User manual

Edge Gateway NIOT-E-TIJCX-GB-RE

Passive Operating Mode

V1.1.1

Hilscher Gesellschaft für Systemautomation mbH
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1 Introduction

1.1 About this document

This document describes the usage and configuration of the Edge Gateways in the **passive mode**, i.e. the Edge Gateway receives data on the OT interface and provides the received data for further processing via OPC UA, Node-RED or Docker.

1.2 List of revisions

Revision	Date	Author	Revision
1	2018-04-09	RG	All sections created.

Table 1: List of revisions

2 Passive process data acquisition with the Edge Gateway

This chapter

- compares the concepts of active and passive network diagnosis
- provides an introduction to the concept of the passive test access point
- introduces different circuitry variants with and without a test access point and explains, when to use which one.
- presents the modes of operation of the Edge Gateway and the tool-based configuration of the passive process data acquisition.
- presents various application scenarios (PROFINET, EtherCAT, custom-value filters), for instance in order to adapt to other communication systems or to select special frame characteristics.
- shows how to access to the captured process data within Node-RED or via OPC UA.
- gives hints for improving the performance of analyzing and capturing process data with the Edge Gateway.
- shows other sources of information about the passive process data acquisition with the Edge Gateway

2.1 Introduction

2.1.1 Comparison of active and passive process data acquisition

Besides its usual function which has already been described in detail within the preceding chapters, the Edge Gateway can also be used for passive process data acquisition within the network.

At passive process data acquisition the Edge Gateway "listens" to the data traffic of the connected field network (OT network) and captures it. by using the passive mode, any interference with the field communication is excluded as the Edge Gateway does not actively participate in the data traffic within the field network.

There is a large amount of configuration settings and post processing options which are mostly provided by the tool „Passive Fieldbus Configurator". Configuration settings are provided by the tool „Passive Fieldbus Configurator“.

Post-processing options are provided by Node-RED and OPC Ut.

2.1.2 The Edge Gateway as test access point

A Test Access Point, abbreviated as TAP is an appliance (hardware or software) used for the supervision of the network traffic at a specific position within the network, where data shall be accessed for diagnosis.

Absence of feedback is the most important requirement for a test access point.
The influence of a test access point to the network must be as small as possible.

Due to its special function the Edge Gateway is located at a very central position within the network, i.e. between the Master/Controller and the first Slave/Device of the OT network and as well between the IT and the OT network. Depending on the special application, another installation location might also make sense.

A test access point for passive data acquisition can be implemented on two different ways:

- As Software-TAP
- As Hardware-TAP

A software TAP is fully sufficient for many applications. As shown in the following picture, in passive mode the Edge Gateway supplies such a Software-TAP without requiring any additional devices

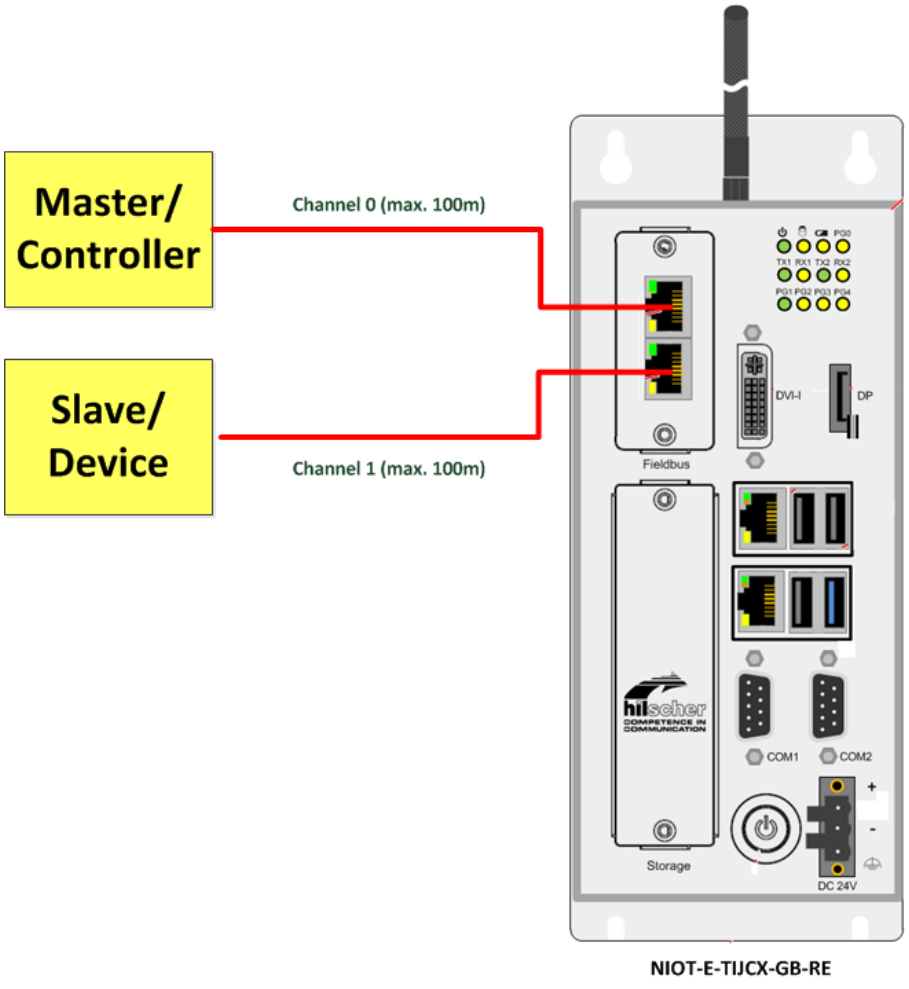


Figure 1: Edge Gateway as Software-TAP

For the solution with Hardware-TAP, an additional device such as the Ethernet mirror TAP netMIRROR NMR-TFE-RE from Hilscher (Part number 7340.100) is required. The following figure explains how to connect the Hardware-TAP with the Edge Gateway:

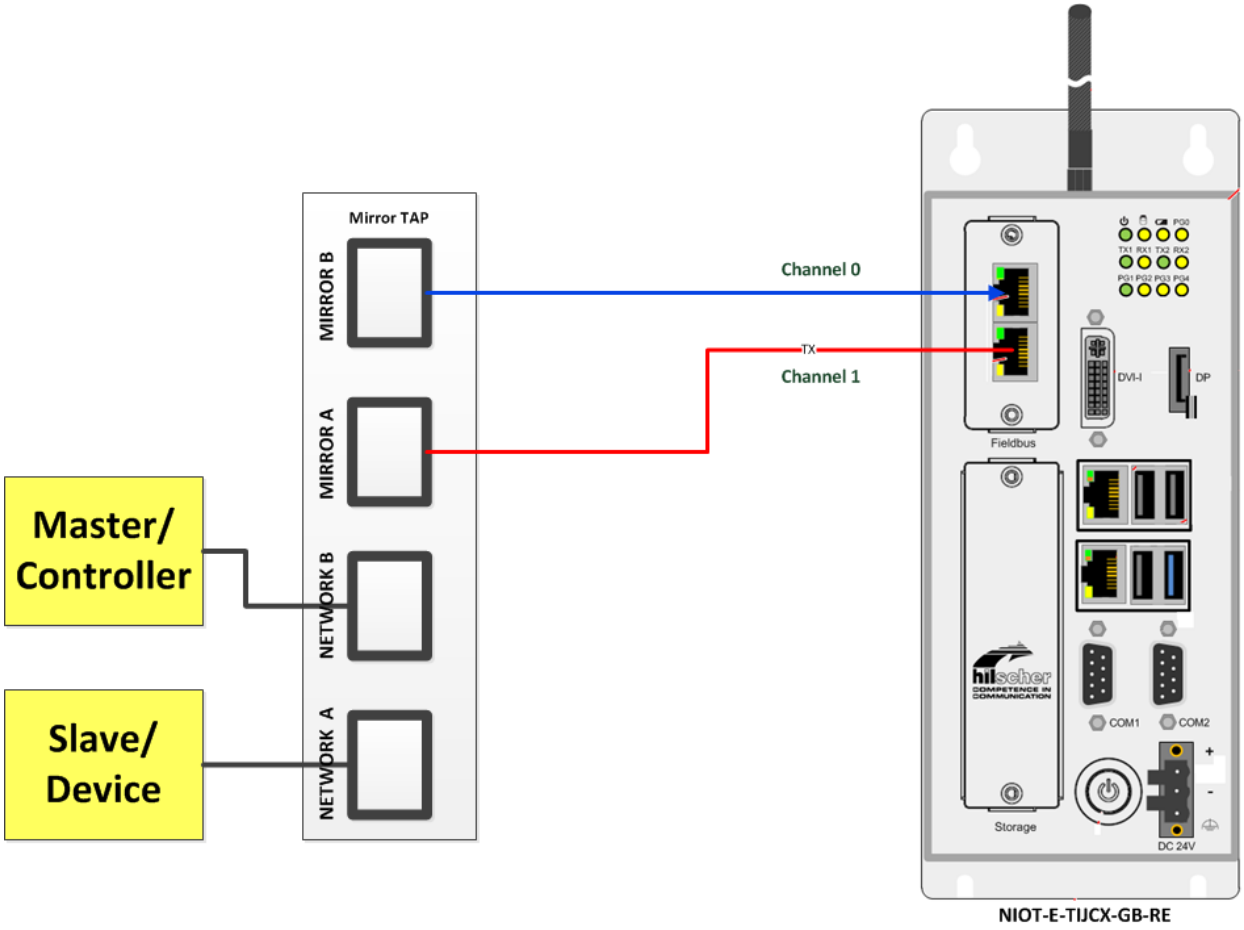


Figure 2: Setup with Hardware-TAP

Note:
More information concerning the Ethernet Mirror TAP netMIRROR NMR-TFE-RE can be found at the Hilscher-Website at https://www.hilscher.com/de/produkte/produktgruppen/analyse-und-datenerfassung/fuer-dauerhafte-installation/nmr-tfe-re/?. Information on how to apply the netMIRROR with the Edge Gateway is available at *Hardware-based TAP (netMIRROR)* [▷ page 11].

Also see about this

- Software-based TAP [▷ 9]
- Hardware-based TAP (netMIRROR) [▷ 11]

2.2 Application scenarios

Depending on aim and conditions of application, there are diffferent wiring scenarios for the Edge Gateway in the passive mode.

- **Software-based TAP:**The Edge Gateway can directly integrated into the OT network without any further devices. Usually, this is done immediatetly behind the master/ Controller. This scenario is described within *Software-based TAP* [page 9].
- **Hardware-TAP:**The Edge Gateway can be applied in conjunction with a hardware TAP, for example at strong demands on time delay or absence of disruption of Master/Slave communication. If uninterrupted operation at switched of state off the Edge Gateway or during parameterization is required, this alternative must be chosen. This scenario is described in *Hardware-based TAP (netMIRROR)* [page 11].
- **Software-based TAP at the mirror port of a switch:**The Edge Gateway can also be used behind he mirror port of a switch. See section *Software-based TAP behind a mirror port* [page 13].

This section should help you to decide which application scenario is best suited for your demands.

2.2.1 Software-based TAP

This section describes the simplest application scenario of the Edge Gateway, namely its use as a purely software-based TAP without use of any additional devices.The following picture explains its principle of operation.

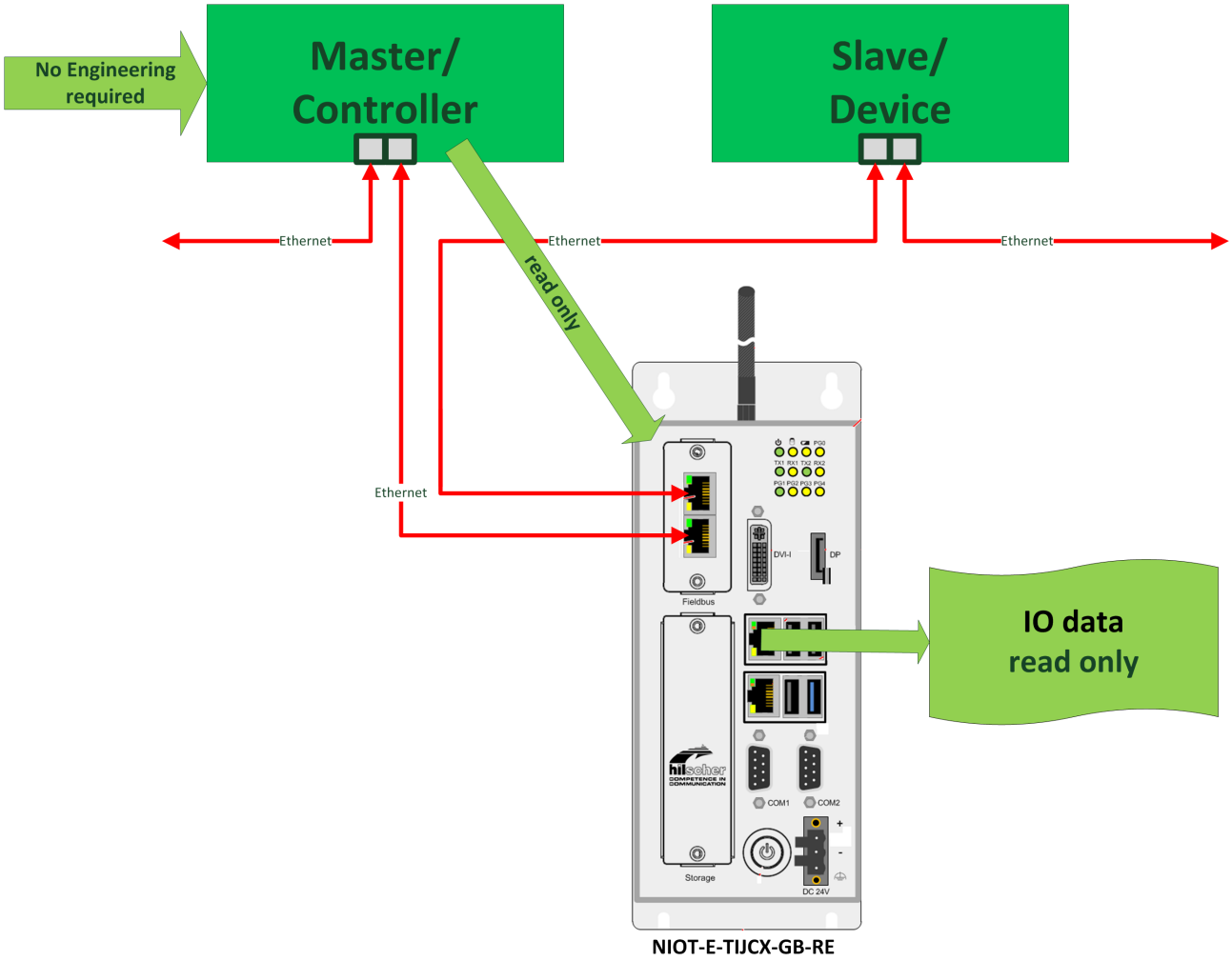


Figure 3: NIOT-E-TIJCX-GB-RE- Passive mode as software TAP

The advantages of this application scenario are:

1. SimplicityThis application scenario offers minimum effort in circuit design .
2. No additional devices required.
   In order to analyze the data traffic between IT and OT network, no additional devices are necessary.
3. Small delay in time of communication in OT network („Fieldbus“). The delay in time of the Ethernet frames caused by the software TAP amounts less than 1 µs. Thus this scenario is suited for non-time-critical applications where a delay in time of such an amount is tolerable.

The following aspects are in disfavor of this application scenario:

1. When switching off or updating the Edge Gateway, the Ethernet connection of the Fieldbus interface is interrupted.
2. Limited suitability for time-critical applications by limited absence of delay: This application scenario is not absolutely free of delay. For strongly time-citical applications, where a delay in time of the scale 1 µs is not tolerable, this scenario is not suited.
3. Short-time link disruption possible when switching between Configuration Mode and Operation Mode.
   Take care of the following hints!

Important notes on the properties of the software TAP

Note:

If the software TAP provided by the Edge Gateway is directly used without connecting a netMIRROR ahead in order to loop through the Ethernet connection, then the Ethernet link can for a short time be lost and established again when either switching between Configuration Mode and Operation Mode or when connecting via the netIOT Edge Passive Fieldbus Configurator Software to the Gateway.

For a short time, the network link is interrupted leading to a short time communication breakdown between the network participants which might cause a restart of your plant as well. This can be avoided by connecting to the Edge Gateway via a hardware TAP.

Note:

The Ethernet connection is interrupted at switching off the Edge Gateway or updating its firmware. For possible consequences see above.

You can avoid all of these disadvantages by connecting via a hardware-based TAP such as the netMIRROR, see next section.

2.2.2 Hardware-based TAP (netMIRROR)

This section describes the application scenario of the Edge Gateway in conjunction with a hardware TAP. The only additional hardware you need is the Ethernet Mirror TAP netMIRROR by Hilscher (Part number 7340.100).

At high demands on interruption-free operation, it makes sense to apply a hardware TAP such as the Ethernet mirror TAP netMIRROR NMR-TFE-RE from Hilscher as short-time link disruption and other back effects from the Edge Gateway to the system are excluded for this application scenario.

If the requirements If the requirements concerning the absence of delay (delay < 1 µs) or reaction of the test access point are very demanding, the use of a hardware TAP such as the Ethernet mirror TAP netMIRROR NMR-TFE-RE from Hilscher (Part number 7340.100) is strongly recommended.the absence of delay (delay < 1 µs) and security (physical data diode) of the test access point are very demanding, the use of a hardware TAP such as the Ethernet mirror TAP netMIRROR NMR-TFE-RE from Hilscher (Part number 7340.100) is strongly recommended.

For this solution, the delay in time amounts approx. 1 ns and is similar to the physically possible minimum delay time.

The following figure illustrates the basic function of this application scenario:

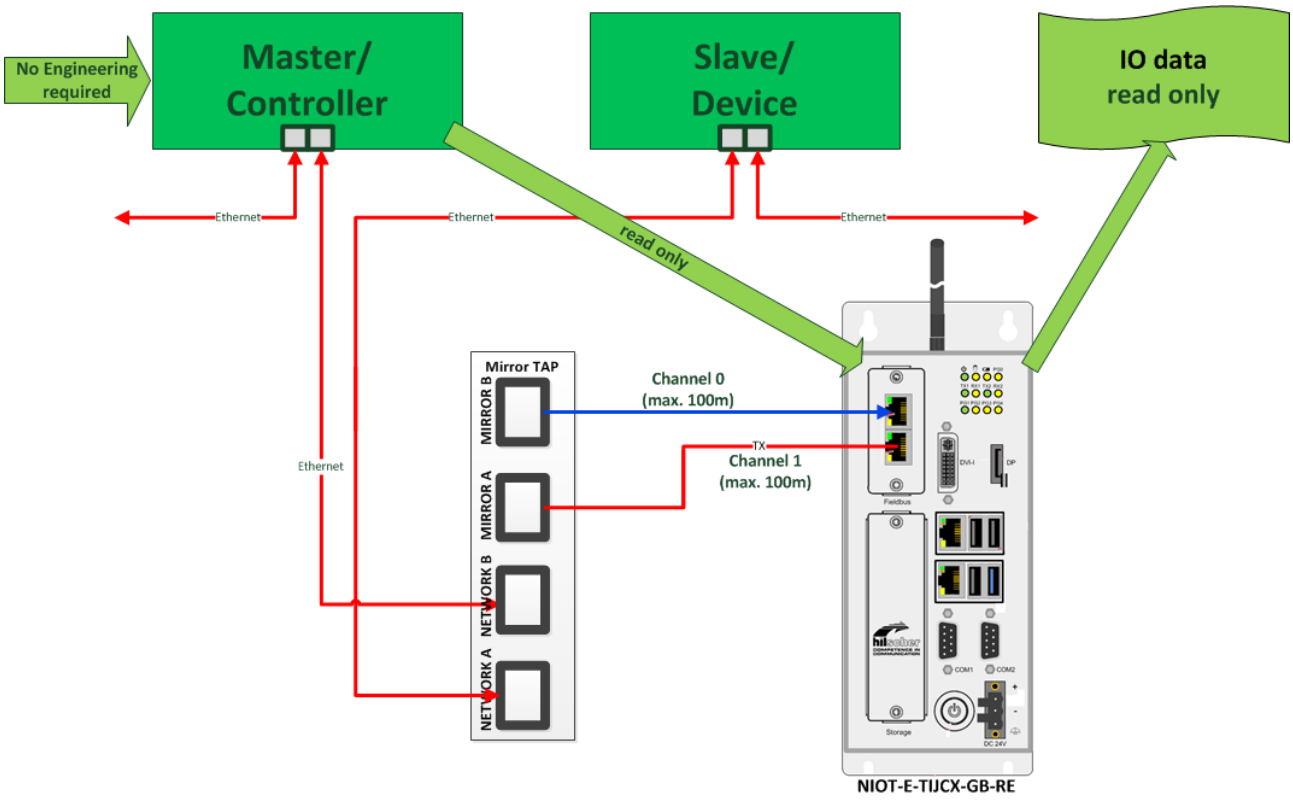


Figure 4: NIOT-E-TIJCX-GB-REwith hardware TAP

The advantages of this application scenario are:

1. Absence of delay:
   The delay in time of the signals which is caused by the hardware TAP amounts roughly in the scale of 1 ns and is thus of the same dimension as the physically caused minimum propagation time delay of the signals (so called „Real-zero delay“). Thus this variant can practically be seen as free of delay.
   So this scenario is also suited for highly time-critical demands.
2. Absence of feedback:
   Under any condition, no unintended or intended intrusion of Ethernet frames will take place. No change occurs within the contents of data packets.
3. No short-time link disruption
   When using a hardware TAP, no problems caused by short-time link disruption may occur like those which might occur within a pure software TAP solution, see *Software-based TAP* [page 10].Especially, switching between configuration and operation mode or changes of the TAP settings of the passive fieldbus will not cause any short-time link disruption.
4. The Ethernet connection is not interrupted at switching off the Edge Gateway or updating its firmware.

Note:
When using the Edge Gateway in the passive mode with hardware-based TAP the speed of the network interface should be adjusted to a fixed value of 100 Mbit/s. This minimizes the link-up time. See Communication settings in the Passive Fieldbus Configurator.

2.2.3 Software-based TAP behind a mirror port

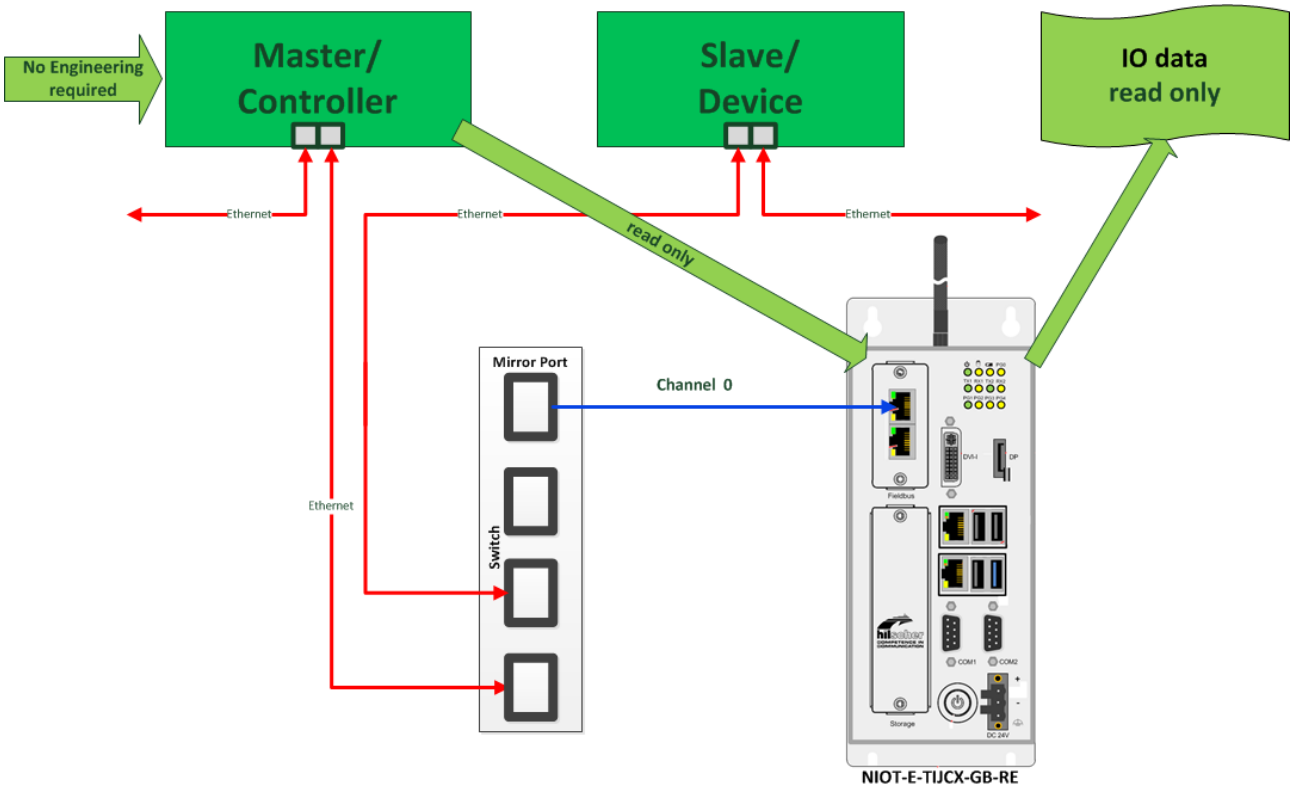


Figure 5: NIOT-E-TIJCX-GB-RE - Passive mode as software TAP at the morror port of a switch

For PROFINET there is another application option by connecting the NIOT-E-TIJCX-GB-RE with the mirror port of a switch. See following figure.

Note:
Do not use this option in conjunction with EtherCAT.

2.3 Configuration for passive mode

This section introduces the basic modes of operation of the Edge Gateway concerning passive process data acquisition and explains the differences between these. Additionally, it shows, how configuration files for passive process data acquisition can be created and then loaded into the Edge Gateway and explains important settings for instance concerning communication and OPC-UA.

2.3.1 Modes of operation

In the following, the basic modes of operation of the Edge Gateway concerning passive process data acquisition are introduced and the differences between these are explained.

- Passive, inactive and active mode of operation
- Properties of the three modes of the passive mode

These can be set using menu entry **Network-Field** of the Control Panel.

2.3.1.1 Operating modes

The mode of operation of the Edge Gateway can be switched within the Control Panel. This is done within menu entry **Field** of the Network menu.

Active mode of operation

In the active mode of operation, the Edge Gateway couples an automation network (OT network) to an external network, a cloud or an IoT application.Within the automation network, the Edge Gateway represents a slave device, i.e. it cyclically exchanges data with a PLC. This slave device **sends and receives process data** over the fieldbus. The PLC program must be adapted accordingly. Another important function of the Edge Gateway is to provide various extensive security mechanisms in order to protect the automation network against attacks from outside.

If the Edge Gateway is in the active mode of operation then menu entry **Network > Field** within the Control Panel is displayed as follows:

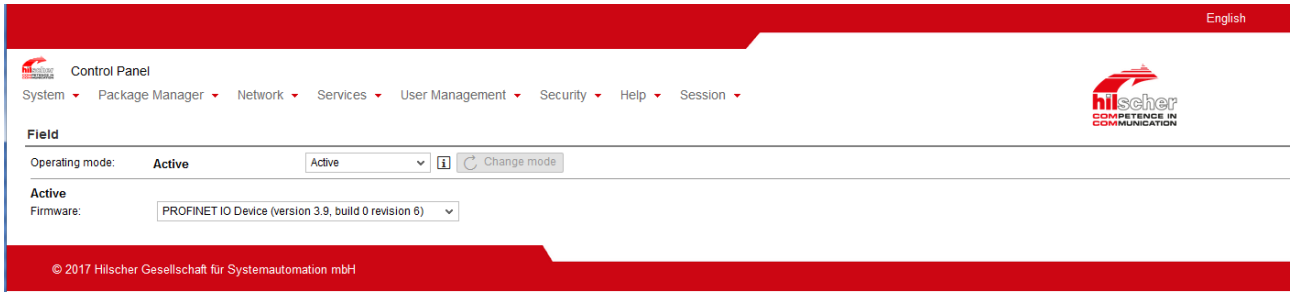


Figure 6: Active mode of operation

Within Node-RED, the fieldbus input node and the fieldbus output node provide a means for coupling the automation network in active mode of operation .

Inactive mode of operation

In the inactive mode of operation, the field interface (Ethernet interface to the automation network (OT network)) is deactivated in both data flow directions, i.e.**neither sending nor reception of data packets** will take place.

The inactive mode of operation is the standard mode of operation of the Edge Gateways (the default mode of operation).

If the Edge Gateway is in the inactive mode of operation, the menu entry **Network > Field** within the Control Panel is displayed as follows:

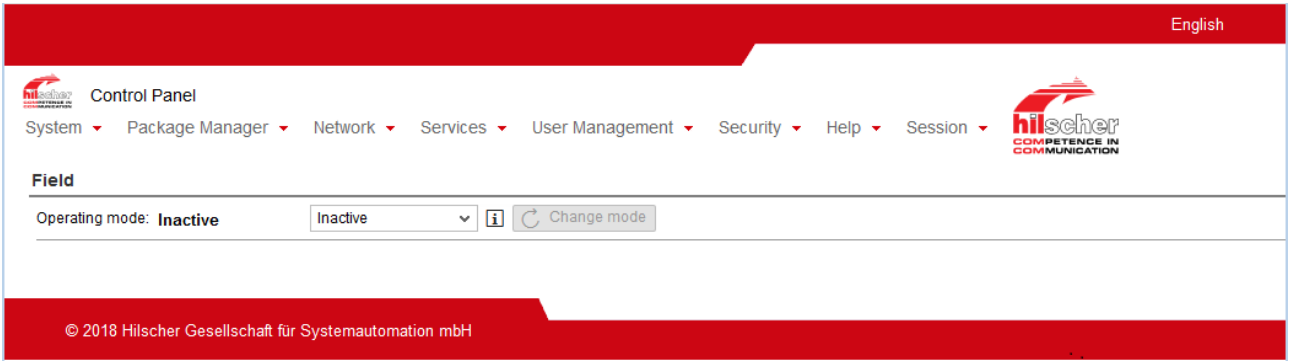


Figure 7: Inactive mode of operation

Passive Operation Mode

In Passive Operation Mode, you can use the Edge Gateway as a passive device in the automation network only. Process data is **received** from the fieldbus network from other field devices **only**. The device does **not send** any process data. A modification of the PLC program is not necessary, because the Edge Gateway is working passive in the fieldbus network.

In the Passive Operation Mode, the automation network is protected against attack from “outside”. How the Edge Gateway works in detail in the Passive Operation Mode depends on the signal configuration which is done largely by a configuration file created with the GUI-based tool Passive Fieldbus Configurator.

Is the Edge Gateway in the Passive Operation Mode, then the **Network > Field** menu in the Control Panel shows:

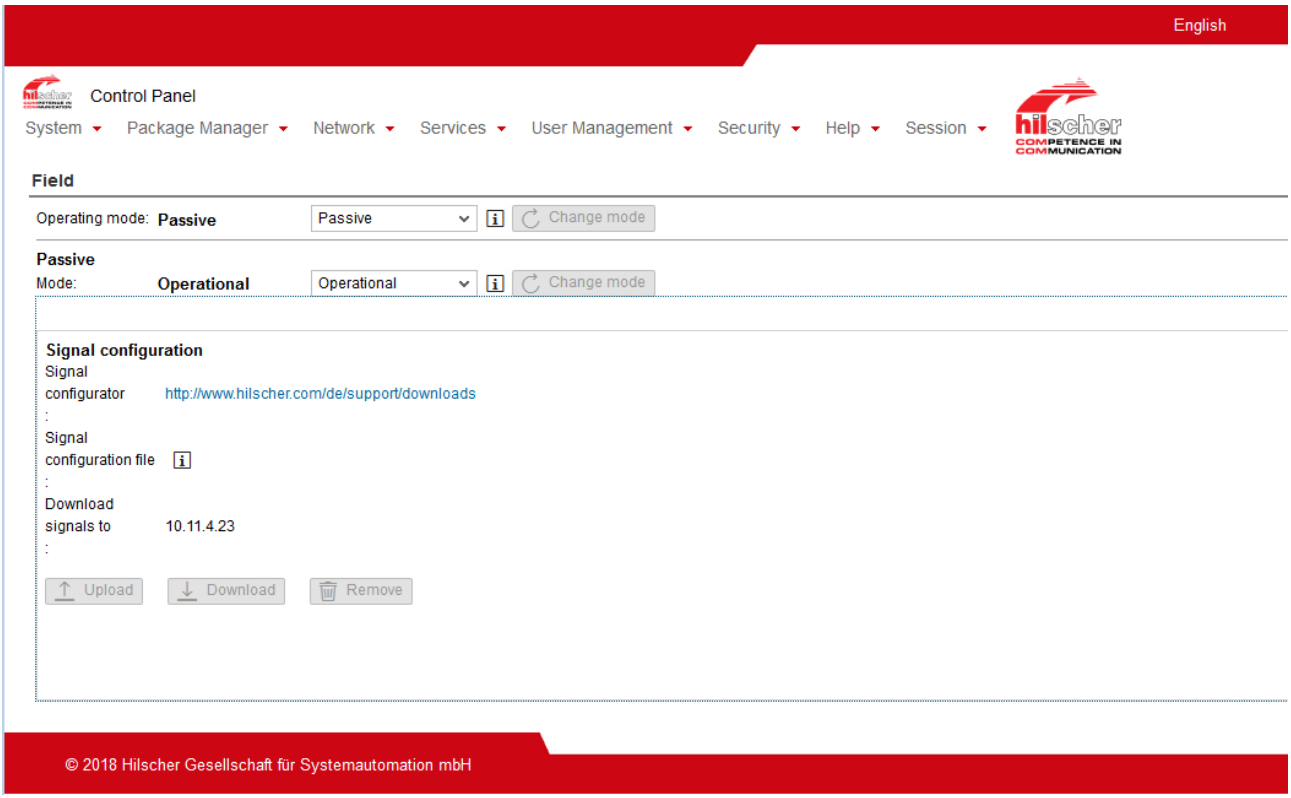


Figure 8: Passive Operation Mode - Operational mode

Access with Node-RED

In the Active Operation Mode, the fieldbus input node and the fieldbus output node have to be used to cconnect to the automation network. In the Passive Operation Mode, these nodes cannot be used. The `passivefieldbus` input node has to be used instead to connect to the automation network.

Switching between the modes of operation

In order to switch to the intended mode of operation, proceed as follows:

➢ Select the intended mode of operation within the selection list in the **Operation mode**.

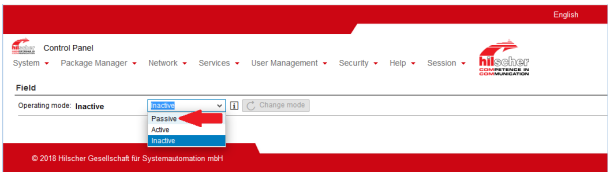


Figure 9: Example: Switching to active mode of operation

↬ The display on the screen changes according to the newly selected mode of operation.

➢ Click at **Change mode**.

↬ A safety query is displayed and informs you about the restart of the Node-RED service. If switching to the active mode of operation, this safety query also informs you about the loading of the desired firmware.

➢ At the confirmation prompt answer with **Yes**.

⇨ The following message text appears on a light green background: *The field operating mode is successfully changed*.

Note:
In any case, the Node-RED service on the Edge Gateway is automatically restarted, when switching between the various modes of operation.

2.3.1.2 Properties of the three modes of the passive mode

In passive mode of operation, there is the option to select between the **Configuration** mode, the **Operational** mode and the **Docker** mode. These have the following meaning:

Configuration mode

This mode is intended for configuration of the passive mode of operation of the Edge Gateway. it allows the Passive Fieldbus Configurator to connect to the Edge Gateway in order to interactively detect and select the available process data signals.

In **Configuration** mode, the TCP/IP Port 50111 on the Edge-Gateway is opened to enable device access by the Passive Fieldbus Configurator. As long as the **Configuration**mode is selected, no data are passively acquired.

Operational mode

This mode has been designed for passive data acquisition with evaluation of the acquired data either using Node-RED or using OPC UA. Changes of the signal configuration cannot be accomplished within this mode.

Docker mode

This mode allows you to analyse the (passive) process data using an application running the a docker container. Changing the signal configuration is not possible in this mode.

The subsequent table explains the properties and differences of the three modes of the passive mode of operation of the Edge Gateway.

Criterion/ mode	Configuration	Operational	Docker
Change of configuration	Allowed	Prohibited	Prohibited
State of the OPC UA server	Inactive	Active	Inactive
State of TCP/IP-Port 50111	Open	Closed	Closed
Access to Docker	Prohibited	Prohibited	Allowed

Table 2: Properties of the three modes of the passive mode

In order to set the operation mode

➢ Within the Control Panel select menu entry **Network>Field**.

↬ The configuration screen is displayed.

➢ Select the intended mode of operation (Configuration, Operational or Docker) of the passive mode of operation in selection list „Mode“. That list is located in the **Passive** area within the configuration screen. The subsequent figure provides an example for the switching from mode **Configuration** to mode **Operational**:

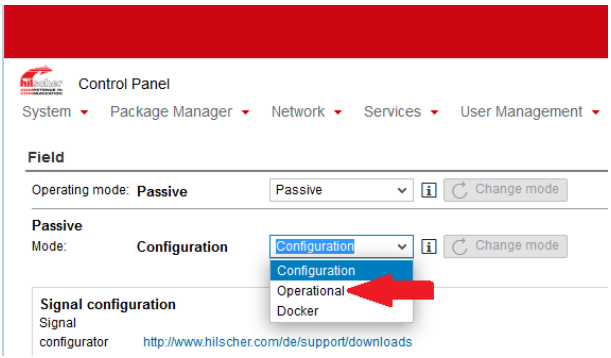


Figure 10: Switching from mode Configuration into the mode Operational of the passive mode (example: swiching from Configuration to Operational).

➢ Click at **Change mode**.

➢ A message window is displayed and informs about the consequences of the mode selection which depend from the slected mode).

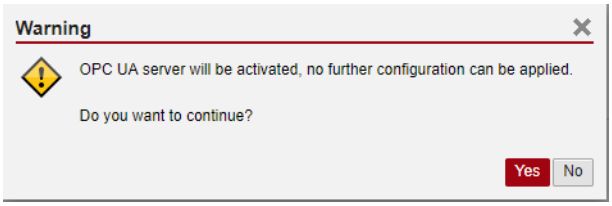


Figure 11: Message window when switching to operational mode in passive mode of operation

➢ The message window contains a safety query. Answer it with **Yes**.

⇨ The message box is closed then.

⇨ The following message text appears on a light green background: *Passive mode is successfully changed.* The mode is being changed.

In this mode the configuration cannot be changed.The data acquisition is running and provides the acquired process data signals via OPC UA or Node-RED (depending on the signal configuration).

2.3.2 Configuration parameters and project files

There are two different kinds of configuration parameters in passive process data acquisition with the Edge Gateway. The definition of the process data signals is stored in configuration files, that you can create and edit using the tool „Passive Fieldbus Configurators“.

This section shows, how you can create detailed configuration files for passive process data acquisition using the tool „Passive Fieldbus Configurator“ and then upload these files into the Edge Gateway. OPC UA- and Node-RED specific parameters are displayed or directly set in the Control Panel or in the Node-RED node.

2.3.2.1 Working with project files

Project files are created and edited using the Passive Fieldbus Configurator. They contain the configuration information for the passive mode of the Edge Gateway. The file extension for project files of the passive fieldbus configurator is `*.fbcfg`.

How to create project files is in detail described within the extensive application examples, see *Use Cases* [page 28].

Upload

In this context, upload means data transfer of project files from the file system of the computer running the Control Panel to the Edge Gateway.

The following requirement applies for the upload of a project: The Edge Gateway is in the passive mode of operation and the mode „Configuration“ is active.

In order to upload project files, click at button **Upload** in the area *Signal Configuration* of control panel page *Network->Field*.

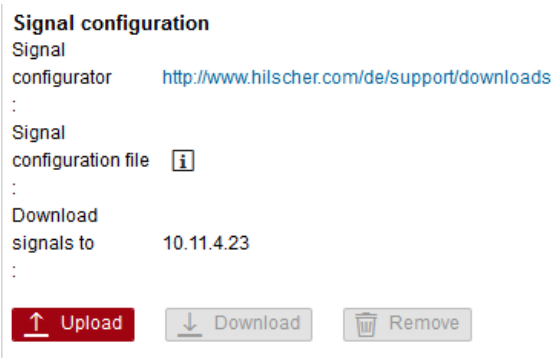


Figure 12: Button "Upload" (part of the configuration page within the control panel)

Download

In this context, download means data transfer of project files from the Edge Gateway to the file system of the computer running the Control Panel.

The following requirement applies for the download of a project: The Edge Gateway is in the passive mode of operation and the mode „Configuration“ is active.

In order to download a project file, click at button **Download** in the area *Signal Configuration* of control panel page *Network->Field*.

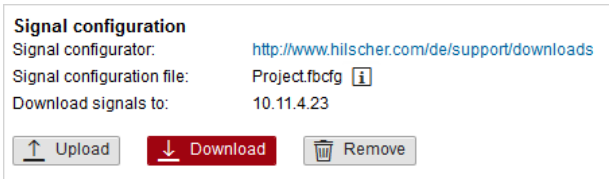


Figure 13: Button "Download" (part of the configuration page within the control panel)

Deleting project files

The following requirement applies for the deletion of project files: The Edge Gateway is in the passive mode of operation and the mode „Configuration“ is active, see Mode "Configuration".

Only delete project files if you are absolutely sure that you do not need these files any longer. In order to be able to restore the project file, it is generally recommended to download project files to your PC before deleting them

In order to delete project files just click button **Remove** in the area *Signal Configuration* of control panel page *Network->Field*.

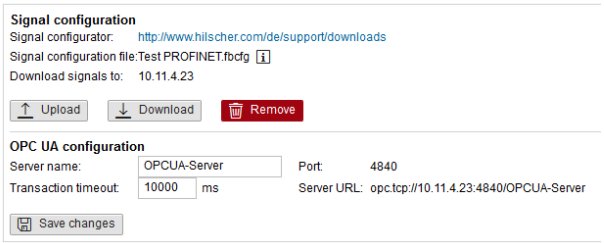


Figure 14: Button "Remove" (part of the configuration page within the control panel)

2.3.2.2 OPC-UA settings within the Control Panel

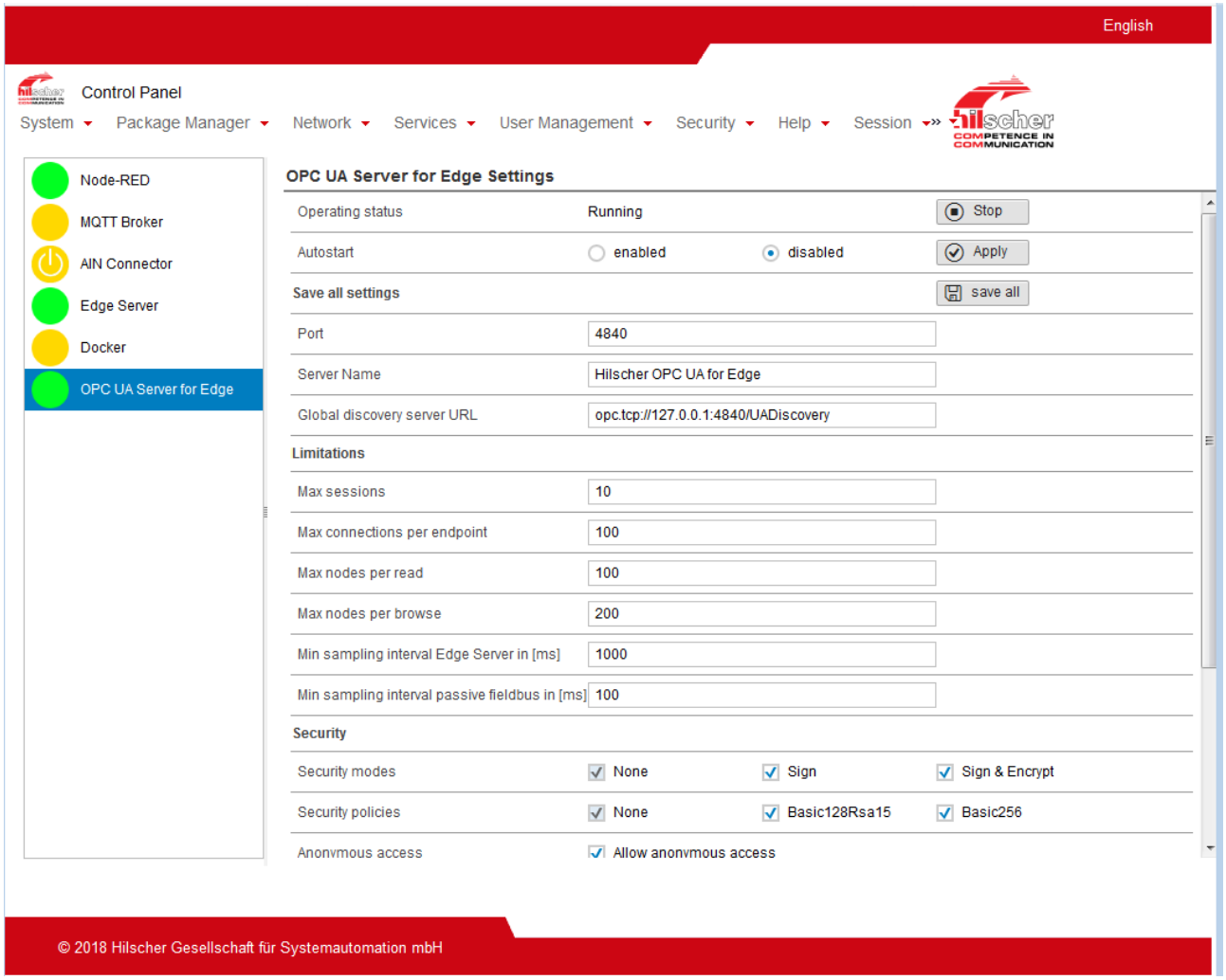


*Figure 15: OPC-UA settings within the Control Panel, page **Network>Field***

In the Control Panel (OPC UA Server for Edge Settings in the service list), the following settings for OPC UA are possible:

Communication settings

The following basic communication settings can be applied:

Field name	Meaning	Comment
Port	The port used by OPC-UA for communication	Numeric field Range of values: integer values, >=0 Default: 100
Server name	The name of the OPC UA server	Text field
Global Discovery server URL	URL of the server	Text field Default: `opc.tcp://127.0.0.1:4840/UADiscovery`

Table 3: Input fields for communication settings of the OPC UA Server for Edge

Limitation settings

The following limitation settings are possible in the **Limitations** area:

Field name	Description	Remark
Max Sessions	Maximum number of sessions	Numeric field. Range of values: integer, >=0 Default: 10
Max connections per endpoint	Maximum number of connections per endpoint	Numeric field. Range of values: integer, >=0 Default: 100
Max nodes per read	Maximum number of nodes per read	Numeric field. Range of values: integer, >=0 Default: 100
Max nodes per browse	Maximum number of nodes per browse	Numeric field. Range of values: integer, >=0 Default: 200
Min sampling interval Edge Server	Minimum sampling interval of the Edge Server, in milliseconds	Numeric field. Range of values: integer, >=0 Default: 1000 milliseconds
Min sampling interval passive fieldbus	Minimum sampling interval of the passive fieldbus, in milliseconds	Numeric field. Range of values: integer, >=0 Default: 100 milliseconds

Table 4: Input fields for limitation settings of the OPC UA Server for Edge

Security settings

The following security settings are available:

Security modes: The following options apply:

- Checkbox **None**
- Checkbox **Sign**
- Checkbox **Sign&Encrypt**

Security policies: The following options apply:

- Checkbox **None**
- Checkbox **Basic128Rsa15**
- Checkbox **Basic256**

Option **Anonymous access**

In order to allow anonymous access, click at checkbox **Allow anonymous access**.

Settings for the Passive Operation Mode

The checkbox **Enable passive fieldbus** the OPC UA Server for the passive operation mode.

Connection settings

Here you can specify via which username and which password all connections of the OPC UA Server will be established.

Fieldname	Meaning	Comment
Username	Username for all connections of the OPC UA Server	Text field
Password	Password for all connections of the OPC UA Server	Text field

Table 5: Input fields for settings concerning connection establishment of the OPC UA Server for Edge

Storing the settings for the OPC UA Server for Edge

After you finished making yor settings for the OPC UA Server for Edge, you have to store these as follows in order to make them effective.

➢ Click at **Save all**.

⇨ The following message box appears:

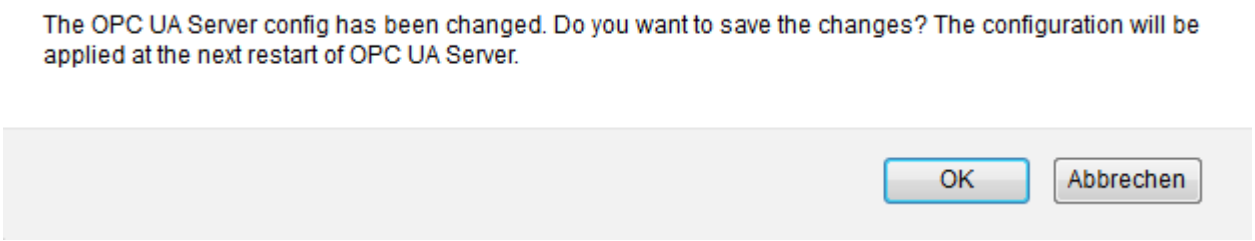


Figure 16: Safety query when storing the OPC UA Server configuration

➢ Click at **OK**.

⇨ The following message appears:
`OPC UA config settings are successfully saved`
The changes are stored in the Edge Gateway now. However, they will get effective after the next restart of the Edge Gateway.

3 Licensing

This section describes, what you should know about the usage of licenses if you intend to work with the Edge Gateway in the passive mode of operation. For the operation of the Edge Gateway in passive mode you require a special license, the *netIOT Passive Fieldbus Integration License*.

3.1 License overview

The functionality of an Edge Gateway can be extended. The following table lists functional extensions, for which a license is required to use those.

License name	Product	Part number	Description
netIOT Passive Fieldbus Integration License	NIOT-S-LIC-SNIF	1350.030	The Edge Gateway can be used in **passive mode**. In the passive mode, the Edge Gateway receives data on the OT interface and provides the received data for further processing via OPC UA, Node-RED or Docker.

Table 6: License overview

3.2 Which licenses are present in the device?

In order to display the licenses contained in the Edge Gateway, use the License Manager. You can open it as follows:

➢ Open the **Control Panel**.

➢ Select **System>License Manager**.

↬ The window of the License Manager opens:

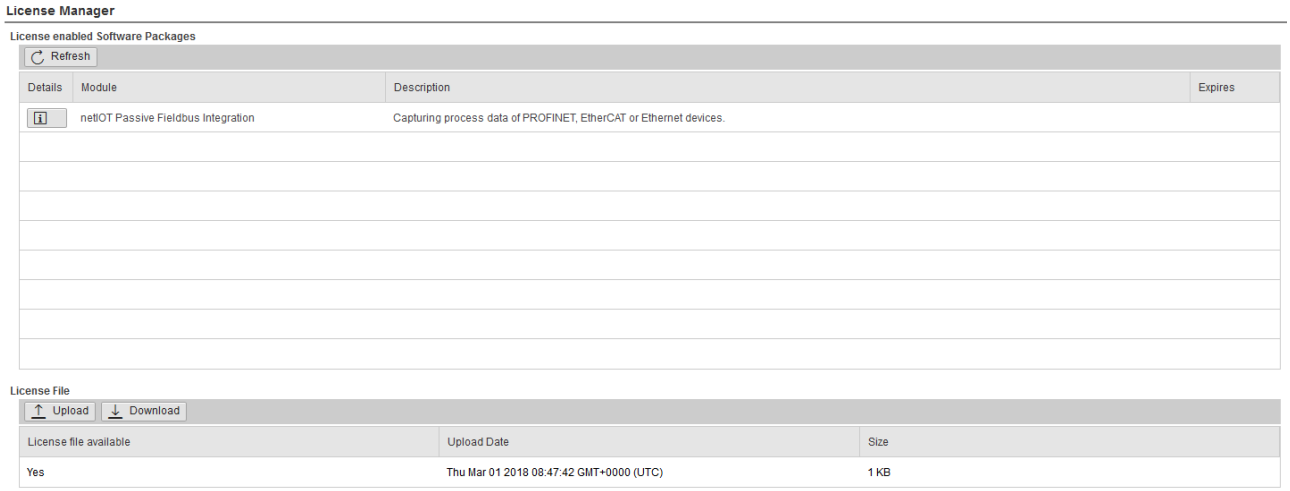


Figure 17: License Manager with license for the passive mode of operation

The table **License enabled Software Packages** displays the currently available licenses, in the example a license for the passive mode of operation of the Edge Gateways is available.

Open Details window in the License Manager

To open the **Details** window:

➢ Click at the info button on the left edge of the line (within column **Details**).

↬ The **Details** window opens:

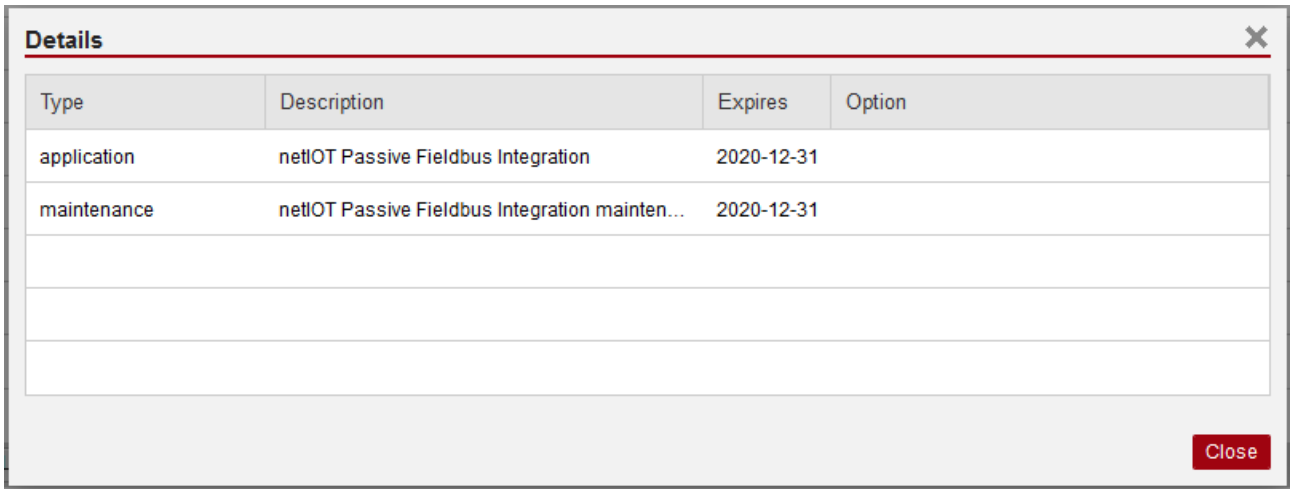


*Figure 18: License information in window **Details***

For each license, it displays the license type (Column **Type**), a brief description (Column **Description**) and the expiration date (Column **Expires**) .

3.3 How to order and receive a license

The following instruction explains how to order a license for your Edge Gateway to be used in passive mode of operation and receive a license file.

If you order device and license together or after ordering the license, you receive a delivery note. After receiving the delivery note order the license file from Hilscher by e-mail. Specify the following information in your e-mail:

1. The denomination of the desired license
2. The number of your delivery note (for reference)
3. The LAN MAC address of your device (to be taken from the device label)
4. The e-mail address, to which the license download link shall be sent to.

Specify the following as the subject of your e-mail:

```
Request for a netIOT Licence
```

- Send the e-mail to Hilscher: vertrieb@hilscher.com
- Hilscher creates an individual license file for your Edge Gateway according to the information supplied by you.
- Hilscher sends this file back to you as an attachment within the answer e-mail. Consequently, this license file has to be transferred into the Edge Gateway as described in section *How to transfer a license into the device?* [page 27].

3.4 How to transfer a license into the device?

Load the individual license file received from Hilscher from your PC into the Edge Gateway. Do the upload as follows:

- ➢ Open the **Control Panel** in a web browser.
- ➢ Select **System > License Manager**.
- ➢ Click on **Upload License**.
- ⇘ A file selection dialog opens.
- ➢ Select the license file. This file has the file extension `*.LIC`.
- ➢ Click on **OK**.
- ⇘ The license file is transferred into the Edge Gateway. If the transfer is successful, the following message is displayed:

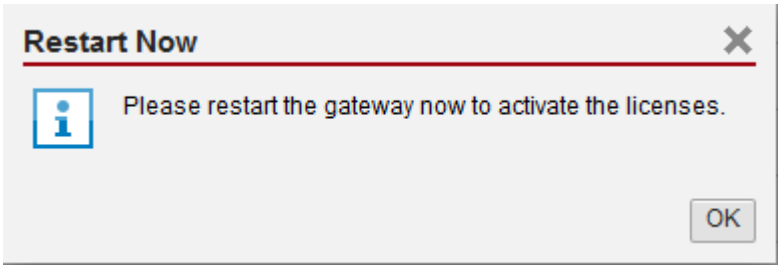


Figure 19: Message after the transfer of the license file into the Edge Gateway

- ⇘ To activate the license, a restart of the Edge Gateways is necessary.
- ➢ Click on **OK**.
- ⇘ The license is installed now, but becomes active after the next restart of the Edge Gateways.
- ➢ For a restart, select **System > Reboot**.
- ⇨ The license is activated.

4 Use Cases

This section describes in step-by-step descriptions for the communication systems PROFINET and EtherCAT, how you can automatically or manually commission the passive process data acquisition with the Edge Gateway. Furthermore, it explains using the example of Powerlink, how you can use custom-value filters for the recognition and acquisition of specific Ethernet-Frames, such as Ethernet-Frames of other Industrial Ethernet systems or other special Ethernet frame types.

4.1 PROFINET (automatic)

By the means of a step-by-step instruction, this section describes the commissioning of the passive process data acquisition with the Edge Gateway in PROFINET networks with automatic recognition of PROFINET devices during the start-up of PROFINET.

The following figure shows the wiring diagram related to this step-by-step instruction. In this context, the Edge Gateway is wired as passive access point into the communication between the PROFINET IO-Controller and the IO-Devices in order to capture it completely.

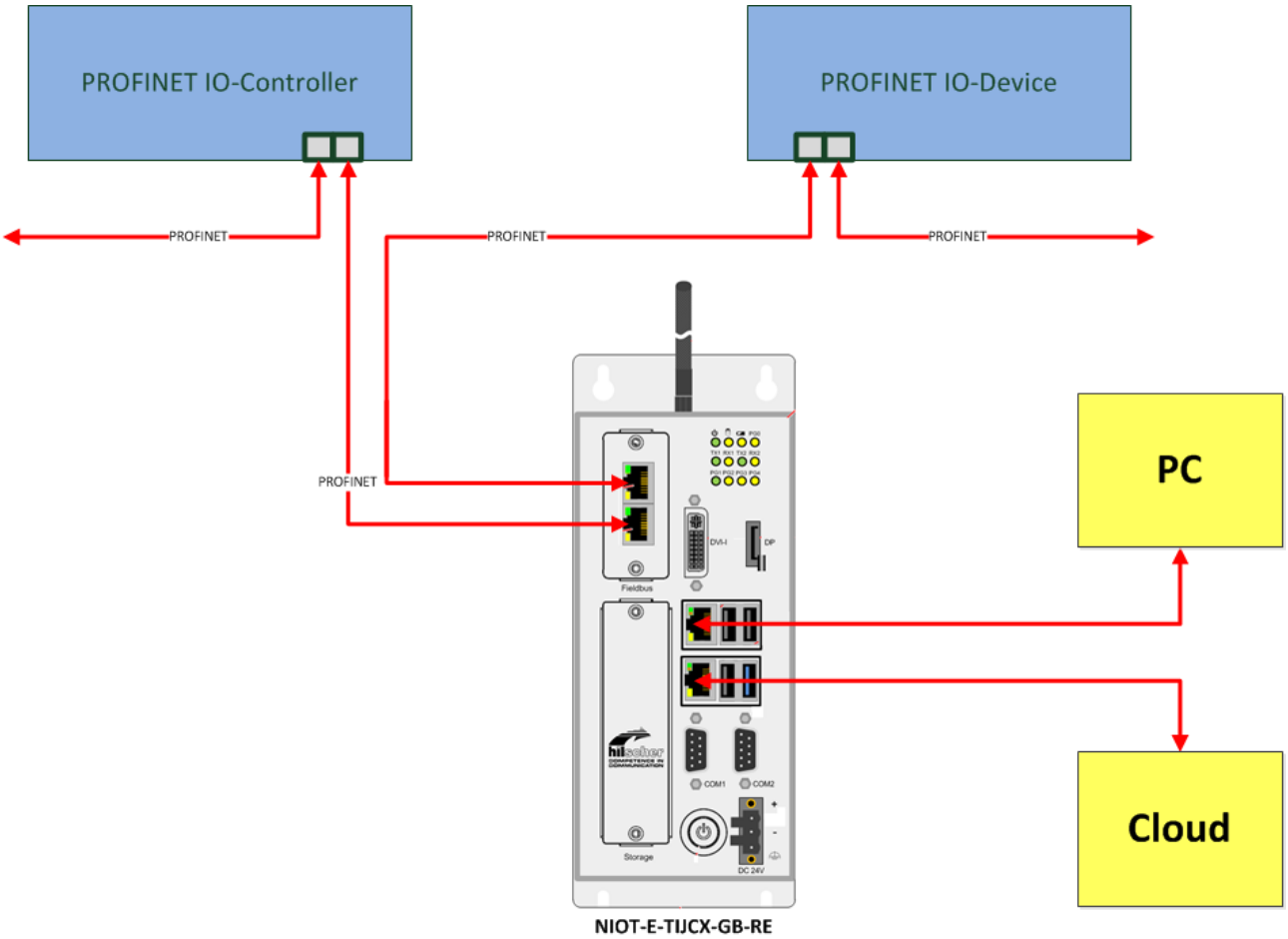


Figure 20: Application example: passive process data acquisition with the NIOT-E-TIJCX-GB-RE in PROFINET networks

In the following description nine steps explain how you can create a project file for passive process data acquisition with the Edge Gateway in your PROFINET- network (Steps1 to 8) and upload this project file into the Edge Gateway then (Step9, see separate description *Uploading the project file to the Edge Gateway* [page 113]).

Prerequisites for the automatic generation of a project file for PROFINET

The following prerequisites have to be met:

1. The Edge Gateway is in the **passive mode of operation** and the **Configuration Mode** is active.
   Otherwise, the assignment of the IP address in step 3 (see below) is not possible.
2. The software **Passive Fieldbus Configurator** must be **installed** on a PC, from which **network access** to the Edge Gateway can be accomplished. If this is not the case, install the softweare according to the installation instructions in the documentation of the Passive Fieldbus Configurator (Document number DOC171103OI01EN).
3. The **IP adress of the Edge Gateway** must be known.
4. For all devices in your PROFINET network suitable **GSDML files** should be available. Otherwise additional manual configuration effort will be necessary.

4.1.1 Step 1 - Start the Passive Fieldbus Configurator.

➢ Start the Passive Fieldbus Configurator on your PC, for example via the entry **netIOT – Passive Fieldbus Configurator** in the Windows start menu or by double-clicking at the icon **netIOT - Passive Fieldbus Configurator**.

⇨ The entry screen of the Passive Fieldbus Configurator is displayed:

4.1.2 Step 2 - Creating an empty project

➢ Build a new project within the Passive Fieldbus Configurator by selecting **Create->New** within the introductory menu..

➢ The GUI of the Passive Fieldbus Configurator is displayed.

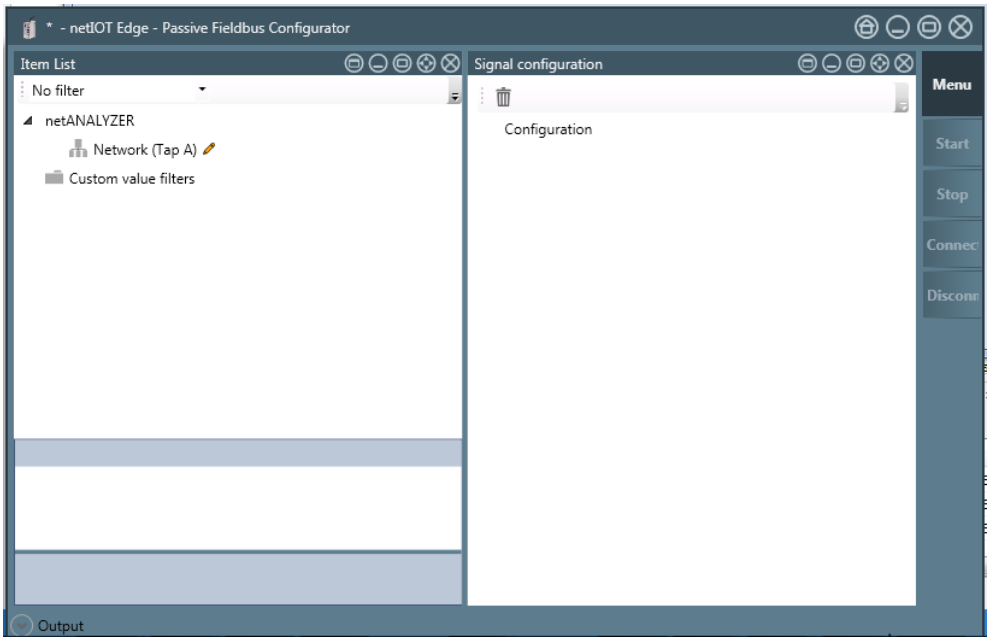


Figure 21: Empty GUI of the Passive Fieldbus Configurator

4.1.3 Step 3 - Adjust basic settings of the Passive Fieldbus Configurator.

The Passive Fieldbus Configurator requires the following basic settings:

- Setting of IP address
- Setting ofSetting of network speed

To do so, proceed as follows:

➢ Open the main menu. in order to do so, click at button **Menu** within the side menu located at the right side.

Figure 22: Side menu

➢ The main menu is opened.

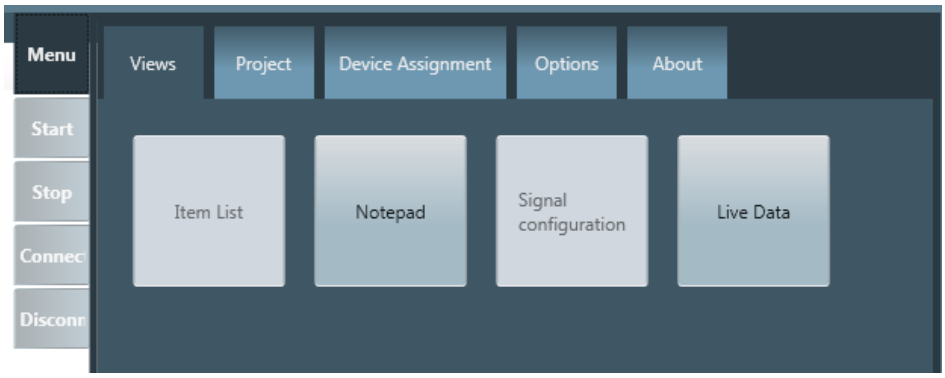


Figure 23: main menu - Register card "Views"

➢ Select the register card **Device assignment**.

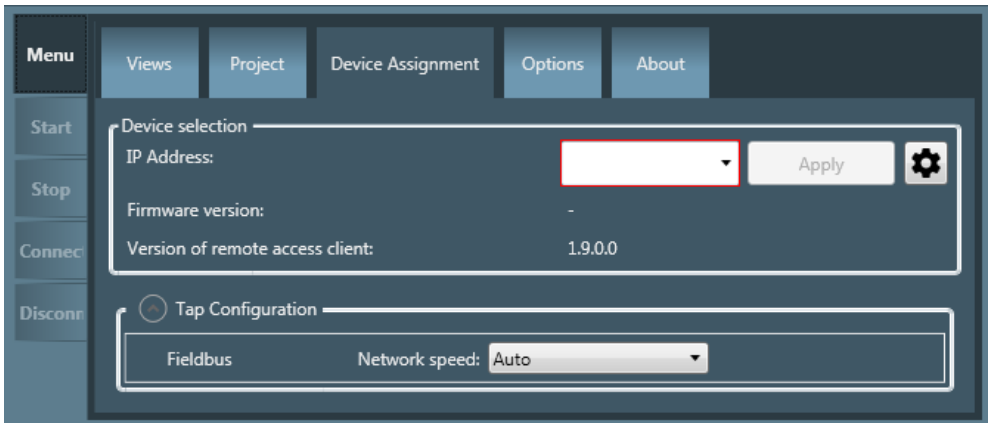


Figure 24: main menu - Register card "Device assignment"

In order to establish a connection with the Edge-Gateway, the IP address of the Edge-Gateway must be assigned to the software. This reqires the Gateway being in the passive mode of operation. Proceed as follows:

➢ Select the IP addresss of the Edge-Gateway to connect with from the selection list **IP Address** in the **device selection** area. If this list is still empty yet or the IP address of the Edge Gateway is missing in it, specify the IP address within the input field or click at the cog wheel symbol  at the right and specify the IP address in the dialog box which will appear. This IP address must comply with the valid rules for specifying IP adresses.

➢ Click at 

.

↬ Finally, the connection with the according Edge Gateway has been established.

As described in the following, you can check whether a connection to the Edge Gateway has been established:

1. In the field Firmware Version the version number of the currently installed firmware of the Edge Gateway is displayed.
2. The status display in the right part of the lower status bar of the Passive Fieldbus Configurator changes from blue indicating status *Idle* to yellow indicating status *Stopped*.
3. In the left part of the status bar now statistic information concerning the Ethernet data traffic and zthe interface configuration are displayed.
4. The formerly grayed ot menu entry **Connect** is activated.

Otherwise the following error message will appear:

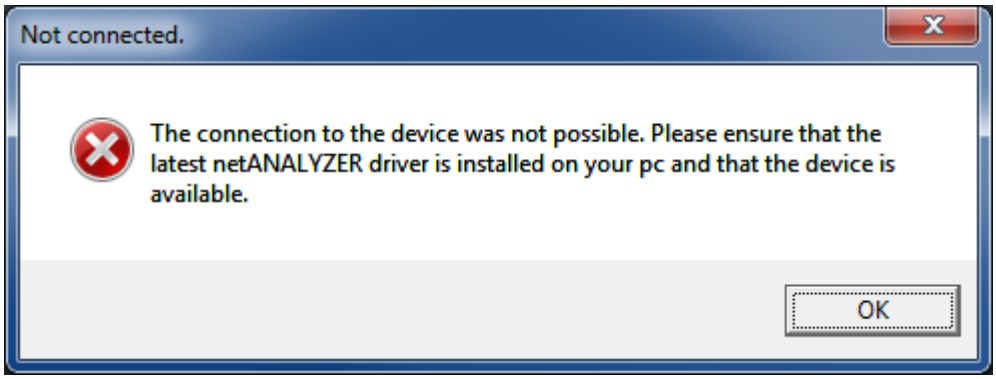


Figure 25: Error message "The connection to the device was not possible"

The most probable cause of this error message is the Edge Gateway not being in the configuration mode of the passive mode of operation!

Note:
For more information concerning the solution of this problem see section *Error handling* [page 116].

➢ In order to adjust the network speed, select the network speed from the selection list **Network speed** in the area **TAP configuration**

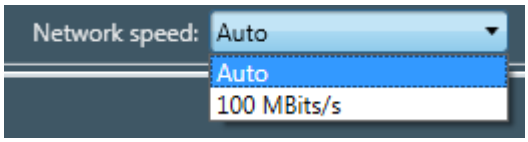


Figure 26: Selection list Network speed

For the network speed, the following settings are applicable:

Setting	Meaning
Auto	Automatic determination of network speed Select this option if using the Edge Gateway as Software TAP.
Possible value are Auto, 10 MBit/s and 100 MBit/s.	Fixed network speed of 100 Mbit/s Select this option if working with an additional Hardware TAP.

Table 7: Settings for network speed

4.1.4 Step 4 - Loading the GSDML files

You can select PROFINET as network to be captured within the Passive Fieldbus Configurator and load GSDML files containing the device descriptions of your connected PROFINET IO-Devices:

➢ Right-click at **Netzwerk (Tap A)**.

↬ The context menu is opened.

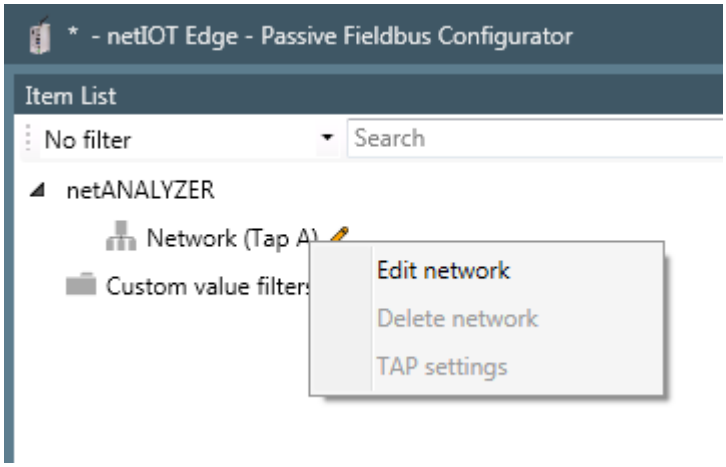


Figure 27: Context menu at network level

➢ Select entry **Edit network** there.

↬ The network wizard is opened.

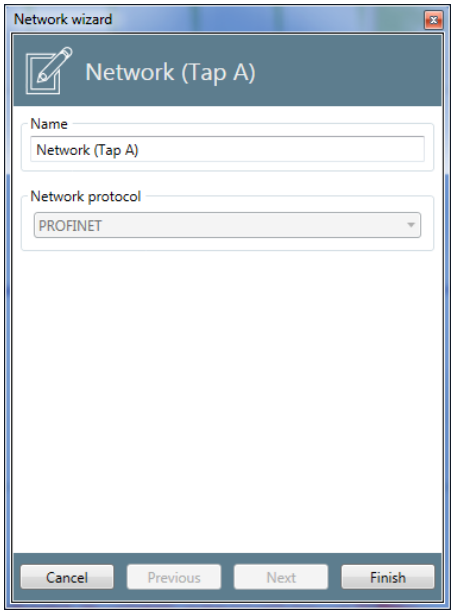


Figure 28: Network wizard

➢ Within the network wizard, select **PROFINET** as network protocol within selection list **Network protocol**.

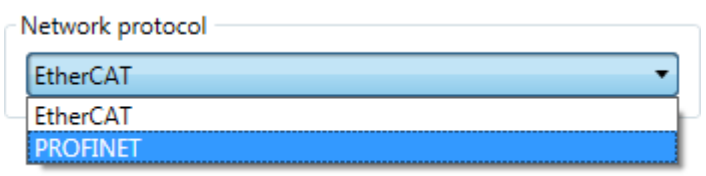


Figure 29: Selection list Network protocol.

➢ Click at **Finish**.

⇨ Thus, PROFINET has been selected as network protocol.

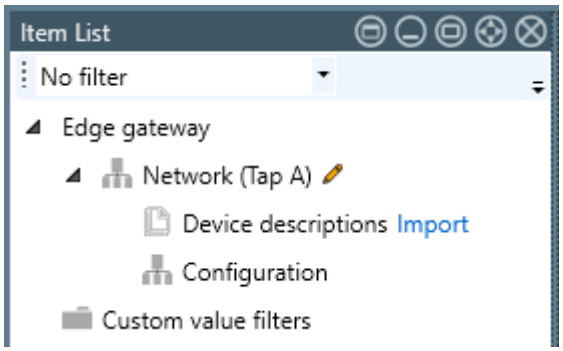


Figure 30: Import of device descriptions.

➢ Within the item list, click at **Import** (right of **device descriptions**). Alternatively, you can point at **Network (Tap A)** with the mouse pointer and right-click there.

⇨ A dialog for the selection of the GSDML file is displayed.

➢ Within this dialog, select one or more GSDML files describing your PROFINET devicews.

⇨ The device descriptions contained within the GSDML file are imported and the contained items are integrated into the structure tree within the Passive Fieldbus Configurator.

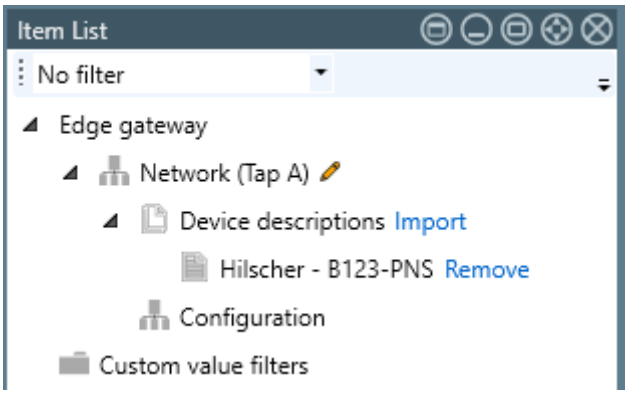
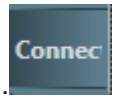


Figure 31: Imported device description within the item list of the Passive Fieldbus Configurator (Example)

4.1.5 Step 5 - Acquiring the start-up of PROFINET communication

Some information relevant for the Edge Gateway and required for its configuration is not contained within the GSDML files of PROFINET. This applies for instance to the MAC addresses of the devices or the FrameID identification of the PROFINET frames. In order to avoid manual acquisition of this information, the Passive Fieldbus Configurator provides the possibility to acquire this information automatically during start-up of PROFINET communication between IO-Controller and IO-Devices with the Edge Gateway.

In order to supervise the start-up phase of the PROFINET configuration you first have to put the Gateway and the Passive Fieldbus Configurator into recording mode . This must be accomplished prior to starting the PROFINET configuration. You can achieve this as follows:

- Within the side menu of the Passive Fieldbus Configurators (right side) aclick at **Connect**
  : 

- Now the start-up phase of the PROFINET communication is supervised. The status within the display in the status bar below changes from Stopped (yellow) to Started (green). The menu entries "Start" and "Disconnect" in the side menu are activated.

Explanation: After successful creation of the connection, the Edge Gateway waits for the connect request and connect response of the PROFINET connection. During the start-up phase of the PROFINET communication, the Edge Gateway supervises the data traffic between the Controller and the Devices. This process may last some seconds. Yet after completion , the Passive Fieldbus Configurator is able to identify the PROFINET-IO-Controller- and PROFINET-IO-Devices within the network and to display these in the item list.
If the button **Connect** has been grayed out, the connection to the Edge Gateway could not be configured correctly. In this case, try again to configure the connection according to step 3.

4.1.6 Step 6 - Signal configuration

In order to activate a signal, proceed as follows:

➢ Within the Passive Fieldbus Configurator, drag the signal from the element list window into the window „Signal configuration“.

↬ In window "Signal configuration", a new entry with the name of the signal is displayed There you can also decide whether the processing of this signal shall be continued by transferring it to OPC UA or Node-RED.

Note:
In order to reduce CPU time and memory consumption on the Edge Gateway only choose those methods for continuation of processing, which you really need in your specific application.

↬ The entry with the name of the signals within the element list still remains there, but it is now protected against editing and erasure, i.e. the respective context menu functions are grayed out and deactivated.

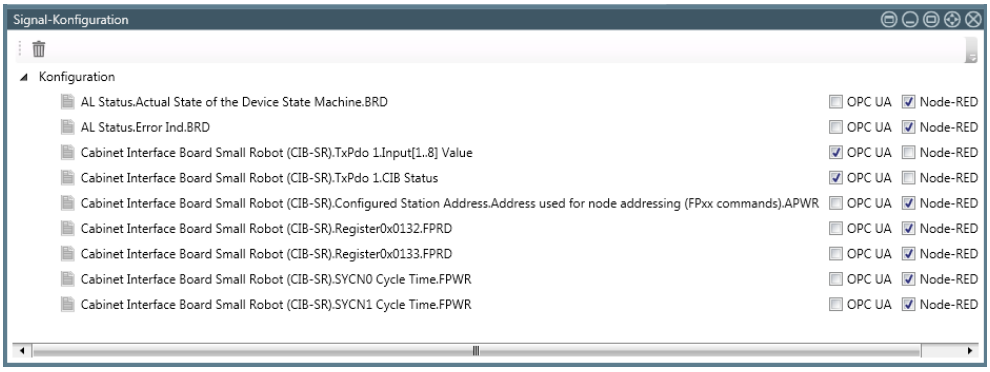


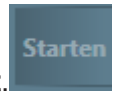
Figure 32: Window "Signal configuration" of the Passive Fieldbus Configurator.

➢ Configure the signals in the window **Signal configuration** of the Passive Fieldbus Configurator. By checking you can decide easily for each single signal whether the acquired data shall be fetched from the Edge Gateway by OPC UA or shall be made available within Node-RED.

4.1.7 Step7 - Check Signals in the Live-Data View

This step is optional. Viewing signals within a live-data window is recommended if you want to check whether a specific signal has been configured correctly .

Proceed as follows:

- ➢ Within the side menu of Passive Fieldbus Configurator (right side), click at button **Start**. 

- ➢ Drag all signals intended to be viewed in the window **Live Data** one by one with the mouse button pressed down from the element list into the right part **Buckets** of the **Live Data** window.
- ⇘ The data acquisition within the Passive Fieldbus Configurator has been started. In the Live View window you can watch the signals and tune your configuration if necessary.

4.1.8 Step 8 - Storing the generated configuration file (PROFINET)

- ➢ Create a configuration file (i.e. a project file) for your PROFINET project using the Passive Fieldbus Configurator. Store this file via **Project > Save** within the main menu before finishing working with the Passive Fieldbus Configurator .
- ⇨ You have now created a project file for the configuration of your PROFINET network within the passive mode of the Edge Gateway. In section *Uploading the project file to the Edge Gateway* [page 113] uploading of this file onto the Edge Gateway and activating it is described.

4.2 PROFINET (manual)

If there is no possibility to record the start-up phase of PROFINET., the devices can also be configured manually. By the means of a step-by-step instruction, this section describes the commissioning of the passive process data acquisition with the Edge Gateway in PROFINET networks with automatic recognition of PROFINET devices during the start-up phase of PROFINET.

For the manual configuration no network connection between configurator program and Edge Gateway is required contrary to the automatic configuration. However, the following requirements must be fulfilled:

- The software Passive Fieldbus Configurator must be installed on a PC, from which network access to the Edge Gateway can be accomplished. If this is not the case, install it according to the installation instructions.
- For all devices in your PROFINET network suitable GSDML files should be available. Otherwise additional manual configuration effort will be necessary.

The following figure shows the wiring diagram related to this step-by-step instruction. In this context, the Edge Gateway is wired as passive access point into the communication between the PROFINET IO-Controller and the IO-Devices in order to capture it completely.

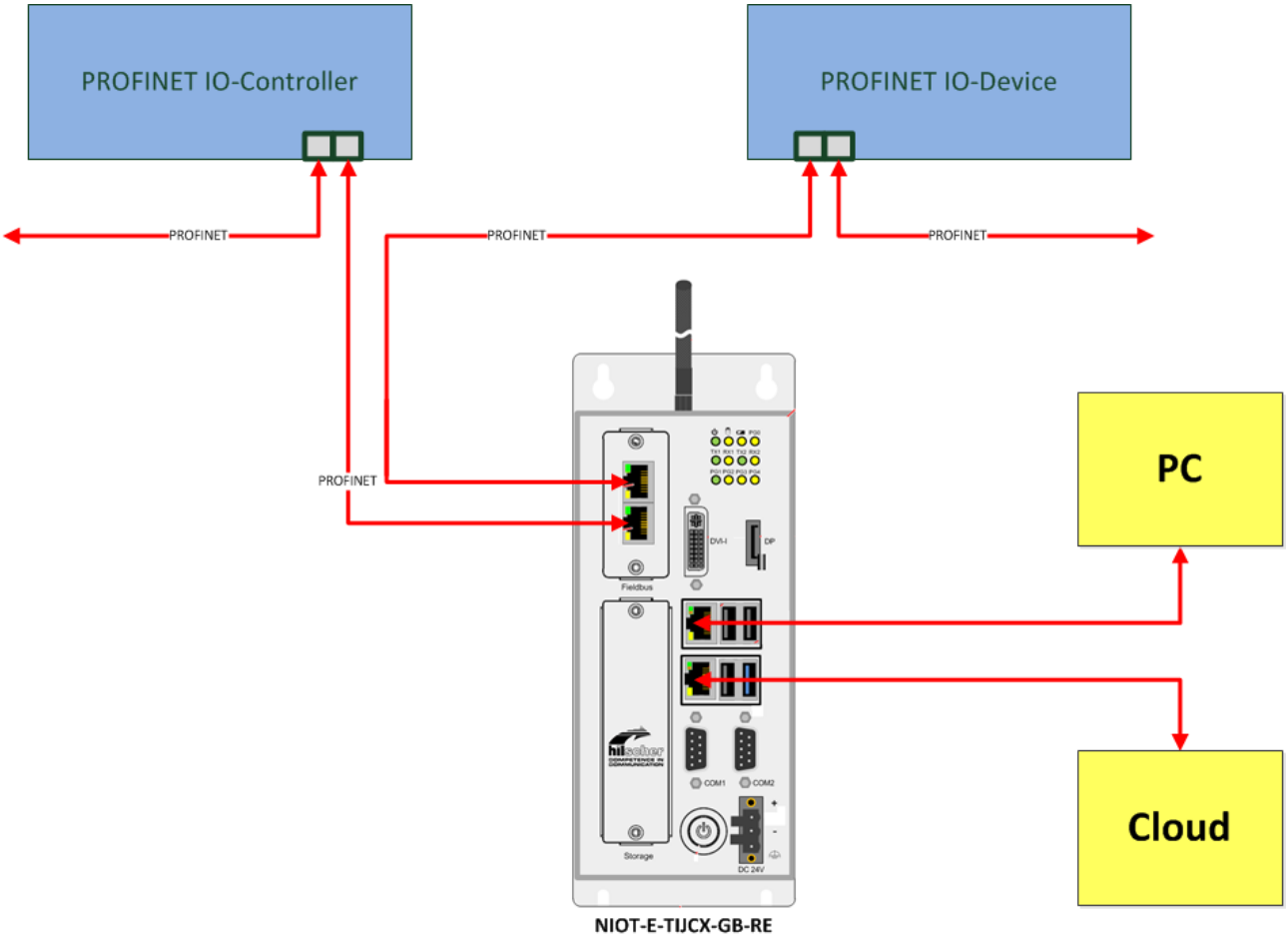


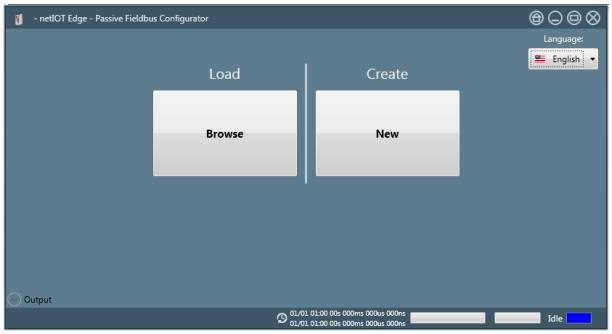
Figure 33: Application example: passive process data acquisition with the NIOT-E-TIJCX-GB-RE in PROFINET networks

In the following description nine steps explain how you can create a project file for passive process data acquisition with the Edge Gateway in your PROFINET network (Steps 1 to 8) and upload this project file into the Edge Gateway then (Step 9, see separate description *Uploading the project file to the Edge Gateway* [page 113]).

4.2.1 Step 1 - Start the Passive Fieldbus Configurator.

➢ Start the Passive Fieldbus Configurator on your PC, for example via the entry **netIOT – Passive Fieldbus Configurator** in the Windows start menu or by double-clicking at the icon **netIOT - Passive Fieldbus Configurator**.

⇨ The entry screen of the Passive Fieldbus Configurator is displayed:



4.2.2 Step 2 - Creating an empty project

➢ Build a new project within the Passive Fieldbus Configurator by selecting **Create->New** within the introductory menu..

⇨ The GUI of the Passive Fieldbus Configurator is displayed.

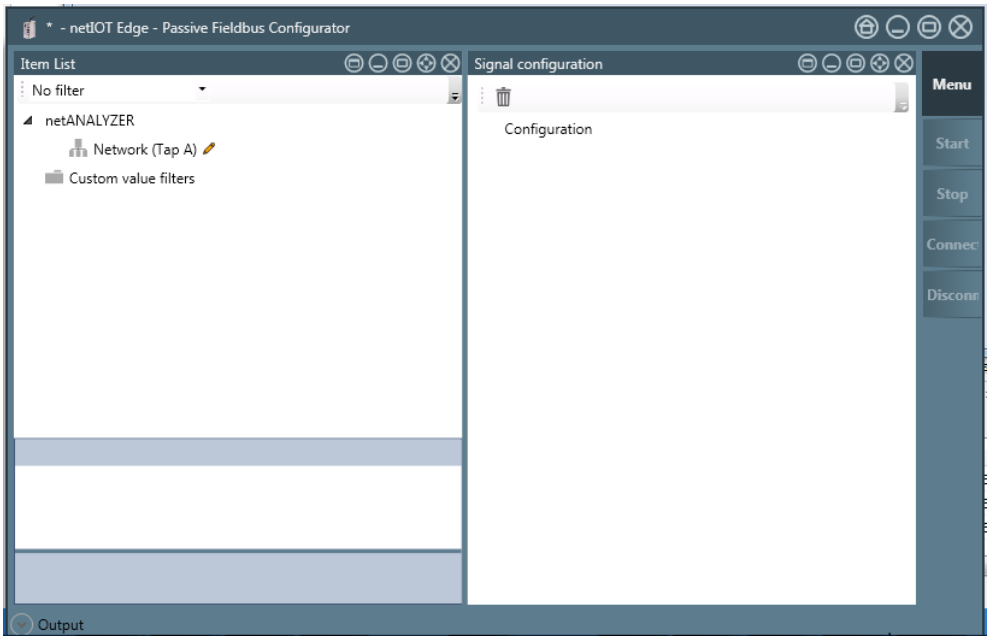


Figure 34: Empty GUI of the Passive Fieldbus Configurator

4.2.3 Step 3 - Adjust basic settings of the Passive Fieldbus Configurator

The Passive Fieldbus Configurator requires the following basic settings:

- Setting of network speed

To do so, proceed as follows:

➢ Open the main menu. in order to do so, click at button **Menu** within the side menu located at the right side.

Figure 35: Side menu

↬ The main menu is opened.

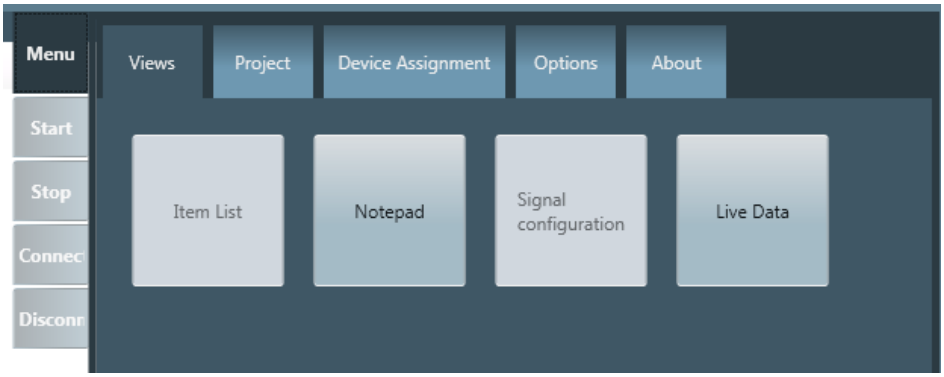


Figure 36: main menu - Register card "Views"

➢ Select the register card **Device assignment**.

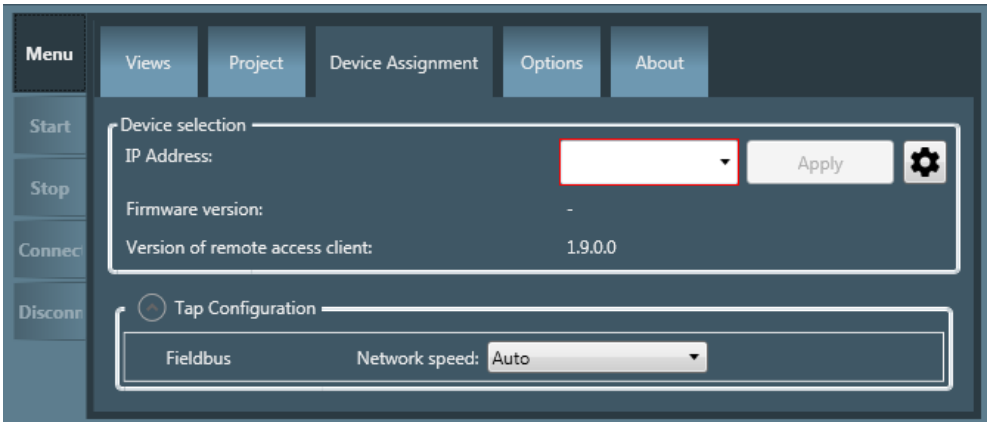


Figure 37: main menu - Register card "Device assignment"

The main menu of the Passive Fieldbus Configurator consists of two areas:

- the area Device selection (top)
- the area TAP Configuration (down)

The network speed is selected in the area **TAP configuration**

➢ In order to adjust the network speed, select the network speed from the selection list **Network speed** in the area **TAP configuration**

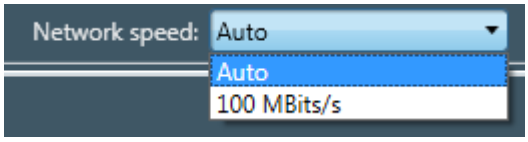


Figure 38: Selection list Network speed

For the network speed, the following settings are applicable:

Setting	Meaning
Auto	Automatic determination of network speed Select this option if using the Edge Gateway as Software TAP.
Possible value are Auto, 10 MBit/s and 100 MBit/s.	Fixed network speed of 100 Mbit/s Select this option if working with an additional Hardware TAP.

Table 8: Settings for network speed

4.2.4 Step 4 - Loading the GSDML files

You can select PROFINET as network to be captured within the Passive Fieldbus Configurator and load GSDML files containing the device descriptions of your connected PROFINET IO-Devices:

➢ Right-click at **Netzwerk (Tap A)**.

↬ The context menu is opened.

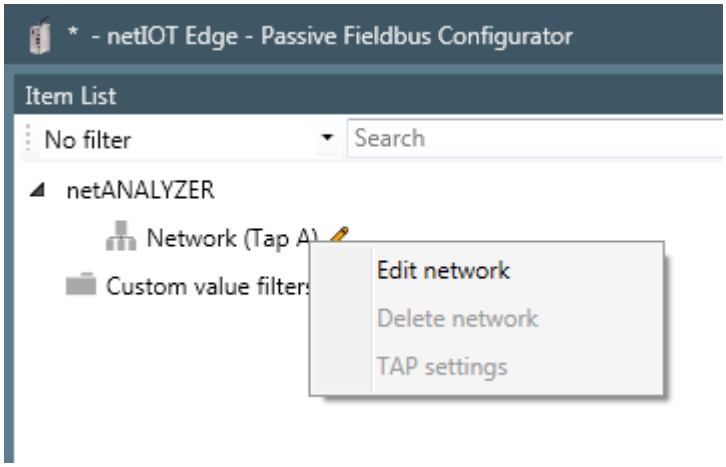


Figure 39: Context menu at network level

➢ Select entry **Edit network** there.

↬ The network wizard is opened.

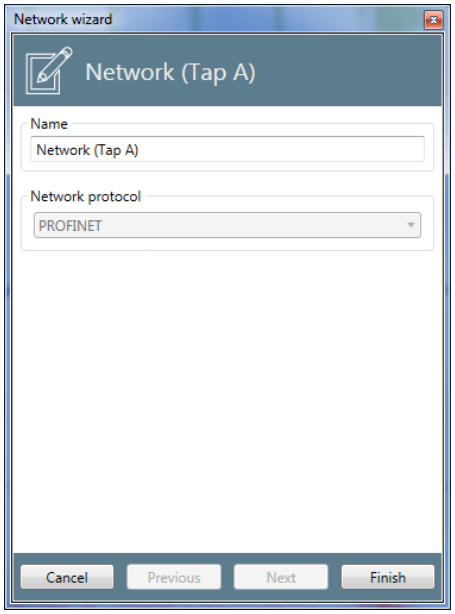


Figure 40: Network wizard

➢ Within the network wizard, select **PROFINET** as network protocol within selection list **Network protocol**.

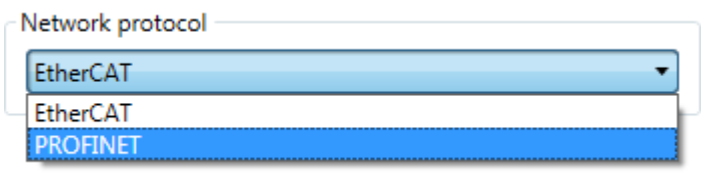


Figure 41: Selection list Network protocol.

➢ Click at **Finish**.

⇨ Thus, PROFINET has been selected as network protocol.

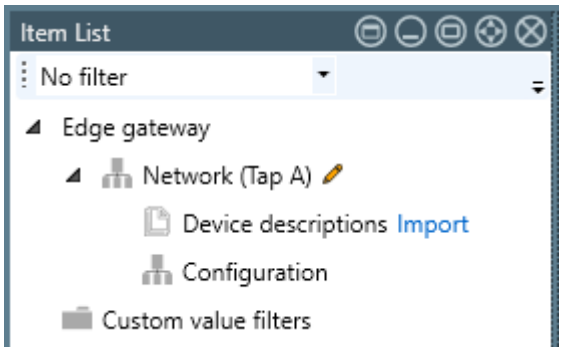


Figure 42: Import of device descriptions.

➢ Within the item list, click at **Import** (right of **device descriptions**). Alternatively, you can point at **Network (Tap A)** with the mouse pointer and right-click there.

⇨ A dialog for the selection of the GSDML file is displayed.

➢ Within this dialog, select one or more GSDML files describing your PROFINET devicews.

⇨ The device descriptions contained within the GSDML file are imported and the contained items are integrated into the structure tree within the Passive Fieldbus Configurator.

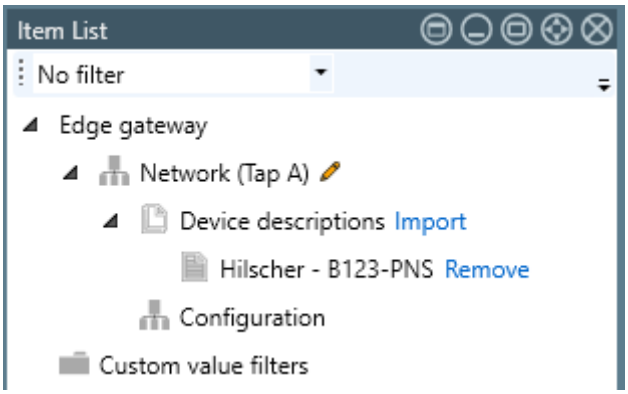


Figure 43: Imported device description within the item list of the Passive Fieldbus Configurator (Example)

4.2.5 Step 5 - Manual configuration of PROFINET IO-Controller and -Devices

All devices of the PROFINET network (PROFINET IO-Controller and IO-Devices) must now be configured manually. Proceed as follows:

Configuring Controller / IO-Controller

The element IO-Controller is the root element of the configuration tree. Therefore, it is the first element of this tree to be configured. Proceed as follows:

➢ Open the context menu. Right-click at **Configuration** within the element list.

➮ The context menu appears.

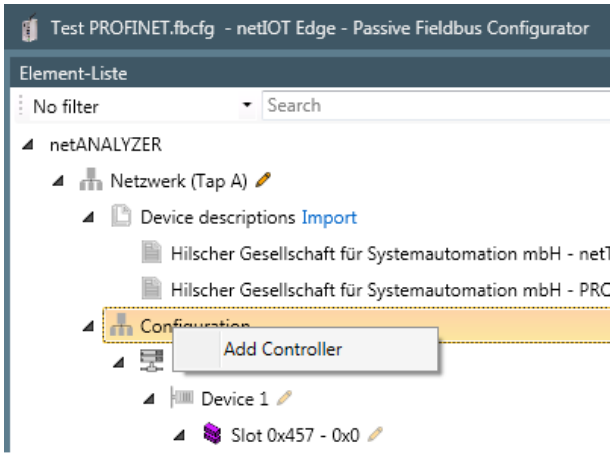


Figure 44: Context menu entry “Add controller”

➢ Choose the only menu entry **Add controller**.

➮ The controller assistant is opened:

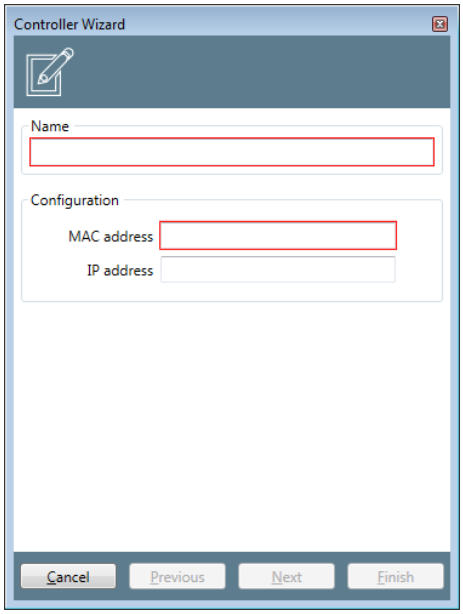


Figure 45: Controller assistant

- ➢ Enter the name of your PROFINET IO-Controller into the field **Name**. This field is mandatory.
- ➢ Enter the MAC address of the PROFINET IO-Controller into field **Name**. This field is mandatory.
- ➢ Click at **Finish**.
- ⇨ Now, the controller is configured.

Configuring Device / IO-Device

One or more IO devices are subordinated to an IO controller. In order to configure these, proceed as follows:

- ➢ Open the context menu. Rightclick at the IO controller within the element list
- ⇜ The context menu appears.

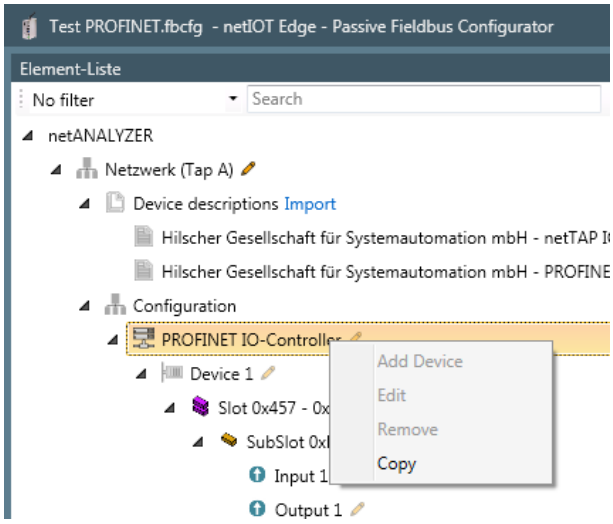


Figure 46: Context menu entry "Add device"

- ➢ Select the entry **Add device**
- ⇜ The device assistant is opened:

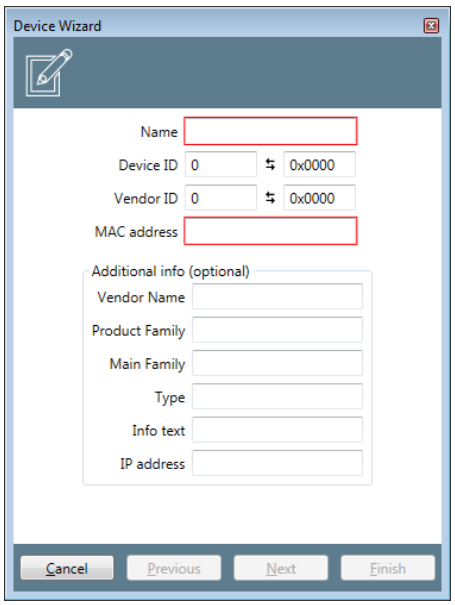


Figure 47: Device assistant

- ➢ Enter the name of the device (*NameOfStation*) into the field **Name**. The device name must be unique within the network. This field is mandatory.
- ➢ Enter the Device ID into the field **Device ID**. The Device ID is a unique identification number for the device. This field is mandatory.
- ➢ Enter the Manufacturer ID into the field **Manufacturer ID**. The Manufacturer ID is a unique identification number which is assigned to the manufacturer by the PNO ,
  This field is mandatory.
- ➢ Enter the MAC address of the device into the field **MAC address**. The MAC address consists of six two-digit hexadecimal values separated by colons. This field is mandatory.
- ➢ Click at Finish.
- ⇨ Now, the IO device is configured.

To configure a module within the device configuration, perform the following steps:

Configure module

One or more modules are subordinated to a device. In order to configure these, proceed as follows:

- ➢ Open the context menu. Rightclick at the IO Device within the element list
- ⇜ The context menu is opened.

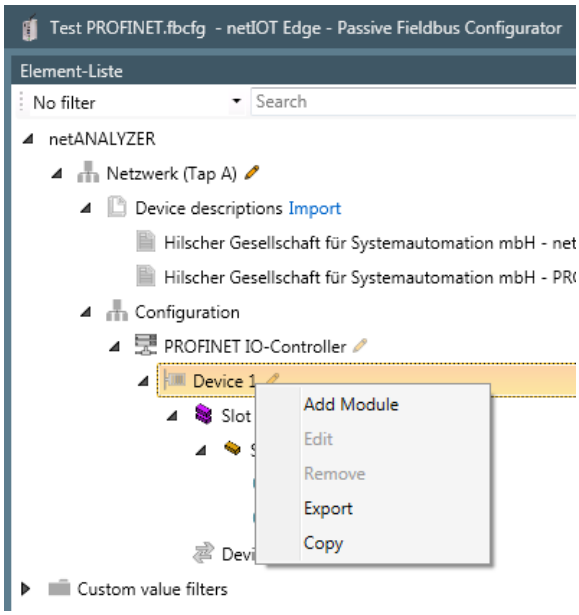


Figure 48: Context menu entry "Add module"

➢ Select the entry **Addodule**

⇨ The module assistant is opened.

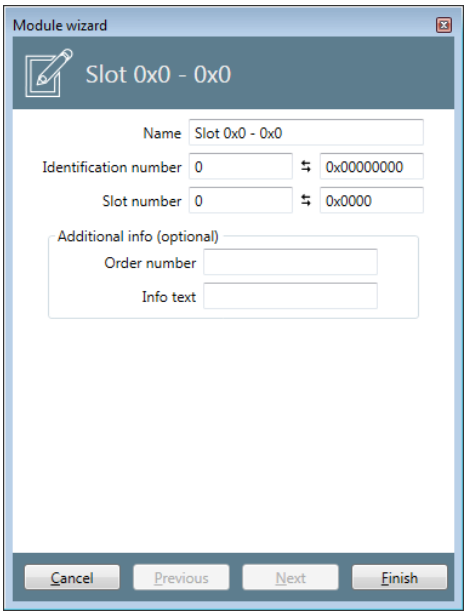


Figure 49: Module assistant

➢ Specify the desired name of the module in the field **Name**. This name can freely be chosen, however, it may not be empty.

➢ Specify the identification number of the module of your PROFINET device in the field **Identification number** either in decimal format in the left input field or in hexadecimal format in the right input field..

➢ Specify the slot number in the field **Slot number** either in decimal format in the left input field or in hexadecimal format in the right input field..

➢ The other fields are optional.
You can specify the order number in field **Order number**.
An additional descriptive Text can be specified in field **Infotext**.

➢ Click at **Finish**.

⇨ Now, the module is configured.

To configure a submodule within the device configuration, perform the following steps:

Configure submodule

One or more submodules are subordinated to a module.

➢ Open the context menu. Rightclick at the module within the element list.

⇘ The context menu is opened.

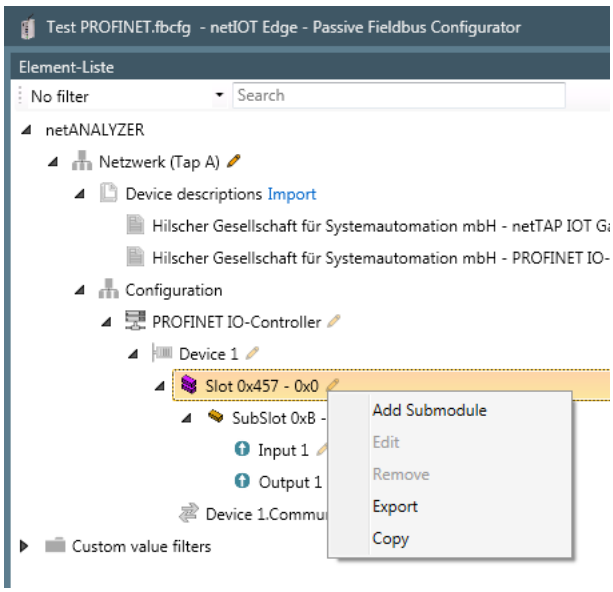


Figure 50: Context menu entry "Add submodule"

➢ Select the entry **Add submodule**

⇨ The submodule assistant is opened.

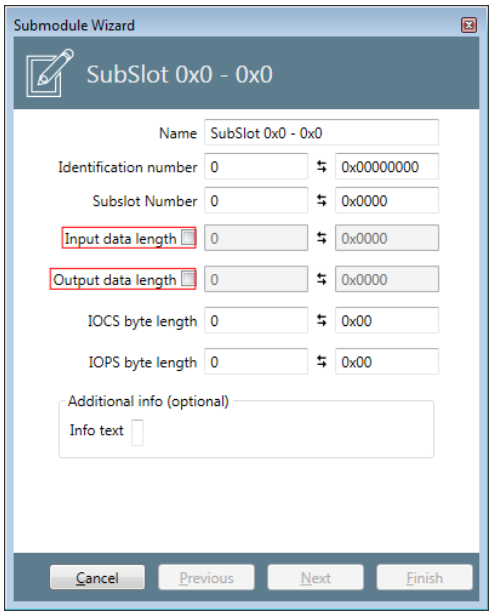


Figure 51: First page of dialog "Submodule assistant".

➢ Specify the desired name of the submodule (subslot) in the field **Name**.

➢ Specify the identification number of the submodule of your PROFINET device in the field **Identification number** either in decimal format in the left input field or in hexadecimal format in the right input field..

- Specify the subslot number in the field **Subslot number** of your PROFINET device either in decimal format in the left input field or in hexadecimal format in the right input field..
- Specify whether the submodule holds input and/or output values by checking the according checkboxes and specify the according data length in bytes.

Note:
At least one of the two input fields Input data length and Output data length must be checked. For submodules working bidirectionally, both directions have to be selected.

- Specify the length of the IOCS byte within the field **IOCS byte length** either decimally in the left input field or hexadecimally in the rightinput field.
- Specify the length of the IOPS byte within the field **IOPS byte length** either decimally in the left input field or hexadecimally in the rightinput field.

The following specification is optional.

- Here you can specify additional info text.

In order to proceed to the second page of the submodule assistant,click at **Continue**.
The following dialog appears:

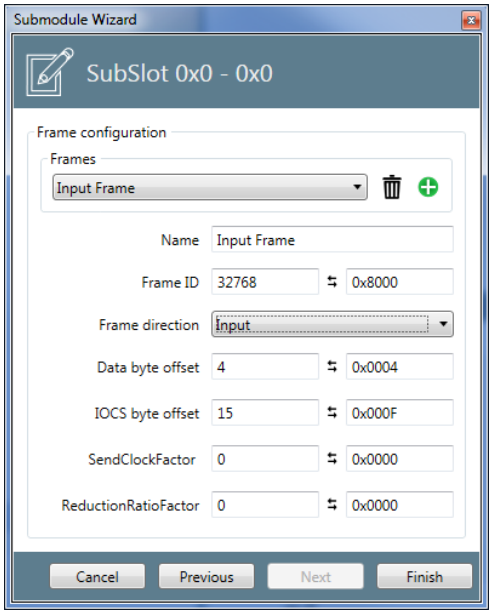


Figure 52: Second page of dialog "Submodule assistant".

This page offers the possibility to specify the following parameters concerning the frame configuration:

The selection list *Frames* enables specifying of multiple process data frames, for instance one for the each data direction (input and output) at bidirectional submodules.

By clicking at the green plus symbol it is possible to specify information for an additional frame. Vice versa, the currently selected frame wiothin the list can be deleted with all related information by clicking at the "trashcan" symbol.

For each frame, the following frame-related information can be stored here:

- Specify a freely selectable name for the frame in field **Name**. The default name to be used when a new frame is generated is *Empty Frame*.
- Specify the frame ID in the field **Frame ID** either in decimal format in the left input field (Range of values `0…65535`) or in hexadecimal format in the right input field (Range of values `0…0xFFFF`).
- Specify te data direction of the frame in field **Frame direction**. You can select between these frame directions:
  - Input
  - Output
- Specify the offset of the data byte in field Data byte offset either decimally in the left input field (Range of values `0…65535`) or hexadecimally in the right input field (Range of values `0...0xFFFF`).
- Specify the offset of the IOCS byte in field **IOCS byte offset** either decimally in the left input field (Range of values `0…65535`) or hexadecimally in the right input field (Range of values `0...0xFFFF`).
- Specify the *SendClockFactor* in the field **SendClockFactor** either in decimal format in the left input field (Range of values `0…65535`) or in hexadecimal format in the right input field (Range of values `0…0xFFFF`).
- Specify the *ReductionRatioFactor* in the field **ReductionRatioFactor** either in decimal format in the left input field (Range of values `0…65535`) or in hexadecimal format in the right input field (Range of values `0…0xFFFF`).

1. In order to store the configured device/module/submodule you have entered within this dialog:
   - Click at *Finish*.
   - ⇨ The entered configuration data for the device/module are stored within the project.

   If for any reason you do not want to store the data, you can leave the dialog by clicking at *Cancel*.

   There are two possibilities to configure a variable within the device configuration. Either you can load a GSDML file describing this variable or you perform the following steps:

Configure variable

One or more variables are subordinated to a submodule. In order to configure these variables, proceed as follows:

➢ Open the context menu. Rightclick at the submodule within the element list

➢ The context menu is opened.

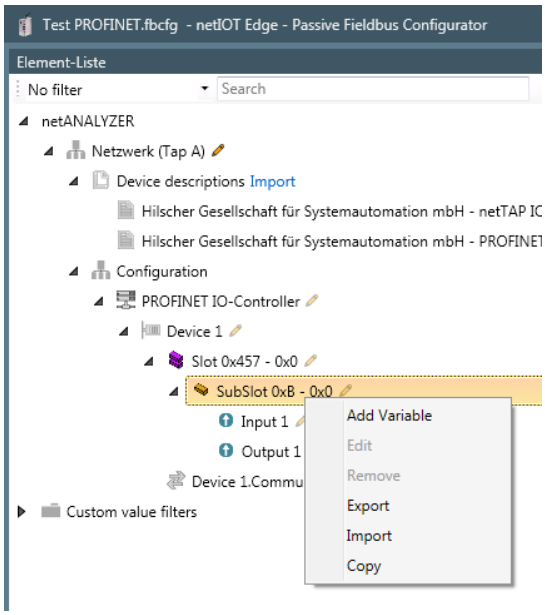


Figure 53: Context menu entry "Add variable"

➢ Select the entry **Add variable**

➢ The variable assistant is opened:

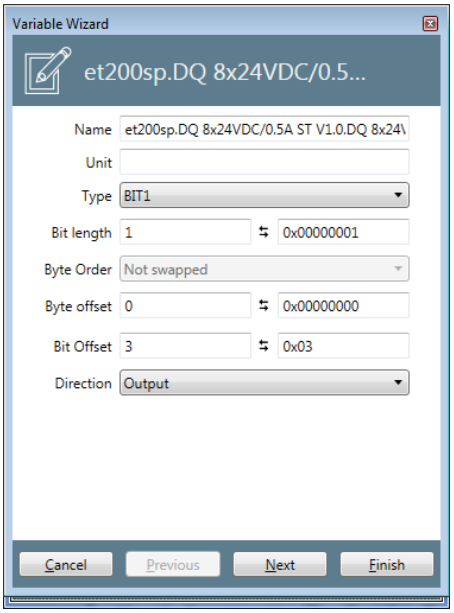


Figure 54: Variable Wizard - first page (Parameter)

Within the **Variable Wizard**, the following specifications concerning the configuration are made:

Name

➢ Specify the name of the variable here. This field is mandatory. As long as no input hs been done, a red frame is displayed around the input field **Name** and the button *Finish* is deactivated and grayed out.
This nameis also displayed in the variable area within the block *Variable Info*, see section „Variable area“.

Unit

➢ This field contains the unit to be applied to the variable. The field is optional and purely informative.

Type

➢ Specify the datatype of the variable here. This field is mandatory.

Note:
List of suitable datatypes
A list of suitable datatypes can be found at Supported Data Types.

➢ The length of the data type specified under **Type** given as number of bits. Specify this length either in the left input field decimally or in the right input field hexadecimally.
This value depends on the choice at **Type**. At every selection of the type, the maximum allowed value matching the length of the data type in bits, is used as default value. However, you can also selct lower values. In such a case, the remaining bits are extended up to the full datatype also taking into account the sign, if necessary.
This field is mandatory.

Byte order

➢ Specify here, whether the order of bytes within a word shall be swapped *Swapped* or not(*Not swapped*). This field is mandatory.

➢ This data field contains the offset of the variable to the beginning ogf the IO Data Object in the PROFINET Frame given as number of bytes.
This field is mandatory.

Bit offset

➢ This data field contains the number of bits which the variable has been shiftted at the beginning of the IO Data Object. A non-negative value between 0 and 7 has to be specified here.

Direction

➢ This selection list allows you to select the signal direction to be applied. Applicable options are:

- Input
- Output

The signal direction is also displayed within the variable area. This field is mandatory

➢ Click at *Next*.

➢ The second page of the dialog *Add variable* appears:

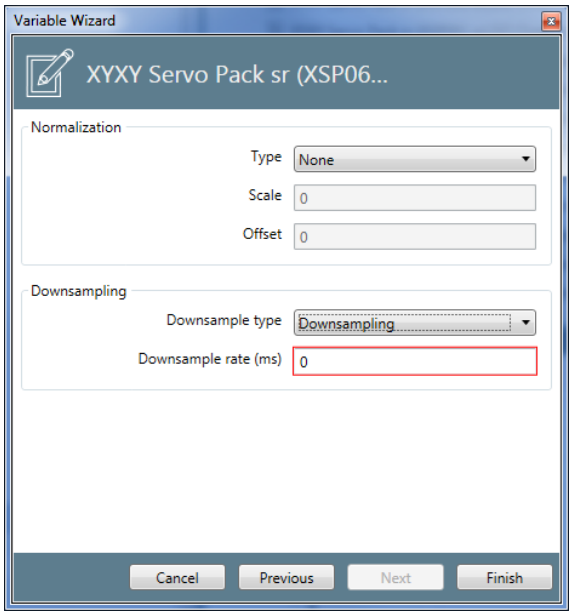


Figure 55: Dialog Variable Wizard - third page (Normalization/Downsampling)

On this page you can specify how to normalize the measured data.

The fields in dialog **Variable Wizard** have the following meaning:

Type

Here select the normalization type of the list.
If the option *None* is chosen, the values Scale and Offset are set to 0 and thus no normalization of the measured data takes place. Otherwise, it is possible to perform a user-defined normalization using the fields **Scale** and **Offset**.
During this normalization, the initial value is first multiplied with the factor Scale and then the Offset is added to the product.

Scale

Specify the factor Scale for the user-defined normalization here.

Offset

Specify the offset for the user-defined normalization here:

➢ Click at **Finish** in order to display the configured variable in your project.

⇨ The entered configuration data for the variable are stored within the project.

Downsampling area

This area contains the specifications for performing downsampling in the Passive Fieldbus Configurator.

Selection list *Downsample Type*

The following options are provided by selection list **Downsample Type**.

Option	Description
Switched off	No downsampling of data occurs. All data values are acquired by the network at their individual cycle.
Only on change	In this setting, acquired data will be transferred to the subsequent processing only if changes occur.
Downsampling	If downsampling has been activated, the data are regularly sampled after a defined time interval (the downsampling rate) and only those sampled values are transferred to subsequent processing. This time interval is specified in input field **Downsample Rate**.

Input field *Downsample-Rate*

If the Downsample Type Downsampling has been selected, in this input field the downsample rate can be specified in units of milliseconds. The allowed range of values extends from 1 to 1000 Milliseconds. See the following figure.

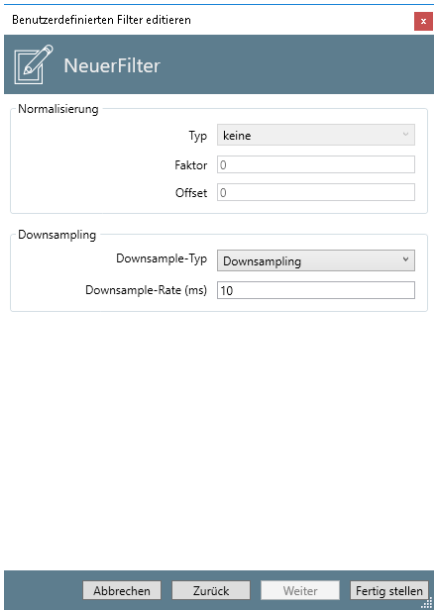


Figure 56: Edit custom value filter – Downsampling-Type and -Rate

4.2.6 Step 6 - Signal configuration

In order to activate a signal, proceed as follows:

➢ Within the Passive Fieldbus Configurator, drag the signal from the element list window into the window „Signal configuration“.

↬ In window "Signal configuration", a new entry with the name of the signal is displayed There you can also decide whether the processing of this signal shall be continued by transferring it to OPC UA or Node-RED.

Note:
In order to reduce CPU time and memory consumption on the Edge Gateway only choose those methods for continuation of processing, which you really need in your specific application.

↬ The entry with the name of the signals within the element list still remains there, but it is now protected against editing and erasure, i.e. the respective context menu functions are grayed out and deactivated.

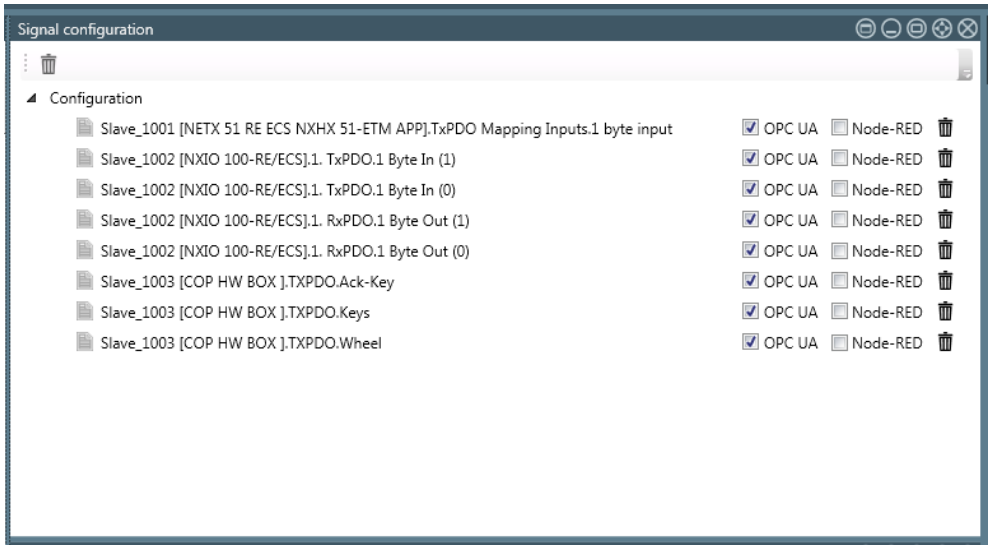


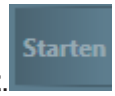
Figure 57: Window "Signal configuration" of the Passive Fieldbus Configurator.

➢ Configure the signals in the window **Signal configuration** of the Passive Fieldbus Configurator. By checking the checkbox, you can separately determine for each single PROFINET IO signal, whether the acquired data shall be fetched from the Edge Gateway by OPC-UA or transferred into the cloud by Node-RED. whether

4.2.7 Step 7 - Check Signals in the Live-Data View

This step is optional. Viewing signals within a live-data window is recommended if you want to check whether a specific signal has been configured correctly

Proceed as follows to start recording the PROFINET network traffic:

- Within the side menu of Passive Fieldbus Configurator (right side), click at button **Start**. 

- Drag all signals intended to be viewed in the window **Live Data** one by one with the mouse button pressed down from the element list into the right part **Buckets** of the **Live Data** window.

⇨ The data acquisition within the Passive Fieldbus Configurator has been started. In the Live View window you can watch the signals and tune your configuration if necessary.

4.2.8 Step 8 - Storing the generated configuration file (PROFINET)

- Create a configuration file (i.e. a project file) for your PROFINET project using the Passive Fieldbus Configurator. Store this file via **Project > Save** within the main menu before finishing working with the Passive Fieldbus Configurator .

⇨ You have now created a project file for the configuration of your PROFINET network within the passive mode of the Edge Gateway. In section *Uploading the project file to the Edge Gateway* [page 113] uploading of this file onto the Edge Gateway and activating it is described.

4.3 EtherCAT (automatic)

This section describes step-by-step the commissioning of the passive process data acquisition of the Edge Gateway in an EtherCAT network using an ENI file.

In the following description eight steps explain how you can create a project file for passive process data acquisition with the Edge Gateway in your EtherCAT network (Steps1 to 7) without any manual slave configuration and upload this project file into the Edge Gateway then (Step 8, see separate description *Uploading the project file to the Edge Gateway* [page 113]).

Contrary to the PROFINET configuration, the EtherCAT configuration can be done offline, i.e. without connection to the Edge Gateway.

The following figure shows the wiring diagram related to this step-by-step instruction. The Edge Gateway is wired as passive access point between EtherCAT Master and the first EtherCAT Slave in order to capture the network communication between those completely.

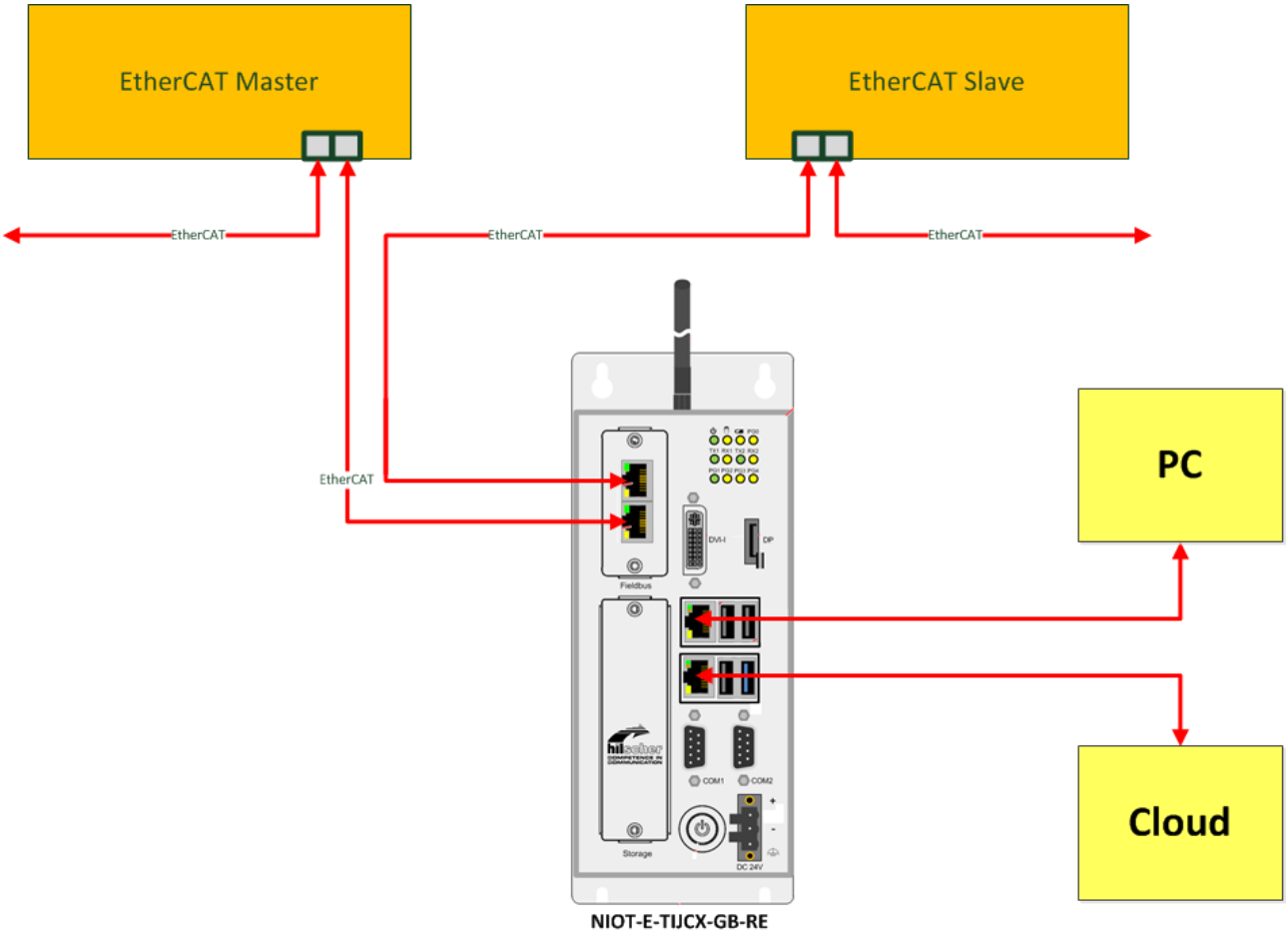


Figure 58: Wiring diagram for passive process data acquisition with the Edge Gateway NIOT-E-TIJCX-GB-RE in EtherCAT networks

The following prerequisites must be fulfilled for the EtherCAT configuration.

1. The software Passive Fieldbus Configurator must be installed on a PC, from which network access to the Edge Gateway can be accomplished. If this is not the case, install it according to the installation instructions.
2. The IP address of the Edge Gateway to be used must be known.
3. A suitable ENI-File for your EtherCAT project must be present.

Note:
ENI files from TwinCAT are supported. ENI files from other Engineering Tools can only be read if these contain detailed descriptions of the RxPDOs and TxPDOs. At Codesys the ENI file uses other bus addresses as they have been parameterized on the network. For affected versions of Codesys, the bus addresses must be manually adapted within the Passive FB Configurator after importing the ENI files. See .

If there is no suitable ENI file present, a manual configuration can be made, see *EtherCAT (manual)* [page 69].

4.3.1 Step 1 - Program start

➢ Start the Passive Fieldbus Configurator on your PC, for example via the entry **netIOT – Passive Fieldbus Configurator** in the Windows start menu or by double-clicking at the icon **netIOT - Passive Fieldbus Configurator**.

⇨ The entry screen of the Passive Fieldbus Configurator is displayed:

4.3.2 Step 2 - Creating an empty project

➢ Build a new project within the Passive Fieldbus Configurator by selecting
Create->New within the introductory menu..

⇨ The (still empty) GUI of the Passive Fieldbus Configurator is displayed.

4.3.3 Step 3 - Adjust basic settings of the Passive Fieldbus Configurator.

The Passive Fieldbus Configurator requires the following basic settings:

- Setting of IP address
- Setting ofSetting of network speed

To do so, proceed as follows:

➢ Open the main menu. in order to do so, click at button **Menu** within the side menu located at the right side.

Figure 59: Side menu

➢ The main menu is opened.

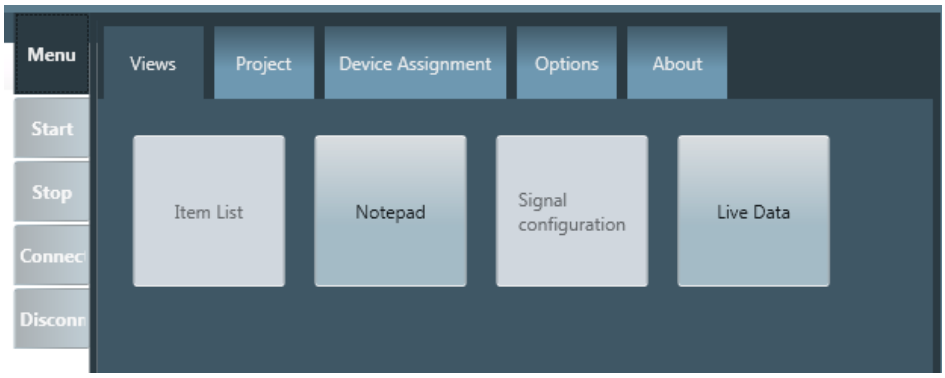


Figure 60: main menu - Register card "Views"

➢ Select the register card **Device assignment**.

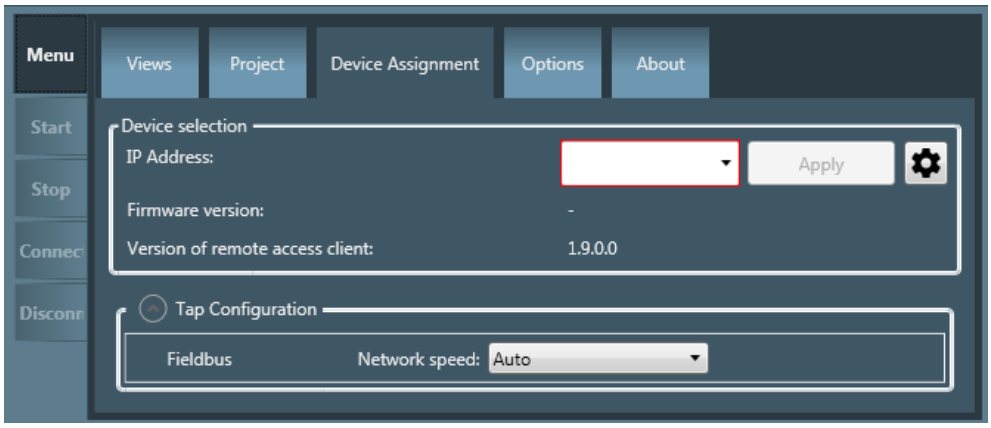


Figure 61: main menu - Register card "Device assignment"

In order to establish a connection with the Edge-Gateway, the IP address of the Edge-Gateway must be assigned to the software. This reqires the Gateway being in the passive mode of operation. Proceed as follows:

➢ Select the IP addresss of the Edge-Gateway to connect with from the selection list **IP Address** in the **device selection** area. If this list is still empty yet or the IP address of the Edge Gateway is missing in it, specify the IP address within the input field or click at the cog wheel symbol  at the right and specify the IP address in the dialog box which will appear. This IP address must comply with the valid rules for specifying IP adresses.

➢ Click at 

.

↬ Finally, the connection with the according Edge Gateway has been established.

As described in the following, you can check whether a connection to the Edge Gateway has been established:

1. In the field Firmware Version the version number of the currently installed firmware of the Edge Gateway is displayed.
2. The status display in the right part of the lower status bar of the Passive Fieldbus Configurator changes from blue indicating status *Idle* to yellow indicating status *Stopped*.
3. In the left part of the status bar now statistic information concerning the Ethernet data traffic and zthe interface configuration are displayed.
4. The formerly grayed ot menu entry **Connect** is activated.

Otherwise the following error message will appear:

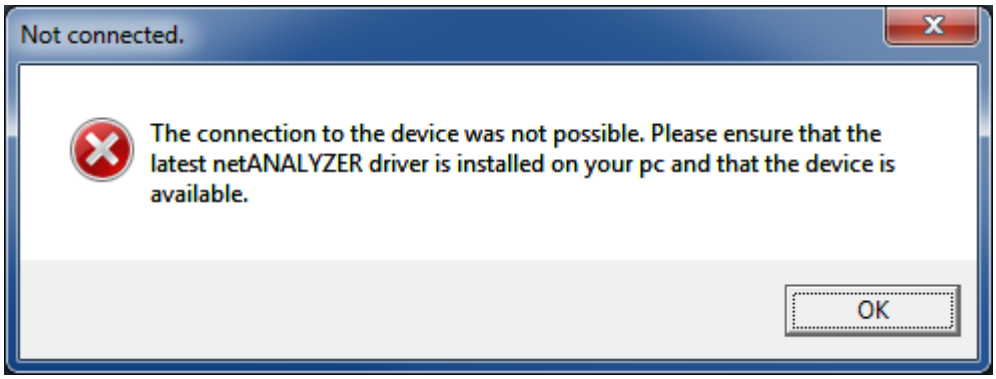


Figure 62: Error message "The connection to the device was not possible"

The most probable cause of this error message is the Edge Gateway not being in the configuration mode of the passive mode of operation!

Note:
For more information concerning the solution of this problem see section *Error handling* [page 116].

➢ In order to adjust the network speed, select the network speed from the selection list **Network speed** in the area **TAP configuration**

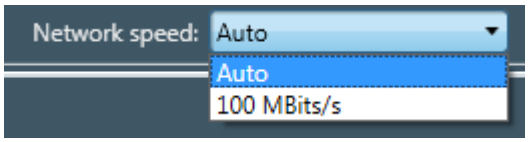


Figure 63: Selection list Network speed

For the network speed, the following settings are applicable:

Setting	Meaning
Auto	Automatic determination of network speed Select this option if using the Edge Gateway as Software TAP.
Possible value are Auto, 10 MBit/s and 100 MBit/s.	Fixed network speed of 100 Mbit/s Select this option if working with an additional Hardware TAP.

Table 9: Settings for network speed

4.3.4 Step 4 - Upload the ENI file

How to load an ENI file with the device description of your EtherCAT-Master and the connected EtherCAT-Slaves into the Passive Fieldbus Configurator (ENI = EtherCAT Network Information):

➢ Right-click at **Network (Tap A)**.

➢ The context menu is opened.

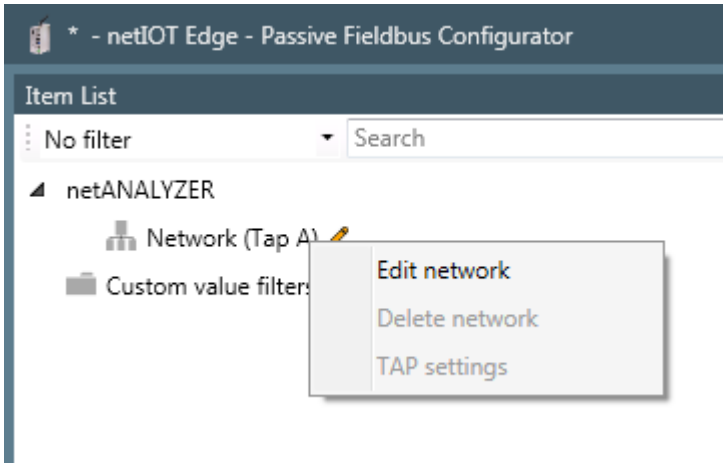


Figure 64: Context menu at network level

➢ There select the topmost entry **Edit network**.

➢ The first page of the Network Wizard for EtherCAT is opened.

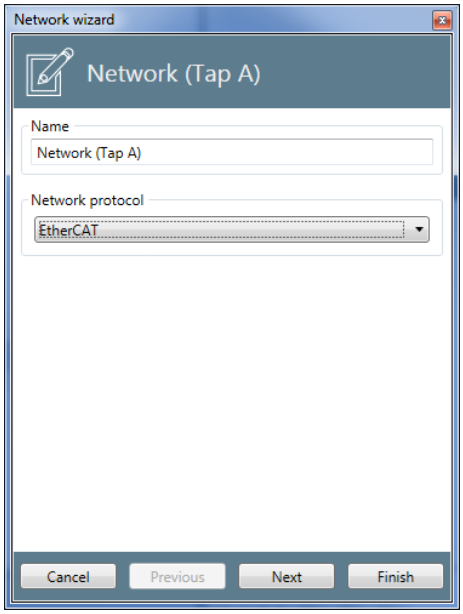


Figure 65: First page of the Network Wizard for EtherCAT

➢ Within the network wizard, select EtherCAT as network protocol.

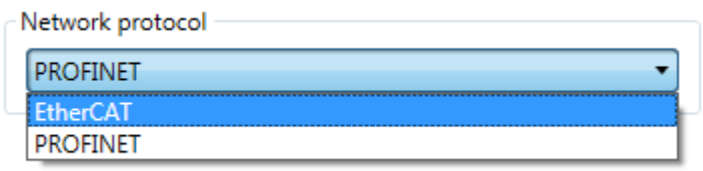


Figure 66: Selection of network protocol

➢ Click at **Next**.

➢ The second page of the Network Wizard for EtherCAT is opened.

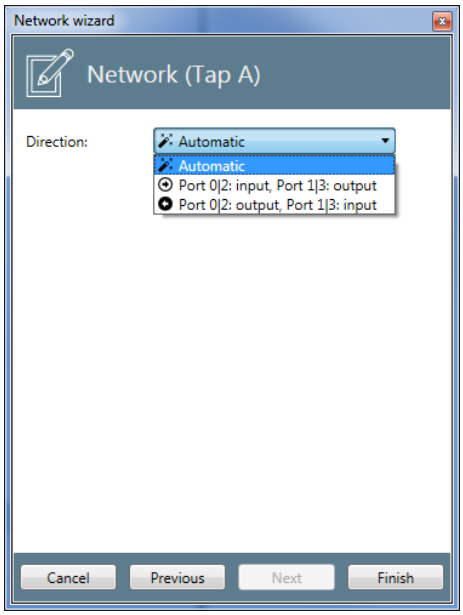


Figure 67: Second page of the Network Wizard for EtherCAT

➢ In the selection Direction the data direction of the EtherCAT network can be configured.

Option	Meaning
`Automatic`	The recognition of the data direction is done automatically. Select this option by default. If you apply a Hardware-TAP, automatic recognition of the data direction is necessarily required.
`Port 0|2 input, Port 1|3 output`	The side of the network close to the PLC is connected to the upper RJ45 connector of the field bus interface (Port 0). By the selection of a fixed direction the decoding performance on the Edge Gateway is increased. Select this option if not using an additional Hardware TAP.
`Port 0|2 output, Port 1|3 input`	The side of the network close to the PLC is connected to the lower RJ45 connector of the field bus interface (Port 1). By the selection of a fixed direction the decoding performance on the Edge Gateway is increased. Select this option if not using an additional Hardware TAP.

Table 10: Options for the data direction within an EtherCAT network

➢ Click at **Finish**.

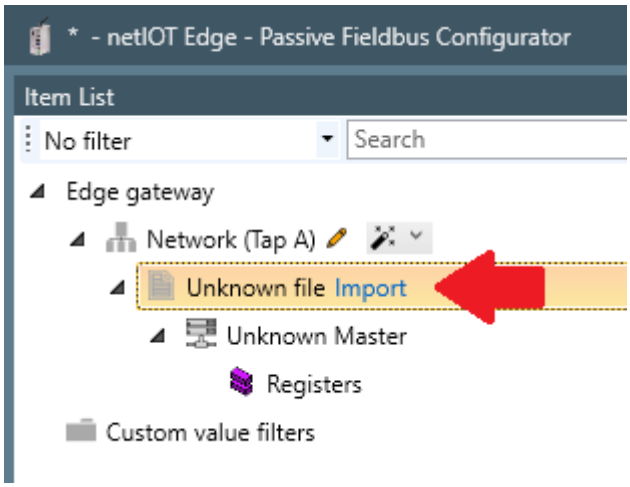


Figure 68: EtherCAT Import

➢ Click at **Import** (right beside **Device descriptions**).

↬ A dialog for selcting the ENI file is displayed.

➢ Select the ENI file for your EtherCAT device there.

⇨ The device descriptions contained within the ENI file are imported and integrated into the structure tree within the element list of the Passive Fieldbus Configurator.

4.3.5 Step 5 - Signal configuration

In order to activate a signal, proceed as follows:

➢ Within the Passive Fieldbus Configurator, drag the signal from the element list window into the window „Signal configuration“.
To do so, check the signal(s) in window Element List and keep the mouse button pressed while moving the mouse cursor to the window "Signal configuration". The figure below shows the state before releasing the mouse button. The red line is used only for clarification.

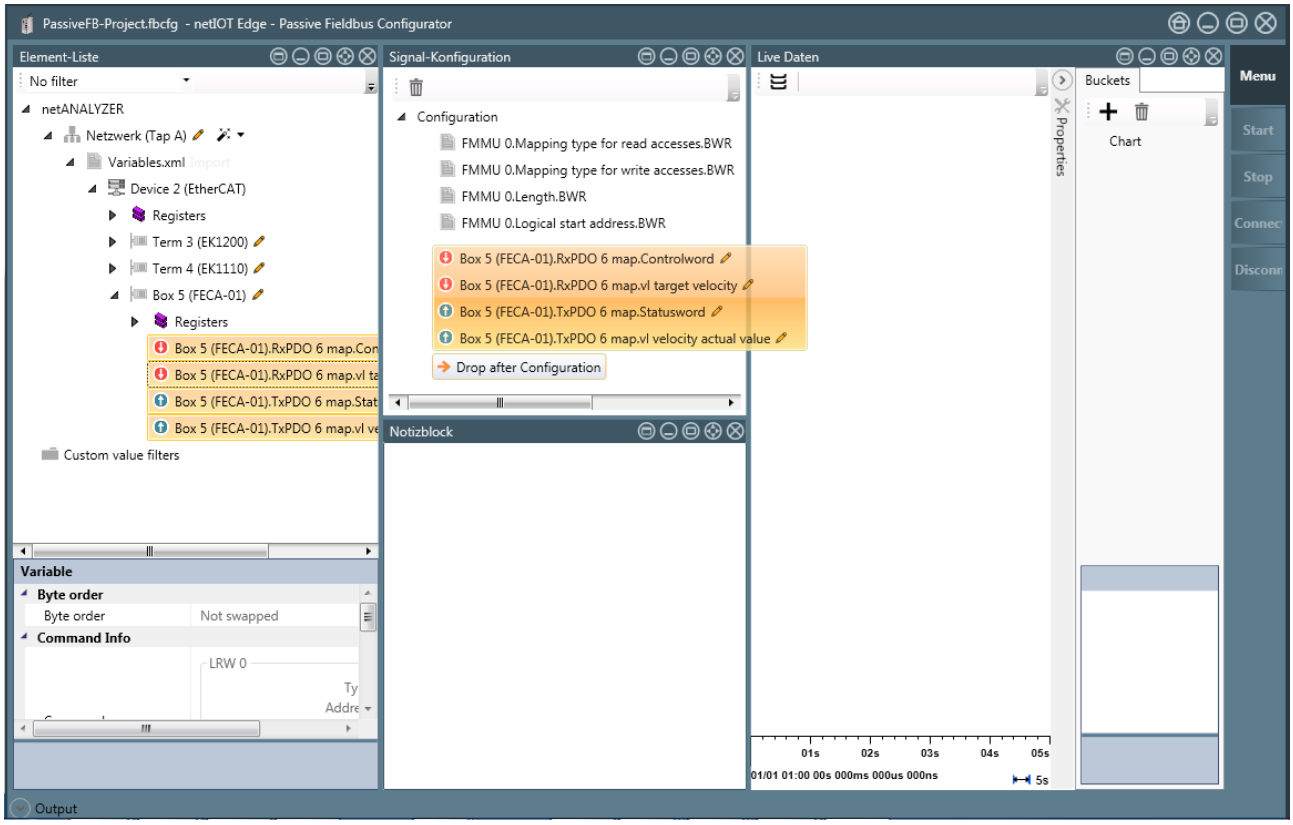


Figure 69: Signal configuration - during Drag&Drop

➢ If the mouse button is released, a new entry with the name of the signal is displayed in window „Signal configuration“.

The entry with the name of the signals within the element list still remains there, but it is now protected against editing and erasure, i.e. the respective context menu functions are grayed out and deactivated.

➢ Configure the signals in the window **Signal configuration** of the Passive Fieldbus Configurator. In window "Signal configuration", a new entry with the name of the signal is displayed. For each single EtherCAT signal, you can also decide there, whether the acquired data shall be fetched from the Edge Gateway by OPC-UA or transferred into the cloud by Node-RED.

Note:

In order to reduce CPU time and memory consumption on the Edge Gateway only choose those methods for continuation of data processing, which you really need in your specific application.

4.3.6 Step 6 - Check Signals in the Live-Data View

This step is optional. However, it allows a quick and easy check whether a signal has been configured correctly.

The Live Data window consists of a display area on the left side, which can be separated into some stacked parts (Buckets), and of an area on the right side only containing a register card buckets that lists the current signals and their assignment to these areas (Buckets)

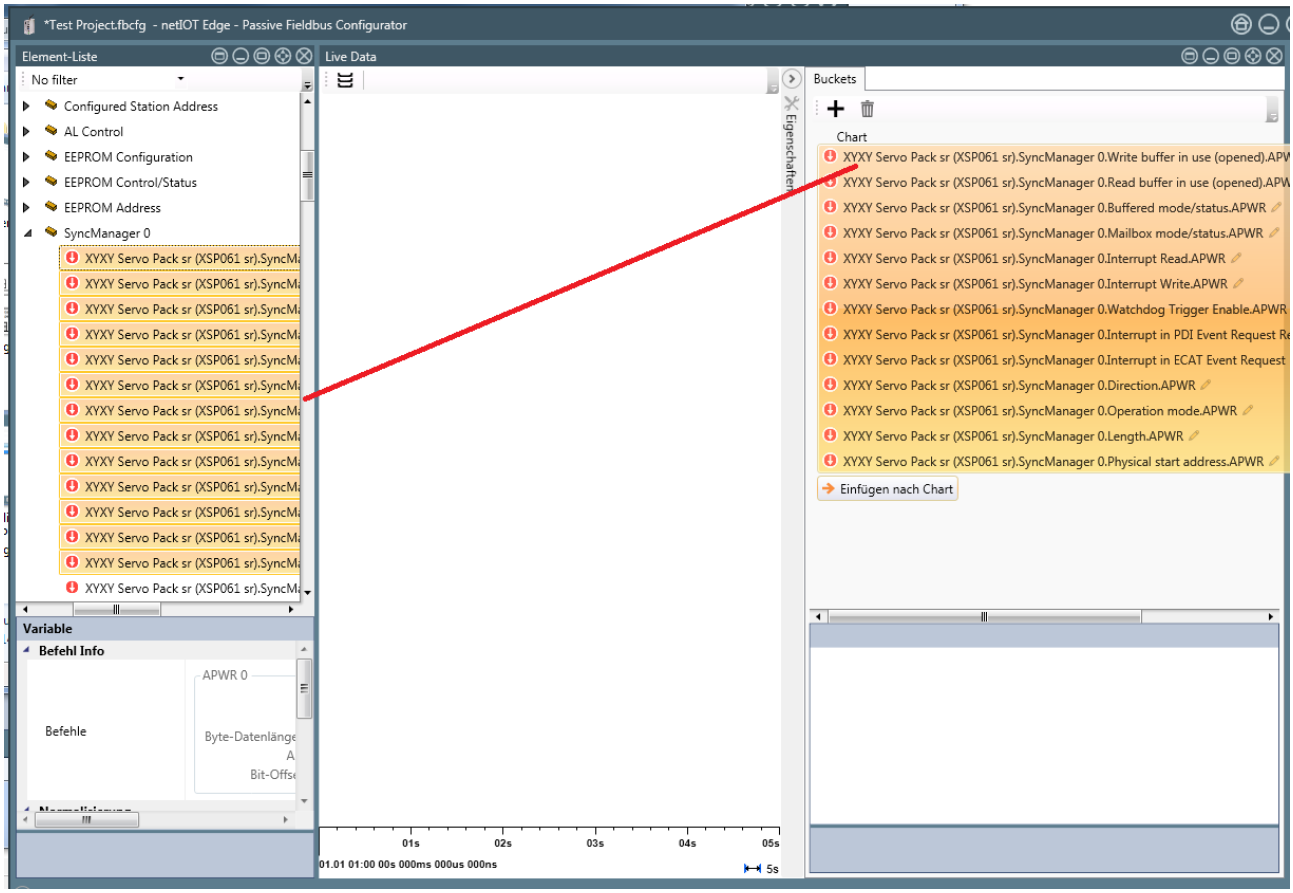


Figure 70: Adding signals to the Live Data window

To view and record arbitrary signals of your choice within the live data window, start recording as follows:

➢ Drag all signals intended to be viewed in the window **Live Data** one by one with the mouse button pressed down from the element list into the right part **Buckets** of the **Live Data** window.

➢ The data acquisition within the Passive Fieldbus Configurator has been started. In the Live View window you can watch the signals and tune your configuration if necessary.

4.3.7 Step 7 - Storing the generated configuration file (EtherCAT)

- ➢ Create a configuration file (i.e. project file) for your EtherCAT project using the Passive Fieldbus Configurator. Store this file via **Project > Save**within the main menu before finishing working with the Passive Fieldbus Configurator .
- ⇨ You have now created a project file in the `*.fbcfg` format for the configuration of your EtherCAT network within the passive mode of the Edge Gateway. In section *Uploading the project file to the Edge Gateway* [page 113] uploading of this file onto the Edge Gateway and activating it there is described.

4.4 EtherCAT (manual)

this section describes themethod for **manually** commissioning the passive process data acquisition with the Edge Gateway in EtherCAT networks.

This method is especially suited if no ENI file for your EtherCAT network is present. This means, all devices of the EtherCAT network have to be configured manually.

The following figure shows the wiring diagram related to this step-by-step instruction. The Edge Gateway is wired as passive access point between EtherCAT Master and the first EtherCAT Slave in order to capture the network communication between those completely.

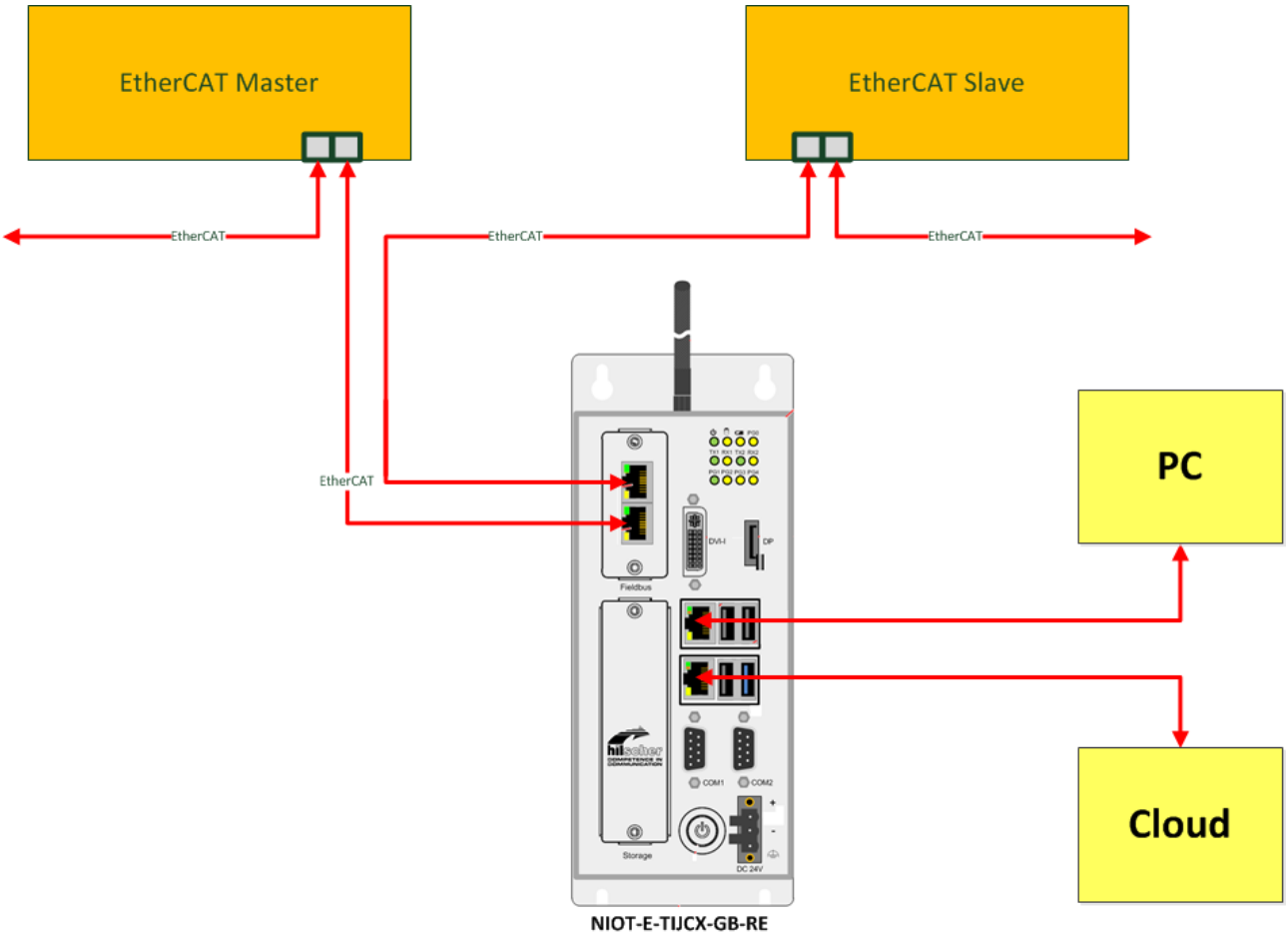


Figure 71: Wiring diagram for passive process data acquisition with the Edge Gateway NIOT-E-TIJCX-GB-RE in EtherCAT networks

In the following description nine steps explain how you can create a project file for passive process data acquisition with the Edge Gateway in your EtherCAT- network (Steps1 to 8) and upload this project file into the Edge Gateway then (Step9, see separate description *Uploading the project file to the Edge Gateway* [page 113]).

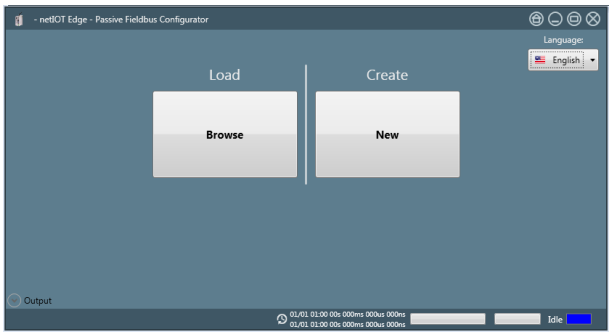
For this, the following prerequisites must be fulfilled:

1. The Passive Fieldbus Configurator has to be installed on a PC that allows you to access to Edge Gateway via the netwok. If this software is not installed yet, then install it according to the installation instruction first.
2. You have to know the IP address of the Edge Gateway.

4.4.1 Step 1 - Start the Passive Fieldbus Configurator.

➢ Start the Passive Fieldbus Configurator on your PC, for example via the entry **netIOT – Passive Fieldbus Configurator** in the Windows start menu or by double-clicking at the icon **netIOT - Passive Fieldbus Configurator**.

⇨ The entry screen of the Passive Fieldbus Configurator is displayed:



4.4.2 Step 2 - Creating an empty project

➢ Build a new project within the Passive Fieldbus Configurator by selecting the right button
Create->New within the introductory menu..

➮ The (still empty) GUI of the Passive Fieldbus Configurator is displayed.

4.4.3 Step 3 - Adjust basic settings of the Passive Fieldbus Configurator.

The Passive Fieldbus Configurator requires the following basic settings:

- Setting of network speed

To do so, proceed as follows:

➢ Open the main menu. in order to do so, click at button **Menu** within the side menu located at the right side.

Figure 72: Side menu

➢ The main menu is opened.

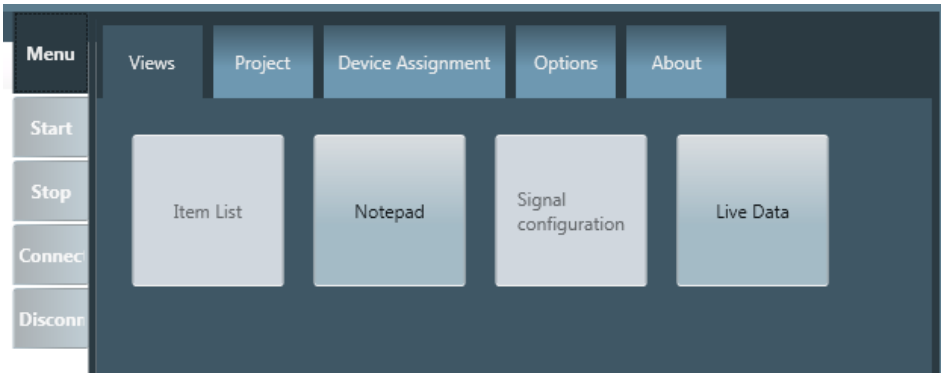


Figure 73: main menu - Register card "Views"

➢ Select the register card **Device assignment**.

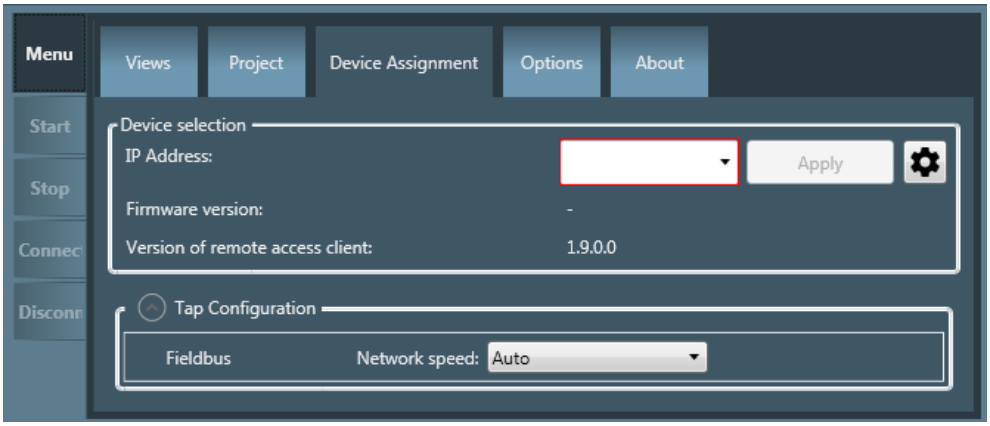


Figure 74: main menu - Register card "Device assignment"

The main menu of the Passive Fieldbus Configurator consists of two areas:

- the area Device selection (top)
- the area TAP Configuration (down)

The network speed is selected in the area **TAP configuration**.

➢ In order to adjust the network speed, select the network speed from the selection list **Network speed** in the area **TAP configuration**

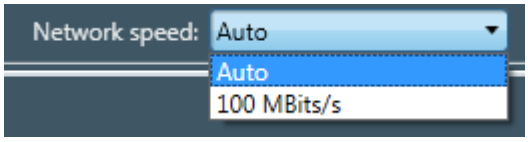


Figure 75: Selection list Network speed

For the network speed, the following settings are applicable:

Setting	Meaning
Auto	Automatic determination of network speed Select this option if using the Edge Gateway as Software TAP.
Possible value are Auto, 10 MBit/s and 100 MBit/s.	Fixed network speed of 100 Mbit/s Select this option if working with an additional Hardware TAP.

Table 11: Settings for network speed

4.4.4 Step 4 - Configuration of the Process Fieldbus Configurators for EtherCAT

So you configure the Process Fieldbus Configurators for EtherCAT

➢ Right-click at **Network (Tap A)**.

↬ The context menu is opened.

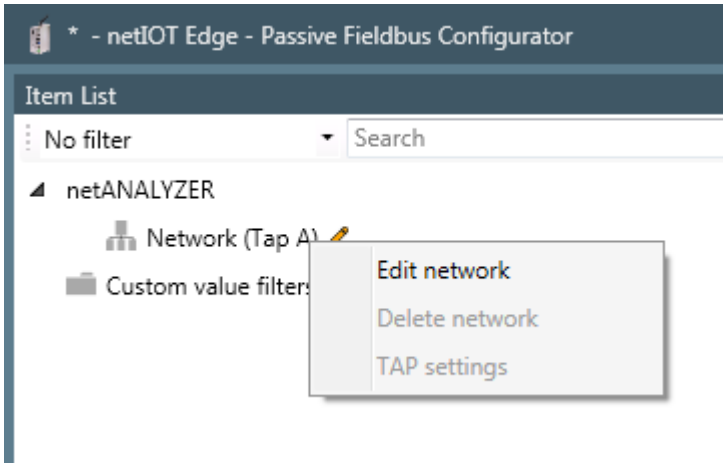


Figure 76: Context menu at network level

➢ There select the topmost entry **Edit network**.

↬ The first page of the Network Wizard for EtherCAT is opened.

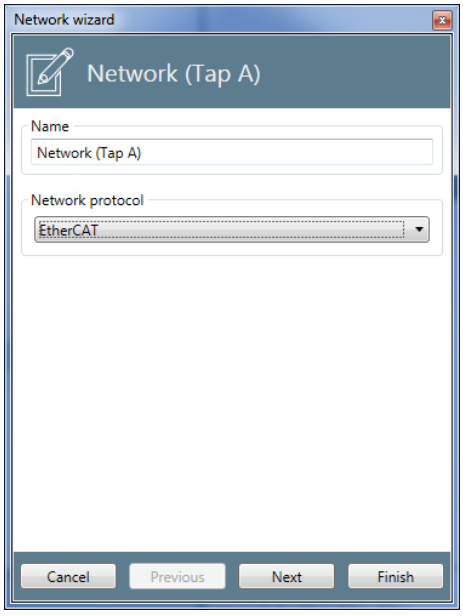


Figure 77: First page of the Network Wizard for EtherCAT

➢ Within the network wizard, select EtherCAT as network protocol.

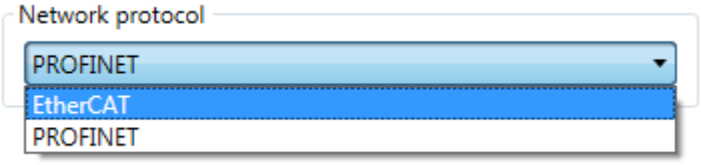


Figure 78: Selection of network protocol

➢ Click at **Next**.

↬ The second page of the Network Wizard for EtherCAT is opened.

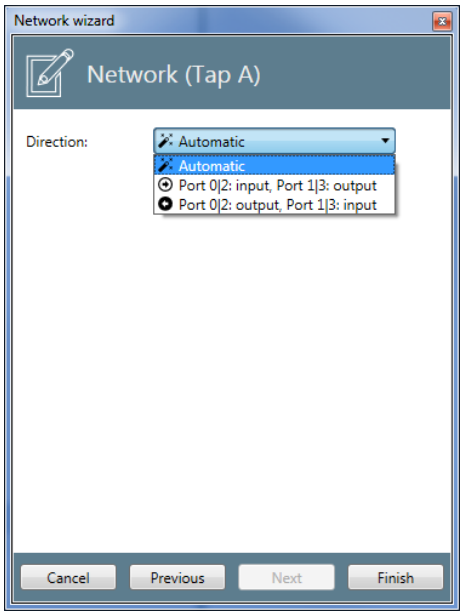


Figure 79: Second page of the Network Wizard for EtherCAT

➢ In the selection Direction the data direction of the EtherCAT network can be configured.

Option	Meaning
`Automatic`	The recognition of the data direction is done automatically. Select this option by default. If you apply a Hardware-TAP, automatic recognition of the data direction is necessarily required.
`Port 0|2 input, Port 1|3 output`	The side of the network close to the PLC is connected to the upper RJ45 connector of the field bus interface (Port 0). By the selection of a fixed direction the decoding performance on the Edge Gateway is increased. Select this option if not using an additional Hardware TAP.
`Port 0|2 output, Port 1|3 input`	The side of the network close to the PLC is connected to the lower RJ45 connector of the field bus interface (Port 1). By the selection of a fixed direction the decoding performance on the Edge Gateway is increased. Select this option if not using an additional Hardware TAP.

Table 12: Options for the data direction within an EtherCAT network

➢ Click at **Finish**.

4.4.5 Step 5 – Manual configuration of the EtherCAT network

If there is no ENI file present for the EWtherCAT network, all devices of the EtherCAT network must be configured manually. To do so, you have to model the network structure manually within the structure tree of the Passive Fieldbus Configurator, by performing both of the steps of work described in the following (if necessary, repeatedly), until all slave devices and variables are present.

1. Add a slave device to the network
2. Add variables to a master or slave device

Add a slave device

When manually defining a new slave, the configuration data must be entered via the dialog **Add slave**(Context menu entry **Add slave**). Bei der manuellen Definition eines neuen Slaves müssen die Konfigurationsdaten über den Dialog Slave einfügen eingegeben werden (Kontextmenü-Eintrag Gerät hinzufügen). Um ein Slave-Gerät im Strukturbaum innerhalb der Element-Liste des Passive Fieldbus Configurators hinzuzufügen und dessen Konfigurationsdaten manuell einzugeben, gehen Sie wie folgt vor:

➢ Within the element list, rightclick at the **Master** under which the variable shall be added.

➭ Open the context menu of the master.

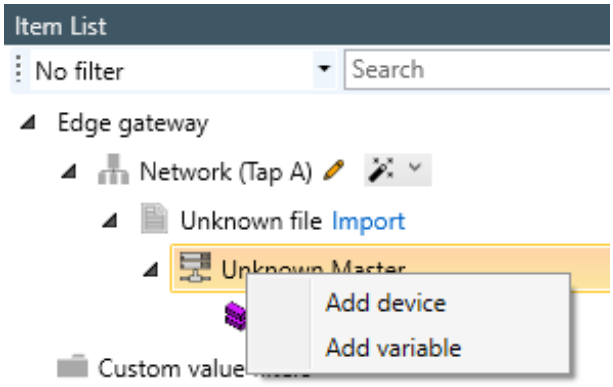


Figure 80: Context menu for EtherCAT Master

➢ Within the context menu, click at the entry **Add device**

➧ The first page of the dialog **Add slave** is opened.

Figure 81: Dialog „Add slave - first page (Name)"

➢ Under *Name* specify the name which shall identify the EtherCAT Slave device in future.

➢ Click at *Next*.

➧ The second page of the dialog **Add slave** is opened.

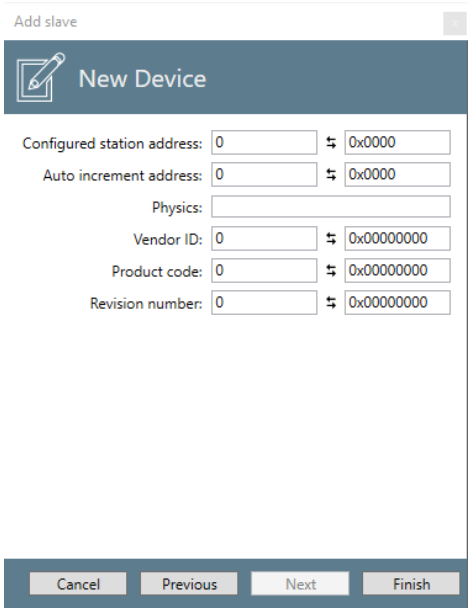


Figure 82: Dialog Add slave - second page"(Parameter)

Within the dialog **Add slave**, the following specifications concerning the configuration are made:

Configured station address

This address is used at the node addressing method. The value is entered decimally in the left input field or hexadecimally in the right input field. The allowed range of values for the configured station address extends from 0 to 0xFFFF.

Note:
For more information on the node addressing method, see the EtherCAT specification, Part 3, Section 4.8.3.3 "Node Addressing".

Autoincrement address

This address is used at the position addressing method. The value is entered decimally in the left input field or hexadecimally in the right input field. The allowed range of values for the configured station address extends from 0 to 0xFFFF.

Note:
For more information on the node addressing method, see the EtherCAT specification, Part 3, Section 4.8.3.2 "Position Addressing".

Physics

This parameter specifies the port type of the connection on the physical layer (i.e. on layer 1 of the OSI/ISO layer model of networking).

Up to four capital letters taken from the set `{B, F, K, Y}` characterizes the port typeof port 0 up to port 3 in this order.

The meaning of these letters is defined as follows:

Letter	Corresponding port type
Y	Ethernet Copper (100BaseTX)
F	Ethernet Fiber-optic (100BaseFX)
K	E-Bus Backplane
B	Reserved
Space	Not used

Table 13: Coding of parameter "Physics"

Vendor ID

This parameter represents the Vendor ID within the Identity Object of the EtherCAT Object Dictionary (Index 0x1018, Subindex 1).

The value is entered decimally in the left input field or hexadecimally in the right input field. The allowed range of values for Vendor ID extends from 0 to 0x7FFFFFFF (`0` up to `2.147.483.647`).

Product code

This parameter represents the product code in the Identity Object within the EtherCAT Object Dictionary (Index 0x1018, Subindex 2).

The value is entered decimally in the left input field or hexadecimally in the right input field. The allowed range of values for the Product Code extends from `0` up to `0xFFFFFFFF` (corresponding to 0 up to `4294967295`).

Revision number

This parameter represents the Revision number in the Identity Object within the EtherCAT Object Dictionary (Index 0x1018, Subindex 3).

The value is entered decimally in the left input field or hexadecimally in the right input field. The allowed range of values for the Product Code extends from `0` up to `0xFFFFFFFF` (corresponding to `0` up to `4294967295`).

Note:
For more information concerning VendorID, Product Code and Revision Number, see EtherCAT Specification Part 6 Section 5.6.7.4.6 *Identity Object*.

In order to insert a variable, proceed as follows:

Add a variable

A variable can either be inserted below the Master or an arbitrary EtherCAT Slave device.

Below the EtherCAT Master, the context menu looks like this:

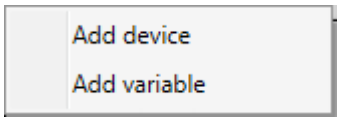


Figure 83: Context menu for EtherCAT Master

Below any EtherCAT Slave device, the context menu looks like this:

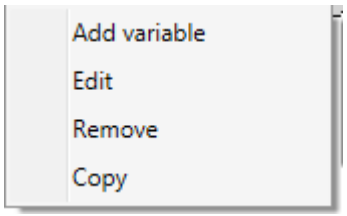


Figure 84: Context menu for EtherCAT Slave

In both cases you can use the context menu entry *Add variable* as follows in order to add a variable to the element list.

➢ Within the element list, rightclick at the master or slave under which the variable shall be added.

↰ The context menu appears, see above.

➢ Click at the context menu entry *Add variable*

⇨ The frst page of the dialog **Variable Wizard** is opened.It looks as follows:

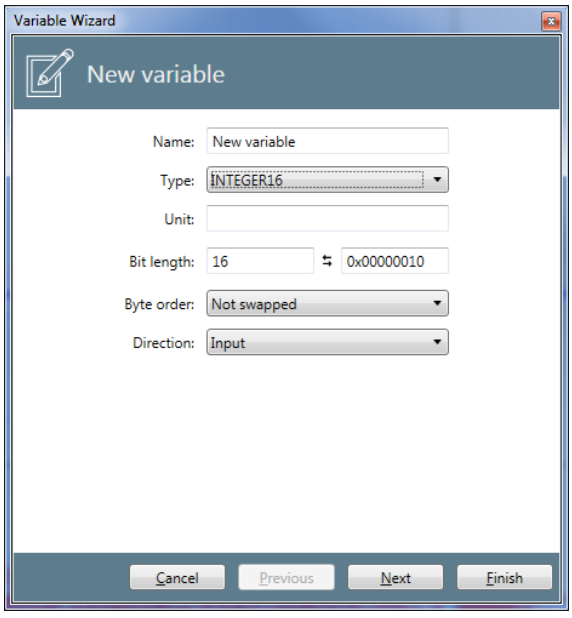


Figure 85: Variable Wizard - first page

➢ Under *Name* specify the name which shall identify the variable in future.

The fields within the dialog *Add variable* have the following meaning:

Name

The name of the variable

The name identifying the variable to be defined here. As long as no input into this mandatory field occurs, the input field has a red frame.

This name is also displayed in the variable area of the variable to be defined within the block Variable Info, see section „Variable area“.

Type

The datatype of the variable You can find a list of suitable datatypes in List of supported Data Types for Variables.

Unit

The coreresponding unit of the variable

The length of the data type specified under Type given as number of bits.

Here, the bit length can be set to values from 1 up to the maximum bit width of the selected datatype. If less bits are chosen than the used data types has, for unsigned datatypes the remaining bits are filled with 0..For signed datatypes the sign is extended onto the remaining bits.

Byte order

Here it can be spefcified whether the order of bytes in a data word is swapped (*Swapped*) or not (*Not swapped*).

Direction

This selection list allows you to select the signal direction to be applied.

Here, "*input*" means data transfer from the EtherCAT Slaves to the EtherCAT Master, while "*output*" means data transfer from the EtherCAT Master to the EtherCAT Slaves,

See also section Definition of Signal Directions.

However, the available choices depend on the kind of command selected at selection list Command which has been described just above:

Kind of command	Affected EtherCAT command codes	Selection options
Read commands	APRD, FPRD, BRD and LRD	Input only
Write commands	APWR, FPWR, BWR and LWR	Output only
Read/ write commands	APRW, ARMW, FPRW, FRMW, BRW and LRW	*Input* and *Output* are selectable

Table 14: Possible selections depending on mode of operation

➢ Click at *Next*.

➢ The second page of the dialog **Variable Wizard** is opend.

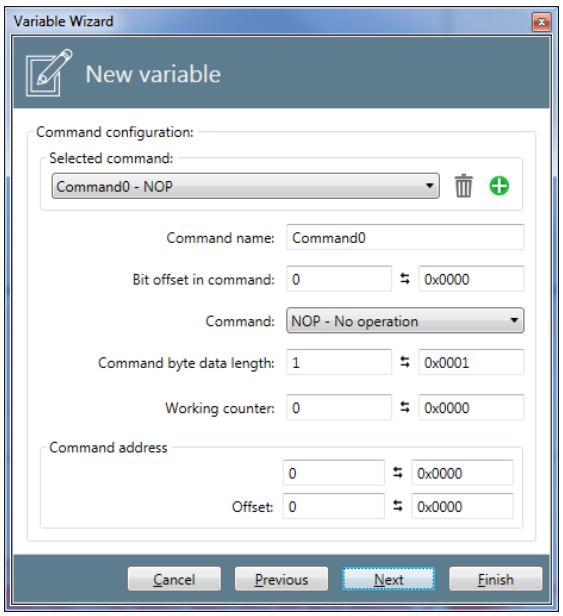


Figure 86: Dialog Variable Wizard - second page

On the second page of the dialog it is possible to store a sorted series of EtherCAT commands.

These EtherCAT commands can be accessed by the selection list below **Selected command**. Anyway, specified changes only affect the command currently selected in the selection list **Selected command**. This happens as follows:

Adding a command

For each variable exactly one EtherCAT command is stored by default. In order to add further EtherCAT commands perform the following series of steps once per EtherCAT command to be added.

- ➢ Click at the plus-symbol righjt of theselection list below **Selected command**.
- ⇘ A new EtherCAT command is added at the end within the series of commands.
- ➢ Specify the name of the command at **Command name**.
- ➢ Select the EtherCAT command to be executed from a list of commands supported by EtherCAT using the selection list **Command**.
- ➢ Fill the other fields for this commands as shown below.
- ⇨ Now the command has been entered.

Editing a command

A prevciously entered command can be changed as follows:

- ➢ Perform the desired change in the respective field. For instance, in order to edit the name of the command, just specify the new command name in the field **Command name**.
- ⇨ The command is changed.

Deleting a command

You can delete an already entered command as follows:

- ➢ Click at the trashcan symbol right of the selection list below **Selected command**
- ⇨ The command including all stored related information is deleted.

The other fields witin the dialog **Variable Wizard** have the following meaning:

Freely selectable command name (editable, is displayed in selection list *Selected command* along with the command code

Bit offset in command

This data field contains the offset of the variable relative to the beginning of the Data field in the EtherCAT datagram. It is counted as number of bits from the position of the first bit of the first variable in the data field of the EtherCAT datagram.If the variable to be defined is the first one within the data field of the EtherCAT datagram, then this value equals 0.

If an invalid value is entered, this is emphasized by a red frame around the field Bit offset. However, it does not make sense to specify values exceeding `11888` (equivalent to `8*1486`).

Command

If a single variable value should be transferred via EtherCAT by multiple commands, more commands can be added in the command list as necessary.

For an overview on the applicable EtherCAT command codes, see section List of Commands or the EtherCAT specification (reference [2]).

This data field contains the length of the EtherCAT datagram specified as number of bytes of the datagram.

This corresponds to the EtherCAT command specified in field "Data Length" in the EtherCAT datagram, see EtherCAT Datagram Structure.

The allowed range of values extends from 0 to 1486. If an invalid value is entered, this is emphasized by a red frame around the field Data length of the command..However, it does not make much sense to specify larger values than 1486 here.This value corresponds to the length of the data area within the EtherCAT datagramm.

Working counter

This field contains the expected value of the working counter (WKC).

The WKC value is used for the determination of the validity status of a variable value. For a WKC value unequal to the value specified here, the status is automatically set to invalid.

This corresponds to the EtherCAT command specified in the field *Expected Working Counter* within the EtherCAT datagram. See EtherCAT Datagram Structure.

The WKC value is automatically adjusted if another Edge Gateway installation location is chosen.

The allowed range of values extends from `0` to `4294967295`.

Command address

Depending on the choice in the selection list **Command** different kinds of addresses can be specified here.

- If a command with autoincrement addressing such as APRD, APWR or APRW has been chosen there, the autoincrement address and an offset can be specified here. The input field is denominated as *autoincrement address*. The values of the autoincrement address and the offset are both specified as hexadecimal value. The allowed range of values extends from `0` to `0xFFFF`.
- If a command with addressing via the configured station address such as CPRD, CPWR or CPRW has been chosen there, the configured station address and an offset can be specified here. The input field is designated as *configured station address*. The values of the configured station address and the offset are both specified as hexadecimal value. The allowed range of values extends from `0` to `0xFFFF`.
- If a command with broadcast addressing such as BRD, BWR or BRW has been chosen there, the broadcast address and an offset can be specified here. The input field is designated as *broadcast address*. The values of the broadcast address and the offset are both specified as hexadecimal value. The allowed range of values extends from `0` to `0xFFFF`.
- If a command with logical addressing such as LRD, LWR or LRW has been chosen there, the logical address can be specified here. The input field is designated as *logical address*. The values of the logical address is specified as hexadecimal value. The allowed range of values extends from `0` to `0xFFFFFFFF`.

This field corresponds to the EtherCAT command specified in the field "Command address" within the EtherCAT datagram. See EtherCAT Datagram Structure.

➢ Click at **Next**..

➢ The third page of the **Variable Wizard** dialog is opened.

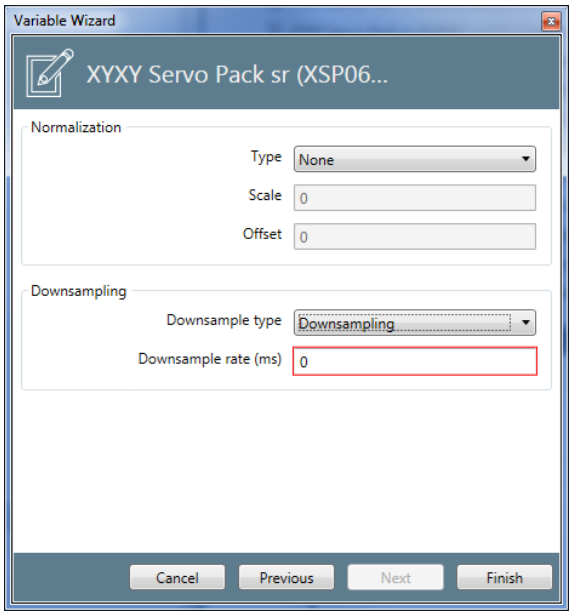


Figure 87: Dialog Variable Wizard - third page (Normalization/Downsampling)

On this page you can specify how to normalize the measured data.

The fields in dialog **Variable Wizard** have the following meaning:

Type

Here select the normalization type of the list.
If the option *None* is chosen, the values Scale and Offset are set to 0 and thus no normalization of the measured data takes place. Otherwise, it is possible to perform a user-defined normalization using the fields **Scale** and **Offset**.
During this normalization, the initial value is first multiplied with the factor Scale and then the Offset is added to the product.

Scale

Specify the factor Scale for the user-defined normalization here.

Offset

Specify the offset for the user-defined normalization here:

➢ Click at **Finish** in order to display the configured variable in your project.

⇨ The entered configuration data for the variable are stored within the project.

Downsampling area

This area contains the specifications for performing downsampling in the Passive Fieldbus Configurator.

Selection list *Downsample Type*

The following options are provided by selection list **Downsample Type**.

Option	Description
Switched off	No downsampling of data occurs. All data values are acquired by the network at their individual cycle.
Only on change	In this setting, acquired data will be transferred to the subsequent processing only if changes occur.
Downsampling	If downsampling has been activated, the data are regularly sampled after a defined time interval (the downsampling rate) and only those sampled values are transferred to subsequent processing. This time interval is specified in input field **Downsample Rate**.

Input field *Downsample-Rate*

If the Downsample Type Downsampling has been selected, in this input field the downsample rate can be specified in units of milliseconds. The allowed range of values extends from 1 to 1000 Milliseconds. See the following figure.

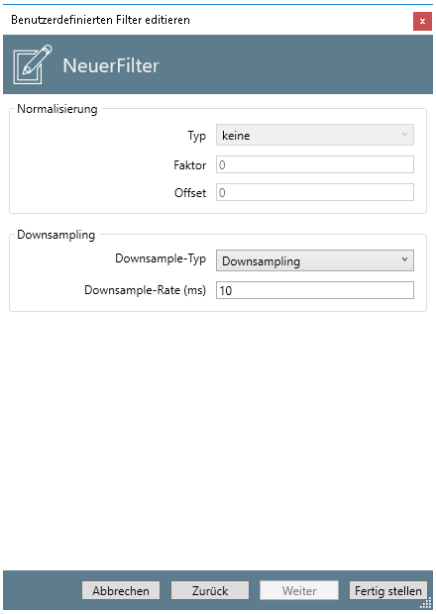


Figure 88: Edit custom value filter – Downsampling-Type and -Rate

4.4.6 Step 6 - Signal configuration

In order to activate a signal, proceed as follows:

➢ Within the Passive Fieldbus Configurator, drag the signal from the element list window into the window „Signal configuration“.
To do so, check the signal(s) in window Element List and keep the mouse button pressed while moving the mouse cursor to the window "Signal configuration". The figure below shows the state before releasing the mouse button. The red line is used only for clarification.

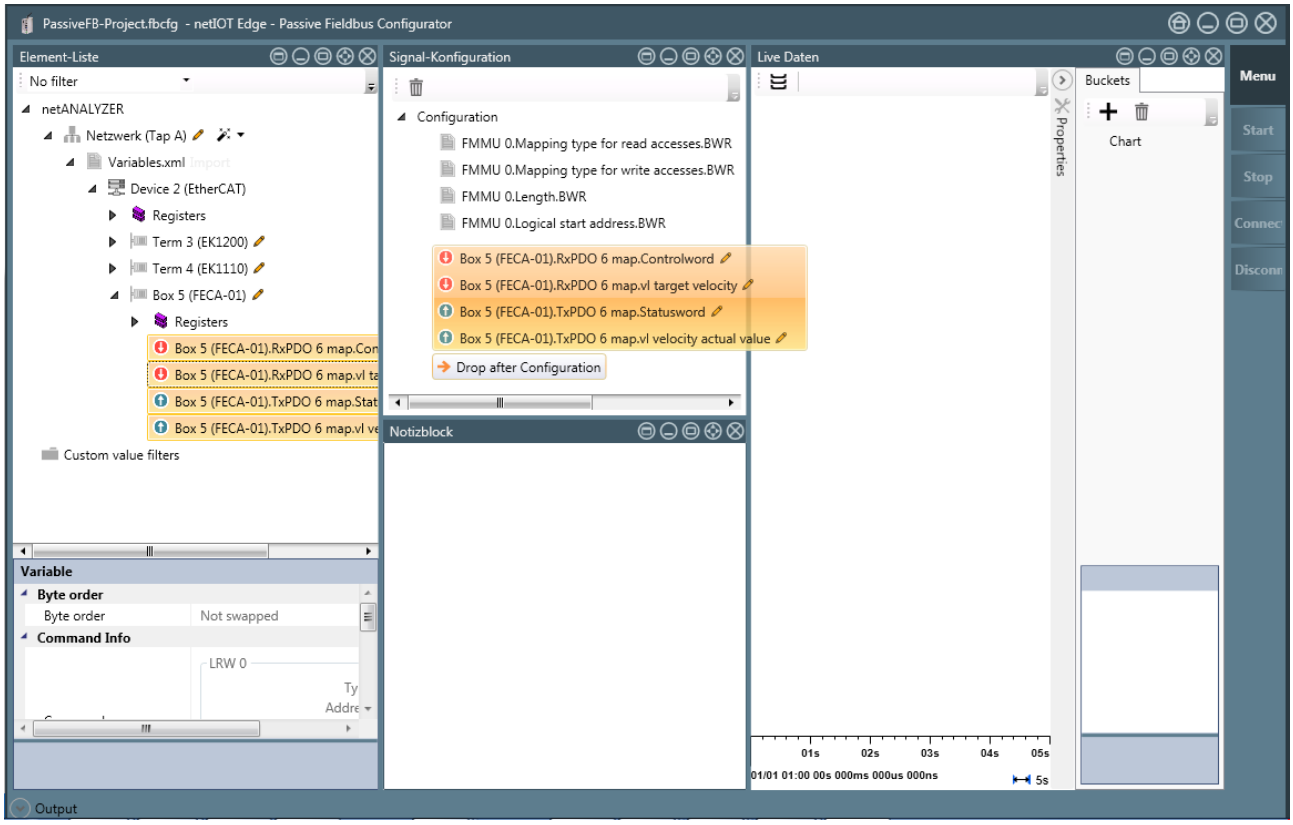


Figure 89: Signal configuration - during Drag&Drop

➢ If the mouse button is released, a new entry with the name of the signal is displayed in window „Signal configuration“.

The entry with the name of the signals within the element list still remains there, but it is now protected against editing and erasure, i.e. the respective context menu functions are grayed out and deactivated.

➢ Configure the signals in the window **Signal configuration** of the Passive Fieldbus Configurator. In window "Signal configuration", a new entry with the name of the signal is displayed. For each single EtherCAT signal, you can also decide there, whether the acquired data shall be fetched from the Edge Gateway by OPC-UA or transferred into the cloud by Node-RED.

Note:

In order to reduce CPU time and memory consumption on the Edge Gateway only choose those methods for continuation of data processing, which you really need in your specific application.

4.4.7 Step 7 - Check Signals in the Live-Data View

This step is optional. However, it allows a quick and easy check whether a signal has been configured correctly.

The Live Data window consists of a display area on the left side, which can be separated into some stacked parts (Buckets), and of an area on the right side only containing a register card buckets that lists the current signals and their assignment to these areas (Buckets)

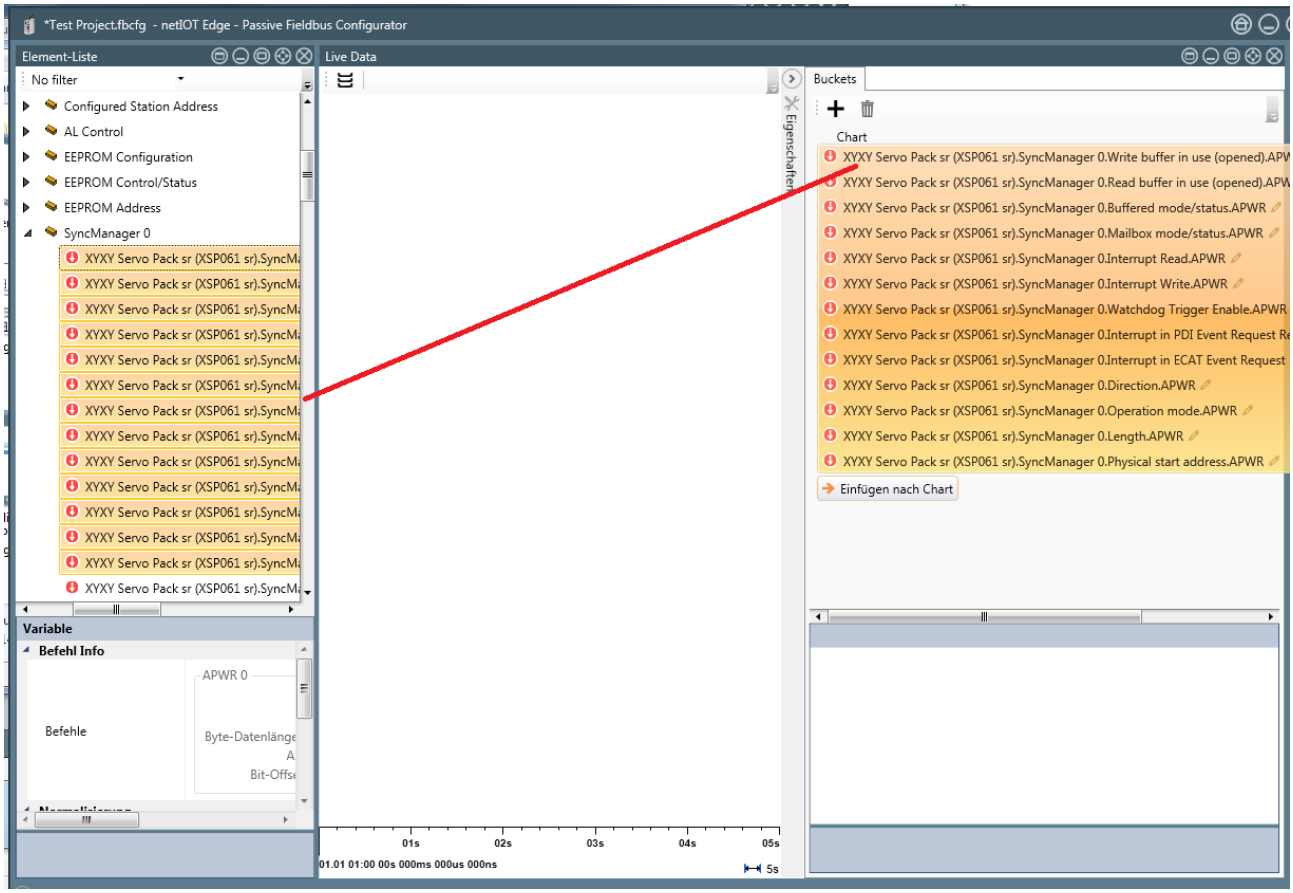


Figure 90: Adding signals to the Live Data window

To view and record arbitrary signals of your choice within the live data window, start recording as follows:

➢ Drag all signals intended to be viewed in the window **Live Data** one by one with the mouse button pressed down from the element list into the right part **Buckets** of the **Live Data** window.

➢ The data acquisition within the Passive Fieldbus Configurator has been started. In the Live View window you can watch the signals and tune your configuration if necessary.

4.4.8 Step 8 - Storing the generated configuration file (EtherCAT)

- ➢ Create a configuration file (i.e. project file) for your EtherCAT project using the Passive Fieldbus Configurator. Store this file via **Project > Save**within the main menu before finishing working with the Passive Fieldbus Configurator .
- ⇨ You have now created a project file in the `*.fbcfg` format for the configuration of your EtherCAT network within the passive mode of the Edge Gateway. In section *Uploading the project file to the Edge Gateway* [page 113] uploading of this file onto the Edge Gateway and activating it there is described.

4.5 Custom value filters

In Passive Fieldbus Configurator you can work with custom-value filters (i.e. user- defined filters). This gives you the chance to detect and select nearly arbitrary kinds of Ethernet frames.

A single criterion for frame selection can be specified using selection list *Type*.

This opens many possibilities to define new criteria that are presented within the following table:

Frame selection method	Typical examples
According to Ethernet characteristics	Only select frames with a certain Ethertype or VLAN-Tag Only select frames with a certain Source or Destination MAC
According to IP characteristics	Only select IP-Frames, IPv6-Frames, TCP-Frames, UDP-Frames Only select IP-Frames with a certain Source or Destination-IP-Address Only select TCP-Frames with a certain Source or Destination-Port
According to protocol-specific frame types	Only select EtherCAT-Frames Only selectPROFINET-Frames Only select frames with a certain Frame-ID Only select ICMP, LLDP, ARP, MRP or SNMP frames

Table 15: Criteria for frame selection

After the filter has been defined, it must finally be taken over into the signal configuration and thereby be activated.

This shall be illustrated in the following using an example:

Example - Definition of own filter conditions

As an example how to apply the Edge Gateway in the passive mode for the detailed analysis of Ethernet frame data, we show you how to extract all poll requests out of the data traffic within a Powerlink network which are sent from a Powerlink Controlled Node with address 1 as broadcast (i.e. to all participants).

This is accomplished by defining a filter for the Edge Gateway within the Passive Fieldbus Configurator which is able to select all Powerlink frames with a certain Message Type (here Poll Request) and a certain source address (Controlled Node) and destination address (Broadcast).

This section describes how you can use custom-value filters to create a project file enabling the Edge Gateway for passive data acquisition within a Powerlink network In this way you can learn valuable and important concepts how you can solve a manifold of similar problems using thepassive data acquisition.

If the project file has been generated, it finally has to be uploaded to the Edge Gateway as described in *Uploading the project file to the Edge Gateway* [▸ page 113].

The following prerequisites have to be met:

1. The Passive Fieldbus Configurator must be installed. If this is not the case, install it according to the installation instructions.
2. The IP address of the Edge Gateway to be used must be known.

4.5.1 Step 1 - Start the Passive Fieldbus Configurator.

➢ Start the Passive Fieldbus Configurator on your PC,

4.5.2 Step 2 - Creating an empty project

➢ Build a new project within the Passive Fieldbus Configurator by selecting the right button
Create->New in the introductory menu..

➢ The (still empty) GUI of the Passive Fieldbus Configurator is displayed.

4.5.3 Step 3 - Adjust basic settings of the Passive Fieldbus Configurator.

The Passive Fieldbus Configurator requires the following basic settings:

- Setting of IP address
- Setting ofSetting of network speed

To do so, proceed as follows:

➢ Open the main menu. in order to do so, click at button **Menu** within the side menu located at the right side.

Figure 91: Side menu

↬ The main menu is opened.

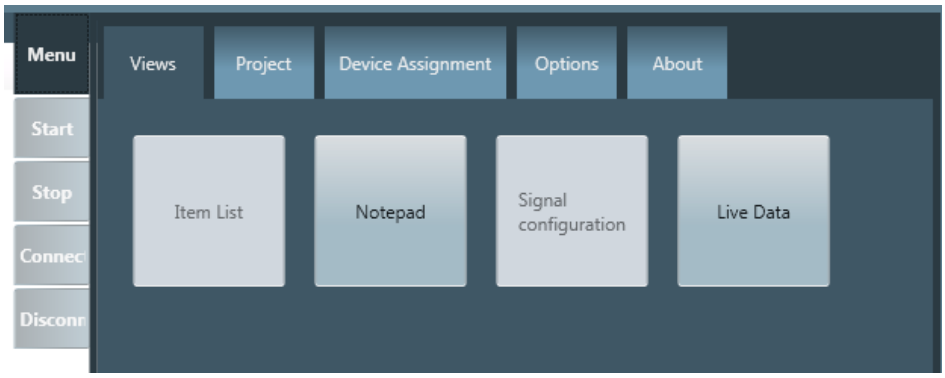


Figure 92: main menu - Register card "Views"

➢ Select the register card **Device assignment**.

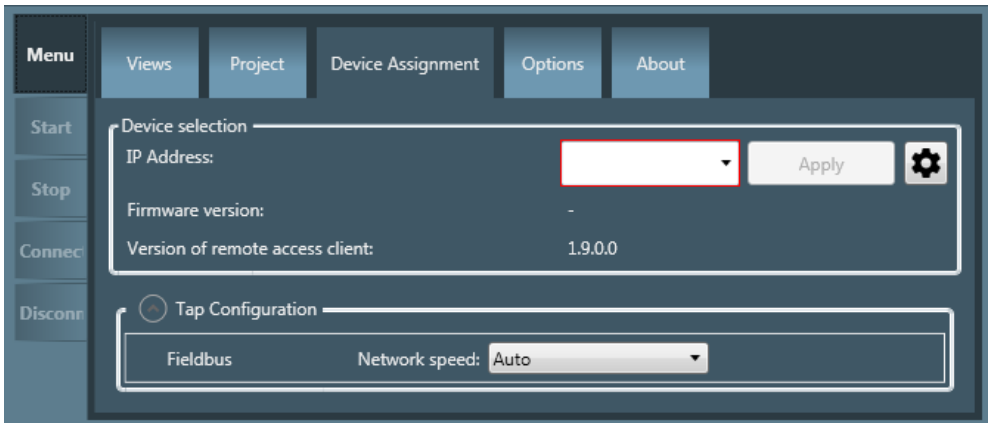


Figure 93: main menu - Register card "Device assignment"

In order to establish a connection with the Edge-Gateway, the IP address of the Edge-Gateway must be assigned to the software. This reqires the Gateway being in the passive mode of operation. Proceed as follows:

➢ Select the IP addresss of the Edge-Gateway to connect with from the selection list **IP Address** in the **device selection** area. If this list is still empty yet or the IP address of the Edge Gateway is missing in it, specify the IP address within the input field or click at the cog wheel symbol  at the right and specify the IP address in the dialog box which will appear. This IP address must comply with the valid rules for specifying IP adresses.

➢ Click at 

.

↬ Finally, the connection with the according Edge Gateway has been established.

As described in the following, you can check whether a connection to the Edge Gateway has been established:

1. In the field Firmware Version the version number of the currently installed firmware of the Edge Gateway is displayed.
2. The status display in the right part of the lower status bar of the Passive Fieldbus Configurator changes from blue indicating status *Idle* to yellow indicating status *Stopped*.
3. In the left part of the status bar now statistic information concerning the Ethernet data traffic and zthe interface configuration are displayed.
4. The formerly grayed ot menu entry **Connect** is activated.

Otherwise the following error message will appear:

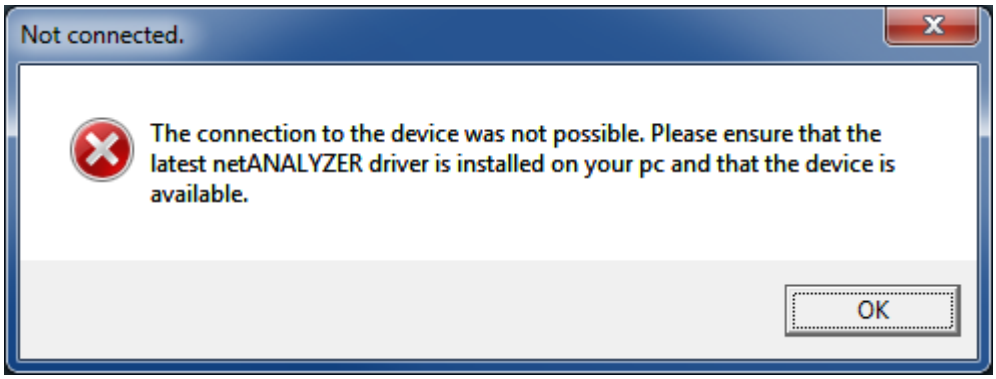


Figure 94: Error message "The connection to the device was not possible"

The most probable cause of this error message is the Edge Gateway not being in the configuration mode of the passive mode of operation!

Note:
For more information concerning the solution of this problem see section *Error handling* [page 116].

4.5.4 Step 4 - Define filter conditions for custom-value filters

The editor allows logic operations connecting multiple criteria.

The following kinds of logic operations are available.

- `Void` (no logic operation, only a single filter value is used)
- `and`(AND operation)
- `Or`(OR conjunction)
- `not`(Negation, only a single filter value is used)
- `xor`Exclusive-OR-conjunction)

To define the filter required for the example totally four filter criteria which are related to one another are used.

- The first filter criterion is used to detect whether the current frame is a Powerlink frame. In order to detect Powerlink frames their Ethertype can be used. In general, Powerlink frames have the Ethertype `0x88AB`. So the Ethertype of the frame to be tested must be checked for equality with the hexadecimal value `0x88AB`.
- The second filter criterion is used to check whether a poll request is present.A check whether the Message Type located in thew byte with offset 14 within the Ethernet frame equals 4 is required
- The third filter criterion is used for detection of broadcasts. In order to do so, it must be checked whether the Destination-IP address located at the byte with offset 15 within the Ethernet frame equals 255.
- The fourth filter criterion is used to check whether the frame originates from the Controlled Node (Slave) with the address 1 stammt. To do so, the Source-IP address located at the byte with offset 16 within the Ethernet Frame must be checked whether it equals 1.

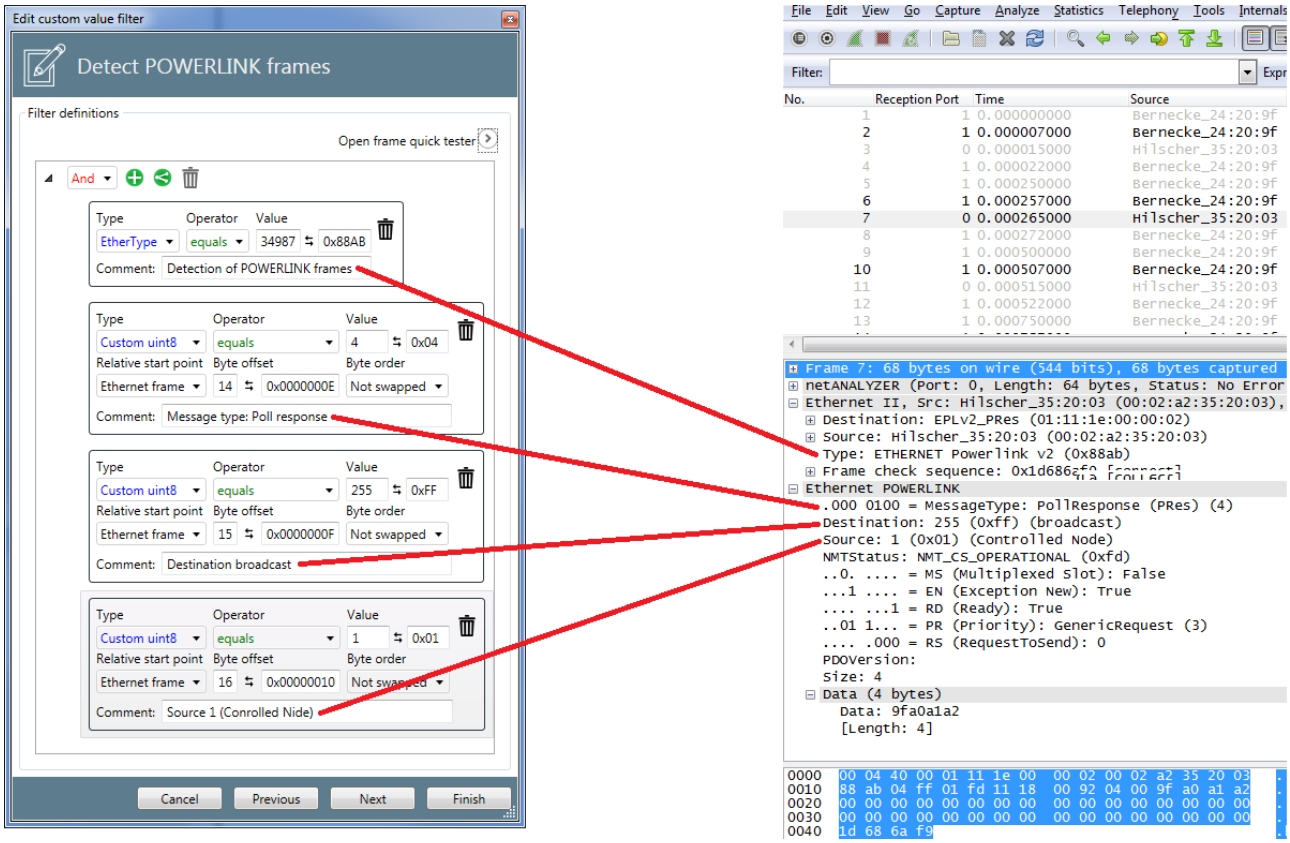


Figure 95: Assignment of the four filter criteria to the Wireshark Trace

This is accomplished by defining a filter for the Edge Gateway within the Passive Fieldbus Configurator which is able to select all Powerlink frames with a certain Message Type (here *Poll Request*) and a certain source address (Controlled Node) and destination address (Broadcast).

➢ Open the dialog *Add custom value filter* using the context menu.

➢ At Filtername specify the Filtername, here *Detect Powerlink frames*.

➢ Now the dialog looks as follows.

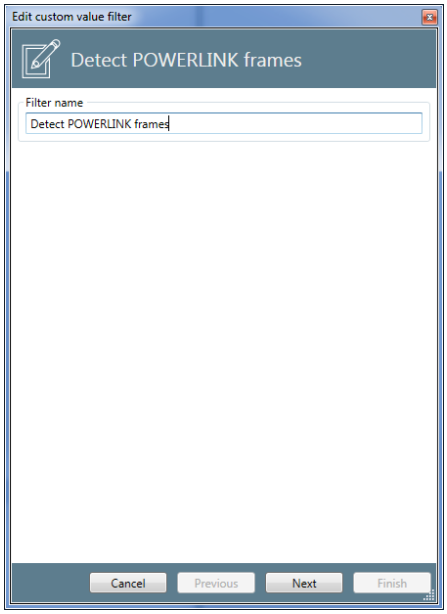


Figure 96: Specify filter name

➢ Click at **Next**..

➢ In order to combine to criteria with a AND operation, open the selection list and select the option *And* for the relation as shown in the figure.

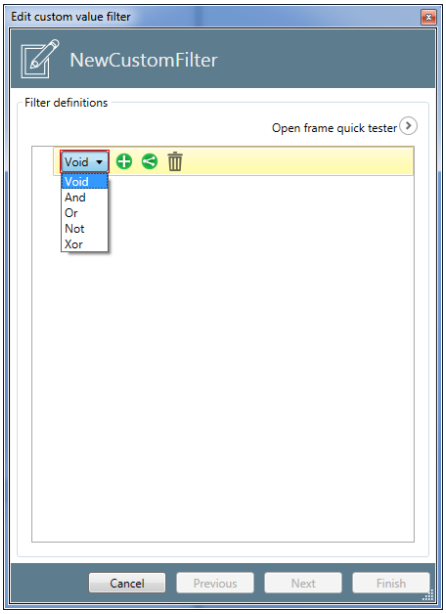


Figure 97: Custom-value filters - Selection of logical function

For an And-operation, you need (at least) two filter criteria.

➢ For specifying the first filter criterion *Ethertype equals 0x88AB* click at the symbol  .

➢ A box for specifying the filter criterion appears.

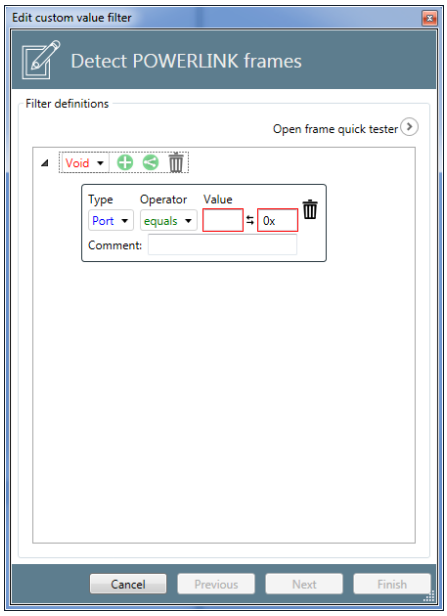


Figure 98: Custom value filters

➢ Then select the entry *Ethertype* directly below **Ethernet** within the selection list *Type*, see figure:

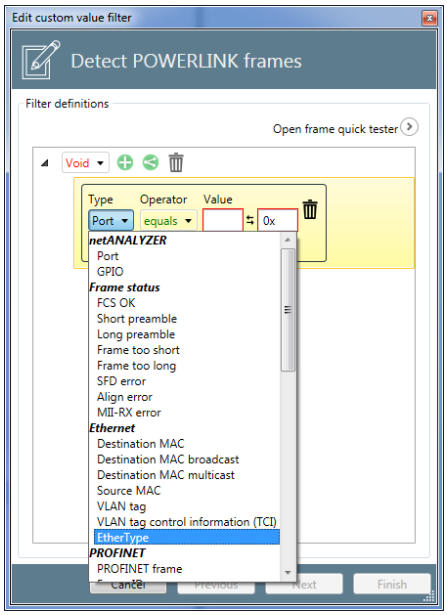


Figure 99: Custom value filters - Selection of Ethertype for recognition of Powerlink frames

➢ At operator select *equals* in order to check for existence of Powerlink frames.

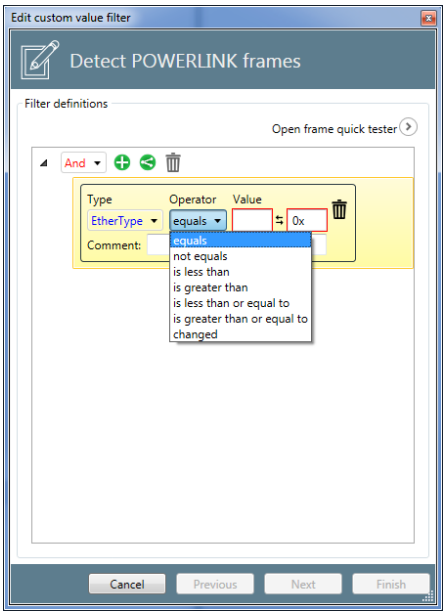


Figure 100: Custom value filters

➢ Specify the hexadecimal value `0x88AB` within the right of both fields below Value.

⇨ The first filter condition `Ethertype equals 0x88AB` has now been specified completely and is displayed within a box.

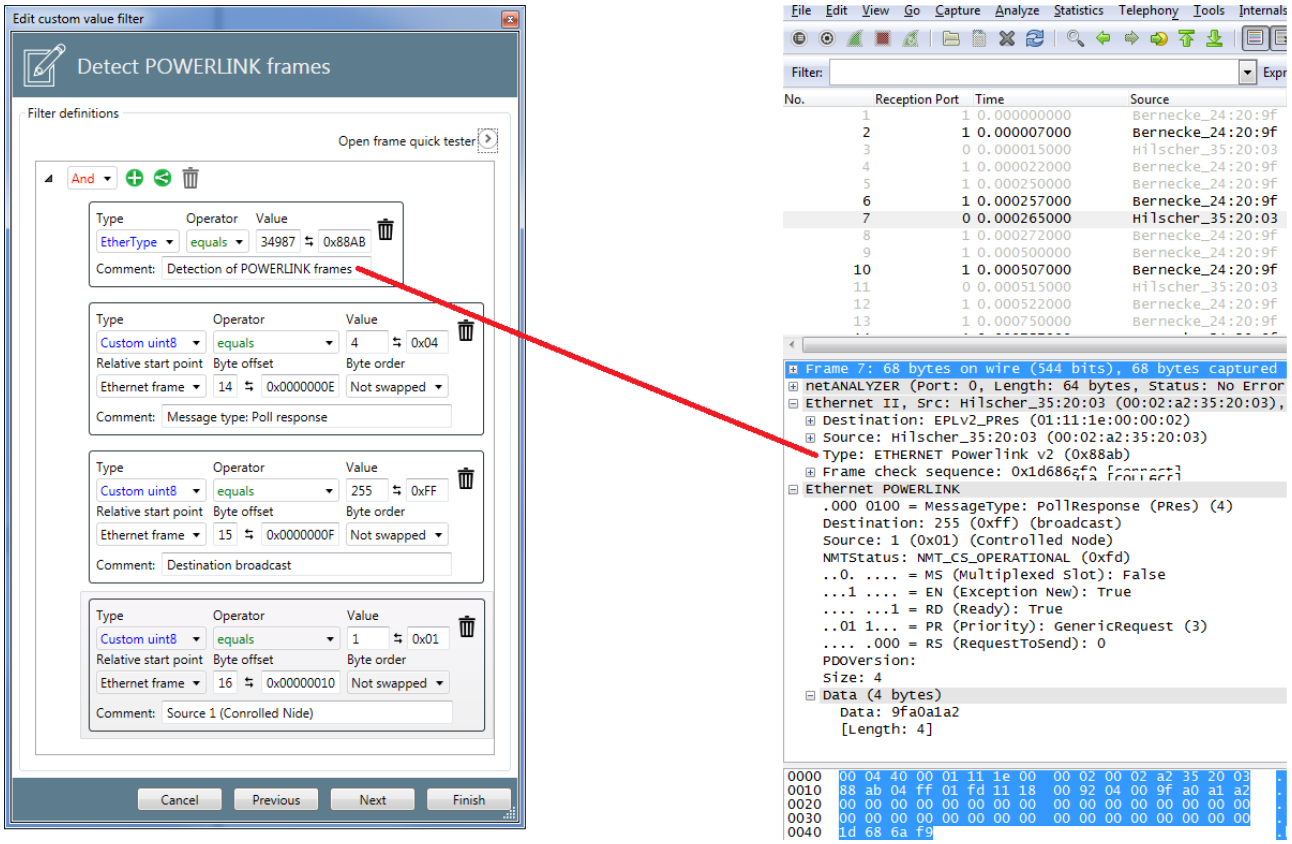


Figure 101: Custom value filters - first filter condition complete (including Wireshark trace)

➢ Here, you may write an optional comment into the input field **Comment**, for instance *Detection of Powerlink frames*.

Now the second filter criterion must be specified.

➢ In order to specify the second filter criterion *Byte at Offset 14 of the Ethernet Frames equals 4*, again click at the Symbol  .

➢ A second box for specifying a filter criterion appears.

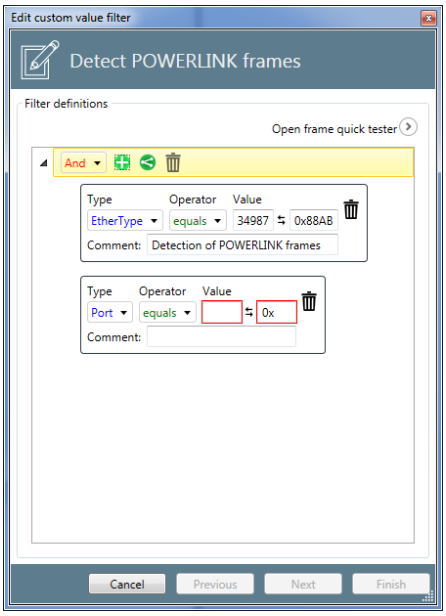


Figure 102: Specifying the second filter criterion - Entering the filter condition

➢ Below type select *User-definedt uint8*.

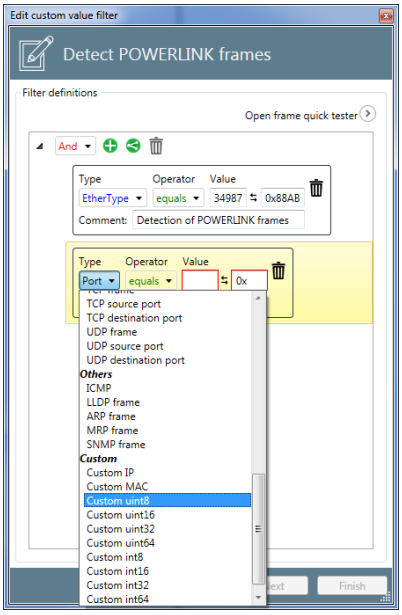


Figure 103: Specifying the second filter criterion - Selection of User-defined uint8

➢ After the selection, the dialog looks as follows:

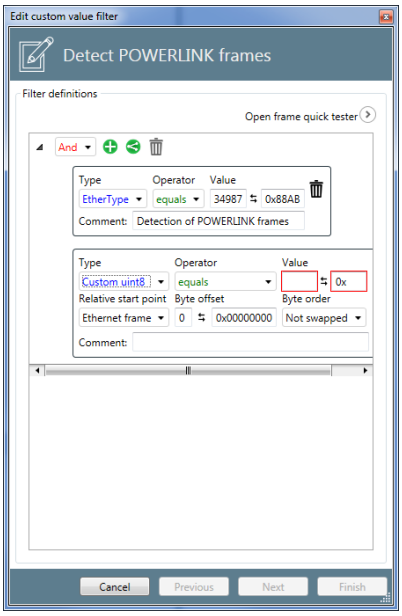


Figure 104: Specifying the second filter criterion -Afdter selection of User-defined uint8

- ➢ At operator the option *equals* must be selected - this is also the default option.
- ➢ For **Value** there are two input fields. the left of these is dedicated for decimal inputs, the right one for hexadecimal inputs. Specify the value 4 within the left (decimal) input field.

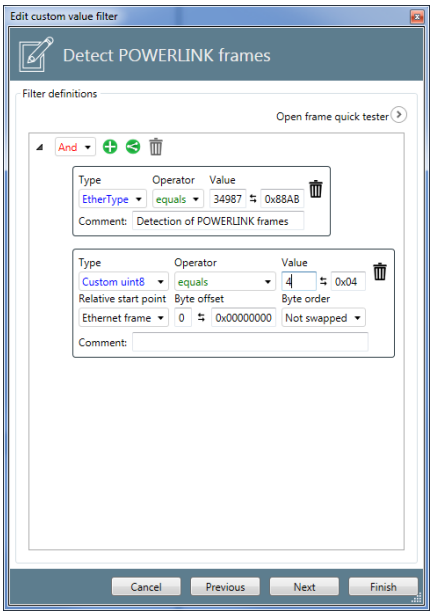


Figure 105: Specifying the second filter criterion - Input of the value of Ethernet frame, byte offset 14

- ➢ As soon as a valid value has been entered, the red frames around the mandatory input fields **Value** are displayed in grey.
- ➢ Specify the offset of the byte within the Ethernet-Frameto be used for comparison, here the byte with offset 14.

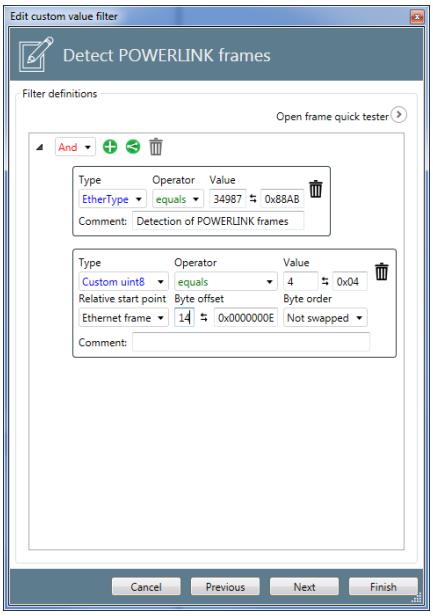


Figure 106: Specifying the second filter criterion - Input of the offset

➢ You may write an additional comment into the input field Comment, for instance *Destination broadcast*.

⇨ Now the dialog looks as follows.

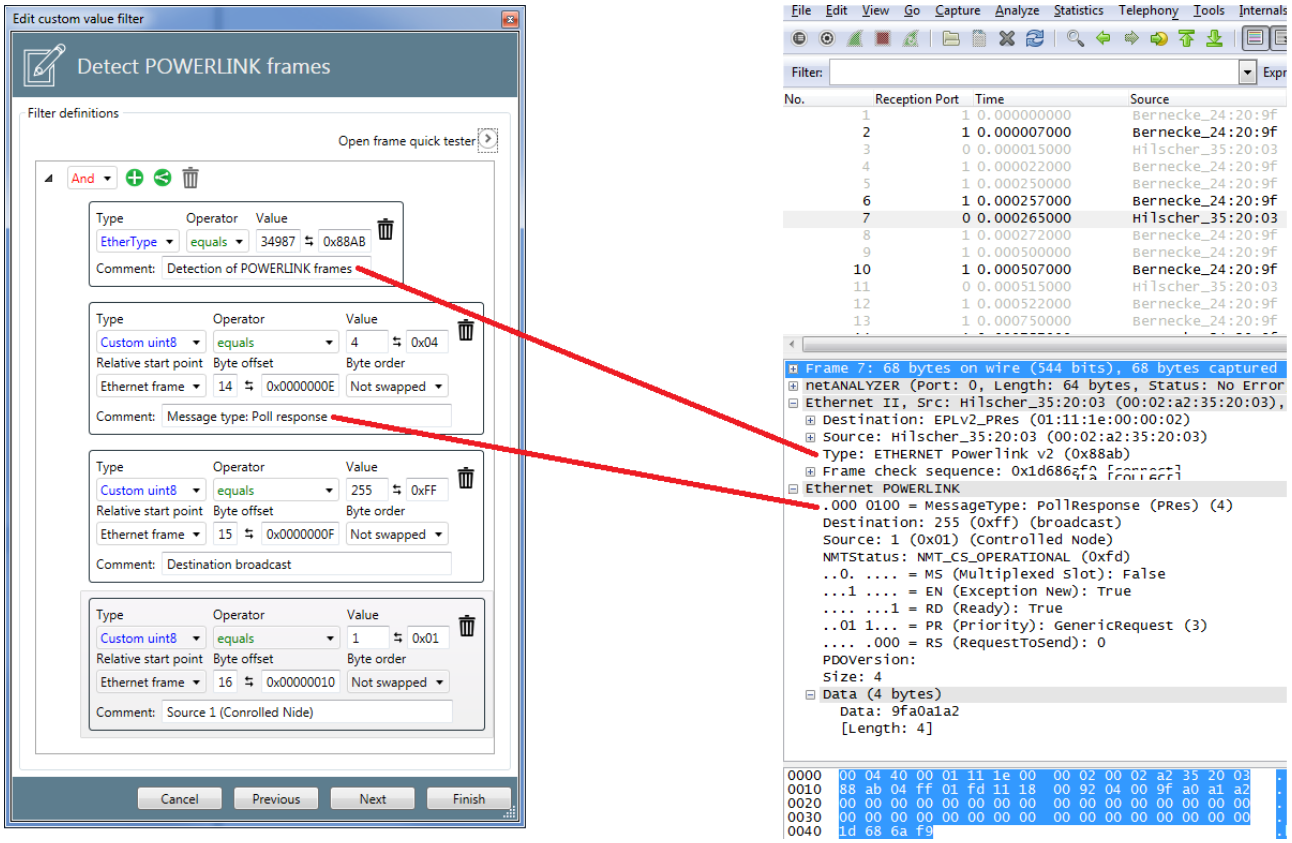


Figure 107: Specifying the second filter criterion -

Now the third filter criterion must be specified.

➢ In order to specify the third filter criterion *Byte at Offset 15 of the Ethernet Frames equals 255*, again click at the Symbol .

↬ Another box for specifying the filter criterion appears.

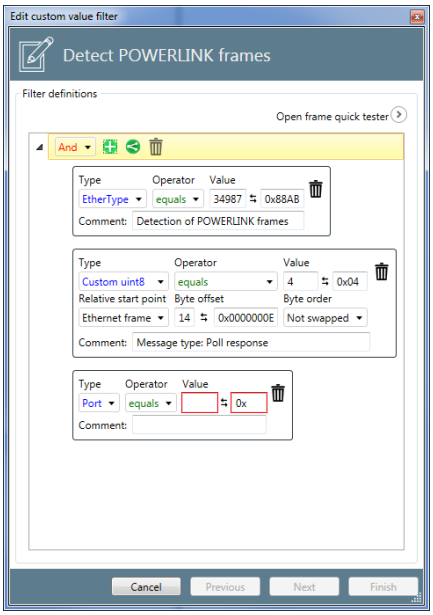


Figure 108: Specifying the third filter criterion - Entering the third filter condition

➢ Below type select *User-definedt uint8*.

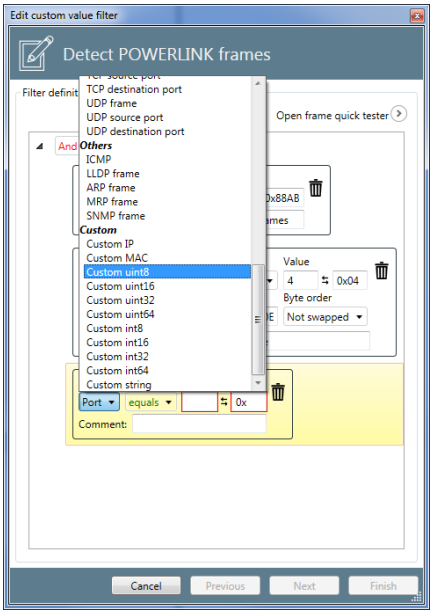


Figure 109: Specifying the second filter criterion - Selection of User-defined uint8

After the selection, the dialog looks as follows:

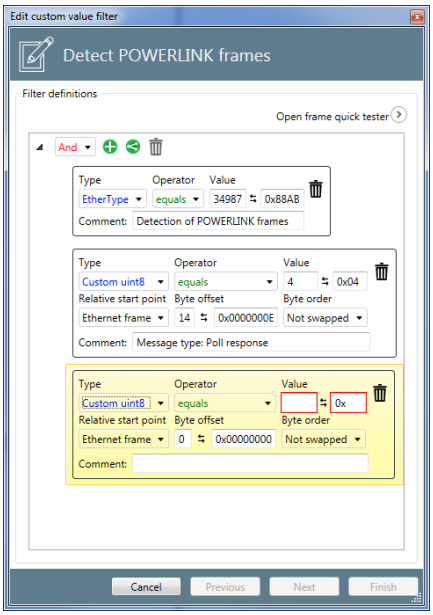


Figure 110: Specifying the third filter criterion -After selection of User-defined uint8

- At operator the option *equals* must be selected - this is also the default option.
- For **Value** there are two input fields. The left of these is dedicated for decimal inputs, the right one for hexadecimal inputs.Enter the value 255 in the left (decimal) input field.

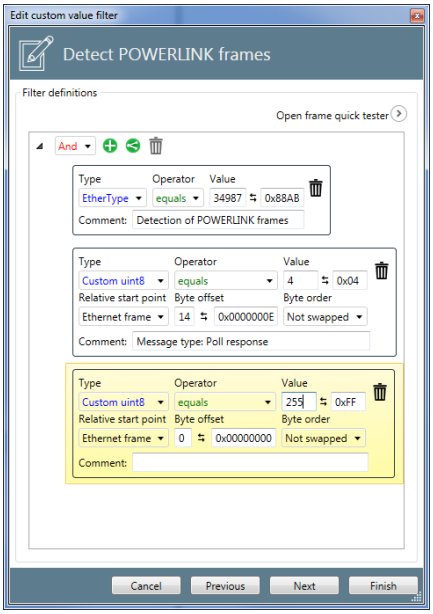


Figure 111: Specifying the third filter criterion - Input of the value of Ethernet frame, byte offset 15

As soon as a valid value has been entered, the red frames around the mandatory input fields **Value** are displayed in grey.

➢ Specify the offset of the byte within the Ethernet-Frameto be used for comparison, here the byte with offset 15.

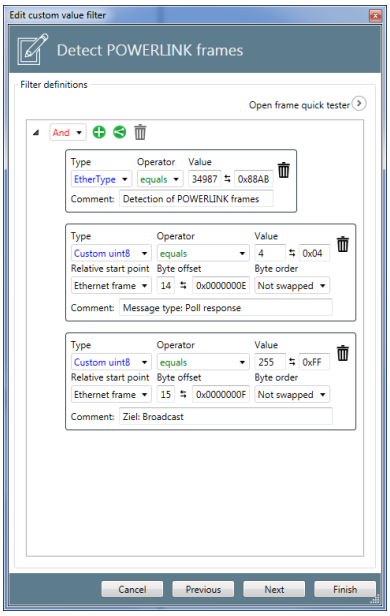


Figure 112: Specifying the third filter criterion - Input of the offset

➢ Here, you may write an optional comment into the input field **Comment**, for instance *Message type: Poll response*.

⇨ Now the dialog looks like this.

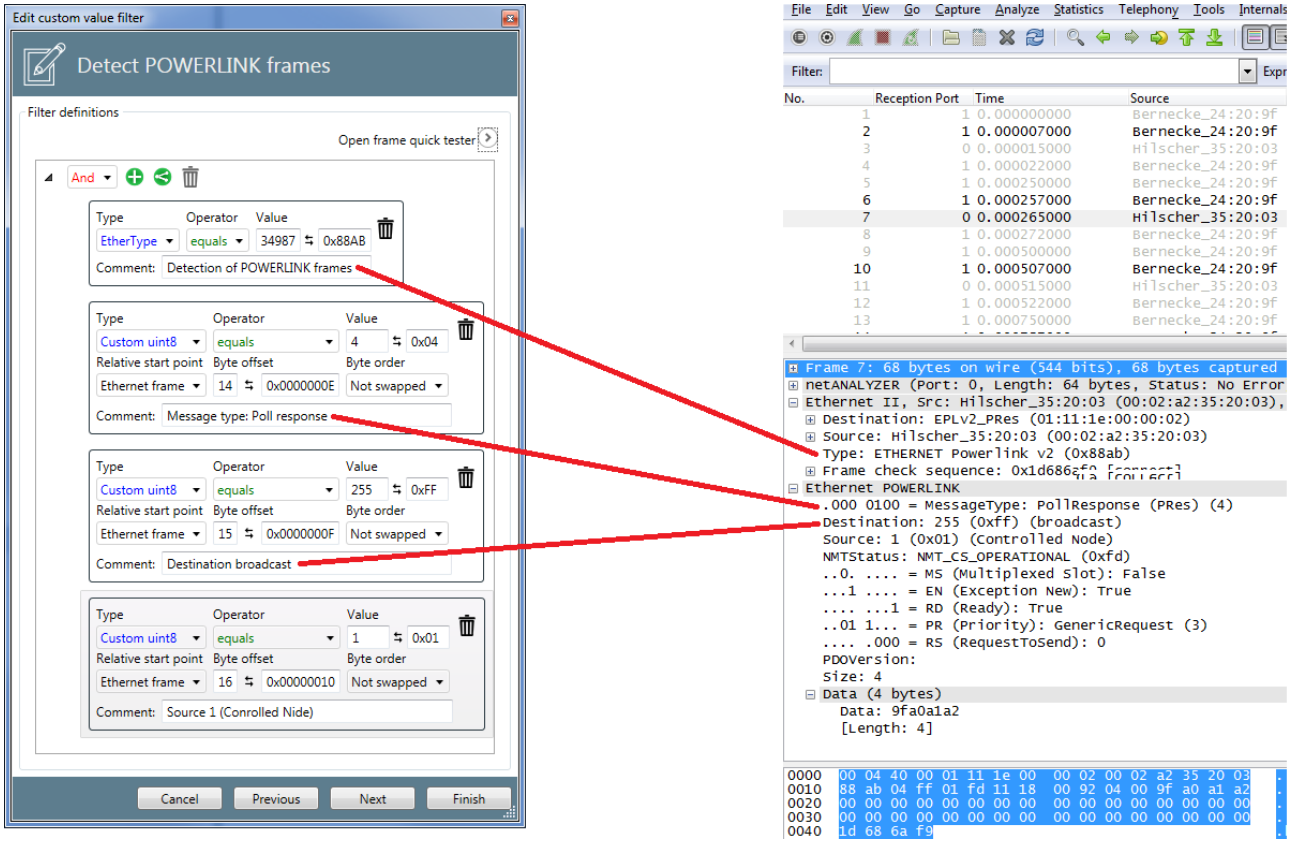


Figure 113: Specifying the third filter criterion (with Wireshark trace)

Now the fourth filter criterion must be specified.

➢ In order to specify the third filter criterion *Byte at Offset 16 of the Ethernet Frames equals 1*, again click at the Symbol  .

➢ Another box for specifying a filter criterion appears.

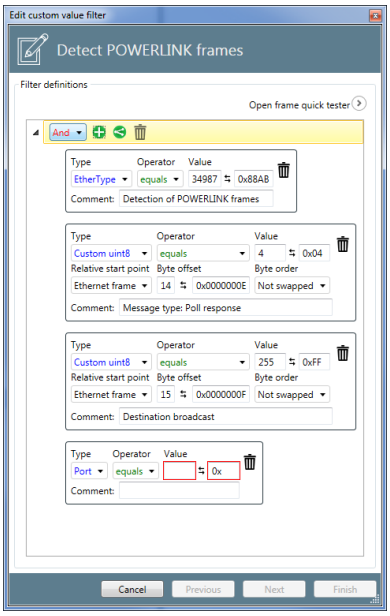


Figure 114: Specifying the fourth filter criterion - Entering the filter condition

➢ Below type select *User-definedt uint8*.

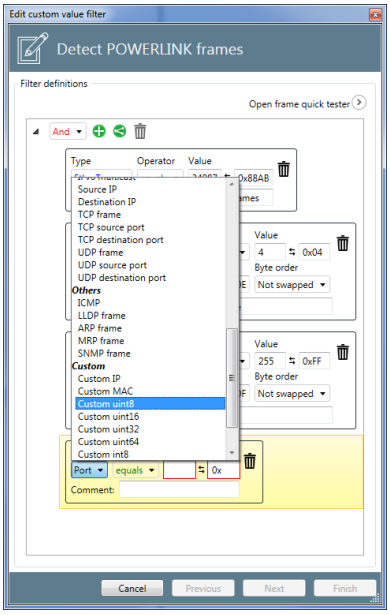


Figure 115: Specifying the fourth filter criterion - Selection of User-defined uint8

After the selection, the dialog looks as follows:

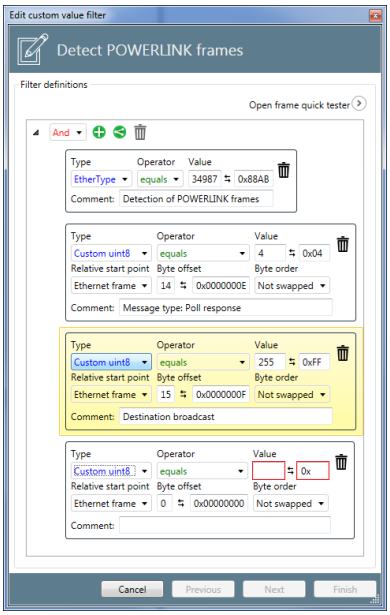


Figure 116: Specifying the fourth filter criterion - After selection of User-defined uint8

- At operator the option *equals* must be selected - this is also the default option.
- For **Value** there are two input fields. the left of these is dedicated for decimal inputs, the right one for hexadecimal inputs.

As soon as a valid value has been entered, the red frames around the mandatory input fields **Value** are displayed in grey.

- Specify the offset of the byte within the Ethernet-Frame to be used for comparison, here the byte with offset 16.

➢ Here, you may write an optional comment into the input field *Comment*, for instance *Source 1 (Controlled Node*.

⇨ Now the dialog looks as follows.

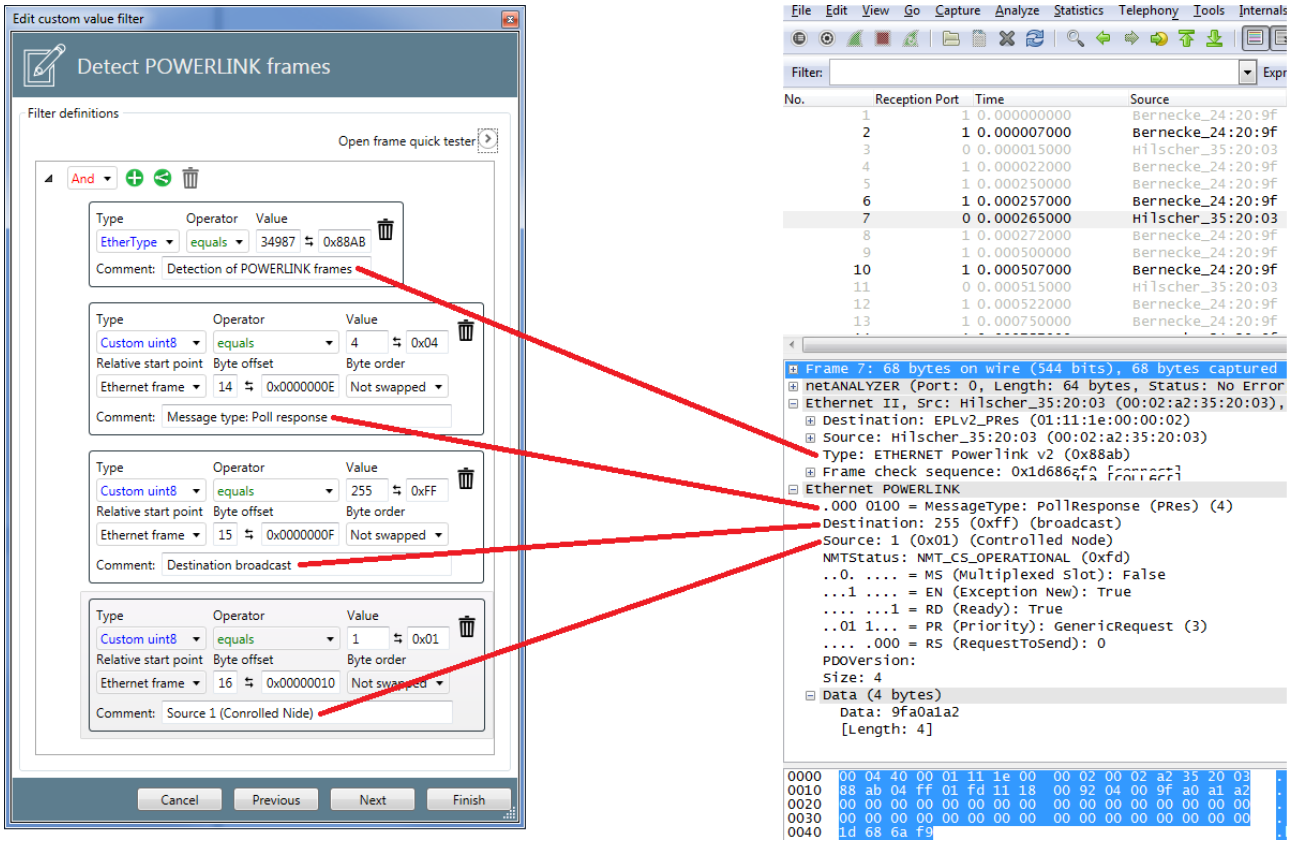


Figure 117: Specifying the flurth filter criterion - (with Wireshark trace)

If you want to analyze the frames more precisely, you may view these using the Frame Quicktesters.

To open the Frame Quicktester, click at the small arrow right of the text **Open Frame Quicktester** un the upper right corner of the dialog. The dialog is then enlarged by the area of the Frame Quicktester. The controls of the Frame Quicktester are self-explaining if clicking at the **i**-signs within a circle adjacent to these controls. When doing so, additional explanatory texts about the controls are displayed.

➢ Click at **Next**.

➮ The third page of the dialog **Edit custom-vslue filters** is opened.

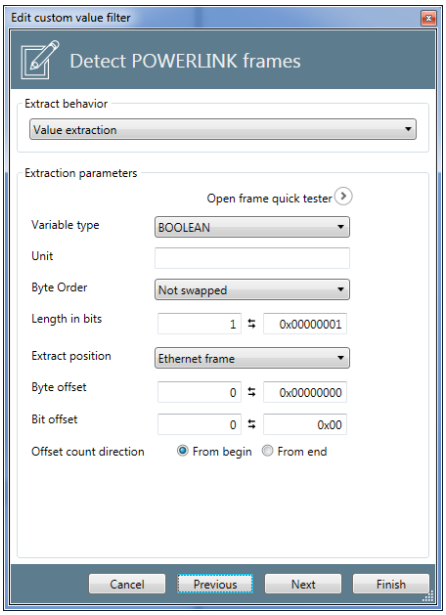


Figure 118: Custom-value filters - Specifications for extracting the values out of the acquired frames

On this page specifications for the extraction of data values from selected incoming Ethernet frames can be made.

I.e. here it can be defined how a certain value is assigned to each incoming Ethernet-Frame , which can subsequently be displayed in the Live View or postprocessed by OPC UA or Node-RED, for instance.

The reaction to incoming Ethernet frames of a certain selected type can be defined using the following approaches to extraction:

Method	Line of action
Event extraction	Only an event to be counted occurs indicating the occuremce of the selected frame type.An explicite assignment of a value to the frame does not happen. For instance, this approach allows counting the number of incoming frames fulfilling a certain filter condition.
Value extraction	Each incoming Ethernet frame is assigned a certain value by analysis of the frame contents using defined rules.

Table 16: Custom-value Filters – Approaches to extraction

In order to define these rules for the value extraction, the following parameters can be specified for this approach:

Parameter	Meaning
Variable type	The variable type of the value to be determined The selection possibilities include the type „Boolean“, various bit types and string types, unsigned and signed integer types and floating-point types.
Unit	The unit assigned to the value to be determined (optional specification)
Byte order	This parameter decides whether the byte order shall be swapped or not.
Length in bits	The length of the value to be determined, specified as number of bits.
The extraction position.	This specification allows to decide from which position within the frame the byte offset is counted. The possible options are: • Ethernetframe • Ethernet payload • TCP payload • UDP payload
Byte offset	The byte offset. It specifies the first byte to be extracted relative to the extraction position, i.e.how many bytes after the start (or before the end) of the extraction position the extraction begins
Bit offset	The bit offset. It specifies how many bitsafter the start (or before the end) of the first byte to be evaluatted within the Ethernet frame the extraction begins. The range of values extends from 0 to 7.
Counting direction for offset	Indicates the direction into which the byte offset works: Bytes after the beginning or before the end of the extraction position. The possible options are: • From the beginning • From the end

Table 17: Custom-value Filters – Parameters for extraction and their meaning

➢ Click at **Next**.

↬ The fourth page of the dialog **Edit custom-value filters** is opened now:

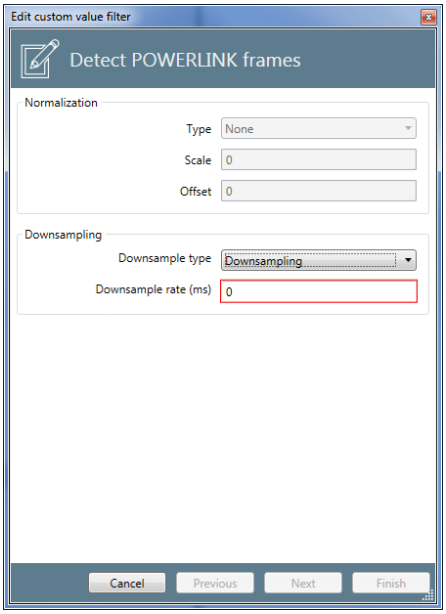


Figure 119: Custom-value filters – Specification for normalization of acquired data

On this page you can enter specifications for normalization of the acquired data values. During normalization the data value is multiplied with a ficxed factor and then a fixed offset is added to the product. Whether this clculation occurs and which values the scale factor and the offset should have, can be specified on this dialog page.

The fields within the dialog **Edit custom-value filter** have the following meaning:

Type

Select the normalization type of the list here.
If the option *None* is chosen, the values Scale and Offset are set to 0 and thus no normalization of the measured data takes place. Otherwise, it is possible to perform a custom-defined normalization based on the fields **Factor** and **Offset**.
During this normalization, the original value is first multiplied with the specified scale factor and then the offset is added to the intermediate result.

Scale

Specify the factor Scale for the user-defined normalization here:

Offset

Specify the offset for the user-defined normalization here:

➢ Click at **Finish** in order to display the configured variable in your project.

⇨ The entered configuration data for the variable are stored within the project.

➢ Click at **Finish**.

⇨ The custom-value filter just having been defined is stored.

4.5.5 Step 5 - Signal configuration

To activate the filter, proceed as follows:

➢ Within the Passive Fieldbus Configurator, drag the signal from the element list window into the window „Signal configuration“.

⇨ In the window **Signal configuration** of the Passive Fieldbus Configurator, a new entry with the name of the filter (in the example *Detect Powerlink-Frames*is displayed. By checking By checking the checkbox, you can separately determine for each single filter, whether the acquired data shall be fetched from the Edge Gateway by OPC-UA or transferred into the cloud by Node-RED. whether the acquired data shall be fetched from the Edge Gateway by OPC UA or made available within Node-RED.

⇨ The entry with the name of the custom-value filter within the element list still remains there, but now it is protected against editing and erasure, i.e. the respective context menu functions are grayed out and deactivated.

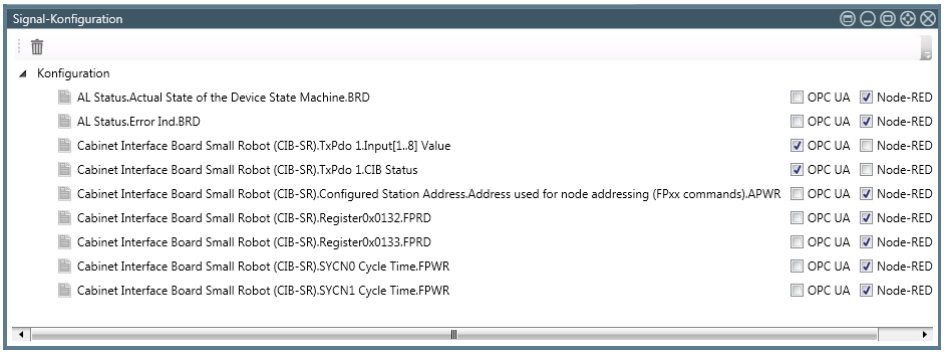


Figure 120: Window "Signal configuration" of the Passive Fieldbus Configurator.

⇨ Finally, the configuration of the custom-value filters has been completed.

Note:

In order to reduce CPU time and memory consumption on the Edge Gateway only choose those methods for continuation of data processing, which you really need in your specific application.

4.5.6 Step 6 - Check Signals in the Live-Data View

This step is optional. Viewing signals within a live-data window is recommended if you want to check whether a specific signal has been configured correctly .

Proceed as follows:

- ➢ Drag all signals intended to be viewed in the window **Live Data** one by one with the mouse button pressed down from the element list into the right part **Buckets** of the **Live Data** window.
- ⇨ The data acquisition within the Passive Fieldbus Configurator has been started. In the Live View window you can watch the signals and tune your configuration if necessary.

4.5.7 Step 7 - Storing the generated configuration file

- ➢ Create a configuration file (i.e. project file) for your project using the Passive Fieldbus Configurator. Store this file via **Project > Save** within the main menu before finishing working with the Passive Fieldbus Configurator .
- ⇨ You have now created a project file for the configuration of your network within the passive mode of the Edge Gateway. In section *Uploading the project file to the Edge Gateway* [page 113] is described, how you can upload this file to the Edge Gateway and activate it there.

4.6 Uploading the project file to the Edge Gateway

In the following it is assumed that the Edge Gateway is set to the passive mode of operation and to configuration mode.

To upload the project file from the PC running the Passive Fieldbus Configurator Ito the Edge Gateway and commission it there, a new network connection to the Edge Gateway must be present.

To do so, the following actions are required:

1. Opening the configuration page within the Control Panel
2. Only when using OPC UA:
   Adjust OPC UA settings like server name or timeout time
3. Upload of configuration into the Edge Gateway
4. Start of passive data acquisition

In detail, proceed as follows:

➢ Open the Control Panel in the window of a Web Browser such as Microsoft Internet Explorer, Firefox or Google Chrome,.

➢ Within the Control Panel select menu entry **Network>Field**.

↬ The configuration page for the operation mode of the Edge Gateway in the Control Panel is opened.

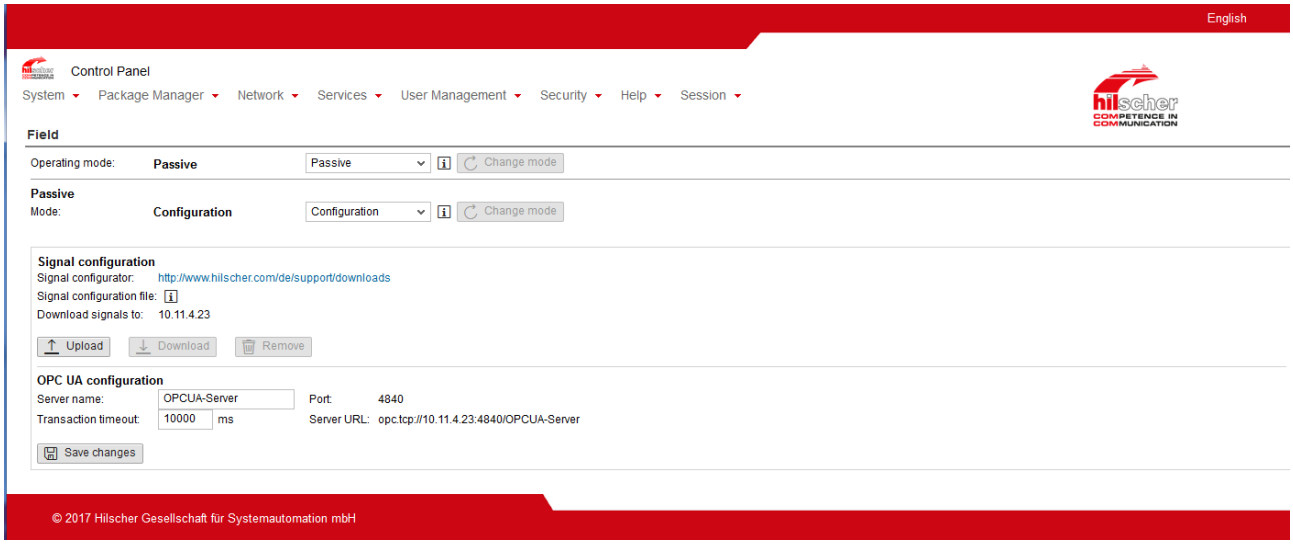


Figure 121: Passive mode of operation - Config mode

The OPC UA configuration is only required on demand and can be left out if exclusively using Node-RED:

➢ Specify the name of the OPC-UA Server to be applied in the field **Server name**. (1)

➢ Additionally configure the Timeout time for transactions in field **Transaction timeout**. (2)

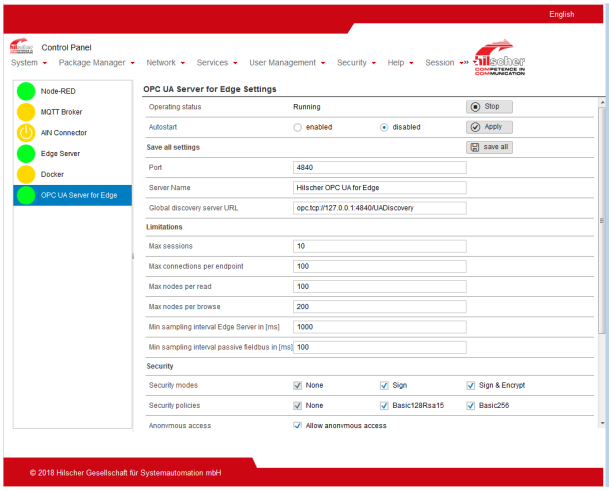


Figure 122: OPC UA configuration (Figure only shows a part)

➢ Confirm the changes in the OPC UA configuration by clicking at "Save changes".

↬ All specifications required for the configuration of the Edge Gateway have now been entered completely. In order to make the signal configuration file effective, it has to be transferred to the Edge Gateway.

➢ To transfer the selected configuration into the Edge Gateway, click at **Upload**.

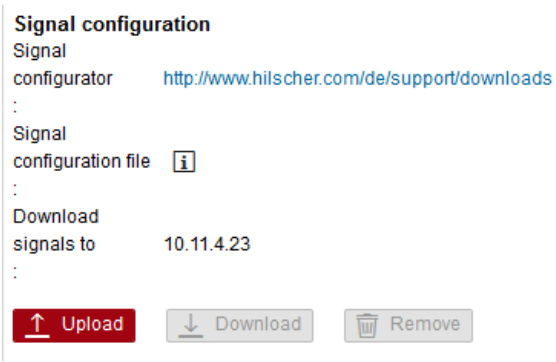


Figure 123: Button "Upload" in the signal configuration area of the configuration page in the control panel

↬ A dialog for selcting the project file is displayed.

➢ Select the project file generated by the Passive Fieldbus Configurator within previous step (File type `*.fbcfg`)

↬ After your selection the project file is transferred to the Edge Gateway. However, the data acquisition has not yet been started.

➢ To activate the data acquisition, switch to the *Operational Mode*.

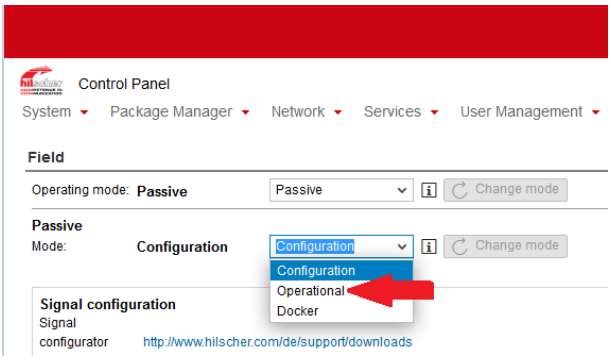


Figure 124: Switching to operational mode in passive mode of operation

A dialog window appears and informs about the OPC UA Server being activated and no further changes in configuration being applicable.

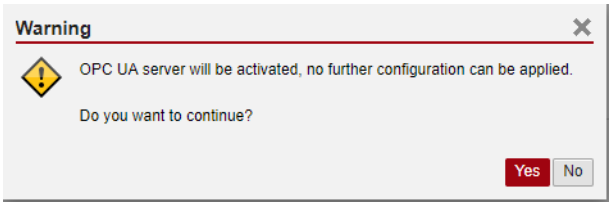


Figure 125: Dialog window displayed when switching into the Operational Mode of the Passive Mode.

➢ At the confirmation prompt answer with **Yes**.

⇨ The OPC-UA Server and the „passive fieldbus“ node of Node-RED are restarted. The passive data acquisition according to the configured settings and the currently active Node-RED flow begins.

The configured signals are then continued to be processed according to the setting in window „Signalkonfiguration“ :

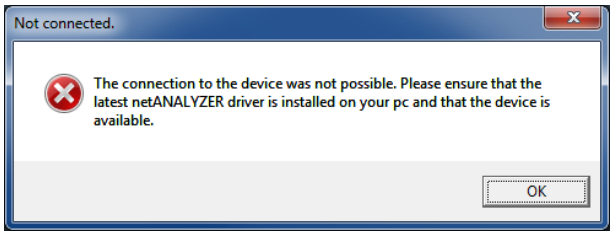
- Any arbitrary OPC UA client can access all signals for which the checkbox **OPC UA** has been checked in the signal configuration. Also see *OPC UA Client reads process data from Edge Gateway* [page 122]
- The `passivefieldbus` node can access all signals for which the checkbox Node-**Node-RED** has been checked in the signal configuration, for instance in order to transfer data to the cloud.. See *Node-RED transfers process data into the Cloud* [page 126].

4.7 Error handling

The following error situations may occur when working with the assive Fieldbus Configurator:

Error message "No connection to the Edge Gateway" at assignment of IP address.

If an error message that no connection to the Edge Gateway could be established is received during the assignment of the IP address, then check the following topics and repeat the assignment.



1. Is the Edge Gateway switched on and is it connected to the IT- and OT-networks?
2. Has the Edge Gate3way been switched to the passive mode of operation?
3. Has the Edge Gateway been switched to configuration mode.
   In mode *Operation* no assignment is possible.
4. Has the correct IP address been entered?
5. Is the used driver version of the Passive Fieldbus Configurators the most current one?

If question (2) or question (3) have been answered with "No", proceed as follows in order to solve the problem:

➢ Invoke the Control Panel and select the menu **Network > Field** there.

➢ Select the passive mode of operation at **Operating mode**.

➢ At **Passive Mode** select „Configuration“.

➢ Repeat the assignment.

⇨ Now the assignment of the IP address should beperformed successfully.

Error message during loading the GSDML file.

If an error occurs during reading the GSDML file, the following error message appears:

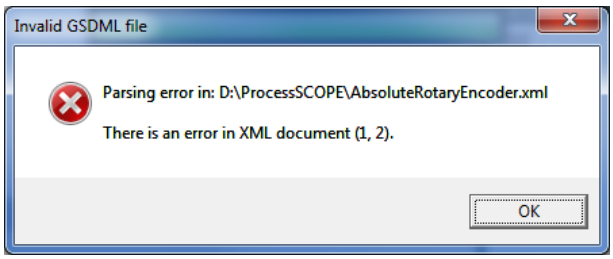


Figure 126: Error message "Parsing error in..."

In this case check the GSDML file for correctness and evaluate the additional information concerning the error which might be shown in the output window of the Passive Fieldbus Configurator.

Error message when loading the ENI file

If an error occurs during reading the ENI file, the following error message appears:

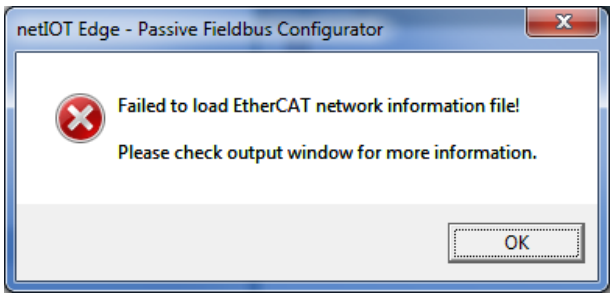


Figure 127: Error message "failed to load ENI file"

In this case check the ENI file for correctness and evaluate the additional information concerning the error which might be shown in the output window of the Passive Fieldbus Configurator.

Error message: GSDML file already exists

If the follwoing message appears during reading in the PROFINET device description file:

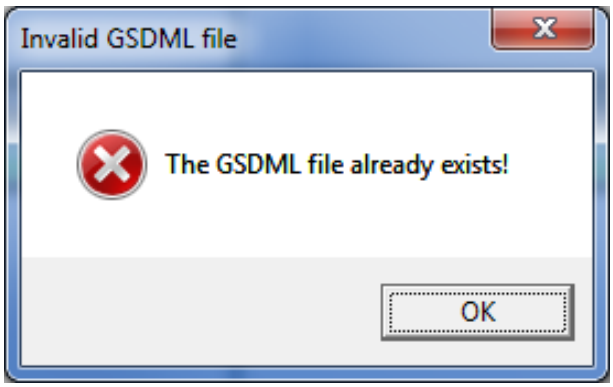


Figure 128: GSDML file already exists

The selected GSDML file is already loaded.

Error message in order to prevent overwriting existing elements

If the following message appears when reading the EtherCAT device decription file:

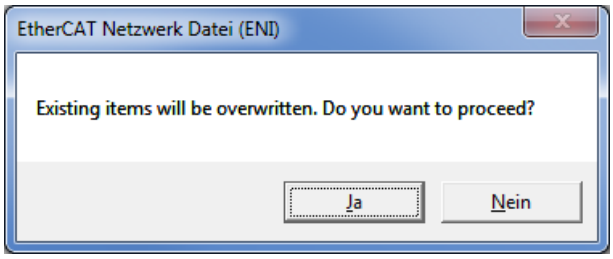


Figure 129: Overwriting of existing elements

An EtherCAT network information file (ENI file) has already been loaded.

- If you click at "Ja", this already existing ENI file will be overwritten by the selected ENI file.
- If you click at "Nein", the currently loaded ENI file will be preserved.

Error message if a module with same slot number is already present

If the following message should occur when creating PROFINET modules:

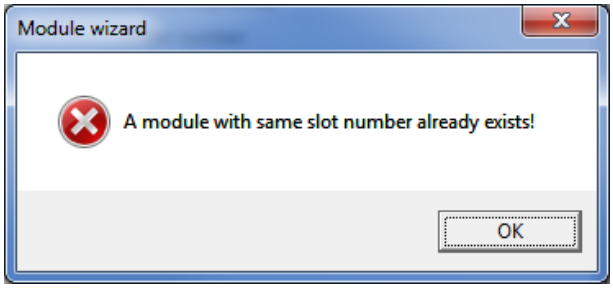


Figure 130: A module with same slot number already exists!

Check, whether the correct slot number is in use as a slot with the specified number already exists.

Error message if a module with same subslot number is already present

If the following message should occur when creating PROFINET submodules:

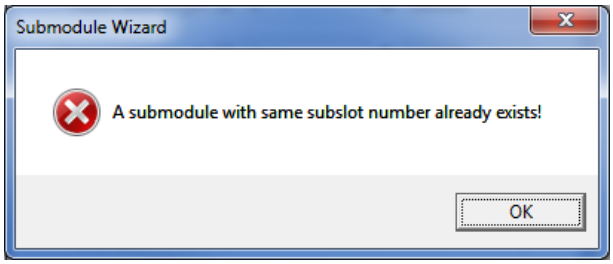


Figure 131: A submodule with same subslot number already exists!

Check, whether the correct subslot number is in use as a subslot with the specified number already exists.

Process data invisible when importing an ENI file generated by Codesys

When exporting ENI files from Codesys, it may happen that the exported ENI file does not match the actual network configuration. Specifically, other logical bus addresses are exported into the ENI file, than the ones actually used by the Codesys PLC. Possibly incorrect address assignments for your variables can be manually edited in netANALYZER Scope. Thus, the incorrect address can be replaced by the correct address (the changes are stored in the `.fbcfg` project and are only necessary once).

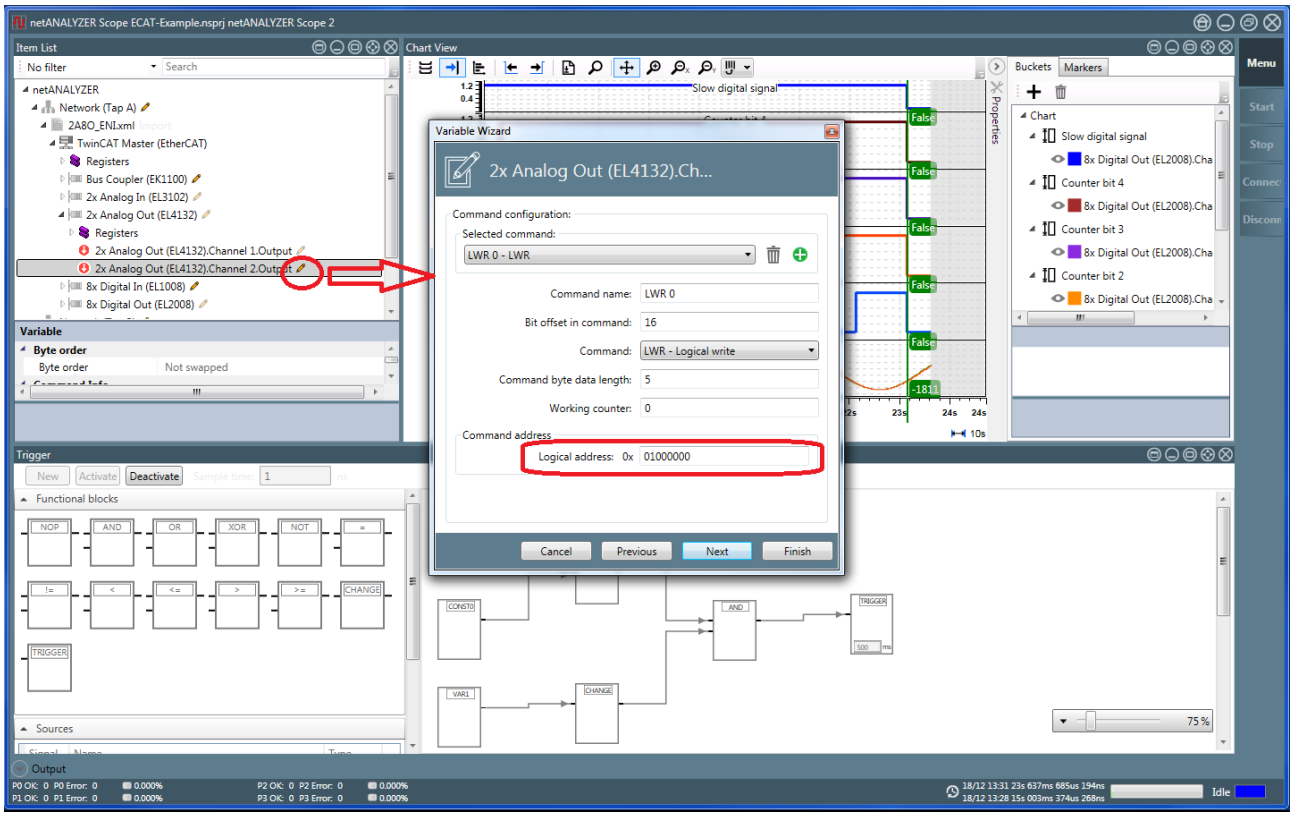


Figure 132: Wireshark example for Codesys ENI-Import

You can observe which address the Codesys PLC actually uses during real network communication by getting the addresses from a Wireshark trace.

In the following it is assumed that the Edge Gateway is set to the passive mode of operation and to configuration mode.

To upload the project file from the PC running the Passive Fieldbus Configurator lto the Edge Gateway and commission it there, a new network connection to the Edge Gateway must be present.

5 Further processing of the process data

5.1 Overview

In the Edge Gateway, the received process data can be analyzed, processed, provided or sent to another device. The following table contains an overview about the possibilities for further processing of the process data.

Further processing	Description
OPC UA	An OPC UA Client reads the process data from the Edge Gateway. Which process data is provides via OPC UA has to be configured with the netIOT Passive Fieldbus Configurator. Section *OPC UA Client reads process data from Edge Gateway* [page 122] describes the selection of signals and uses an example to show the configuration of an OPC UA Client.
Node-RED	The passivefieldbus node in Node-RED receives the process data. These can be processed within Node-RED and then be sent into a Cloud. Configure the netIOT Passive Fieldbus Configurator which process data is to be processed in Node-RED. Section *Node-RED transfers process data into the Cloud* [page 126] describes further processing of process data with Node-RED.
Docker container	An application in a Docker container can access the raw data of the fieldbus interface and process these data. For further details, see section *Using a Docker container to access to the raw data* [page 132]. In this mode, the Edge Gateway does not need a signal configuration by netIOT Passive Fieldbus Configurator.

Table 18: Possibilities for further processing of the process data

5.2 OPC UA Client reads process data from Edge Gateway

A possibility to access the data acquired by the Edge Gateway is transferring these via the OPC UA protocol to a PC executing an OPC UA Client.

Note:
However, access via OPC UA is only applicable for slowly changing signals such as temperatures or switches. The achievable resolution amounts approximately 5 changes per second.

The following example explains the OPC UA-based access to the data acquired by the Edge Gateway in the passive mode.

5.2.1 Selecting signals for OPC UA

You have to select the signals for OPC UA with the netIOT Passive Fieldbus Configurator. Check **OPC UA** in the **Signal Configuration** window for signals that the OPC UA Server in the Edge Gateway should provide.

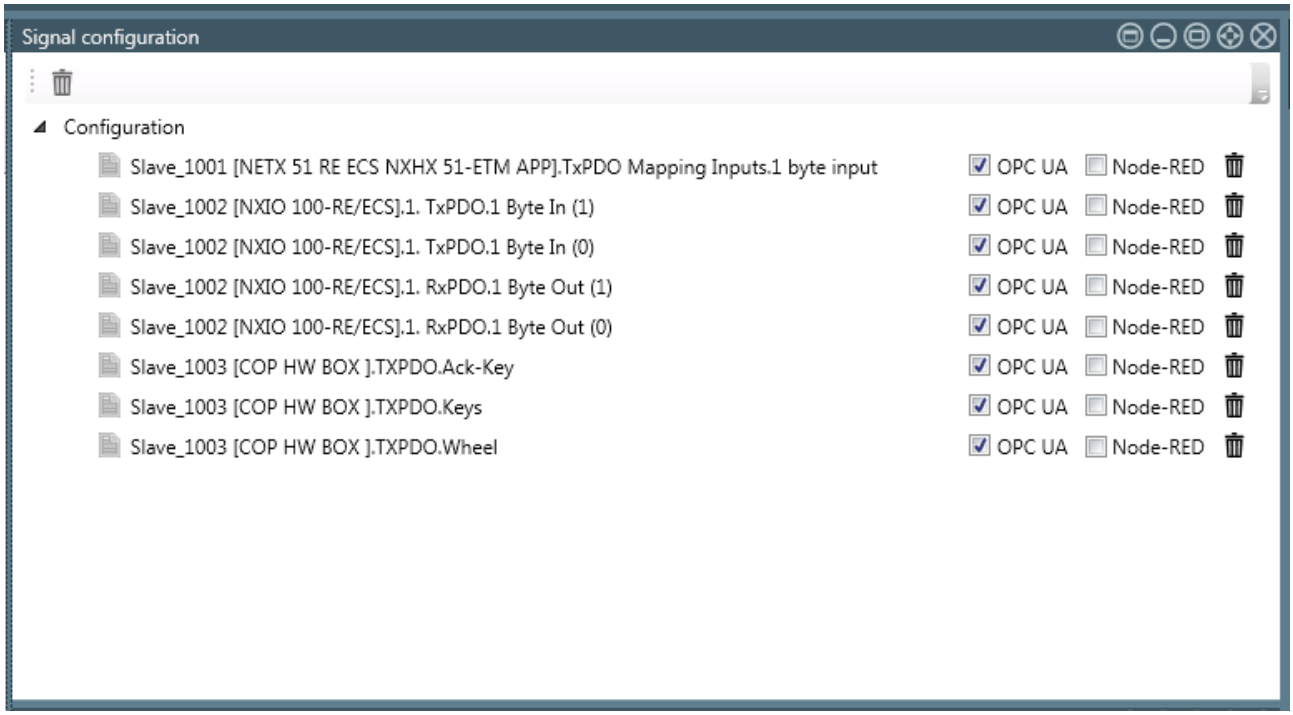


Figure 133: Selecting signals for OPC UA

5.2.2 Example: Access to the Edge Gateway over OPC UA using the Client UA Expert

Prerequisites

This example uses the OPC UA-Client **UA Expert** from Unified Automation (http://www.unified-automation.com). Fulfill the following conditions in order to access the current data of the Edge Gateway via the **UA Expert**:

1. UA Expert must have been installed.
2. The Edge Gateway is currently in the passive mode of operation and the mode *Operational* is active.

Approach

Proceed as follows:

➢ Start the UA Expert.

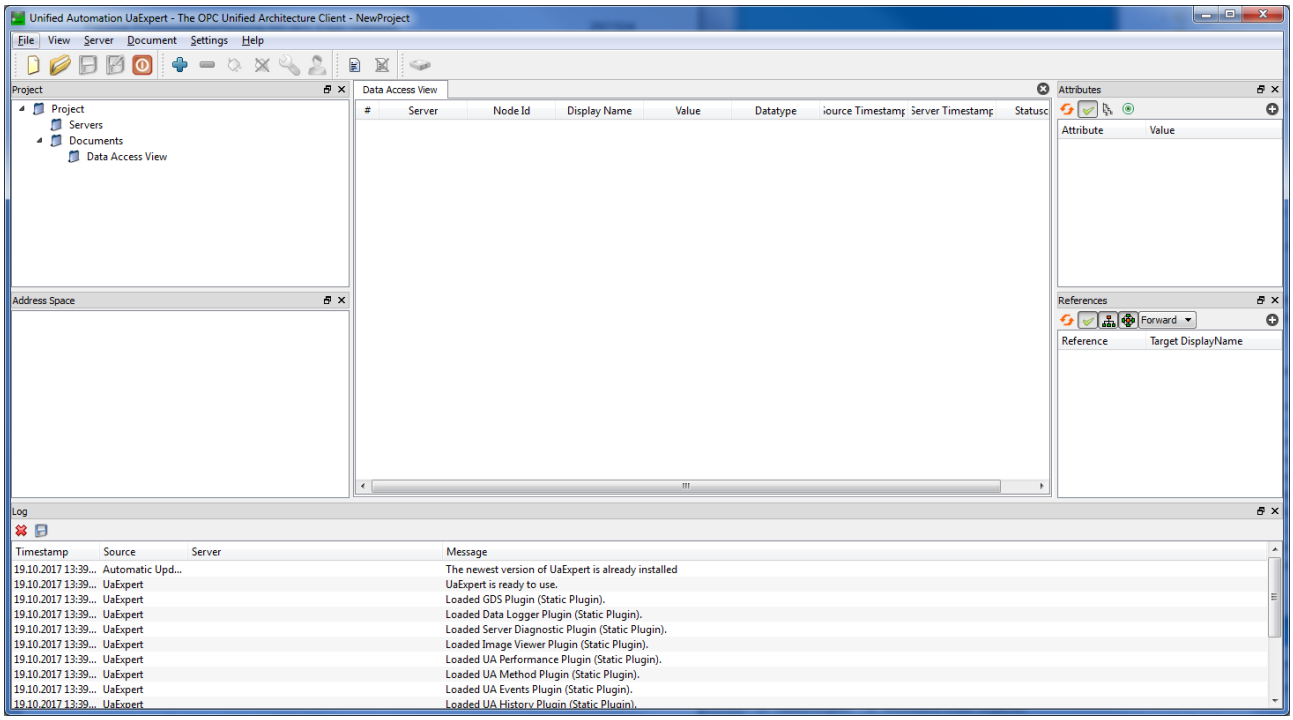


Figure 134: Intro screen of OPC UA Client UA Expert

➢ Specify the Server URL of the OPC UA Server of the Edge Gateway. In UA Expert, open the context menu of entry **Project>Servers** in window **Project** using the right mouse button, usually the left upper window.

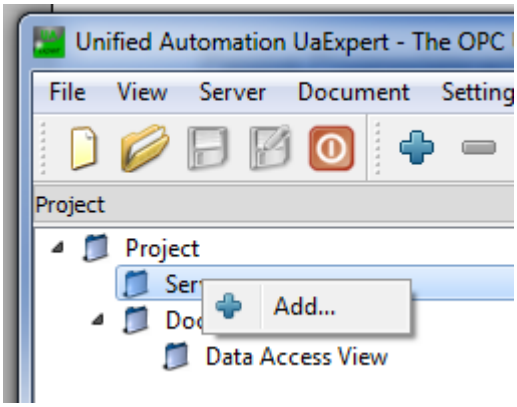


Figure 135: Context menu of the UA Expert

➢ Select entry **Add**.

↬ The window **Add Server** is opened in UA Expert.

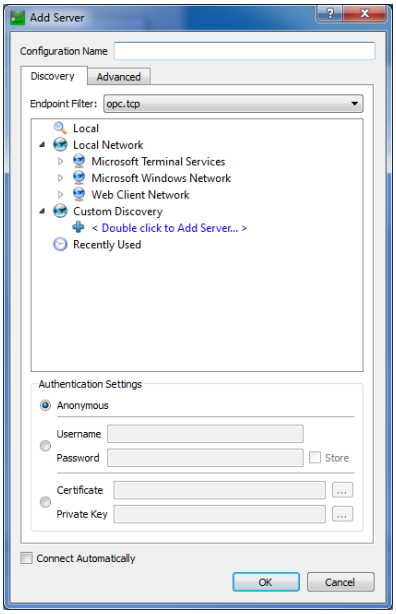


*Figure 136: Dialog **Add Server** in UA Expert*

➢ Click at the entry **Double click to Add Server** below Custom Discovery.

↬ The dialog box **Enter Url** is opened:

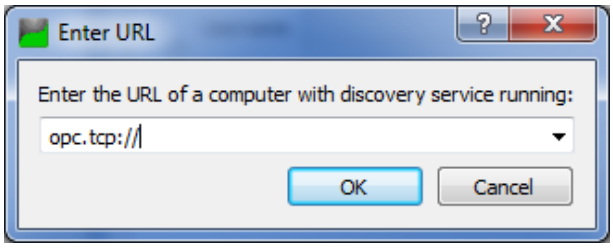


*Figure 137: Dialog box **Enter Url** in UA Expert*

➢ The Server URL to be entered into this dialog box can be taken from the page **Network>Field** of the Control Panel. This URL is structured as follows:
`opc.tcp://<IP-Address>:<OPC UA Port>`

➢ In order to close the dialog box, click at **Ok**.

↬ The dialog box is closed.

➢ In order to close the window **Add Server** click at **Ok**.

⇨ The window is closed. The window **Address Space** displays an object-oriented data model within a tree-structure. There, you find the configuration tree of the Passive Fieldbus Configurator below entry **Root>Objects>passivefieldbus**. Below this entry, all process data are listed which have been taken over into the signal configuration within the Passive Fieldbus Configurator and for which the respective checkbox **OPC UA** has been checked.

⇨ In the window **Data Access View** of the UA Expert, the process data are displayed in „live mode“ and regularly updated.

If you should receive the error message *Bad Certification Trust* , this message is caused by the use of the self-signed certificate stored within the Edge Gateway in its state of delivery.

You have two possibilities to react:

1. **Recommended solution:** Install an own certificate instead of the self-signed one from the delivery state of the Edge Gateway.
2. **Alternative solution:**You can also just ignore the message *Bad Certification Trust*. Although the message text states the opposite, there is really no danger in using the self-signed cerificate provided by Hilscher.

Note:
Concerning this topic read the notes at the following link Secure connection.

5.3 Node-RED transfers process data into the Cloud

The acquired data can also be transferred to Node-RED instead of an OPC UA-Client. By its flexibility, Node-RED offers a multitude of possibilities for post-processing the acquired data.

Note:
The access via Node-RED allows processing highly dynamic process values, for instance from processes in drive technology, as each value is acquired with a precise time-stamp according to the current cycle.

When designing the Node-RED flow, use the node `passivefieldbus` in order to access the data.

5.3.1 Selecting signals for Node-RED

You have to select the signals for Node-RED with the netIOT Passive Fieldbus Configurator. Check **Node-RED** in the **Signal Configuration** window for signals for further processing in Node-RED.

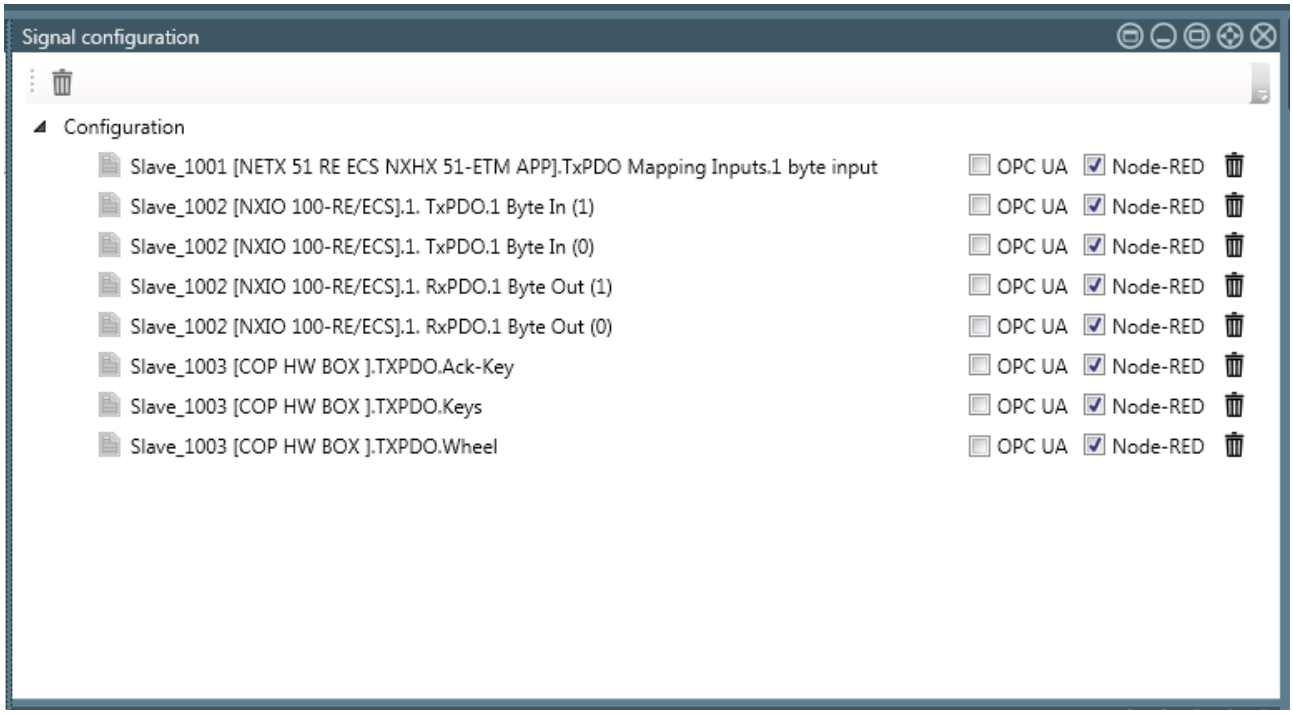


Figure 138: Selecting signals for Node-RED

5.3.2 The input node "passivefieldbus"

The input node "`passivefieldbus`" is used in a similar way as the fieldbus input node "`fieldbus`". It allows you to receive data from the Real-Time Ethernet network in the passive mode of the Edge Gateway. The following condition must be fulfilled: These data to be received must be checked within the signal configuration.

The input node "`passivefieldbus`" just like the Edge Gateway in the passive mode only works in one direction: it only delivers data, but it cannot receive any data.

Configuration

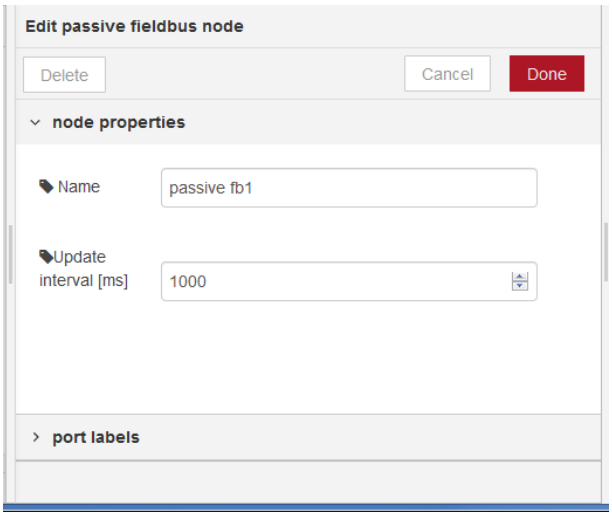


Figure 139: Edit passive fieldbus node

At the configuration of the node `passivefieldbus`, the following parameters must be specified:

Parameter	Default	Meaning
Name	`passive fb1`	Specify the name of the `passivefieldbus` node here.
Update interval	1000	Specify the time interval of the `passivefieldbus` node in units of the milliseconds here after which the `passivefieldbus` node is read out.

Table 19: Parameters for the configuration of node `passivefieldbus`:

Considerations concerning the update interval

The minimum applicable value amounts 200 ms. We recommend to use a value of about some seconds in order to avoid a frame buffer overflow of the Edge Gateway and consequential data drops.

Example Access to the `passivefieldbus` node via the debug node

The following example shows how you can access the data delivered by the input node "`passivefieldbus`" . It uses the input node `passivefieldbus` together with a debug node.

The input node `passivefieldbus` has to receive data from the Edge-Gateway. The debug node is used to display these data in the register card Debug in the edge bar of Node-RED.

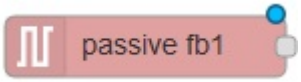
Prerequisites

The following prerequisites have to be met:

1. A connection to the Edge Gateway has been established (see section Using the web browser to establish a connection with the Edge Gateway):
2. The Node-RED workspace is open.

Step-by-step instructions

Reproduce this example as follows in Node-RED:

1. Insert input node "passivefieldbus" within the Node-RED workspace area:
   - ➢ Pull an input node "passivefieldbus" from the node library and insert it into the worksheet.
   - ↬ The input node passivefieldbus is displayed.
   - ↬ 

2. Open bar at the right edge
   - ➢ Open the bar at the right edge with the key combination Ctrl+Space or via the Node-RED menu **View>Show Sidebar**
   - ➢ Click at register card **Info** of the bar at the right edge
   - ➢ Click at the input node **passivefieldbus** in order to display its properties and function description in register card **Info**.
3. Edit input node "passivefieldbus":
   - ➢ Open the edit window by double-clicking at the input node passivefieldbus.
   - ↬ The edit window for specifying the parameters is displayed.

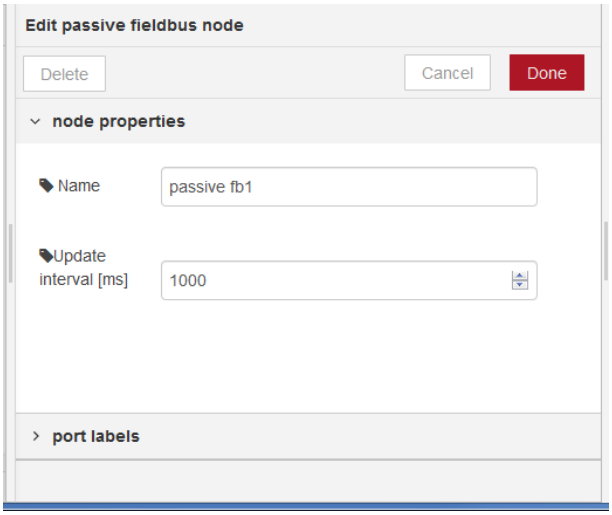
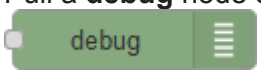


Figure 140: Edit window for specifying the parameters.

4. Specify the name
   - ➢ Specify a node name for Name. The default name is passive fb1.
5. Specify the update interval
   - ➢ Specify the desired update interrval here. The default value amounts to 1000 ms.
6. Complete fieldbus input node
   - ➢ Click at **Done**.
   - ↬ The configuration of the input node passivefieldbus is now completed.

7. Insert debug node
   - ➢ Pull a **debug** node out of the node library and insert it to the worksheet.



8. Connect nodes
   - ➢ Connect the fieldbus with the "**Debug**" node by dragging a line from the output connector of the fieldbus node to theinput connector of the debug node.

Deploy

   - ➢ Click at **Deploy** in order to transfer the nodes still only existing in the editor to the Edge Gateway and to activate those there.
   - ⇨ The data flow within the Edge Gateway is activated.

Every time the update interval passes again, the input node "`passivefieldbus`" periodically delivers new data, the variable `msg.payload` of the debug node is updated with new values. You can display these in register card **Debug** of the bar at the right edge of the Node-RED window.

5.3.3 Structure of the data delivered by the input node

The data delivered from the input node to the debug node (Variable `msg.payload`) are delivered as an array of process variables.

Each process variable i.e. each element of this array

- represents an object in JSON notation
- corresponds to a checked variable of the Node-RED signal configuration (see *Step 6 - Signal configuration* [▶ page 37]).

In the following, two objects are shown as example:

```
[
{
"valueList": [
{
"ts": "1508346006127776395",
"val": 104,
"state": "valid"
},
{
"ts": "1508346006129766435",
"val": 56,
"state": "valid"
},
{
"ts": "1508346006131767355",
"val": 104,
"state": "valid"
},
{
"ts": "1508346006133801555",
"val": 32,
```

```
"state": "valid"
}
],
"name": "et200sp.AQ 4xU/I ST V1.0.AQ 4xU/I ST V1.0.O-channel 0",
"datatype": "INTEGER16"
},
{
"valueList": [
{
"ts": "1508346006127776395",
"val": 1,
"state": "valid"
},
{
"ts": "1508346006129766435",
"val": 1,
"state": "valid"
},
{
"ts": "1508346006131767355",
"val": 0,
"state": "valid"
},
{
"ts": "1508346006133801555",
"val": 0,
"state": "valid"
}
],
"name": "et200sp.DQ 8x24VDC/0.5A ST V1.0.DQ 8x24VDC/0.5A ST
V1.0.Outputs.Bit 0.0",
"datatype": "BIT1"
}
]
```


Structure of the process variables

The following table explains the structure of the elements of the JSON array representing the process variables:

Variable	Meaning
ValueList	Value list containing the acquired data values of the process
Name	Name of the array element
Datatype	Datatype of the acquired process data values

Table 20: Structure of the process variables (Elements of JSON array)

The number of values in the value list `ValueList` can be computed as follows:

Example: If the cycle time of the process data acquisition amounts 2 ms and the update interval is set to the default value of 1000 ms, then the list within `ValueList` contains 1000 : 2 = 500 values. For each of these values, the following structure is present (see below)

Structure of the elements of the value list `ValueList`

The value list stored in ValueList has the following structure:

Name	Meaning	Explanation
ts	Timestamp	Time specification with nanosecond precision. It is stored in the UNIX timestamp format, i.e. it contains the number of nanoseconds since 1970/01/01.
val	Data value	The process data values are stored and process in the datatype which has been specified at Datatype (at the array element).
status	Status	Status of the measured value (binary). Bit set (Valid). Value is valid Bit not set (Invalid): Value is invalid

Table 21: Structure of the elements of the value list

5.3.4 Display of data processing status

Node-RED also shows the current status of data processing. The following status values are defined:

Status	Meaning
recording	Datá are being recorded This status only appears, if the Edge Gateway is in the passive mode and is in state *Operational*.
disconnected	No Connection. This status is displayed, if no data are acquired, for instance in case of the Edge Gateway just being in configuration mode.
Dropped data	Data loss by overflow of the internal ring data buffer within the Edge Gateway or by too slow processing of the data in Node-RED.

Table 22: Status of data processing in Node-RED

5.3.5 Adjusting the timing in order to prevent data loss

The following timing diagram explains the causes of possible data loss:

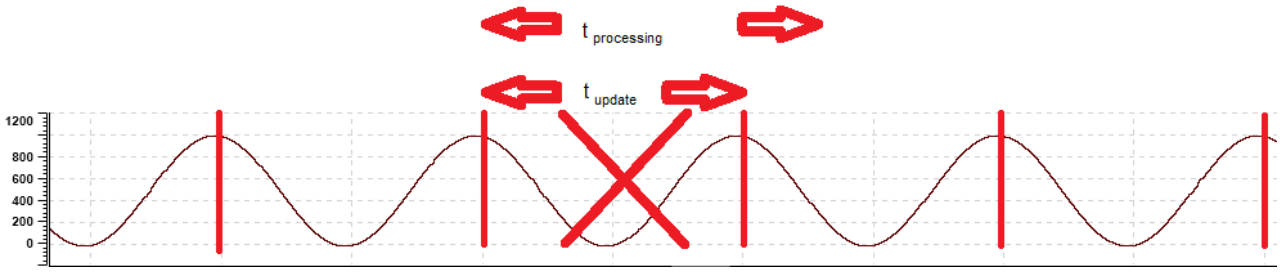


Figure 141: Example: Timing diagram

To prevent data loss during Node-RED-based data processing, take care of the following two causes:

1. The JSON data are read out in the distance in time specified by the update interval. If data processing in Node-RED lasts too long so that it is not yet finished after the update intervall has passed, the complete data acquired within the affected update intervall are rejected.
2. In the Edge Gateway, there is a 100 MB ring buffer continuously storing incoming frames and overwriting the oldest frames. An overflow of this 100 MB ring buffer in the Edge Gateway can cause data loss. If data losses occur (Status *Dropped data*), at least all data of the affected update interval are rejected in any case.

Apply these remedies against data loss:

1. Reduce the amount of data within the ring buffer by decreasing either the update interval or the amount of data to transferred to Node-RED.
2. Optimize the Node-RED-Flow for reduced processing time

5.4 Using a Docker container to access to the raw data

The libpcap library allows you to access the raw data of the passive fieldbus interface within a Docker container.

Prerequisites

1. The NIOT-E-LIC-SNIF license must be installed on the Edge Gateway, in order to use the Passive Operation Mode. Section *Which licenses are present in the device?* [page 25] describes how can display available licenses.
2. In the Control Panel (**Control Panel > Field**), Operation mode **passive** and the Passive mode **Docker** has to be set.
3. Use the libpcap library, create and load a Docker container into the Edge Gateway. An example for Docker including documentation is hosted in the Docker hub repository. The URL is: https://hub.docker.com/r/hilschernetiotedge/passive-fieldbus/

6 Performance considerations

6.1 Only use a single passivefieldbus node

Note:

Per Node-RED flow, always only use a single `passivefieldbus` node! Defining multiple `passivefieldbus` node in one Node-RED flow will strongly deteriorate the performance!

If you should need access to the data provided by the `passivefieldbus` node at other locations in the Node-RED flow, then you should work with a link node in order to provide the desired data access.

7 Appendix

7.1 Legal notes

Copyright

Important notes

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Terms and conditions

Please read the notes about additional legal aspects on our netIOT web site under http://www.netiot.com/netiot/netiot-edge/terms-and-conditions/.

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