VECTOR

VN4610
Manual

Version 1.3 | English

Imprint

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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
`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 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.

1.1.2 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.

Caution!
Do not operate the device without antennas! To avoid physical damage to the device, please attach the provided antennas to the device before operation!

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 work-shops 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.

1.2.2 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 VN4610 802.11p/CAN/GNSS Interface

In this chapter you find the following information:

2.1 Scope of Delivery

Contents

The delivery includes:

- 1x VN4610 802.11p/CAN/GNSS Interface
- 2x 5.9 GHz DSRC antenna (part no. 07204)
- 1x GNSS antenna (part no. 07205)
- 1x Power supply (part no. 05024)
- 1x USB 2.0 cable (part no. 05011)

2.2 Introduction

About the VN4610

The VN4610 is a powerful interface with USB PC connection for accessing IEEE 802.11p and CAN FD networks. The dedicated short range communication (DSRC) is based on the IEEE802.11p standard, which transmits/receives frames in the 5.9 GHz frequency range. The VN4610 supports the unfiltered receiving and sending of IEEE 802.11p frames used for the implementation of Car2x/V2x applications. It is possible to synchronize the received radio frames with CAN FD messages. The built-in GNSS receiver supplies the absolute UTC time and current position.

Figure 1: VN4610 802.11p/CAN Interface (bus side)

Overview of Advantages

- Sending/receiving frames according to IEEE 802.11p
- Two configurable IEEE 802.11p WLAN channels
- Unfiltered forwarding of IEEE 802.11p data packets to the application
- Adjustable communication parameters such as radio channel selection, bandwidth, transmission power, modulation type and protocol format LPD/EPD

- Two CAN high-speed channels CAN (FD) capable
- GNSS receiver provides current position and time
- Precise time stamp based on GNSS time
- Time synchronisation with PTP according to IEEE 1588 standard (future Release)
- VN4610 and CANoe.Car2x/CANalyzer.Car2x are optimally matched to each other
- Synchronization with several interfaces and with other bus systems (Ethernet, CAN, LIN, FlexRay, ...)
- Robust housing, power supply and temperature range ideal for automotive and industrial applications
- IO port with digital/analog in/out
- Ethernet with IEEE802.3: 100BASE-TX and 1000BASE-T
- Support of customer CAN/DAIO applications via XL-Driver Library (XL-API)
- Multi-application support (simultaneous operation of different applications on one channel, e. g. CANoe and CANape)
- High time stamp accuracy
- Time synchronization of multiple devices and with other bus systems (CAN, LIN, FlexRay, MOST, Ethernet)
- Software time synchronization
- Hardware time synchronization
- GNSS time synchronization to absolute UTC time
- Time synchronization with PTP according to IEEE 1588 standard
- Connection to host PC via USB 2.0
- LEDs indicating status and activities
- External power supply, galvanically isolated

2.3 Accessories

Reference
Information on available accessories can be found in the separate accessories manual on our website.

3 Examples of Usage

In this chapter you find the following information:

3.1 General Use Cases

Analysis

The VN4610 forwards all received radio frames of the two radio channels unfiltered to the test tool for analysis. Therefore, frames can also be analyzed which would berejected by a ECU due to timing, geo information orprotocol errors caused by Car2x/V2x. Since the time stampsof the messages on the bus channels are synchronized intime, latency measurements can also be carried out.

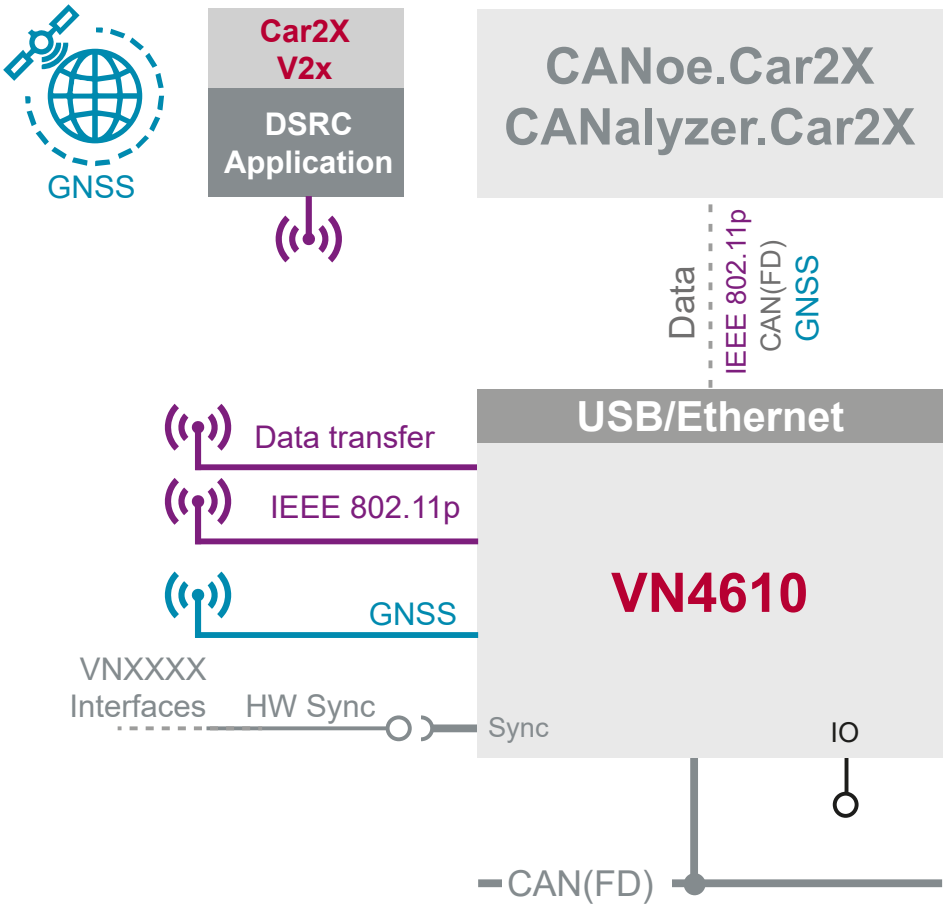


Figure 2: General use cases

Simulation/ Stimulation

CANoe.Car2x together with the VN4610 offers a perfectly coordinated solution for creating an environment stimulation for testing Car2x/V2x applications. The VN4610 sends the transmitted frames, whereby the communication parameters can be easily and individually configured for the different tests.

GNSS Receiver

The VN4610 provides precise position, time and speed information that can be used by the application as test stimulus or for documentation. In addition, the absolute GNSS timestamps can be used to synchronize recordings of distributed measurements for subsequent analysis. Additionally, the VN4610 can act as IEEE 1588 time master and provide the GNSS time in a network (in a future release).

Time synchronization

The VN4610 enables precise time synchronization with PTP according to IEEE1588 standard. The device can be configured e. g. as PTP master with UTC time base, which is provided by the built-in GNSS receiver.

4 Device Description

In this chapter you find the following information:

4.1 Connectors Bus Side

Device connectors

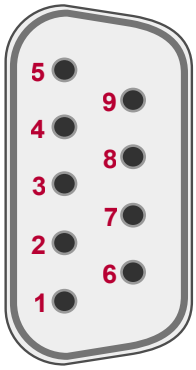
Figure 3: Connectors on the bus side

- **Antenna 1/2 (CH1/CH2)**
  The VN4610 has two 802.11p channels which can be used to transmit and receive data packages. Please attach the provided antennas before using these channels.

- **GNSS (CH5)**
  This channel can be used to receive GNSS time and position.

- **D-SUB9 (CH3/CH4)**
  The VN4610 has two D-SUB9 connectors for CAN/CAN FD. The channels are electrically isolated. The pin assignment is as follows:

Pin	Assignment
1	Not connected
2	1057G CAN Low
3	GND
4	Not connected
5	Not connected
6	Not connected
7	1057G CAN High
8	Not connected
9	Not connected



4.2 Connectors USB Side

Device connectors

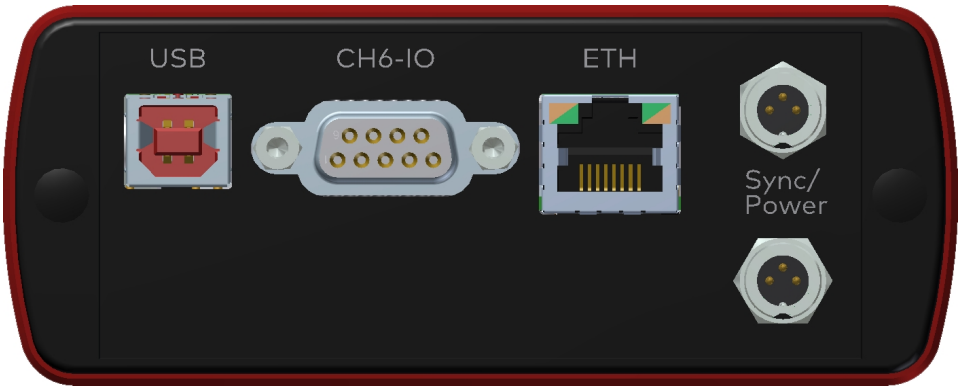
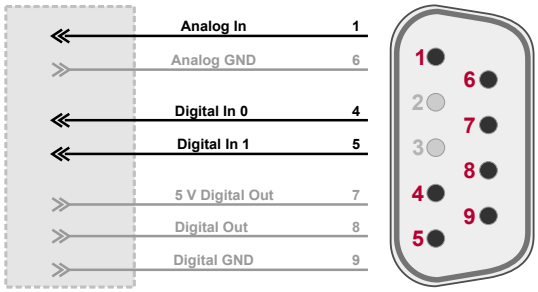


Figure 4: Connectors on the USB side

- **USB**
  Connect your PC and the VN4610 over USB to install and to use the device with measurement applications (CANoe, CANalyzer). Use the USB 2.0 compliant cable found in the delivery (USB extension cables may generate faults between the PC and the device). Connect the device directly to a USB port at your PC or use a USB hub with its own power supply (self-powered).

- **D-SUB9 (CH6)**
  The VN4610 has a D-SUB9 connector for dedicated digital input/output tasks. The pin assignment is as follows:

Pin	Assignment
1	Analog input
2	Not connected
3	Not connected
4	Digital input 0
5	Digital input 1
6	Analog GND
7	5 V digital output
8	Digital output
9	Digital GND



Internal interconnection of digital input 0/1

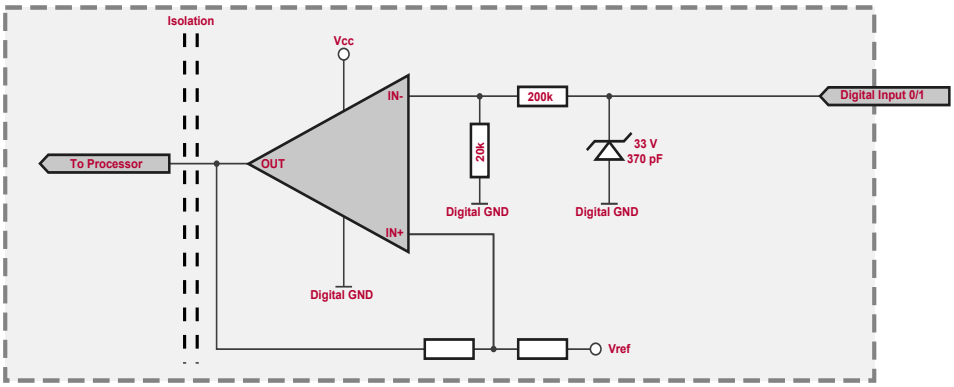


Figure 5: Digital input 0/1

Internal interconnection of digital output

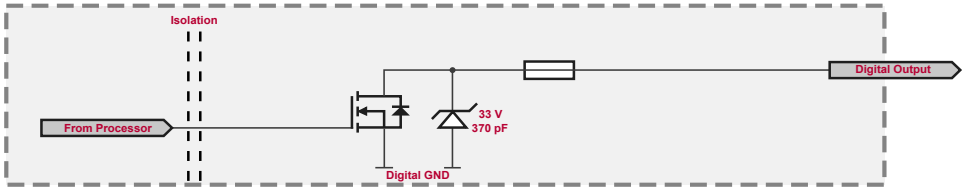


Figure 6: Digital output

Internal interconnection of analog input

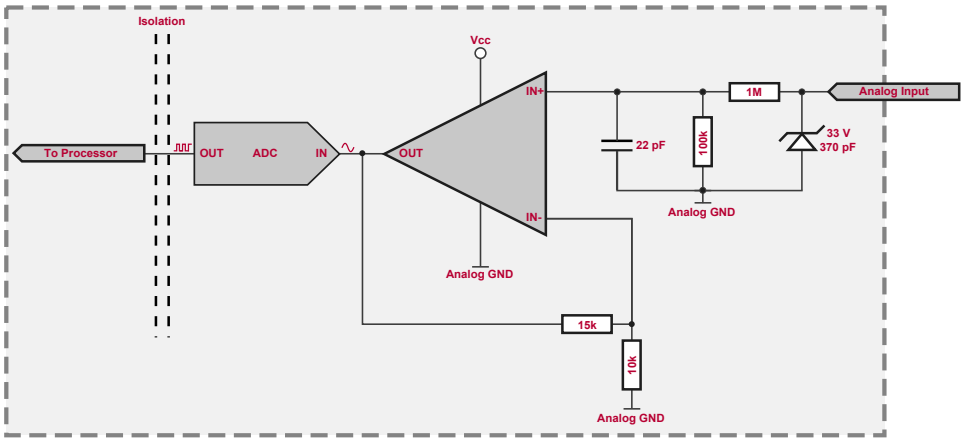


Figure 7: Analog input

Internal interconnection of 5 V digital output

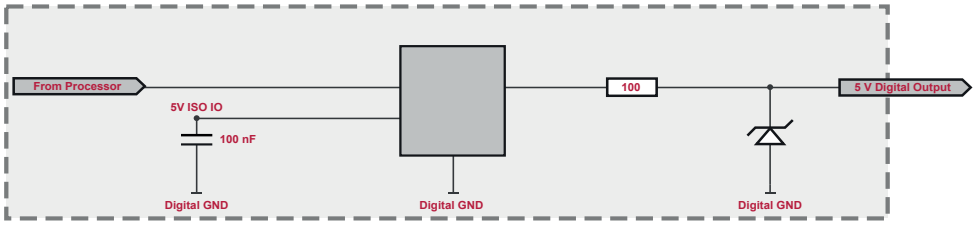


Figure 8: 5 V digital output

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 input voltage U_{input} 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:

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

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)

- **Ethernet (RJ45)**
  Connect your PC and the VN4610 via this Ethernet port to install the device and use it together with measurement applications (CANoe, CANalyzer).

- **Power/Sync (Binder connector)**
  The VN4610 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 35) or for power. It does not matter which connector is used to supply the device. For proper operation of the VN4610, an external power supply is required.

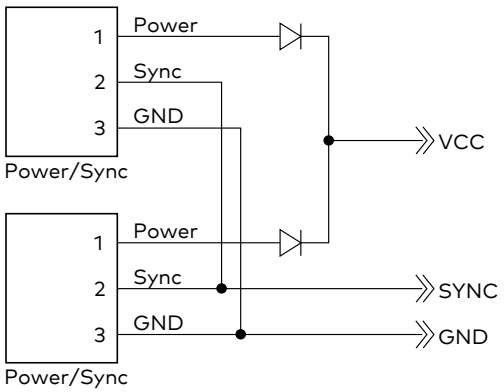


Figure 9: Internal wiring of the power/sync connector

Pin	Assignment
1	Power supply (typ. 12 V)
2	Synchronization line
3	Ground

4.3 LEDs

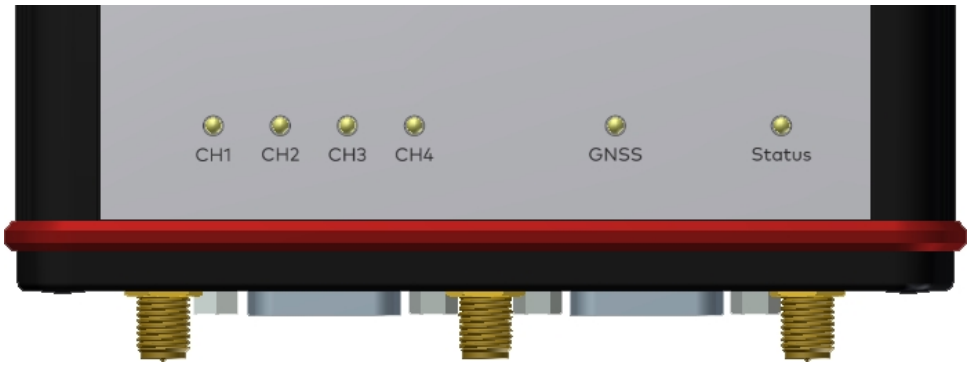


Figure 10: LEDs of the VN4610

- **CH1/CH2**
  Multicolored channel LEDs indicating the WiFi activity.

Color	Description
Green	Data frames have been sent or receicved correctly.
Red	Transmission errors during sending or receiving.

WiFi: The flashing frequency depends on the bus load.

- **CH3/CH4**
  Multicolored channel LED indicating the bus activity.

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

CAN: The flashing frequency depends on the bus load.

- **GNSS**
  Multicolored channel LED indicating the GNSS activity.

Color	Description
Green	▶ On: SAT fix within the specified accuracy settings achieved. ▶ Flashing: SAT fix without reaching the specified accuracy settings.
Red	▶ On: No Satellite signal. ▶ Flashing: Satellite signal too weak.

- **Status**
  Multicolored channel LED indicating the status..

Color	Description
Green	Device is ready for operation/running measurement.
Orange	Initializing driver. Please wait.
Red	Error. Device not working.

4.4 Technical Data

802.11p channels	NXP SAF5100 depending on modulation type up to 27 Mbit/s
GNSS channel	uBlox NEO-M8U, supports GPS, GLONASS, Beidou, Galileo; up to 3 systems at the same time
CAN/CAN FD channel	2x NXP TJA1057G CAN up to 2 Mbit/s. CAN FD up to 8 Mbit/s.
Ethernet channel	IEEE 100BASE-TX/1000Base-T
Analog input	10 bit Input 0 V...18 V (Ri = 1.1 MΩ) Voltage tolerance up to 30 V
Digital input	Range 0 V...32 V Schmitt trigger high 2.8 V, low 2.3 V Input frequencies up to 1 kHz
Digital output	Open Drain External supply up to 32 V Output frequency up to 1 kHz Current max. 500 mA Short circuit / over voltage protected
5 V digital output	5V TTL output signal on D-SUB9 connector, pin 7. GND reference of the signal is digital GND on pin 9.
Time stamps	Accuracy (within one device): 1 µs Accuracy software sync: typ. 50 µs Accuracy hardware sync: typ. 1 µs
PC interface	USB 2.0 / Ethernet IEEE 100Base-TX/1000Base-T
Time synchronization	PTP according to IEEE1588-2008 standard
Average response time	250 µs
Input voltage	6 V … 50 V DC
Power consumption	Approx. 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. 111 mm x 157 mm x 45 mm without antennas
Weight	Approx. 610 g
Housing	Robust aluminium housing
Operating system requirements	Windows 7 SP1 (32 bit / 64 bit) Windows 8.1 (32 bit / 64 bit) Windows 10 (64 bit)

5 Getting Started

In this chapter you find the following information:

5.1 Driver Installation

Caution!
Do not operate the device without antennas! To avoid physical damage to the device, please attach the provided antennas to the device before operation!

General information

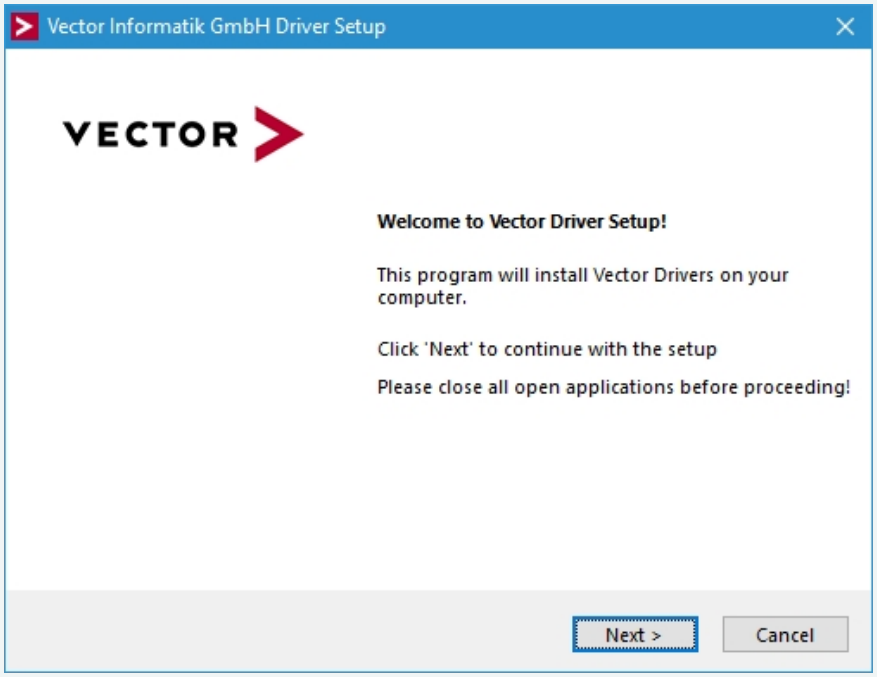
The Vector Driver Disk offers a driver setup which allows the installation or the removal of Vector devices.

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

Step by Step Procedure

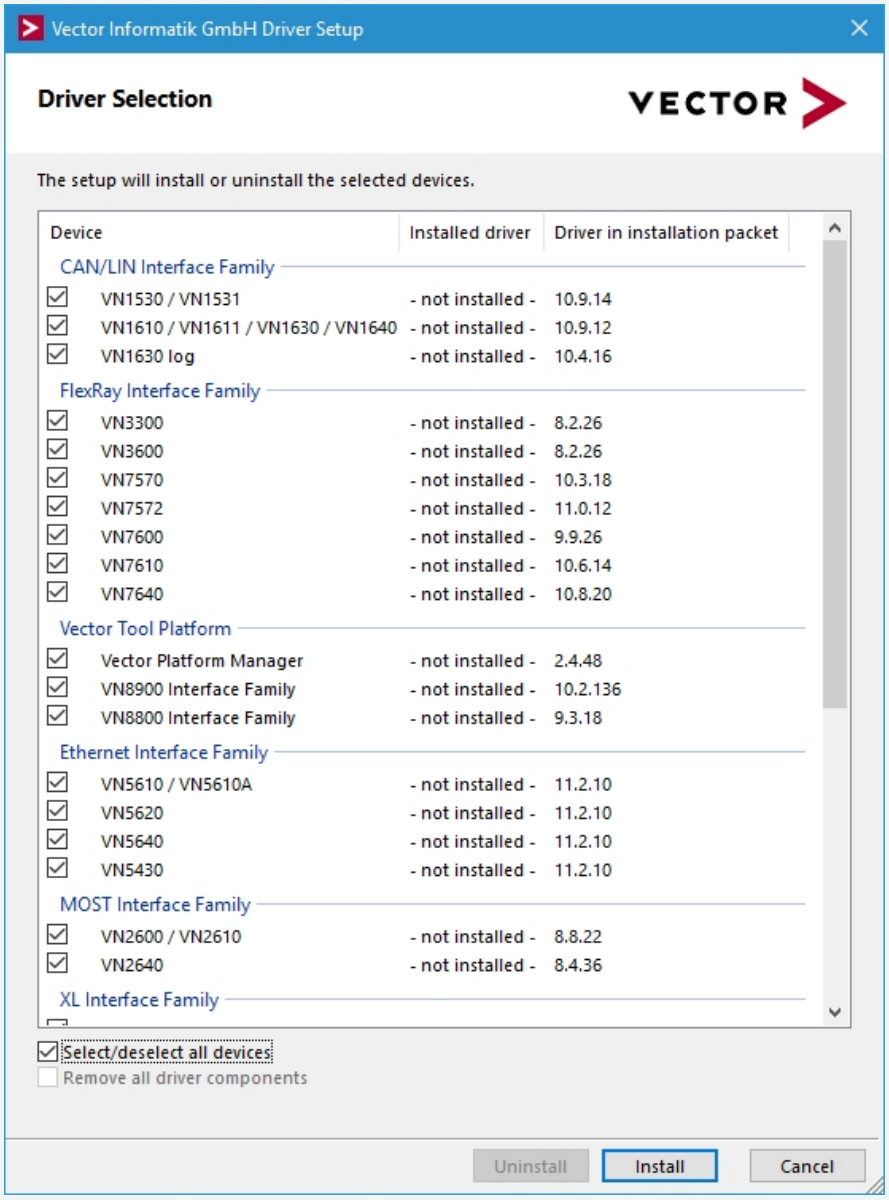
1. Execute the driver setup from the autostart menu or directly from `\Drivers\Setup.exe` before the device is connected to the PC with the included USB cable.

   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).

5.2 Loop Tests

Operation test

The test described here can be performed to check the functional integrity of the driver and the device. This test is identical for Windows 7 / Windows 8.1 / Windows 10 and independent of the used application.

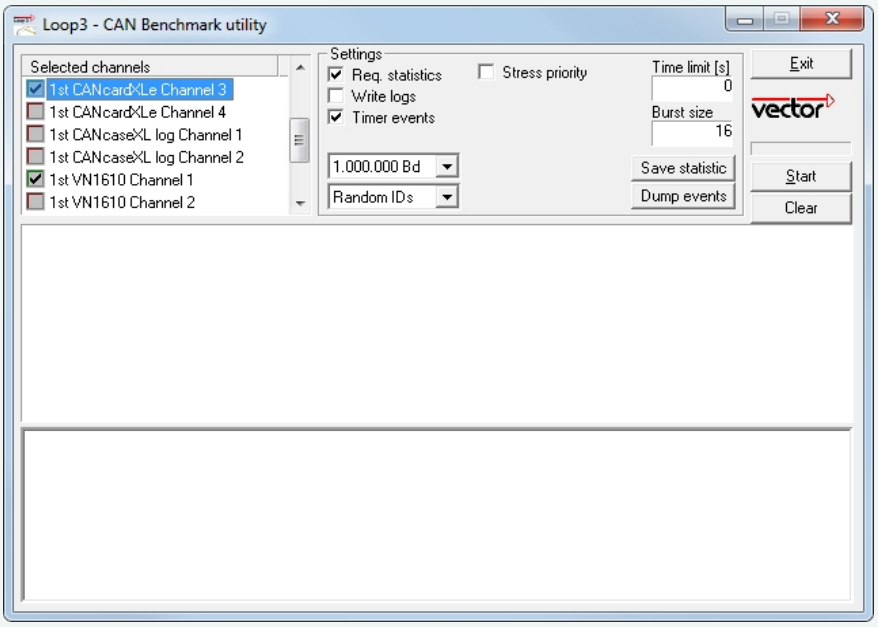
5.2.1 CAN

Device test

The operating test for CAN requires either two high-speed or two low-speed transceivers and can be executed as follows:

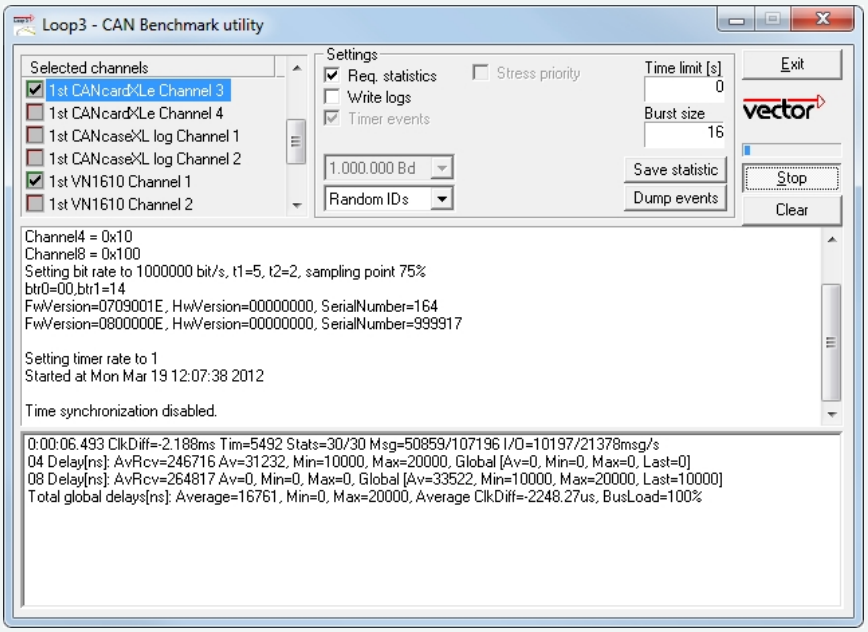
Step by Step Procedure

1. Connect two CAN channels with a suitable cable.
   If two high-speed transceivers are being used, we recommend our **CANcable1** (**CANcable0** for low-speed transceivers).
2. Start `\Drivers\Common\Loop3.exe` from the Vector Driver Disk.
   This program accesses the Vector devices and transmits CAN messages.

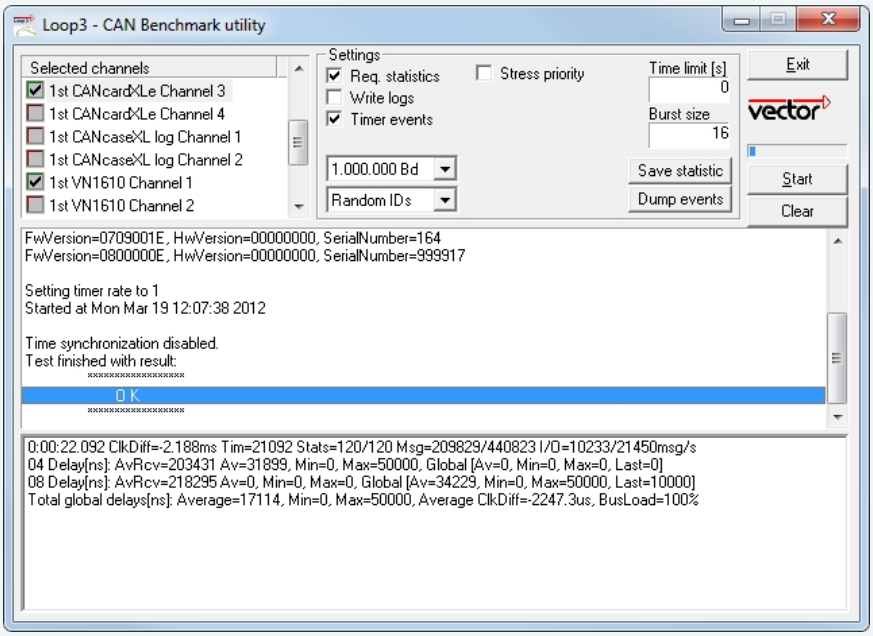


3. Select the connected CAN channels of the device(s) to be tested.

4. Set the appropriate baudrate depending on the transceiver being used (high-speed max. 1,000,000 Bd, low-speed max. 125,000 Bd).
5. Click **[Start]**.
6. You will see statistical data in the lower part of the window if the system has been configured properly.



7. The test procedure can be terminated with the **[Stop]** button.
   An **OK** should appear in the upper part of the window.



6 Vector Hardware Configuration

In this chapter you find the following information:

6.1 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.

6.2 Tool Description

6.2.1 Introduction

Vector Hardware Config

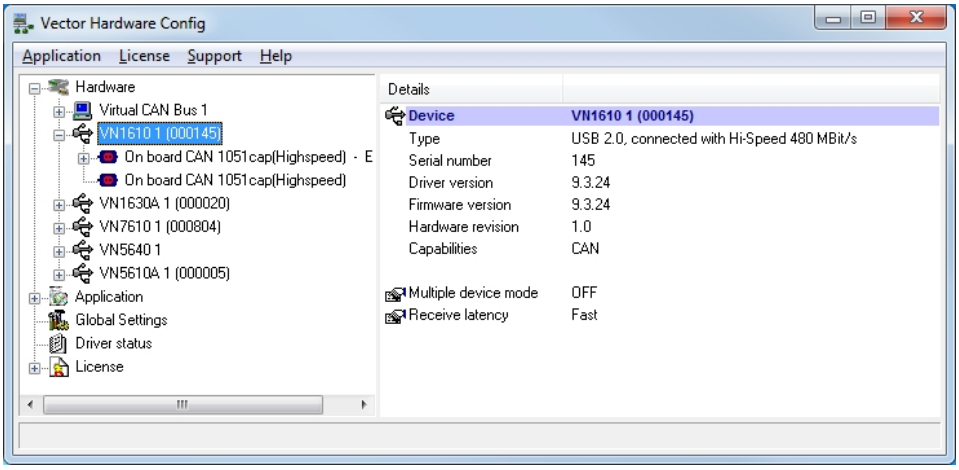


Figure 12: General view of Vector Hardware Config

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.

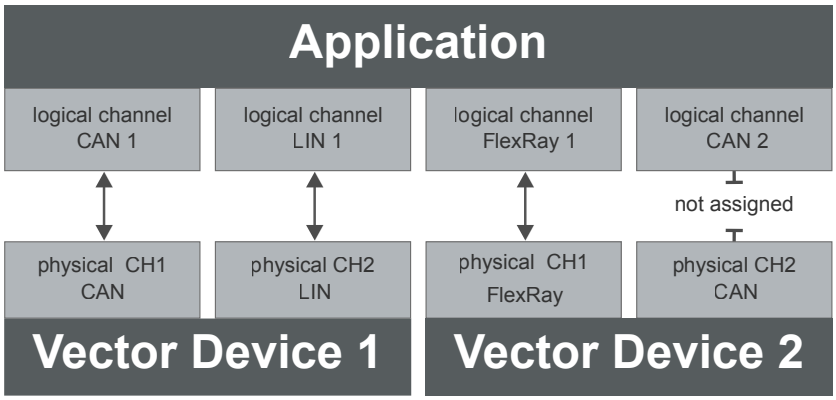


Figure 13: Concept of channel assignments

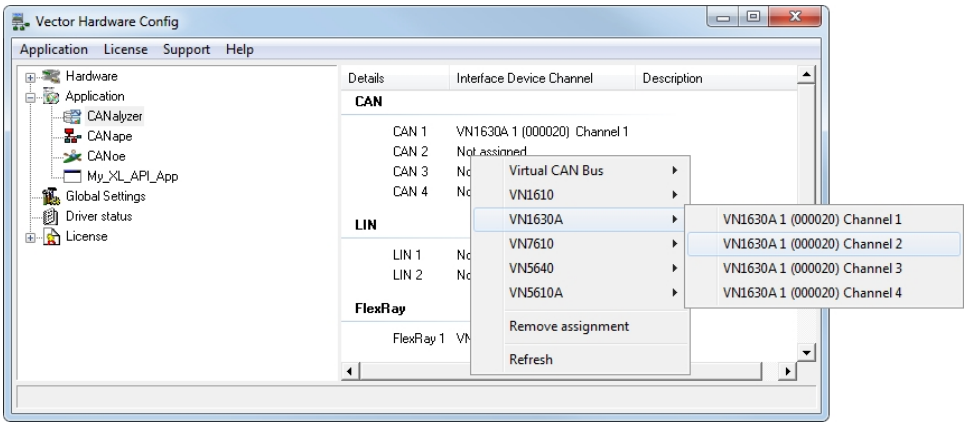


Figure 14: Channel assignment in Vector Hardware Config

6.2.2 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.

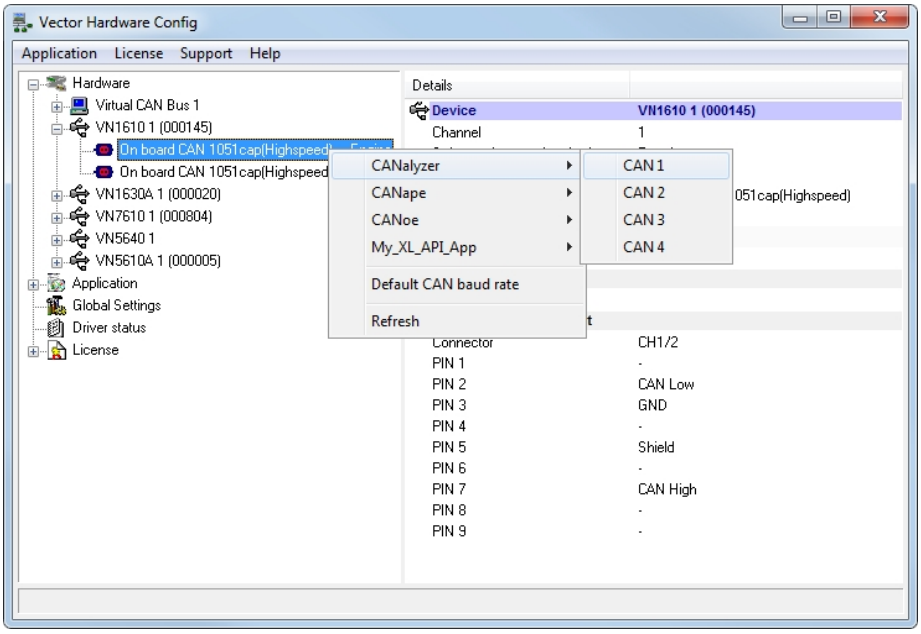


Figure 15: Hardware

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.

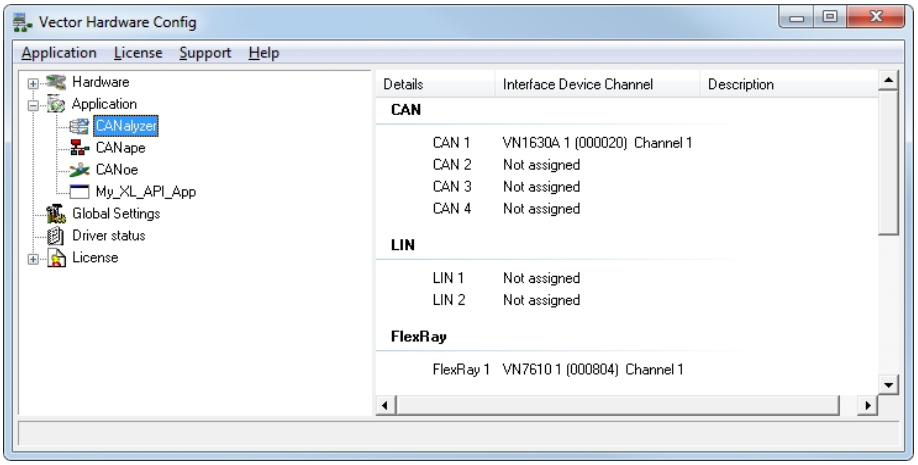


Figure 16: Application

Global settings

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

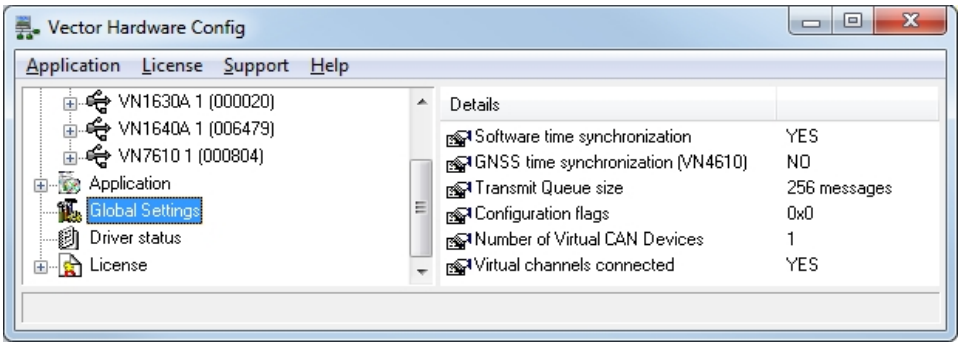


Figure 17: Global settings

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).

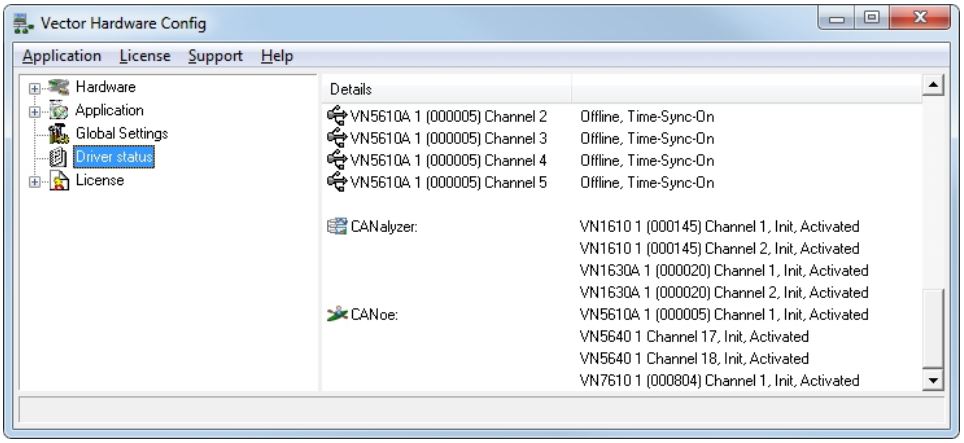


Figure 18: Driver status

License

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

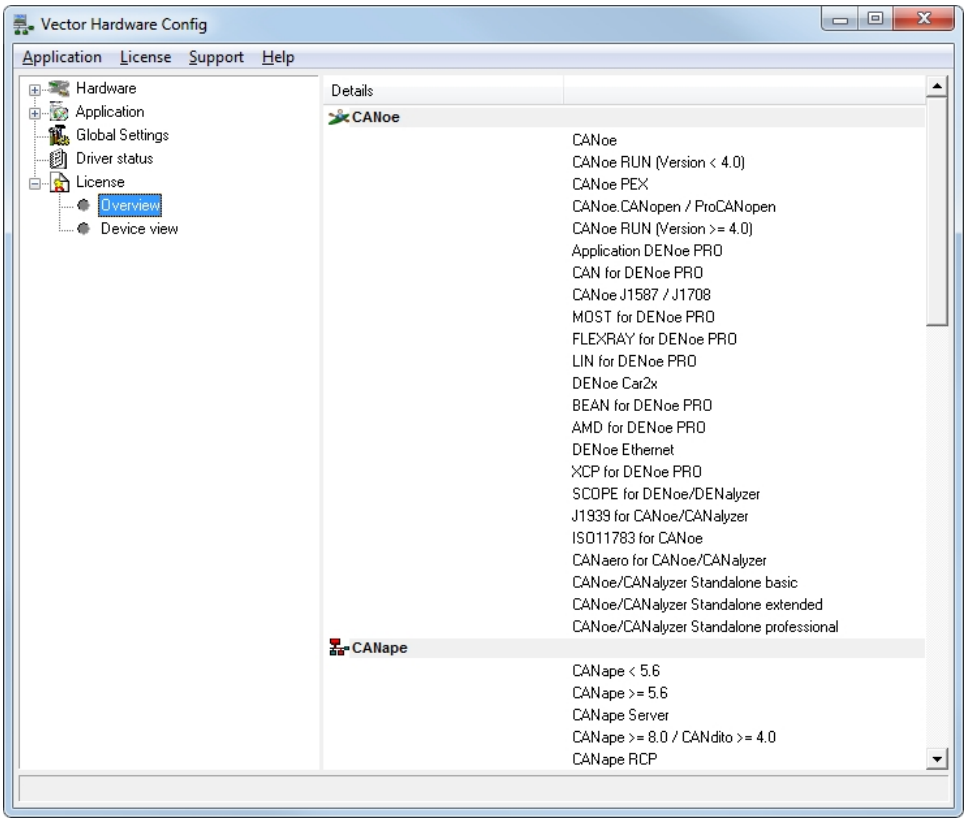


Figure 19: License

Reference

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

7 Time Synchronization

In this chapter you find the following information:

7.1 General Information

Time stamps and events

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

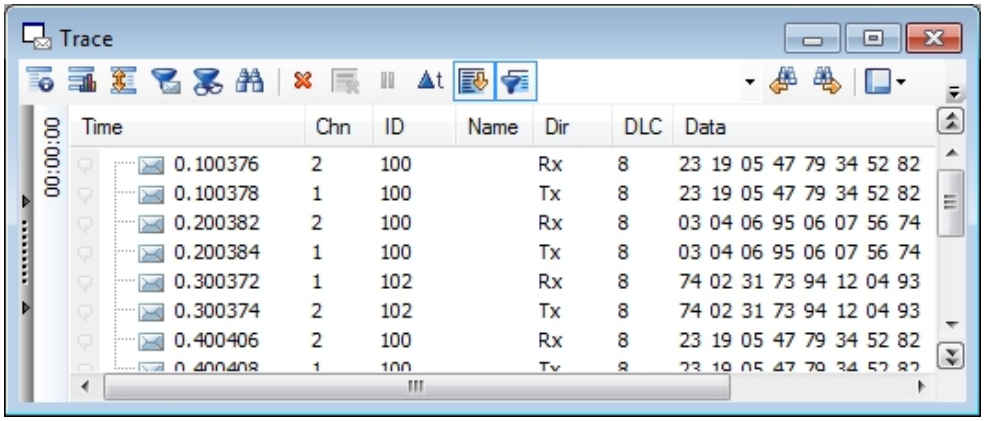


Figure 20: Time stamps of two CAN channels in CANalyzer

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.

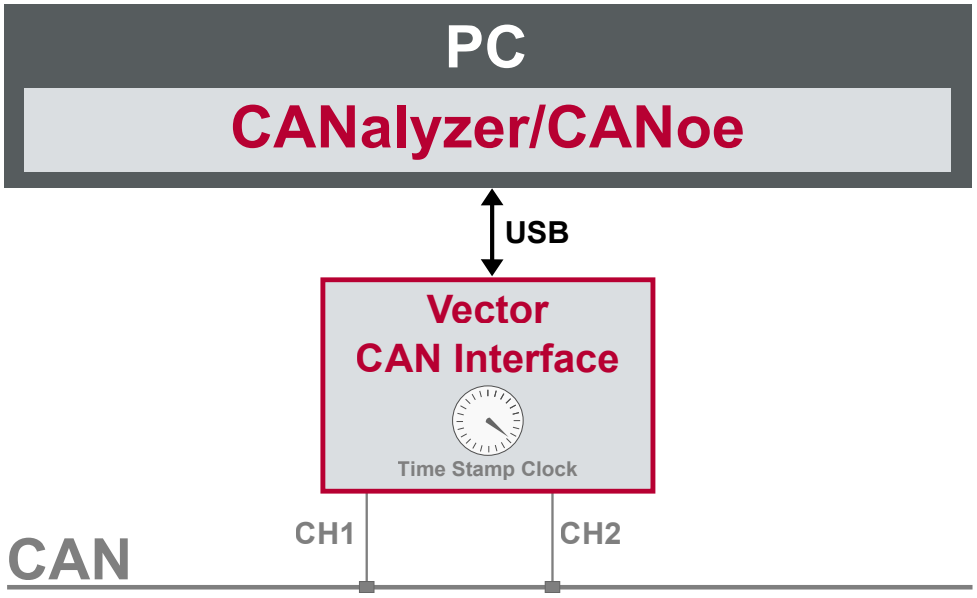


Figure 21: Common time stamp clock for each channel

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.

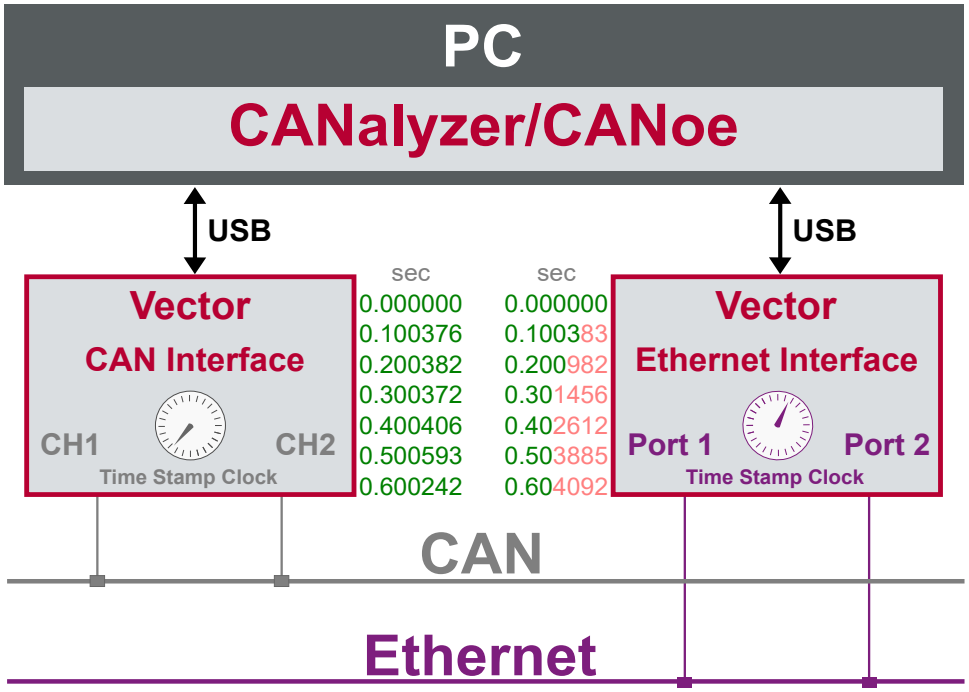


Figure 22: Example of unsynchronized network interfaces. Independent time stamps drift apart

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

Note

The accuracy of the software, hardware, PTP or GNSS sync depends on the interface. Further information on specific values can be found in the technical data of the respective devices.

7.2 Software Sync

7.2.1 General Information

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.

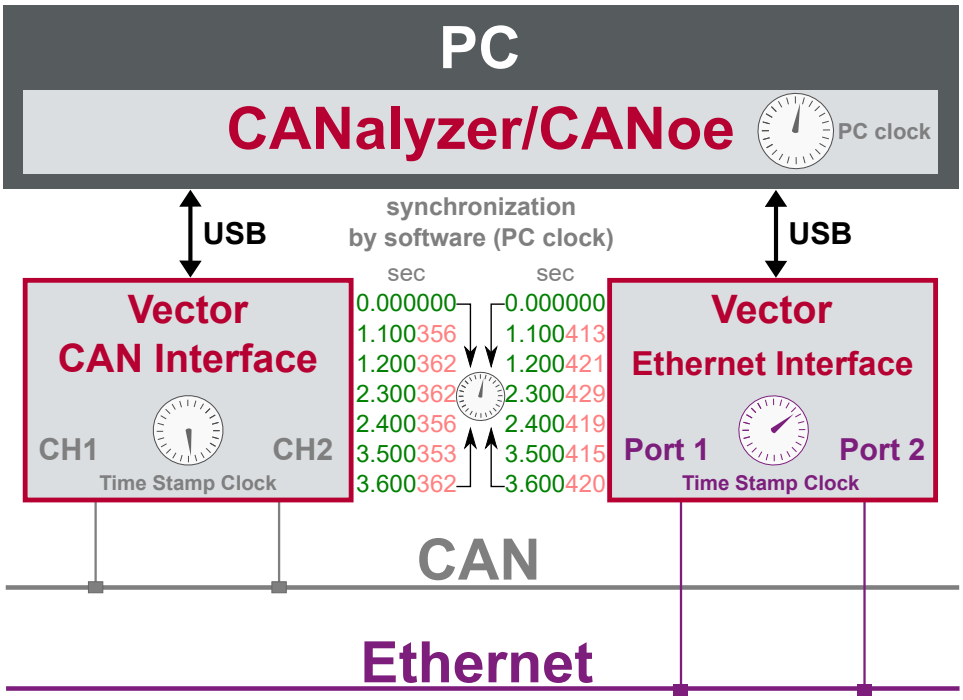


Figure 23: Time stamps of devices are synchronized to the PC clock

Note

Software time synchronization may lead to an increased latency for all connected Vector network interfaces. If a use case requires low latency, deactivate this option and use another synchronization mechanism.

7.2.2 Configuration

Vector Hardware Config

Use the software synchronization if at least one device has no hardware sync connector and to configure all devices to legacy software synchronization.

The setting of the software time synchronization can be changed in the **Vector Hardware Config** tool via a right-clicking on the device and by selecting **Time sync device configuration**.

Software sync modes

In section **Protocol Mode | Software**, select the required mode:

- **Off**
  Synchronization mechanism is turned off.
- **Legacy**
  Device is synchronized to PC performance counter. This setting is compatible with the previous synchronization mechanism **Software time synchronization**. Can be used in conjunction with device drivers older than 11.2.
- **Master**
  Device operates as software synchronization time master.
- **Slave**
  Device operates as software synchronization time slave.

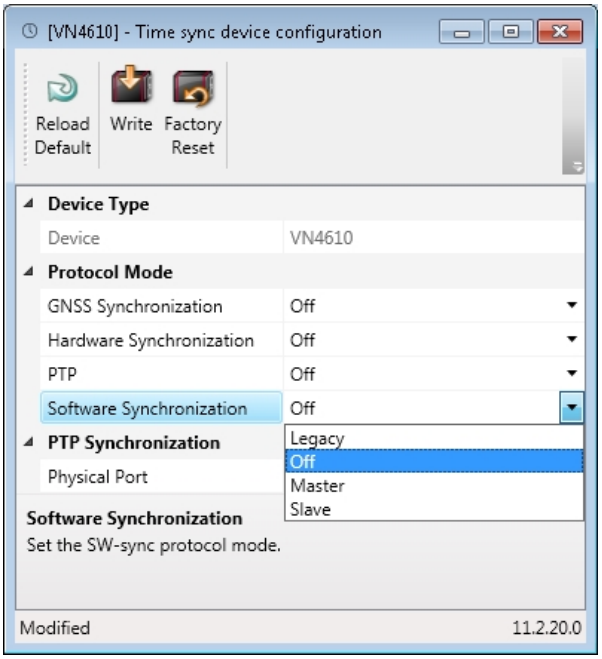


Figure 24: Configuring software synchronization

7.3 Hardware Sync

7.3.1 General Information

Synchronization by hardware

A more accurate time synchronization of multiple devices is provided by the hardware synchronization. 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).

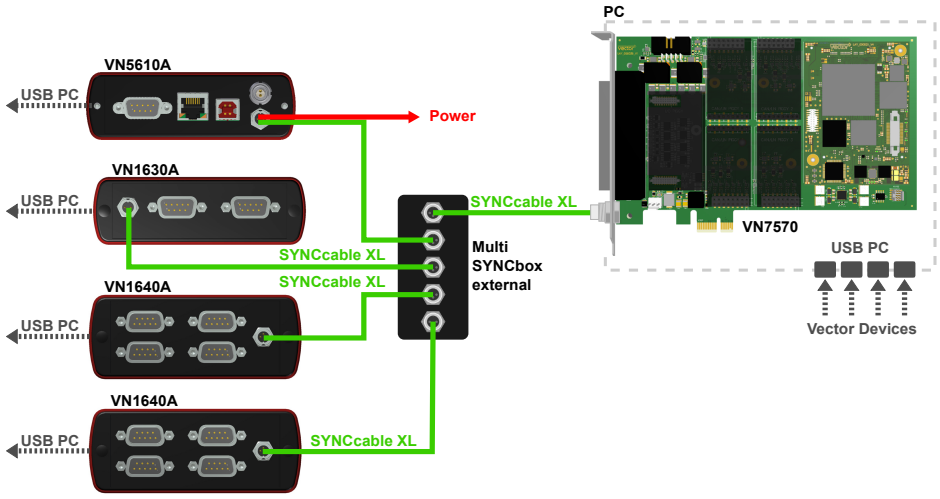


Figure 25: Example of a time synchronization with multiple devices

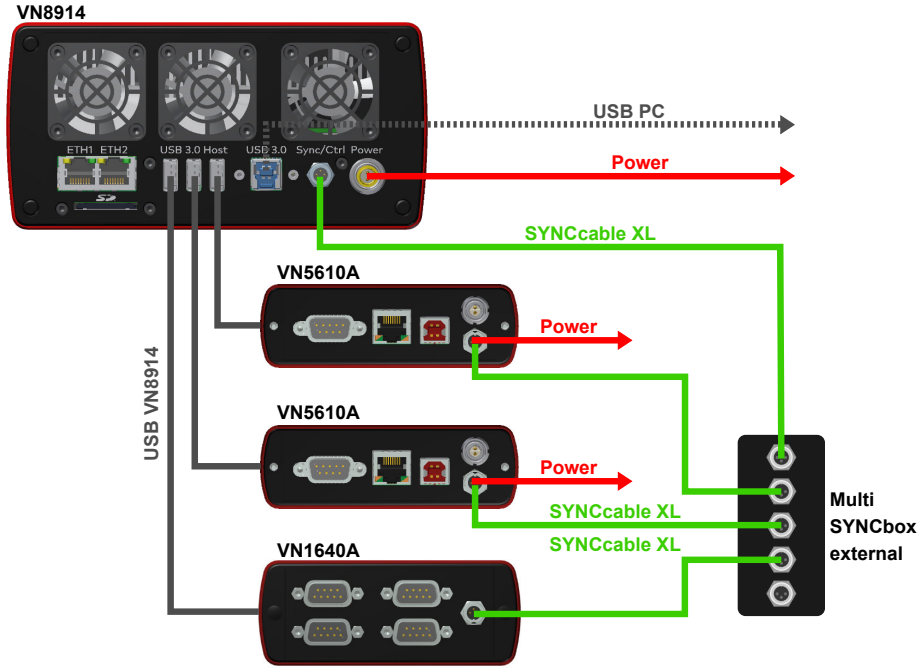


Figure 26: Example of a time synchronization with VN8914 and additional devices

At each falling edge on the sync line which is initiated by the driver, the Vector network interface generates a time stamp that is provided to the driver. This allows the driver to calculate the deviations between the network interfaces and to synchronize

the time stamps to a common time base (master clock) which can be defined by the user.

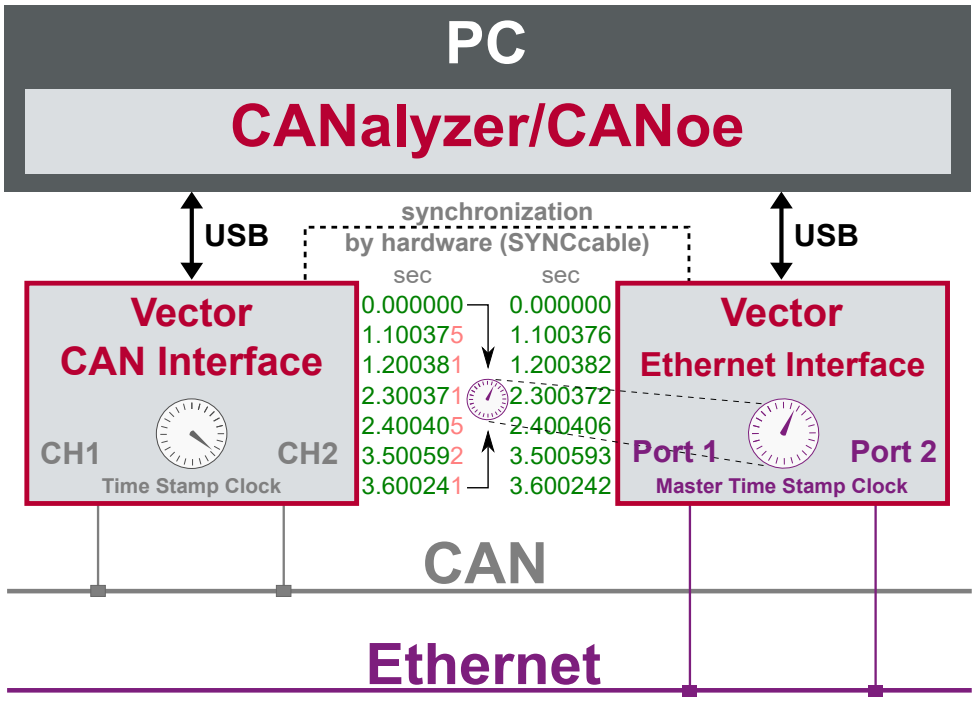


Figure 27: Time stamps are synchronized to the master clock

7.3.2 Configuration

Vector Hardware Config

Use hardware synchronization if at least one device is connected with USB or PCIe to the PC and all devices are hardware sync capable. One device should be configured as master and all other devices as slaves. Therefore, all devices must be interconnected with SYNCcableXL and Multi SYNCbox external or SYNCbox active.

The setting of the hardware time synchronization can be changed in the **Vector Hardware Config** tool via a right-clicking on the device and by selecting **Time sync device configuration**.

Hardware sync modes

In section **Protocol Mode | Hardware**, select the required mode:

- **Off**
  Synchronization mechanism is turned off.
- **Master**
  Device operates as synchronization master, sending sync pulses on the sync line.
- **Slave**
  Device operates as synchronization slave, awaiting sync pulses on the sync line.

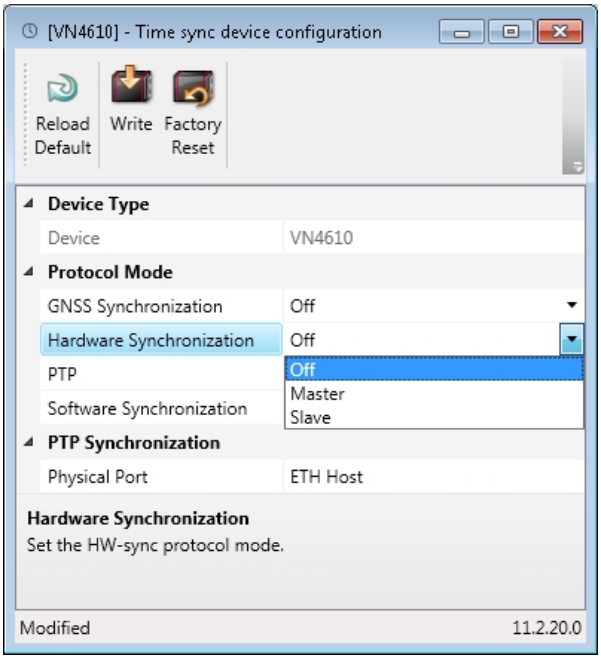


Figure 28: Configuring hardware synchronization

7.4 Precision Time Protocol Sync

7.4.1 General Information

Overview

The Precision Time Protocol (PTP) is a protocol used to synchronize clocks through a computer network. On a local area network, it achieves a synchronization accuracy in the sub-microsecond range, making it suitable for measurement and control systems.

Vector network interfaces support time synchronization with IEEE1588-2008 standard. The following IEEE1588 features are supported.

Note
The PTP feature can only be used on the Ethernet host ports of these devices. Therefore, it can only be used, if the device is connected via Ethernet host port to the PC.

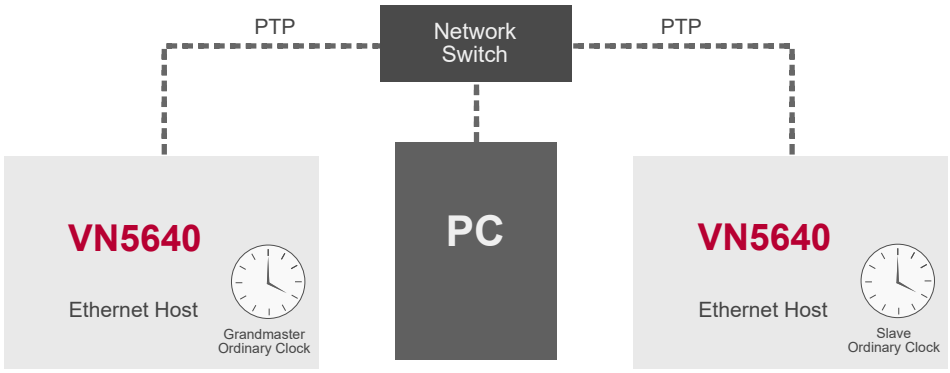


Figure 29: Setup example

7.4.2 Supported Features

IEEE1588 Features	VN Device Support
Clock Types	
Ordinary Clock Master	X
Ordinary Clock Slave	X
Synchronization	
2-step clock	X
E2E	X
BMCA	X
Transport	
PTP over UDP with IPv4	X
PTP over UDP with IPv6	-
Multicast Master/Slave	X
Unicast Master/Slave	-
Synchronization accuracy	
1 µs	X

7.4.3 Network Topology

Network switches

To achieve a maximum accuracy, PTP needs transparent clock support in network equipment. Therefore, a PTP transparent clock capable network switch is strongly suggested.

If no such network switch is available, we have experienced good results with the following network switches. Keep in mind that these switches do not support PTP transparent clocks and thus do not guarantee the promised synchronization accuracy.

- NETGEAR GS108Ev3
- TP-Link TL-SG105
- LogiLink NS0051A2.0
- Cisco SG110D-08

7.4.4 Configuration

Vector Hardware Config

Use the PTP synchronization if all devices are connected via Ethernet host port to the PC and one device is configured as master and all other devices are configured as slaves.

The setting of the PTP synchronization can be changed in the **Vector Hardware Config** tool via a right-clicking on the device and by selecting **Time sync device configuration**.

PTP sync modes

In section **Protocol Mode | PTP**, select the required mode:

- **Off**
  Synchronization mechanism is turned off.
- **Master**
  Device operates as fixed IEEE1588 master.
- **Slave**
  Device operates as fixed IEEE1588 slave.
- **Auto**
  Devices uses the Best Master Clock Algorithm (BMCA) to determine operation mode.

Repeat the steps above to configure each Vector network interface. Keep in mind that only one IEEE1588 Master should be used at the same time and that IEEE1588 Slaves need at least one IEEE1588 Master.

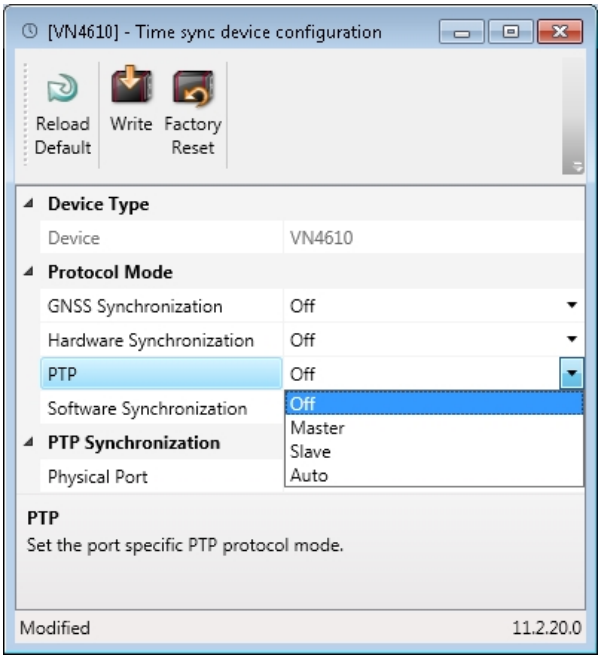


Figure 30: Configuring PTP synchronization

7.5 GNSS Sync

7.5.1 General Information

Synchronization by GNSS

This device supports time synchronization via GNSS, i. e. the internal time stamp clock of the device is synchronized to the GNSS master time.

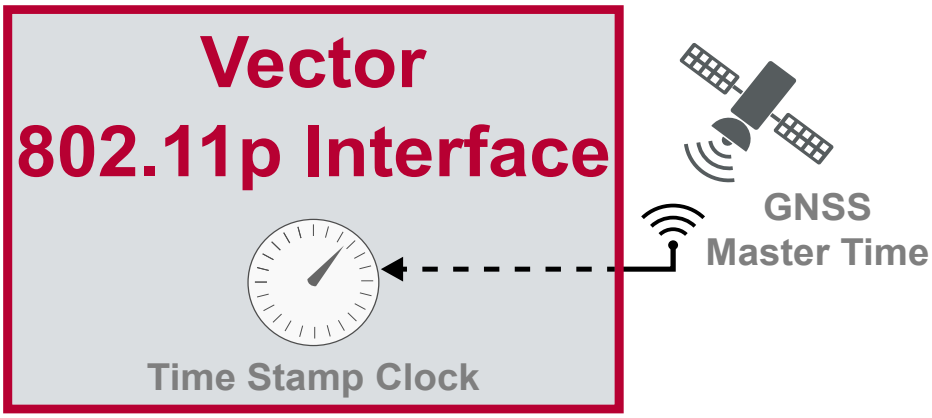


Figure 31: Time stamps are synchronized to GNSS master time

You can use this GNSS synchronization to provide the time to other Vector devices by using PTP time synchronization, hardware time synchronization or software time synchronization. In this case, the GNSS synchronized device has to be configured as time master.

7.5.2 Configuration

Vector Hardware Config

The setting of the GNSS time synchronization can be changed in the **Vector Hardware Config** tool via a right-clicking on the device and by selecting **Time sync device configuration**.

GNSS sync modes

In section **Protocol Mode | GNSS**, select the required mode:

- **Off**
  Synchronization mechanism is turned off.
- **Slave**
  Device synchronizes to GNSS.

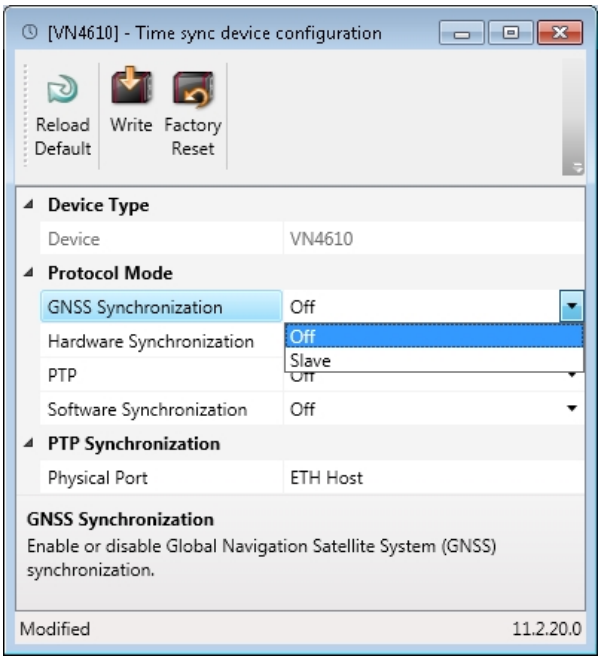


Figure 32: Configuring GNSS synchronization

7.6 Protocol Combinations

General information

All described time synchronization protocols can be combined in several ways to support different use cases. The following example illustrates this in a generic way:

Setup

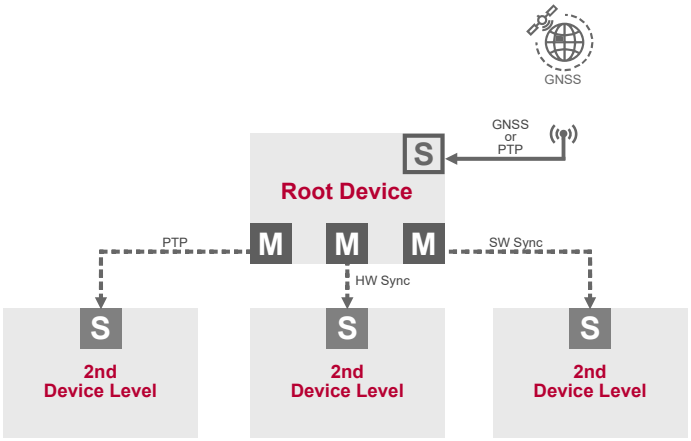


Figure 33: Combination example

Legend

Symbol	Description
S	Active Slave protocol on first device, i. e. protocol which corrects the time on the device.
S	Possible active Slave protocols on second device, i. e. protocol which corrects the time on the device
M	Possible active Master protocol on first device, i. e. protocol which distributes the time to other devices.

Possible combinations

The following table outlines the possible protocol combinations. See legend above. For example, if the first device is synced to GNSS the second device can be synced to the same time using PTP synchronization

	Root Device		2nd Device Level
Sync Role	**Slave**	**Master**	**Slave**
Time Synchronization Protocol	None		Hardware Sync
			Software Sync
			PTP
	GNSS		Hardware Sync
			Software Sync
			PTP
	PTP *		Hardware Sync
	HW Sync		Software Sync
	SW Sync		-

* with external master or Vector device

Note
Only one slave protocol can be active on a device but a device can drive multiple master protocols.

7.7 Use Cases and Configuration Examples

7.7.1 GNSS Synchronization

TAI/UTC time

Synchronizing Vector network interfaces to GNSS (TAI/UTC) time.

Setup

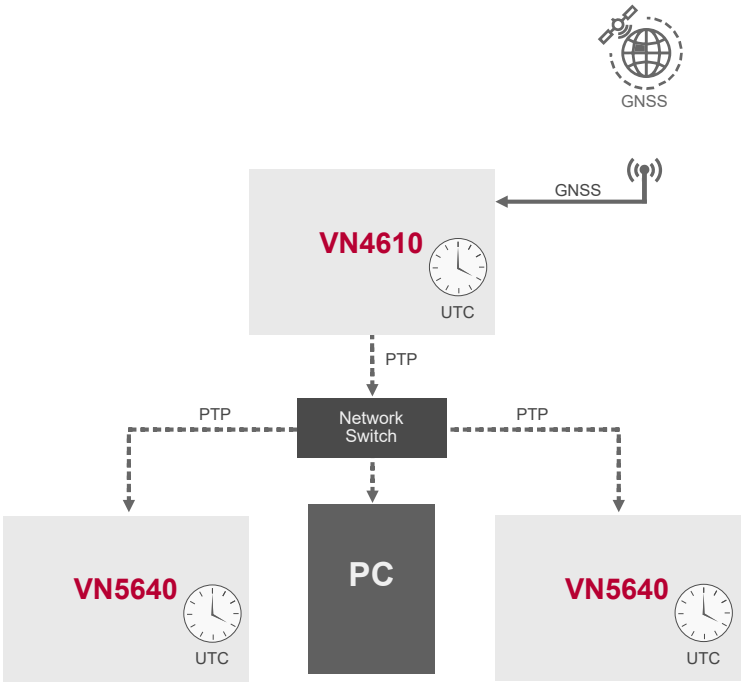


Figure 34: GNSS example

Configuration

In this use-case the devices shall be configured in the following way:

Devices	GNSS	PTP	Software Sync	Hardware Sync
VN4610	Slave	Master	Off	Off
VN5640	Off	Slave	Off	Off

Check the synchronization status of all devices. Configuration shall be ok and all devices shall be In-Sync.

7.7.2 4.2 IEEE1588 Synchronization

PTP master

Synchronizing Vector network interfaces to a PTP master.

Setup

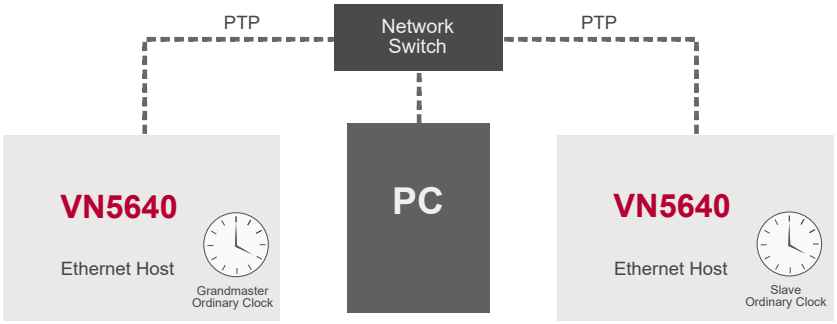


Figure 35: IEEE1588 example

Configuration

In this use-case the devices shall be configured in the following way:

Devices	GNSS	PTP	Software Sync	Hardware Sync
VN5640 (1)	Off	Master	Off	Off
VN5640 (2)	Off	Slave	Off	Off

Check the synchronization status of all devices. Configuration shall be ok and all devices shall be In-Sync.

7.7.3 Hardware Synchronization

Active sync

Synchronizing more than five Vector network interfaces via Multi SYNCbox active.

Setup

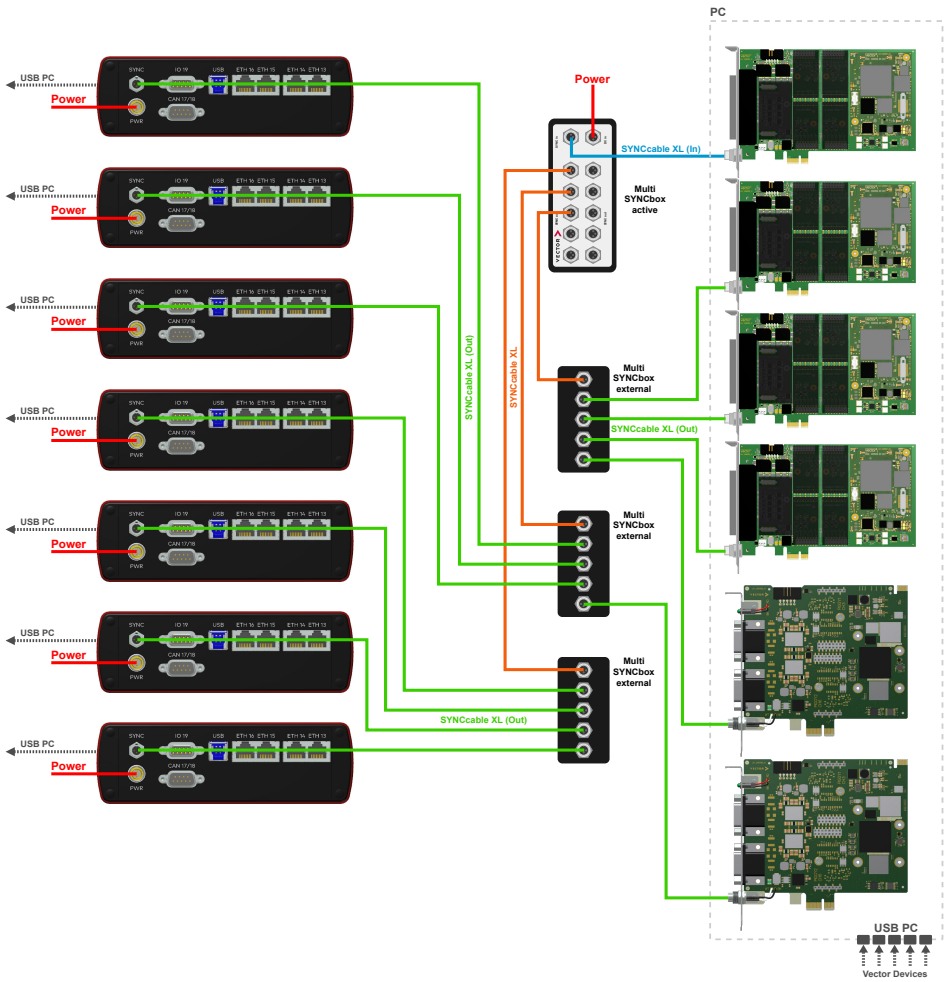


Figure 36: Active sync example

Note

The hardware synchronization topology should be evenly balanced to achieve the best synchronization results. This means all synchronization participants (except the master) shall be interconnected on the same topology level.

Configuration

In this use-case the devices shall be configured in the following way:

Devices	GNSS	PTP	Software Sync	Hardware Sync
VN7572	Off	Off	Off	Master
all others	Off	Off	Off	Slave

Check the synchronization status of all devices. Configuration shall be ok and all devices shall be In-Sync.

7.8 Compatibility

7.8.1 Vector Software

- CANoe 12.0 SP3 or higher
- CANape 18.0 or higher

7.8.2 Device Drivers

- For backwards compatibility, use software synchronization **Legacy** for all devices.
- For devices with driver versions < 11.2, activate **Global Settings | Software time synchronization** in Vector Hardware Config tool.

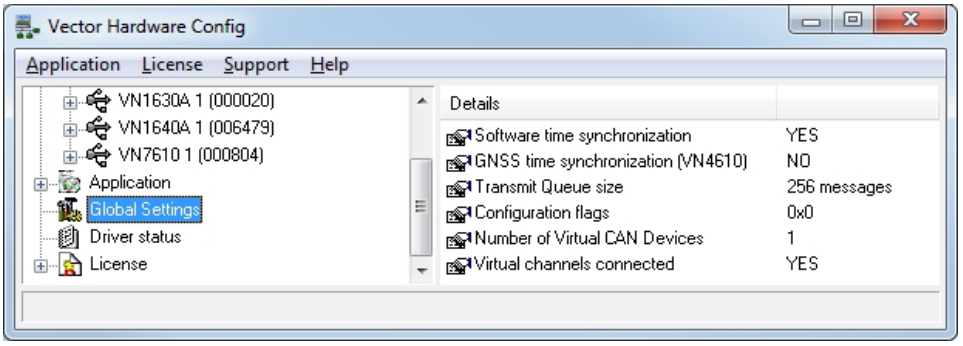


Figure 37: Global settings

Alternatively, disable all synchronization mechanisms and use application hardware synchronization.

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, if application hardware synchronization is used.

7.9 Troubleshooting

Problem	Possible Reason	Solution
Vector Hardware Configuration does not show the context menu to configure timesync on the device.	Old driver.	Update device driver to most recent driver.
Error messages:		
IEEE1588 sync not supported (only with ETH connection)	▶ IEEE1588 Synchronization is only available if the used Host Interface is Ethernet. ▶ A device which uses USB connection for Host Interface cannot be configured for IEEE1588 synchronization (although the Ethernet cable is connected physically in addition to the USB cable).	▶ Disconnect the USB cable from the device. ▶ Connect the Ethernet Host cable to the device. ▶ Power cycle the device. ▶ Use another synchronization protocol if you want to keep the USB Host connection.
Software sync not supported (only with USB connection).	▶ Software synchronization is only available if the host interface used is USB or PCIe. ▶ A device that uses an Ethernet port for the host interface cannot be configured for software synchronization (although the Ethernet cable is physically connected in addition to the USB cable).	▶ Disconnect the Ethernet Host cable from the device. ▶ Connect the USB cable to the device. ▶ Power cycle the device. ▶ Use another synchronization protocol if you want to keep the Ethernet Host connection.
Synchronization cannot be established. Red icon in Vector Hardware Configuration Tool (Status: Out of sync).	▶ Sync cluster not properly configured. ▶ Slave configured but no Master available. ▶ Hw Sync cable not properly connected. ▶ No GNSS satellite signal available (check GNSS LED). ▶ Used Ethernet Switch for IEEE1588 introduces too much jitter.	

8 Ethernet Host Connections

In this chapter you find the following information:

8.1 General Hints

Network switches

It is best to avoid network switches between your Vector network interface and your PC. Best throughput and performance can be achieved by directly connecting your Vector network interface to your PC.

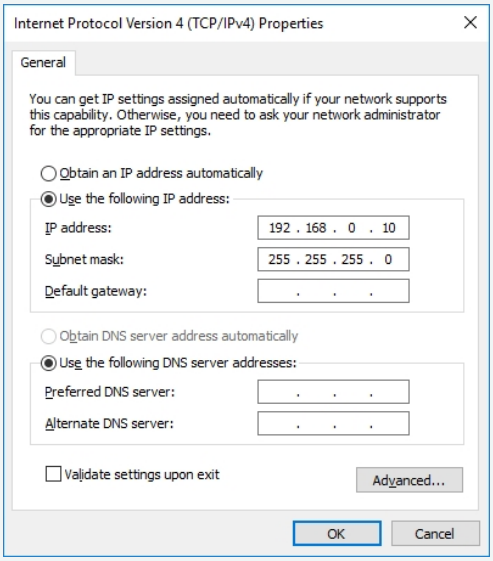
8.2 Getting Started

8.2.1 Connecting the Device

Step by Step Procedure

If you want to connect your device to the PC via Ethernet, the device and the PC have to be configured first.

1. In Windows, first check your TCP/IPv4 settings.



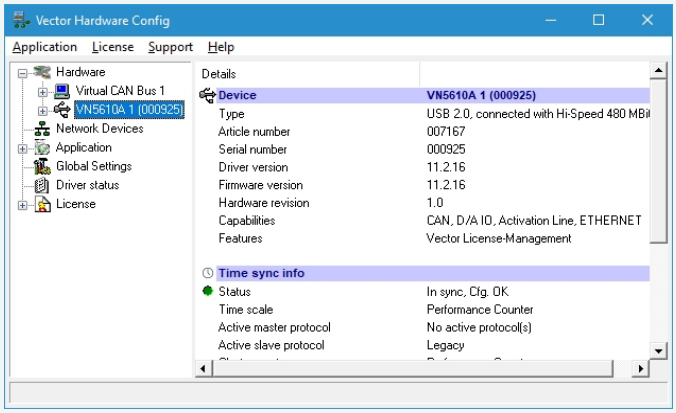
Note

- **Default subnet of device:**
  The devices are initially configured to the subnet 192.168.0.0\24.

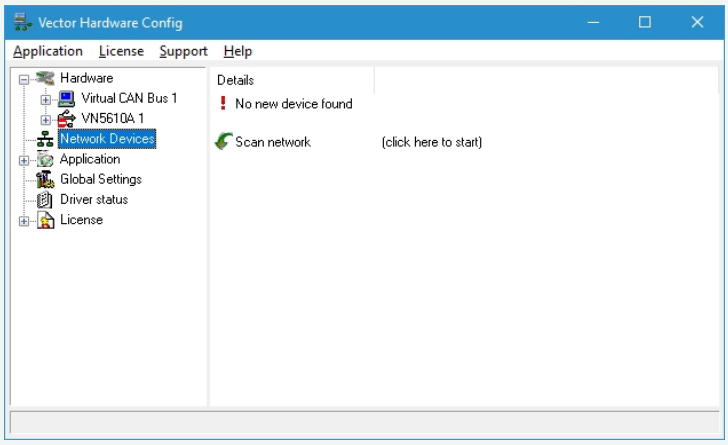
  The default IP address of the devices is 192.168.0.5

- **Firewall settings:**
  The firewall may block the communication. The firewall requires exceptions for the following ports:
  - UDP 42600 (used by Scan network in Vector Hardware Config)
  - TCP 4200, 4201 (necessary for establishing a connection to device)

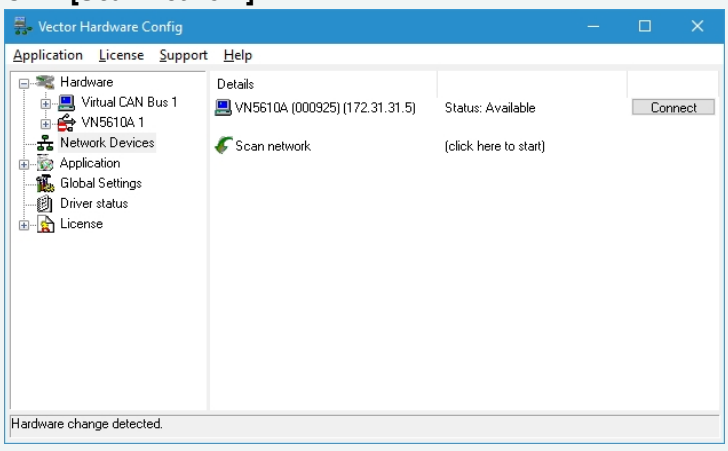
2. Connect the device to your PC via Ethernet. Ensure that no USB cable is connected.
3. Open **Vector Hardware Config**.



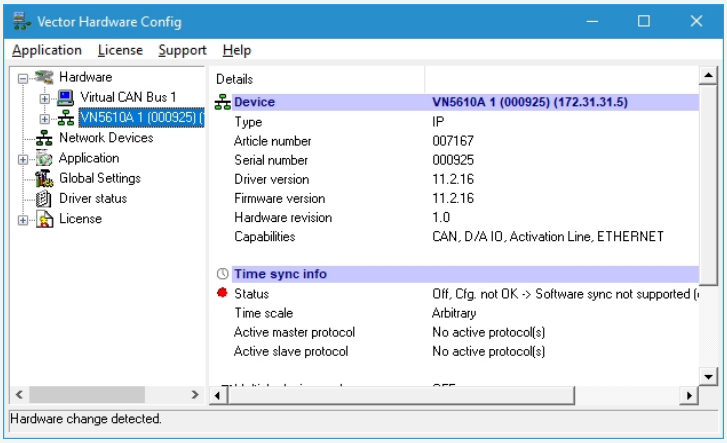
4. Click on **Network Devices**.



5. Click **[Scan network]**. The Ethernet device interface will be listed.



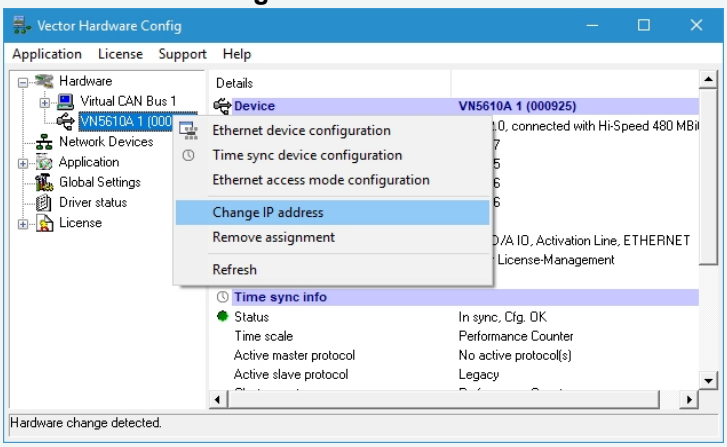
6. Click **[Connect]**. Now, the Ethernet interface is available via your network.



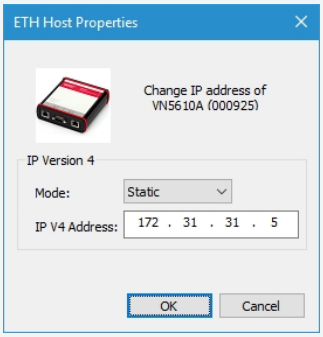
8.2.2 Changing the IP Address

Step by Step Procedure

1. Connect the device to your PC via Ethernet (see section Connecting the Device on page 56) or via USB.
2. In **Vector Hardware Config**, select an installed Ethernet interface with a right-click and select **Change IP address** in the context menu.



3. Enter a suitable IP address according to your network settings and click **[OK]**.



Please follow the extra steps below if your device is connected via USB:

4. Remove the USB cable from your host and the device. Otherwise, the USB connection is always preferred to the Ethernet connection.
5. Connect your host and the device via an Ethernet cable. The device will be listed as not available (red icon).
6. Connect the power supply to your device.

8.3 Windows Network Throttling

8.3.1 Issue

Throttled network traffic

Ethernet network traffic is throttled on Windows PC when running a multimedia application like Windows Media Player or an internet browser. This results in increased latency and less data throughput for Vector network interfaces, connected to the PC via Ethernet.

8.3.2 Solution

Disabling Network Throttling Index

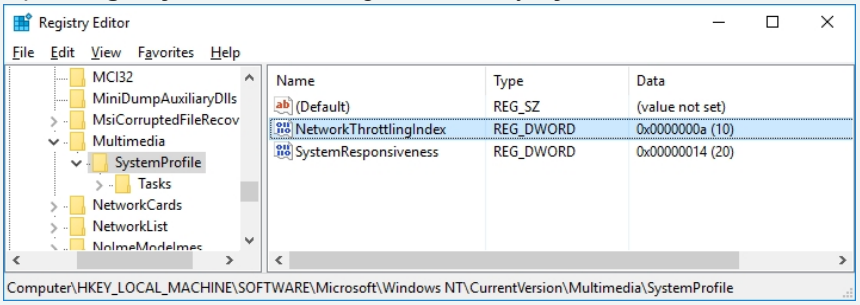
In Windows operating systems, a network throttling mechanism has been existing since 2007 which is activated as soon as the Multimedia Class Scheduler Service is active.

In order to reduce CPU utilization by the network driver, the Network Driver Interface Specification (NDIS) framework passes along a maximum number of packets per milliseconds. This number of packets is defined by the following registry key:

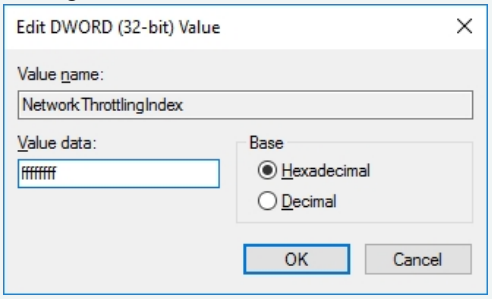
```
HKEY_LOCAL_MACHINE\SOFTWARE\
Microsoft\Windows NT\CurrentVersion\Multimedia\
SystemProfile\NetworkThrottlingIndex
```

Step by Step Procedure
Follow the steps below to disable the Network Throttling Index:

1. Open **Registry Editor** and navigate to the key **SystemProfile**.



2. Change the `Value NetworkThrottlingIndex` to `0xffffffff`.



3. Reboot your PC.

8.4 Jumbo Frames

8.4.1 Issue

Jumbo Frames not supported

For Vector network interfaces connected to a PC via Ethernet, Jumbo Frames must be supported to achieve maximum data throughput.

8.4.2 Solution

Activating Jumbo Frames

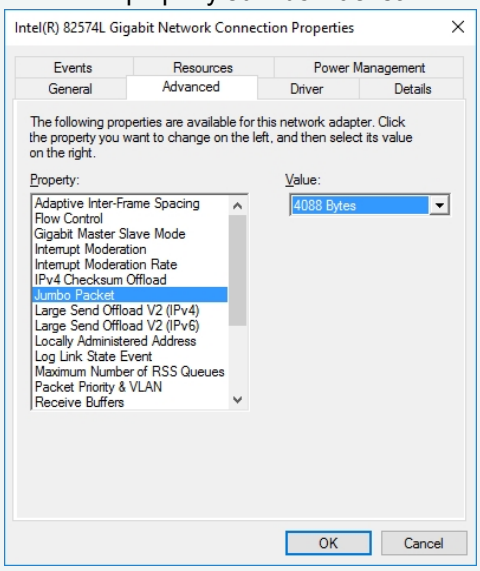
Jumbo Frames allow larger Ethernet frame sizes compared to standard Ethernet frames. Thus more user data can be transferred with a single Jumbo Frame. The data throughput is improved by a smaller proportion of header data relative to the entire packet.

If the data throughput should be maximized, activate Jumbo Frames. This is achieved by directly connecting the Vector network interface to the PC or by using the correct network switches.

Step by Step Procedure

Follow the steps below to enable Jumbo Frames:

1. Open **Device Manager**.
2. In the tree view, open node **Network Adapters**.
3. Select the NIC that is connected to the Vector network interface with a right-lick and select **Properties**.
4. Select tab **Advanced**.
5. Select the property **Jumbo Packet** and choose the highest possible option.



8.5 Interrupt Moderation Rate

8.5.1 Issue

Increased latency

Some network interface cards (NIC) have a property called Interrupt Moderation Rate (IMR). If this property is enabled, the latency is increased while the data throughput is improved.

8.5.2 Solution

Disabling IMR

If latency should be low, disable Interrupt Moderation Rate.

Step by Step Procedure
Follow the steps below to enable Jumbo Frames:

1. Open **Device Manager**.
2. In the tree view, open node **Network Adapters**.
3. Select the NIC that is connected to the Vector network interface with a right-lick and select **Properties**.
4. Select tab **Advanced**.
5. Select the property **Interrupt Moderation Rate** and choose **Disable**.

Note
Depending on the network interface, this option may no be available.

8.6 Known Issues with 3rd Party Hardware

8.6.1 Intel I218 / I219 Network Cards

Issue	Intel I218 and I219 network cards have issues with jumbo frames.
Solution	Disable Jumbo Frames.

VECTOR

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