignment exists, the information **Not assigned** appears. The assignment can be edited via a right-click.

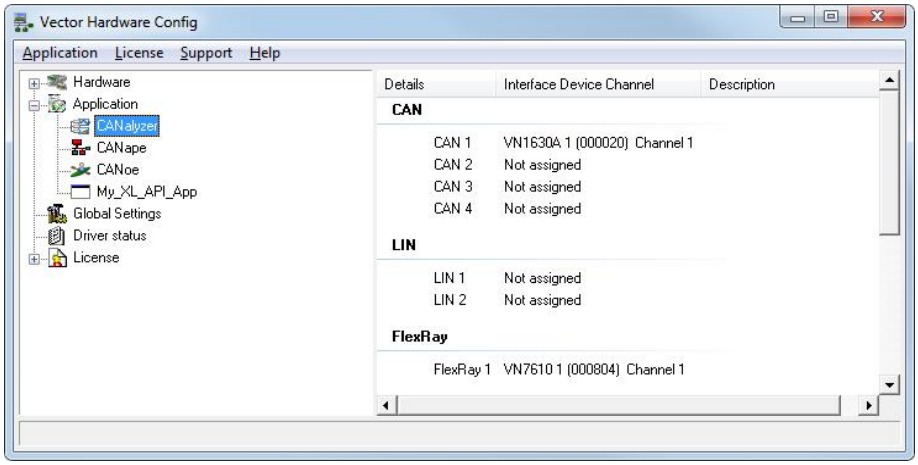


Figure 16: Application

Global settings

Global settings contains global device configuration possibilities, e. g. software time synchronization, transmit queue size, configuration flags or the number of virtual CAN devices.

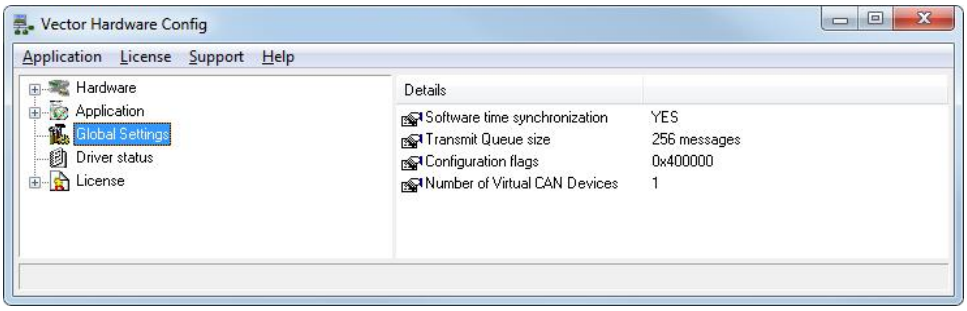


Figure 17: Global settings

Driver status

Driver status offers an overall status information of devices and applications currently in use. You can see whether the channels are connected to the bus (online/offline) and whether the time synchronization is activated or not (Time-Sync-On/Time-Sync-Off).

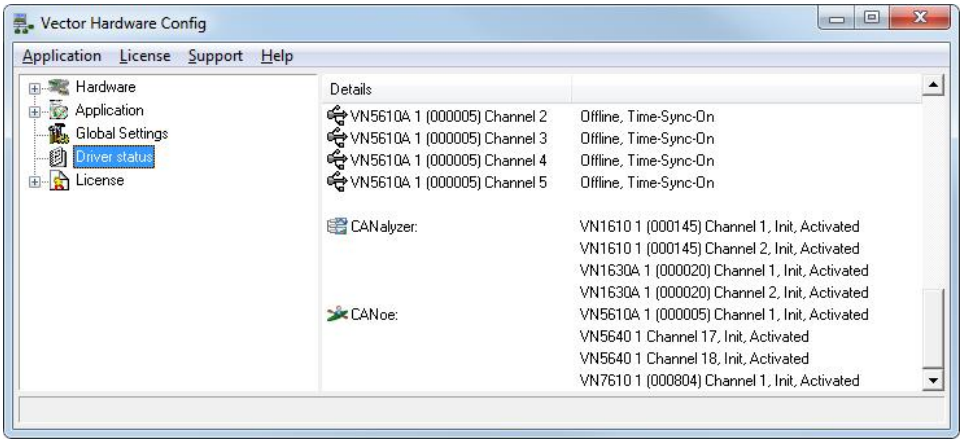


Figure 18: Driver status

License

The **License** section contains information on all current available licenses (Vector bus devices, Vector License USB dongle devices).

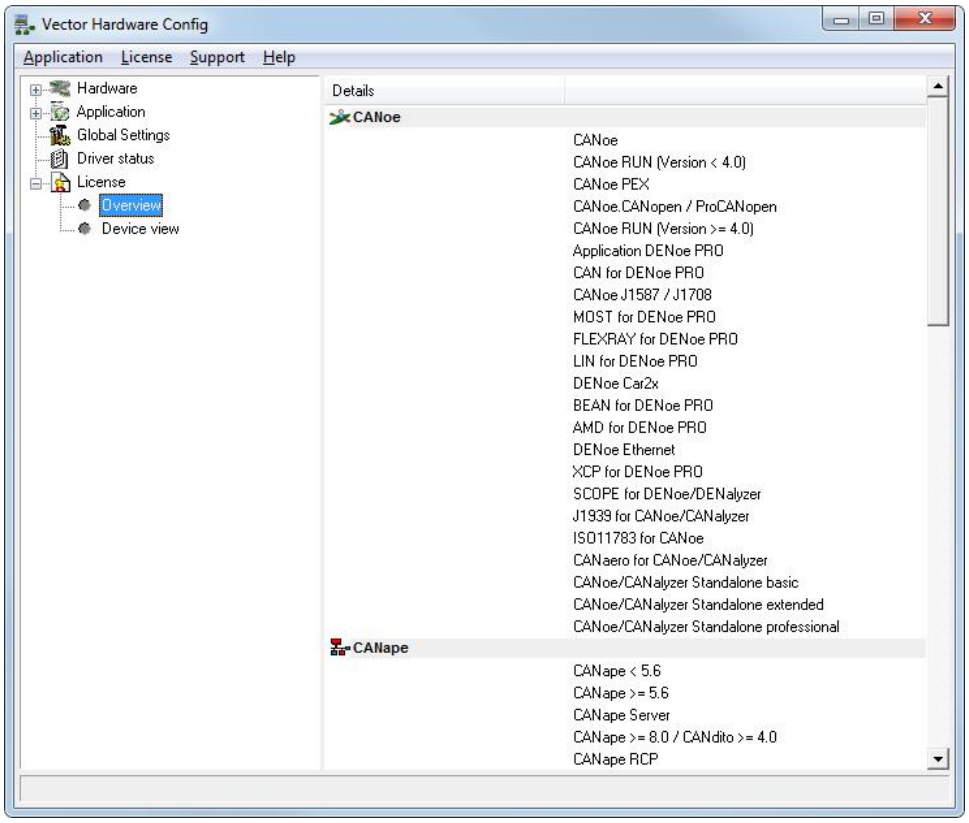


Figure 19: License

Reference
You will find a detailed description of **Vector Hardware Config** in the online help **(Help | Contents)**.

5 Time Synchronization

In this chapter you find the following information:

5.1 General Information

Time stamps and events

Time stamps are useful when analyzing incoming or outgoing data or event sequences on a specific bus.

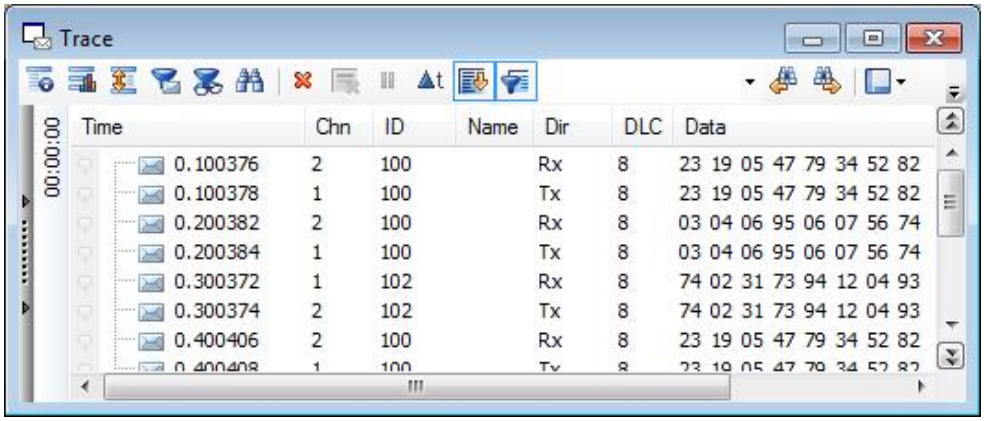


Figure 20: Time stamps of two CAN channels in CANalyzer

Generating time stamps

Each event which is sent or received by a Vector network interface has an accurate time stamp. Time stamps are generated for each channel in the Vector network interface. The base for these time stamps is a common hardware clock in the device.

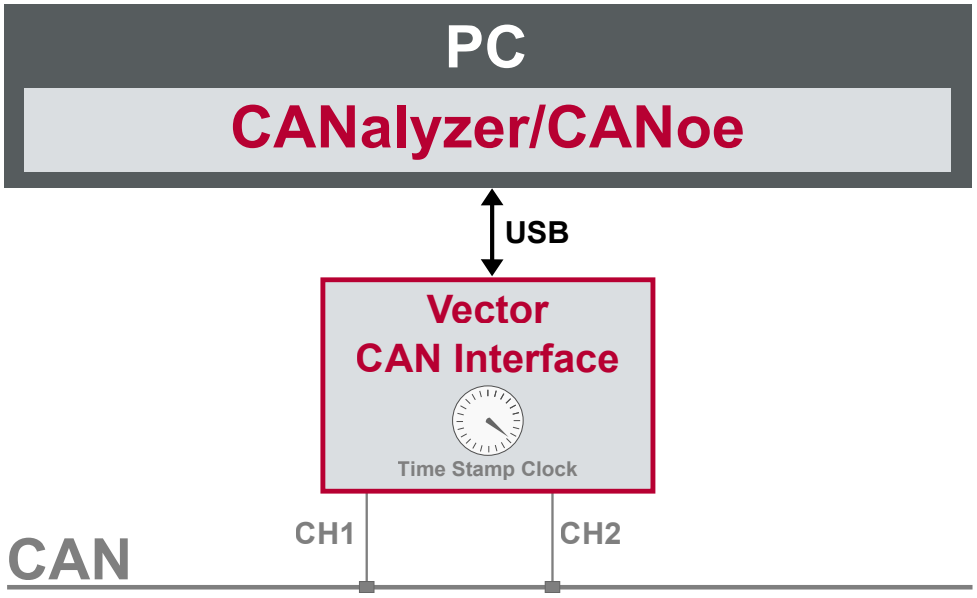


Figure 21: Common time stamp clock for each channel

If the measurement setup requires more than one Vector network interface, a synchronization of all connected interfaces and their hardware clocks is needed.

Due to manufacturing and temperature tolerances, the hardware clocks may vary in speed, so time stamps of various Vector devices drift over time.

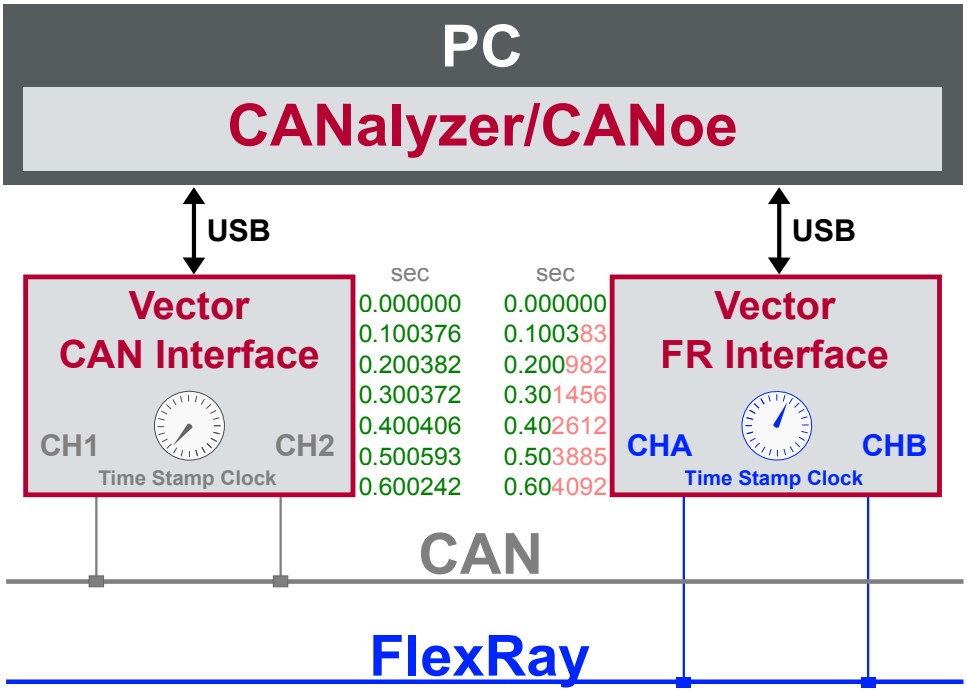


Figure 22: Example of unsynchronized network interfaces. Independent time stamps drift apart

To compensate for these time stamp deviations between the Vector network interfaces, the time stamps can be either synchronized by software or by hardware (see next section).

Note
The accuracy of the software and hardware sync depends on the interface. Further information on specific values can be found in the technical data of the respective devices.

5.2 Software Sync

Synchronization by software

The software time synchronization is driver-based and available for all applications without any restrictions. The time stamp deviations from different Vector network interfaces are calculated and synchronized to the common PC clock. For this purpose no further hardware setup is required.

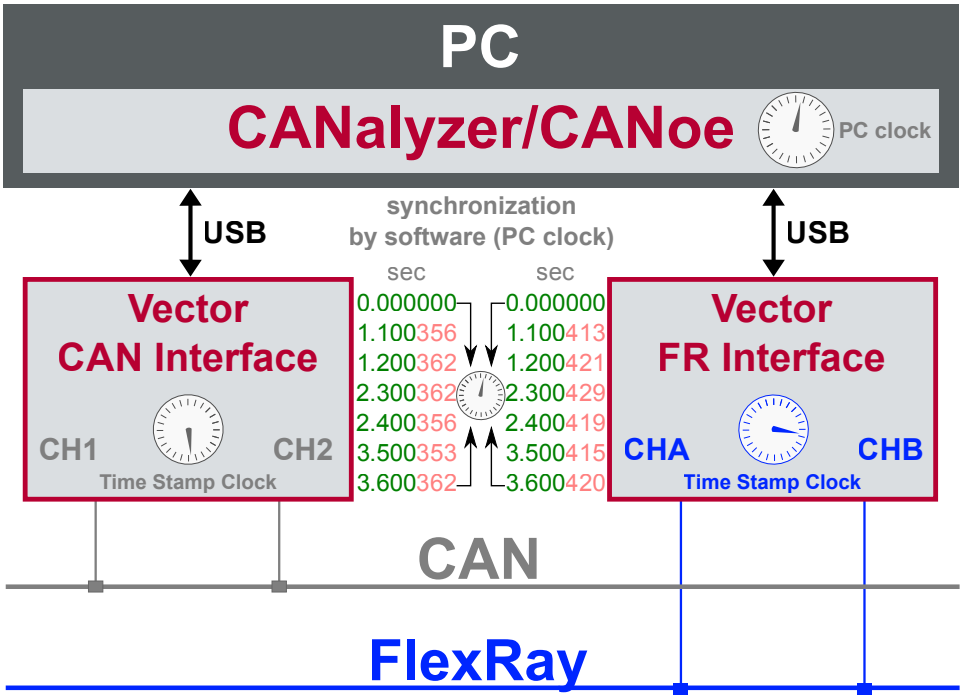


Figure 23: Time stamps of devices are synchronized to the PC clock

The setting of the software time synchronization can be changed in the **Vector Hardware Config** tool in **General information | Settings | Software time synchronization**.

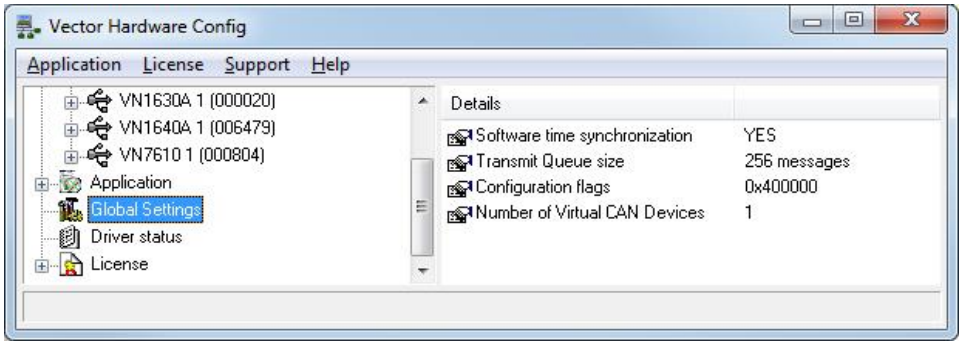


Figure 24: Switching on the software synchronization

> **YES**
The software time synchronization is active.

> **NO**
The software time synchronization is not active. Use this setting only if the Vector network interfaces are being synchronized over the sync line or if only a single device is used.

5.3 Hardware Sync

Synchronization by hardware

A more accurate time synchronization of multiple devices is provided by the hardware synchronization which has to be supported by the application (e. g. CANalyzer, CANoe). Two Vector network interfaces can therefore be connected with the SYNCcableXL (see accessories manual, part number 05018).

In order to synchronize up to five devices at the same time, a distribution box is available (see accessories manual, part number 05085).

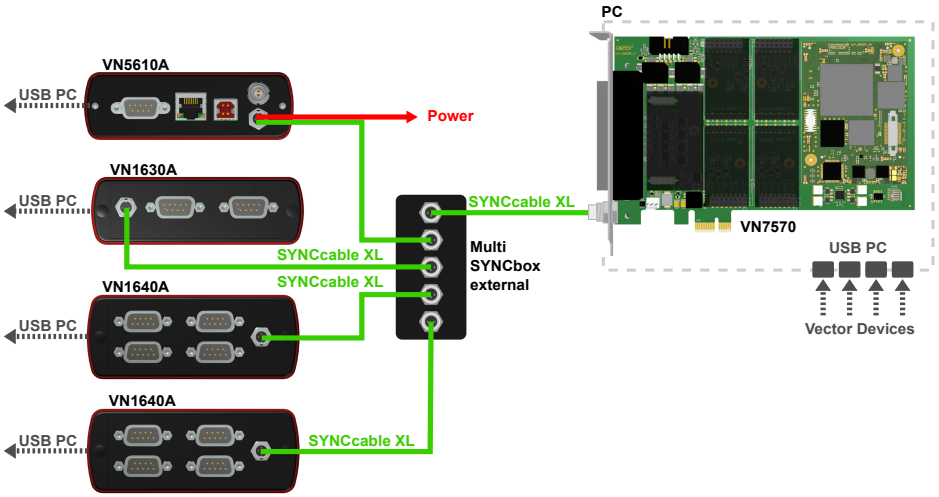


Figure 25: Example of a time synchronization with multiple devices

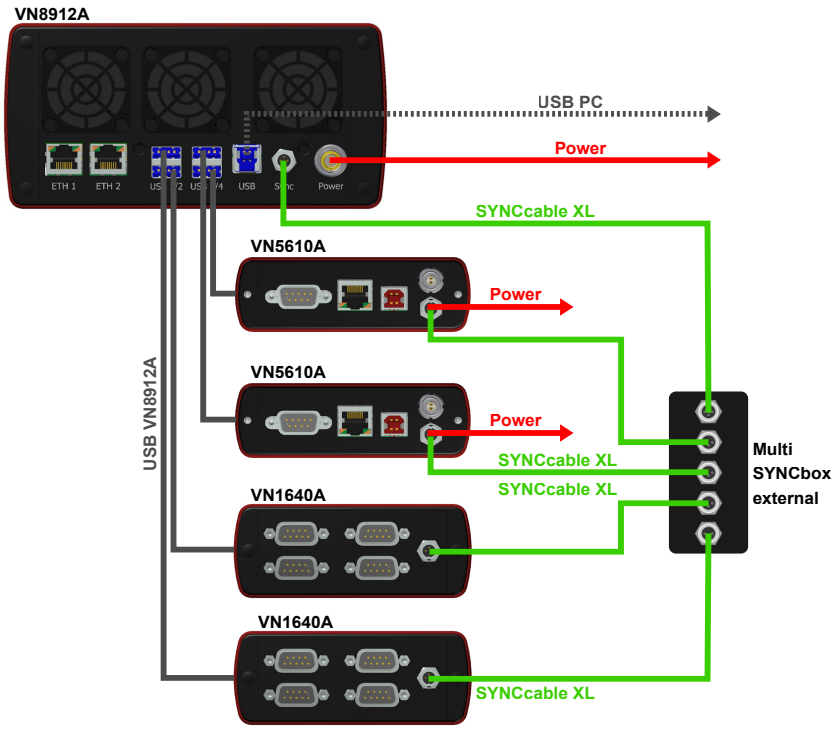


Figure 26: Example of a time synchronization with VN8912A and additional devices

At each falling edge on the sync line which is initiated by the application, the Vector network interface generates a time stamp that is provided to the application. This

allows the application to calculate the deviations between the network interfaces and to synchronize the time stamps to a common time base (master clock) which is defined by the application.

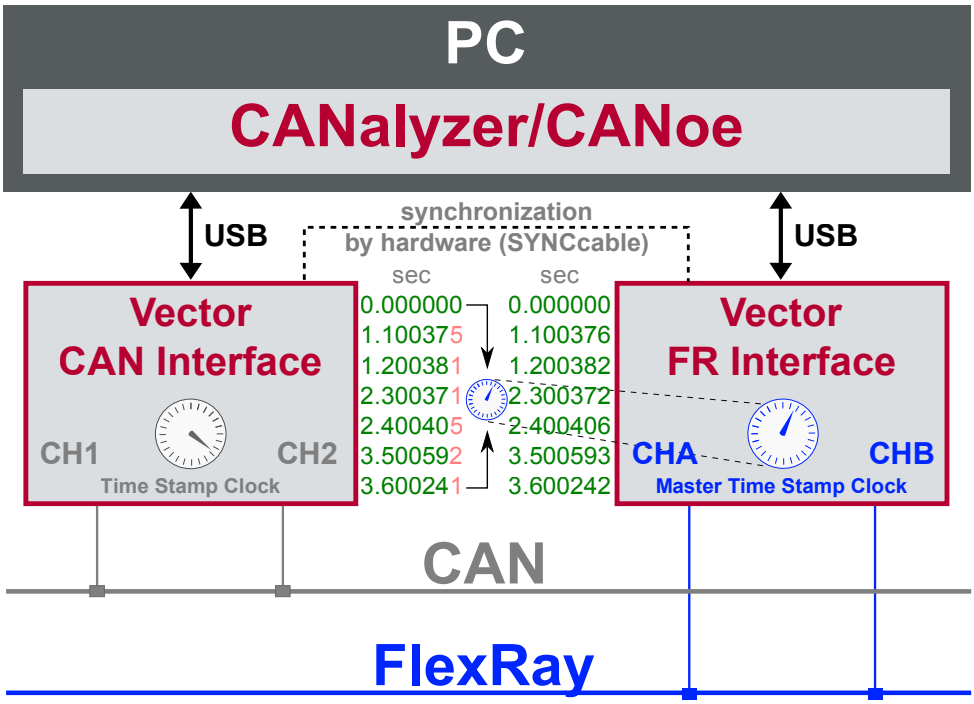


Figure 27: Time stamps are synchronized to the master clock

Note

The hardware synchronization must be supported by the application. For further information please refer to the relevant application manual. Please note that the software synchronization must be disabled (see **Vector Hardware Config | General information | Settings | Software time synchronization**) if the hardware synchronization is used.

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