BECKHOFF New Automation Technology

Operating manual | EN

ELX6233

Two Channel Communication Interface, Ethernet-APL, Ex i

2025-08-01 | Version: 1.1.0

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1 Foreword

1.1 Notes on the documentation

Intended audience

This description is only intended for the use of trained specialists in control and automation engineering who are familiar with the applicable national standards.
It is essential that the documentation and the following notes and explanations are followed when installing and commissioning these components.
The qualified personnel is obliged to always use the currently valid documentation.

The responsible staff must ensure that the application or use of the products described satisfy all the requirements for safety, including all the relevant laws, regulations, guidelines and standards.

Disclaimer

The documentation has been prepared with care. The products described are, however, constantly under development.

We reserve the right to revise and change the documentation at any time and without prior announcement.

No claims for the modification of products that have already been supplied may be made on the basis of the data, diagrams and descriptions in this documentation.

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1.2 Safety instructions

Safety regulations

Please note the following safety instructions and explanations!
Product-specific safety instructions can be found on following pages or in the areas mounting, wiring, commissioning etc.

Exclusion of liability

All the components are supplied in particular hardware and software configurations appropriate for the application. Modifications to hardware or software configurations other than those described in the documentation are not permitted, and nullify the liability of Beckhoff Automation GmbH & Co. KG.

Personnel qualification

This description is only intended for trained specialists in control, automation and drive engineering who are familiar with the applicable national standards.

Signal words

The signal words used in the documentation are classified below. In order to prevent injury and damage to persons and property, read and follow the safety and warning notices.

Personal injury warnings

⚠ DANGER
Hazard with high risk of death or serious injury.

⚠ WARNING
Hazard with medium risk of death or serious injury.

⚠ CAUTION
There is a low-risk hazard that could result in medium or minor injury.

Warning of damage to property or environment

NOTICE
The environment, equipment, or data may be damaged.

Information on handling the product

This information includes, for example:
recommendations for action, assistance or further information on the product.

1.3 Documentation Issue Status

Version	Comment
1.1.0	• Chapter *Technical data* updated • Description of LED displays updated • First release
1.0.0	• Chapter *ELX6233 and PROFIsafe* added • Chapter *ELx663x Settings* updated
0.4	• Chapter *Technical data* updated • Chapter *Intended use* added
0.3	• Chapter *Identification of ELX terminals* updated • Chapter *Introduction* updated (product image) • Chapter *Configuration of ELX terminals in bus terminal block* extended • Chapter *Connection and LEDs* updated (product image) • Chapter *PM Controller Protocol* updated (screen shots) • Chapter *Devices at protocol* updated (screen shots)
0.2	• Chapter *PM Controller Protocol* added • Chapter *Devices at protocol* added
0.1	• First draft

1.4 Suggestions or proposals for documentation

If you have any suggestions or proposals for our documentation, please send us an e-mail stating the documentation title and version number to: documentation@beckhoff.com

1.5 Marking of ELX terminals

Designation

An ELX terminal has a 15-digit technical designation, composed of

- Family key
- Type
- Software variant
- Revision

Example	Family	Type	Software variant	Revision
ELX1052-0000-0001	ELX terminal	1052: Two-channel digital input terminal for NAMUR sensors, Ex i	0000: Basic type	0001
ELX9560-0000-0001	ELX terminal	9560: Power supply terminal	0000: Basic type	0001

Notes

- The elements mentioned above result in the **technical designation**. ELX1052-0000-0001 is used in the example below.
- Of these, ELX1052-0000 is the order identifier, commonly called just ELX1052 in the "-0000" revision. “-0001” is the EtherCAT revision.
- The **order identifier** is made up of
  - family key (ELX)
  - type (1052)
  - software version (-0000)
- The **Revision** -0001 shows the technical progress, such as the extension of features with regard to the EtherCAT communication, and is managed by Beckhoff.
  In principle, a device with a higher revision can replace a device with a lower revision, unless specified otherwise, e.g. in the documentation.
  Associated and synonymous with each revision there is usually a description (ESI, EtherCAT Slave Information) in the form of an XML file, which is available for download from the Beckhoff website.
  The revision has been applied to the terminals on the outside, see *Fig. ELX1052 with date code 3218FMFM, BTN 10000100 and Ex marking.*
- The hyphen is omitted in the labeling on the side of the terminal. Example:
  Name: ELX1052-0000
  Label: ELX1052 $_{0000}$
- The type, software version and revision are read as decimal numbers, even if they are technically saved in hexadecimal.

Identification numbers

ELX terminals have two different identification numbers:

- date code (batch number)
- **B**eckhoff **T**raceability **N**umber, or BTN for short (as a serial number it clearly identifies each terminal)

Date code

The date code is an eight-digit number given by Beckhoff and printed on the ELX terminal. The date code indicates the build version in the delivery state and thus identifies an entire production batch but does not distinguish between the terminals in a batch.

Structure of the date code: **WW YY FF HH**	Example with date code 02180100:
WW - week of production (calendar week)	02 - week of production 02
YY - year of production	18 - year of production 2018
FF - firmware version	01 - firmware version 01
HH - hardware version	00 - hardware version 00

Beckhoff Traceability Number (BTN)

In addition, each ELX terminal has a unique **B**eckhoff **T**raceability **N**umber (BTN).

1.5.1 Ex marking for ATEX, IECEx and cFMus

Marking

The Ex marking can be found at the top left of the right side of the terminal:

II 3 (1) G Ex ec [ia Ga] IIC T4 Gc
II (1) D [Ex ia Da] IIIC
I (M1) [Ex ia Ma] I
IECEx BVS 18.0005X
BVS 18 ATEX E 005 X

Examples

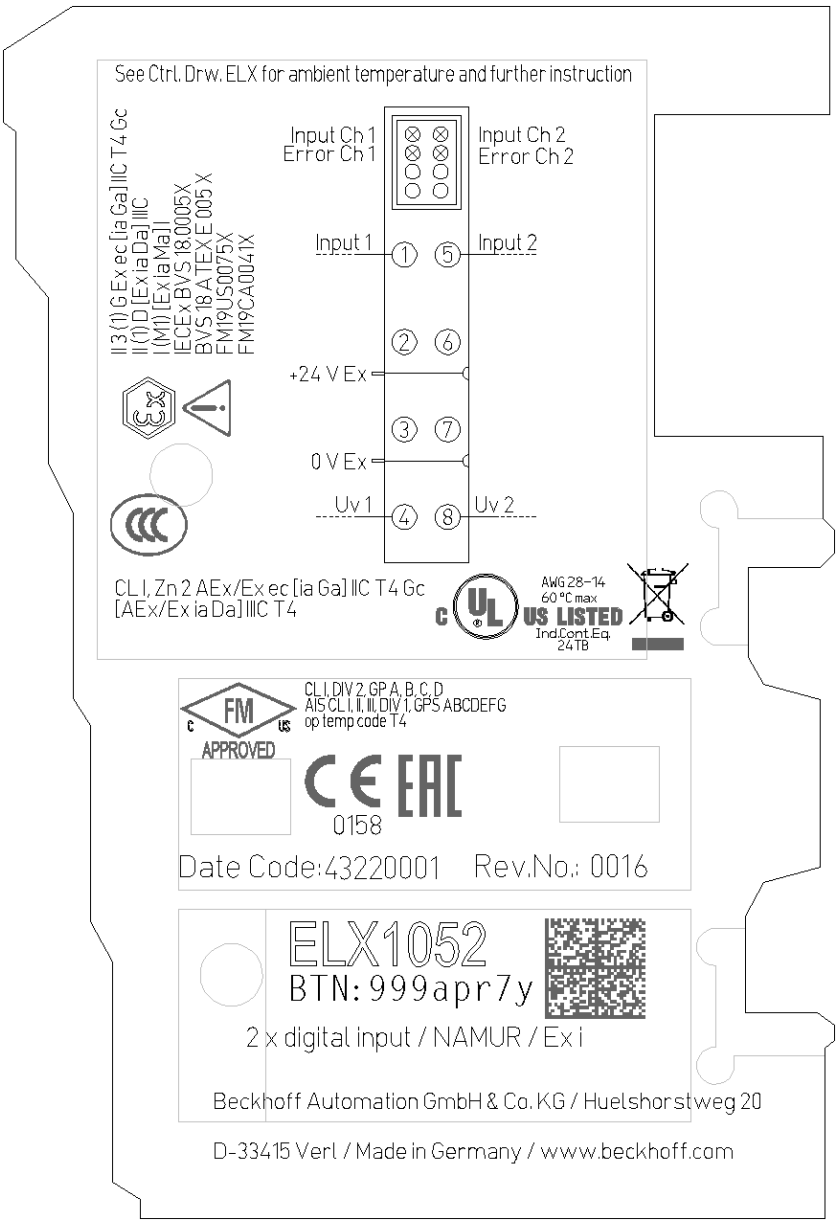


Fig. 1: ELX1052 with date code 43220001, BTN 999apr7y and marking für ATEX, IECEx and cFMus

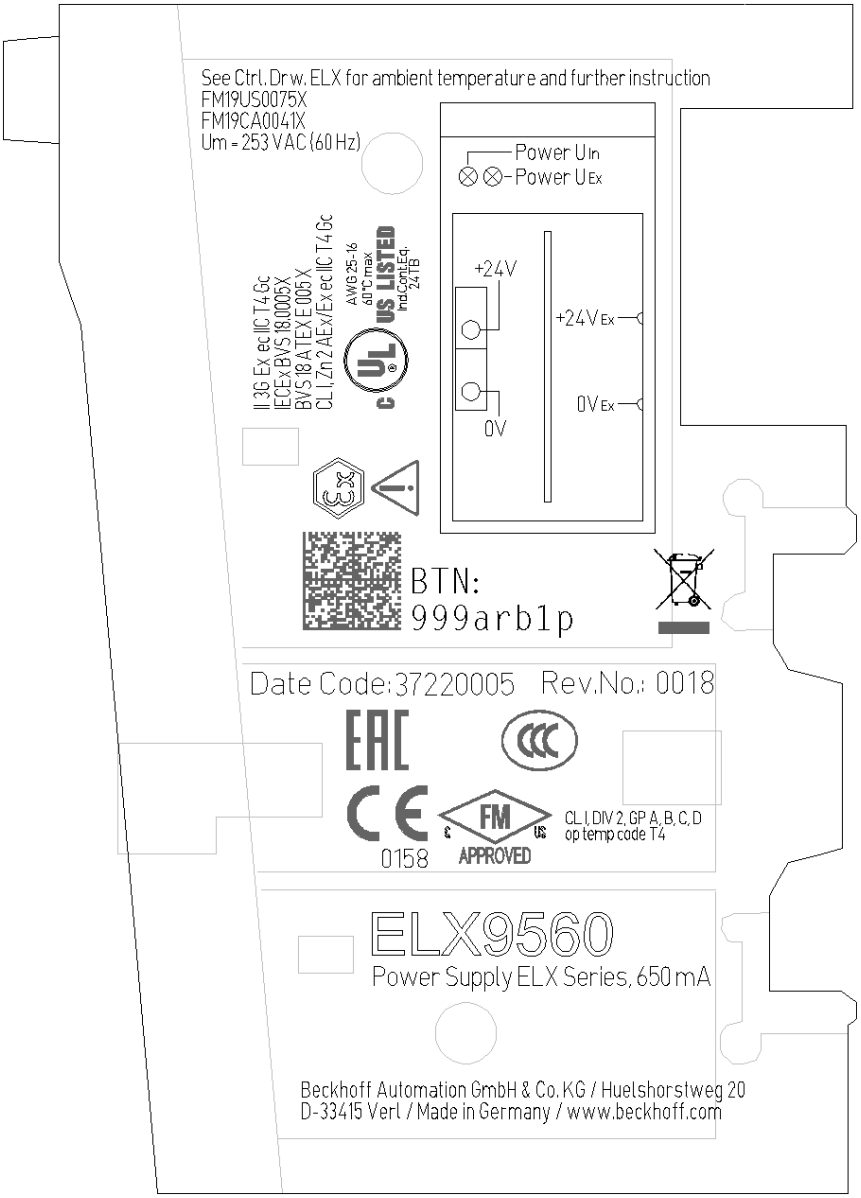


Fig. 2: ELX9560 with date code 37220005, BTN 999arb1p and marking für ATEX, IECEx and cFMus

Fig. 3: ELX9012 with date code 36230000, BTN 000bh4yr and marking für ATEX, IECEx and cFMus

2 Product overview

2.1 ELX6233 - Introduction

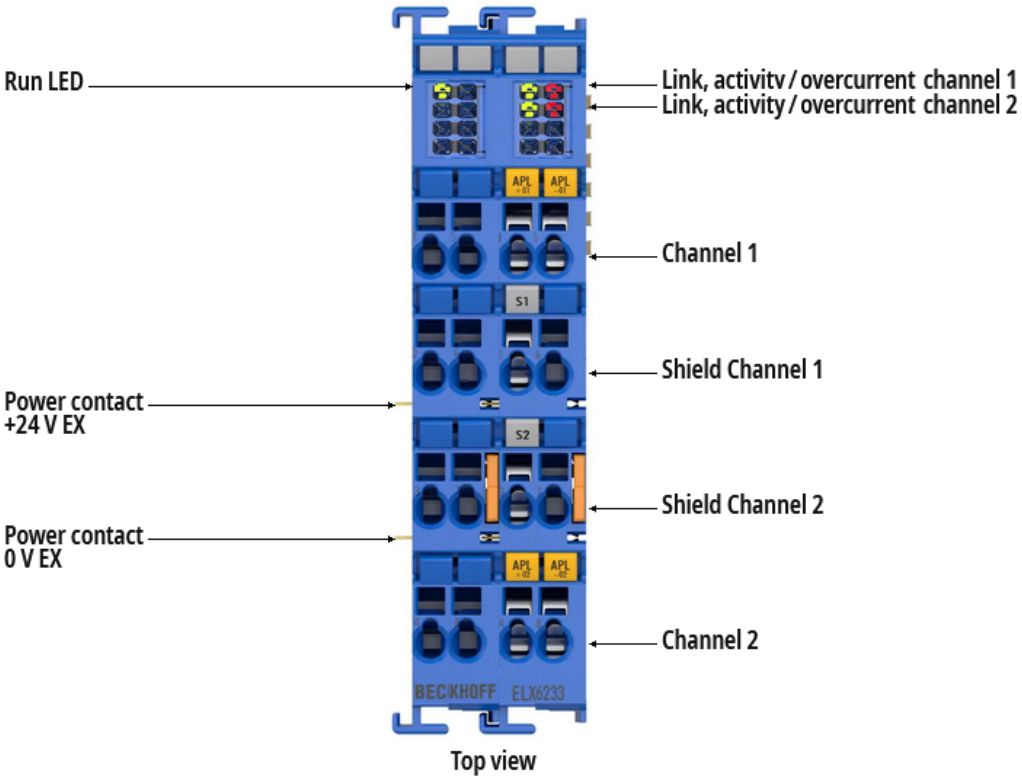


Fig. 4: ELX6233 | 2-channel communication interface, Ethernet-APL, Ex i

The ELX6233 EtherCAT Terminal allows direct connection of Ethernet-APL-capable field devices from the hazardous areas of zones 0/20 and 1/21. The sensors are supplied in accordance with the SPAA (TS10186) port profile and integrated via PROFINET. The flexible EtherCAT system architecture and ELX portfolio allow Ethernet-APL, HART, and simple digital signals to be integrated into the same terminal segment.

The Ethernet Advanced Physical Layer is a communication technology specially developed for the requirements of the process industry. Ethernet-APL describes only the physical transmission layer, based on the 10BASE-T1L single-pair Ethernet standard, and is therefore protocol-independent. Regarding use in hazardous areas, the IEC defines limits for the power supply to the field devices. The TS10186 technical specification developed by the Ethernet-APL project group prescribes guideline values based on these limit values and divides them into port profiles to simplify connectivity. Field devices from zones of the hazardous area can be connected depending on the port profile.

2.2 Technical data

Technical data	ELX6233-0000
Technology	Ethernet-APL
Number of Ethernet APL ports	2
Connection technology	terminal contact
Ethernet interface	10BASE-T1L
Cable length	max. 200 m
Data transfer rates	10 Mbit/s
Protocol	PROFINET
Configuration	via the EtherCAT-Master from TwinCAT 3.1, build 4024.58 or build 4026
Current consumption from the E-bus	typ. 60 mA
Current consumption from the power contacts	typ. 25 mA + load (load = max. 22.5 mA per channel)
Power supply of the electronics	24 V_{DC} (via power contacts), supplied by ELX9560
Connection type	SPAA
Rated power	0.54 W
Permissible ambient temperature range during operation	-25 °C ... + 60 °C
Permissible ambient temperature range during storage	-40 °C ... + 85 °C
Permissible relative air humidity	95 %, no condensation
Permissible air pressure (operation, storage, transport)	800 hPa to 1100 hPa (this is equivalent to an altitude of approx. -690 m to 2000 m above sea level assuming an international standard atmosphere)
Weight	approx. 90 g
Vibration / shock resistance	conforms to EN 60068-2-6 / EN 60068-2-27
EMC immunity / emission	conforms to EN 61000-6-2 / EN 61000-6-4
Protection rating	IP20
Correct installation position	See chapter Installation position and minimum distances [▶ 21]
Approvals / markings*	CE, ATEX, IECEx

*) Real applicable approvals/markings see type plate on the side (product marking).

Housing data

Technical data	ELX6233-0000
Design	compact terminal housing with signal LEDs
Material	Polycarbonate, blue
Size (W x H x D)	approx. 27 mm x 100 mm x 70 mm (width aligned: 24 mm)
Installation [▶ 22]	on 35 mm mounting rail according to EN 60715 with locking
Stackable by	double groove-tongue connection
Labelling	Labeling of the BZxxx series
Power contacts	2 blade/spring contacts

Technical data for explosion protection

Technical data for explosion protection		ELX6233-0000
Ex marking (in preparation)	ATEX	II 3 (1) G Ex ec [ia Ga] IIC T4 Gc II (1) D [Ex ia Da] IIIC I (M1) [Ex ia Ma] I
	IECEx	Ex ec [ia Ga] IIC T4 Gc [Ex ia Da] IIIC [Ex ia Ma] I
Certificate numbers		BVS 18 ATEX E 005 X IECEx BVS 18.0005X
Power supply		without exception in connection with the ELX9560
Field interfaces		2-WISE power source

2.3 Intended use

⚠ WARNING

Endangering the safety of persons and equipment!

The ELX components may only be used for the purposes described below!

⚠ CAUTION

Observe ATEX and IECEx!

The ELX components may only be used in accordance with the ATEX directive and the IECEx scheme!

The ELX terminals extend the field of application of the Beckhoff bus terminal system with functions for integrating intrinsically safe field devices from hazardous areas. The intended field of application is data acquisition and control tasks in discrete and process engineering automation, taking into account explosion protection requirements.

The ELX terminals are protected by the type of protection "Increased safety" (Ex e) according to IEC 60079-7 and must only be operated in hazardous areas of Zone 2 or in non-hazardous areas.

The field interfaces of the ELX terminals achieve explosion protection through the type of protection "intrinsic safety" (Ex i) according to IEC 60079-11. For this reason, only appropriately certified, intrinsically safe devices may be connected to the ELX terminals. Observe the maximum permissible connection values for voltages, currents and reactances. Any infringement can damage the ELX terminals and thus eliminate the explosion protection.

The ELX terminals are open, electrical equipment for installation in lockable cabinets, enclosures or operating rooms. Make sure that access to the equipment is only possible for authorized personnel.

⚠ CAUTION

Ensure traceability!

The buyer has to ensure the traceability of the device via the Beckhoff Traceability Number (BTN).

3 Mounting and wiring

3.1 Special conditions of use for ELX terminals

⚠ WARNING

Observe the special conditions of use for the intended use of Beckhoff ELX terminals in potentially explosive areas!

- The certified components are to be installed in a suitable housing that guarantees an ingress protection of at least IP54 in accordance with IEC 60079-0! The prescribed environmental conditions during installation, operation and maintenance are thereby to be taken into account! Inside the housing, pollution degree 1 and 2 are permissible as defined in IEC 60664-1.
- If the temperatures during rated operation are higher than 70°C at the feed-in points of cables, lines or pipes, or higher than 80°C at the wire branching points, then cables must be selected whose temperature data correspond to the actual measured temperature values!
- Observe the permissible ambient temperature range of -25 to +60°C of Beckhoff ELX terminals!
- Measures must be taken to protect against the rated operating voltage being exceeded by more than 40% due to short-term interference voltages! The power supply of the ELX9560 power supply terminal must correspond to overvoltage category II according to IEC 60664-1
- The individual terminals may only be unplugged or removed from the bus terminal system if all supply voltages have been switched off or if a non-explosive atmosphere is ensured!
- The connections of the ELX9560 power supply terminal may only be connected or disconnected if all supply voltages have been switched off or if a non-explosive atmosphere is ensured!
- Address selectors and switches may only be adjusted if all supply voltages have been switched off or if a non-explosive atmosphere is ensured!

3.2 Installation notes for ELX terminals

NOTICE

Storage, transport and mounting

- Transport and storage are permitted only in the original packaging!
- Store in a dry place, free from vibrations.
- A brand new ELX terminal with a certified build version is delivered only in a sealed carton. Therefore, check that the carton and all seals are intact before unpacking.
- Do not use the ELX terminal if
  - its packaging is damaged
  - the terminal is visibly damaged or
  - you cannot be sure of the origin of the terminal.
- ELX terminals with a damaged packaging seal are regarded as used.

⚠ WARNING

Observe the accident prevention regulations

During mounting, commissioning, operation and maintenance, adhere to the safety regulations, accident prevention regulations and general technical rules applicable to your devices, machines and plants.

⚠ CAUTION

Observe the erection regulations

Observe the applicable erection regulations.

NOTICE

Protect the terminals against electrostatic discharge (ESD)

Electronic components can be destroyed by electrostatic discharge. Therefore, take the safety measures to protect against electrostatic discharge as described in DIN EN 61340-5-1 among others. In conjunction with this, ensure that the personnel and surroundings are suitably earthed.

NOTICE

Do not place terminals on E-bus contacts

Do not place the ELX terminals on the E-bus contacts located on the right-hand side. The function of the E-bus contacts can be negatively affected by damage caused by this, e.g. scratches.

NOTICE

Protect the terminals against dirt

To ensure the functionality of the ELX terminals they must be protected against dirt, especially on the contact points. For this reason use only clean tools and materials.

NOTICE

Handling

- It is forbidden to insert conductive or non-conductive objects of any kind into the interior of the housing (e.g. through the ventilation slots in the housing).
- Use only the openings provided in the housing front and appropriate tools to actuate the spring-loaded terminal contacts on the front side for attaching connection cables to the terminal; see chapter Wiring [▶ 25].
- The opening of the housing, the removal of parts and any mechanical deformation or machining of an ELX terminal are not permitted!

If an ELX terminal is defective or damaged it must be replaced by an equivalent terminal. Do not carry out any repairs to the devices. For safety reasons repairs may only be carried out by the manufacturer.

NOTICE

Contact marking and pin assignment

The colored inscription labels above the front connection contacts shown in the illustrations in the introduction chapter are only examples and are not part of the scope of delivery!
A clear assignment of channel and terminal designation according to the chapter contact assignment to the actual terminal point can be made via the lasered channel numbers 1 to 8 on the left above the respective terminal point as well as via the laser image.
Observe any possible polarity dependency of connected intrinsically safe circuits!

3.3 Arrangement of ELX terminals within a bus terminal block

⚠ WARNING

Observe the following notes on the arrangement of ELX terminals!

- ELX signal terminals may only be mounted behind an ELX9560 power supply terminal without exception!
- Only signal terminals from the ELX series may be installed behind an ELX9560 power supply terminal!
- Several ELX9560 power supply terminals may be set in a terminal block as long as an ELX9410 is set before each additional ELX9560!
- An ELX9410 power supply terminal must not be mounted to the right of an ELX9560 or to the left of an ELX signal terminal!
- The last terminal of each ELX terminal segment must be covered with an ELX9012 bus cap or an EK1110 EtherCAT extension, unless two ELX9410 power supply terminals are installed directly behind each other in order to continue the terminal segment with standard Beckhoff EtherCAT Terminals (e.g. EL/ES/EK)!

Examples for the arrangement of ELX terminals

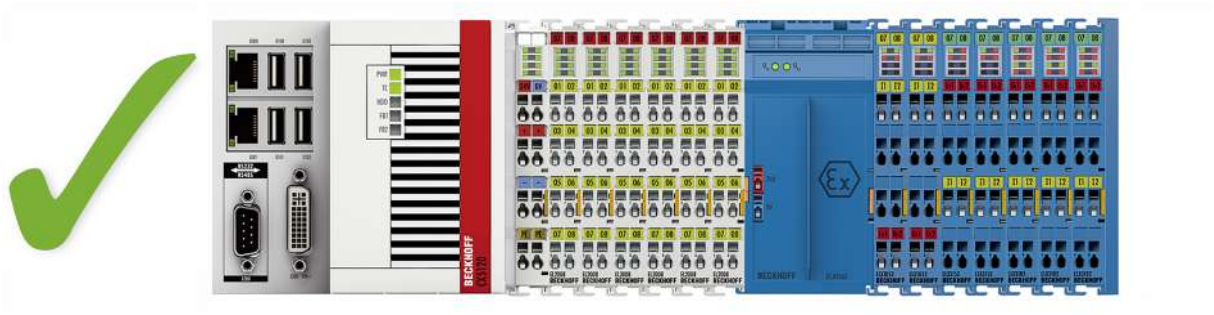


Fig. 5: Permissible arrangement of the ELX terminals (right terminal block).

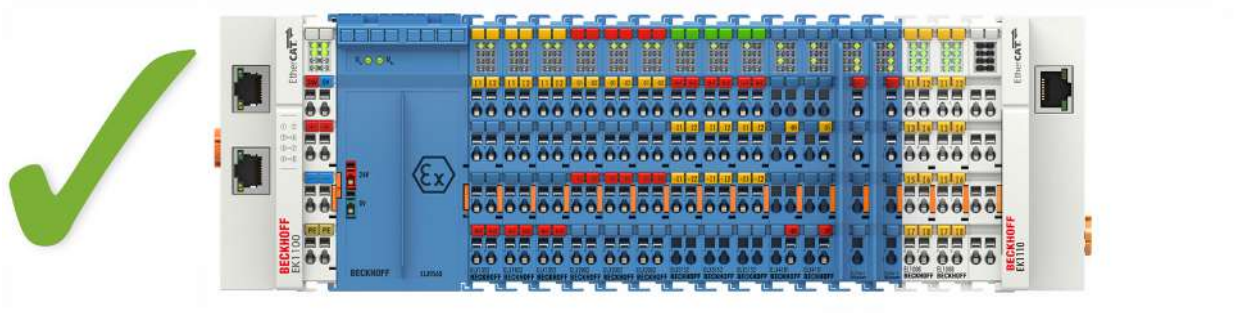


Fig. 6: Permitted arrangement - terminals that do not belong to the ELX series are placed before and after the ELX terminal segment. Isolation is provided by the ELX9560 at the beginning of the ELX terminal segment and two ELX9410 at the end of the ELX terminal segment.

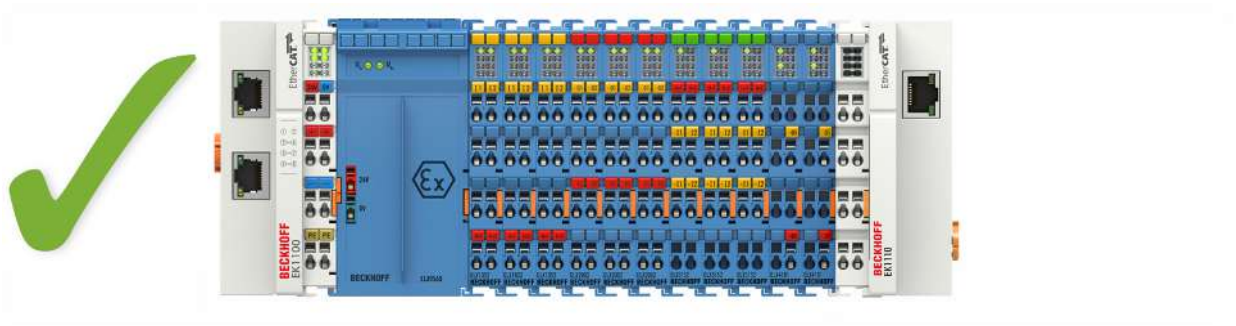


Fig. 7: Permitted arrangement - terminals that do not belong to the ELX series are placed before and after the ELX terminal segment. Isolation is provided by the ELX9560 at the beginning of the ELX terminal segment and the EK1110 at the end of the ELX terminal segment.

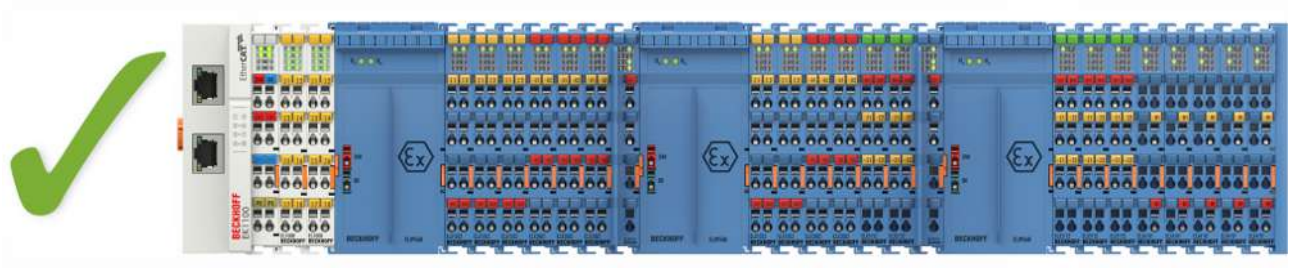


Fig. 8: Permitted arrangement - multiple resupplies by ELX9560 with an upstream ELX9410 in each case.

Fig. 9: Permitted arrangement - ELX9410 in front of an ELX9560 power supply terminal.

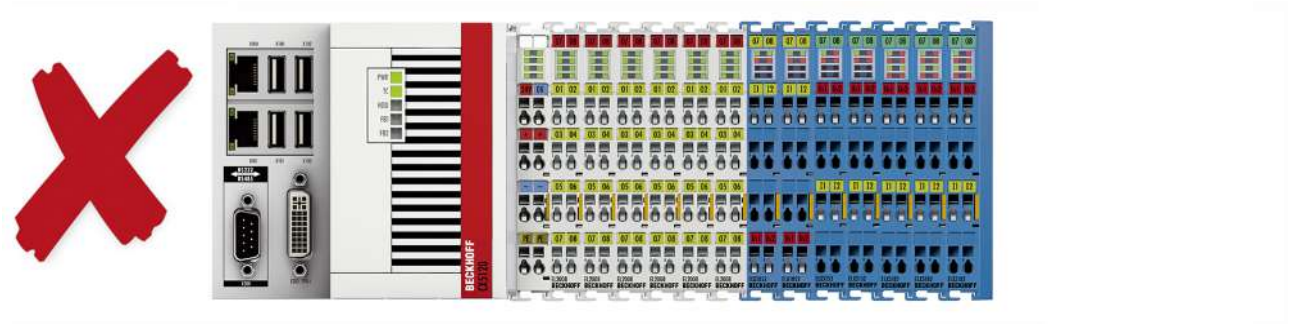


Fig. 10: Illegal arrangement - missing ELX9560 power supply terminal.

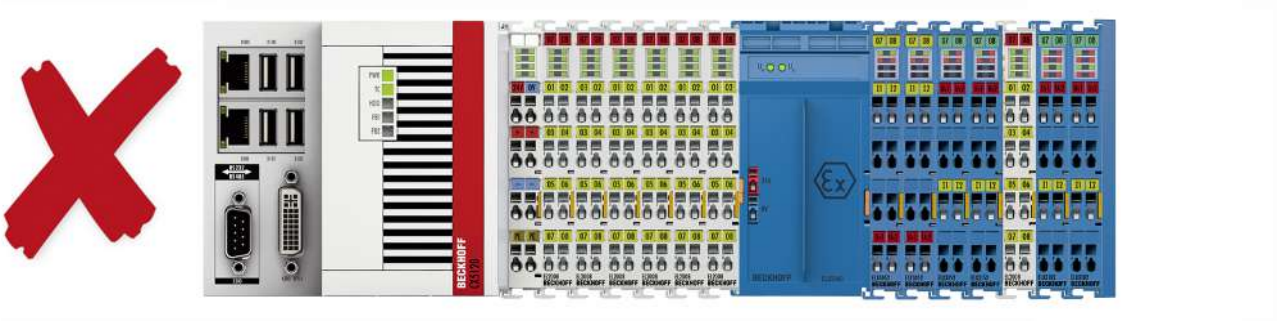


Fig. 11: Impermissible arrangement - terminal in the ELX terminal segment that does not belong to the ELX series

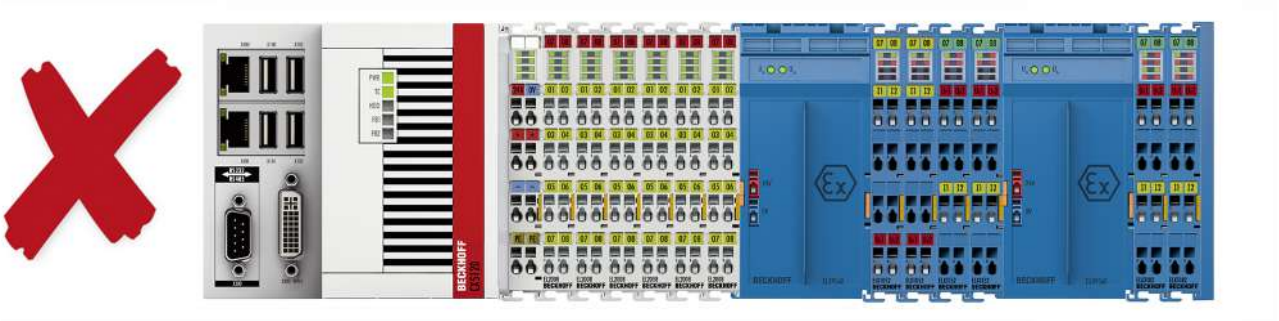


Fig. 12: Impermissible arrangement - second ELX9560 power supply terminal in the ELX terminal segment without upstream ELX9410.

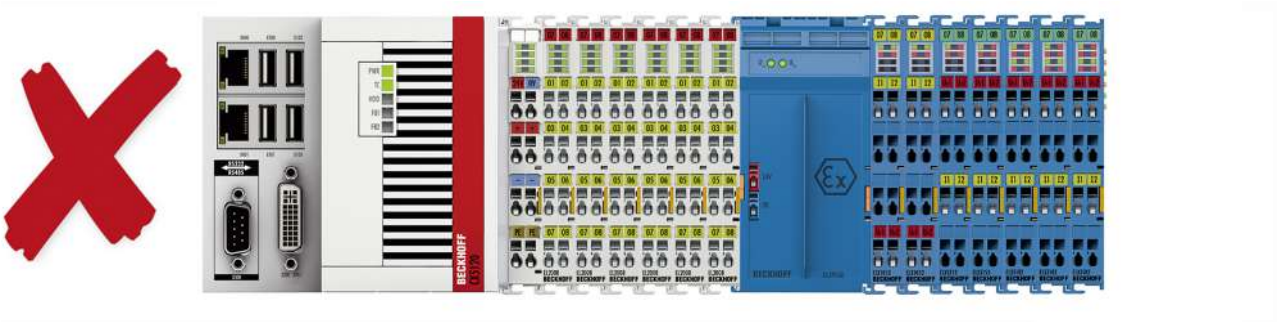


Fig. 13: Illegal arrangement - missing ELX9012 bus end cap.

NOTICE

Note the maximum output current of the ELX9560

When configuring the terminal segment, please observe the maximum available output current of the ELX9560 power supply terminal according to the specified technical data.
If necessary, an additional ELX9560 power supply terminal with upstream ELX9410 (see installation examples) must be installed or a completely new bus terminal block must be configured.

3.4 Installation position and minimum distances

Installation position

For the prescribed installation position the mounting rail is installed horizontally and the mating surfaces of the ELX terminals point toward the front (see illustration below). The terminals are ventilated from below, which enables optimum cooling of the electronics through convection. The direction indication “down” corresponds to the direction of positive acceleration due to gravity.

Minimum distances

Observe the following minimum distances to ensure optimum convection cooling:

- above and below the ELX terminals: 35 mm (required!)
- besides the bus terminal block: 20 mm (recommended)

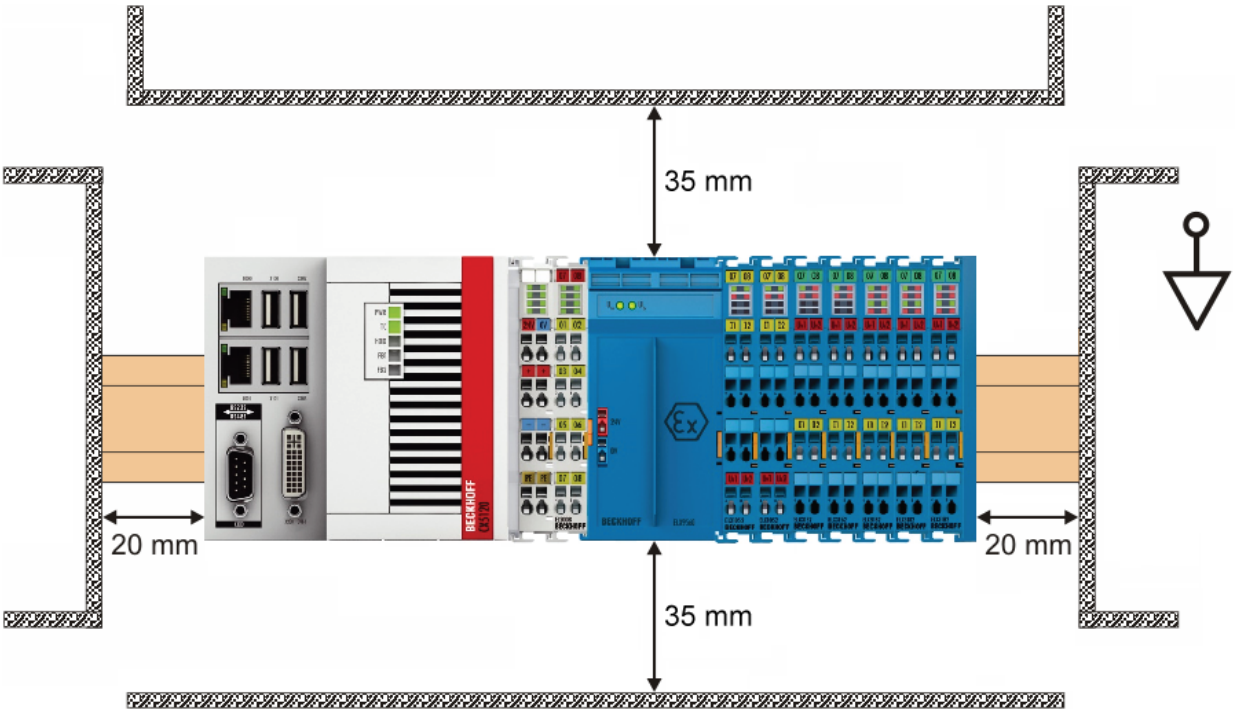


Fig. 14: Installation position and minimum distances

⚠ WARNING

Observe the minimum separation distances according to IEC 60079-14!

Observe the prescribed minimum separation distances between intrinsically safe and non-intrinsically safe circuits according to IEC 60079-14.

3.5 Installation of ELX terminals on mounting rails

⚠ WARNING

Risk of electric shock and damage of device!

Bring the bus terminal system into a safe, powered down state before starting installation, disassembly or wiring of the bus terminals!

⚠ CAUTION

Danger of injury due to power contacts!

For your own protection, pay attention to careful and careful handling of the ELX terminals. In particular, the left side mounted, sharp-edged blade contacts pose a potential risk of injury.

Assembly

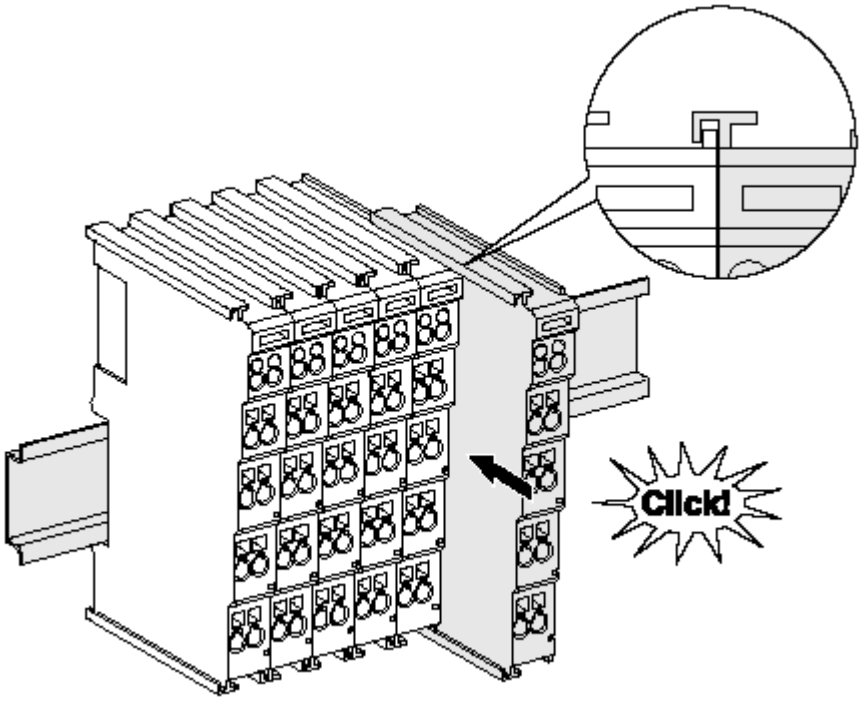


Fig. 15: Attaching on mounting rail

The bus coupler and bus terminals are attached to commercially available 35 mm mounting rails (DIN rails according to EN 60715) by applying slight pressure:

1. First attach the fieldbus coupler to the mounting rail.
2. The bus terminals are now attached on the right-hand side of the fieldbus coupler. Join the components with tongue and groove and push the terminals against the mounting rail, until the lock clicks onto the mounting rail.
   If the terminals are clipped onto the mounting rail first and then pushed together without tongue and groove, the connection will not be operational! When correctly assembled, no significant gap should be visible between the housings.

Fixing of mounting rails

The locking mechanism of the terminals and couplers extends to the profile of the mounting rail. At the installation, the locking mechanism of the components must not come into conflict with the fixing bolts of the mounting rail. To mount the mounting rails with a height of 7.5 mm under the terminals and couplers, you should use flat mounting connections (e.g. countersunk screws or blind rivets).

NOTICE

Ground the mounting rail!

Ensure that the mounting rail is sufficiently earthed.

Connections within a bus terminal block

The electric connections between the Bus Coupler and the Bus Terminals are automatically realized by joining the components:

- The six spring contacts of the E-Bus deal with the transfer of the data and the supply of the Bus Terminal electronics.
- The power contacts deal with the supply for the field electronics and thus represent a supply rail within the bus terminal block.
  The power contacts of the ELX terminals are supplied by the ELX9560 power terminal. This interrupts the power contacts and thus represents the beginning of a new supply rail.

Power Contacts

During the design of a bus terminal block, the pin assignment of the individual Bus Terminals must be taken account of, since some types (e.g. analog Bus Terminals or digital 4-channel Bus Terminals) do not or not fully loop through the power contacts.

Disassembly

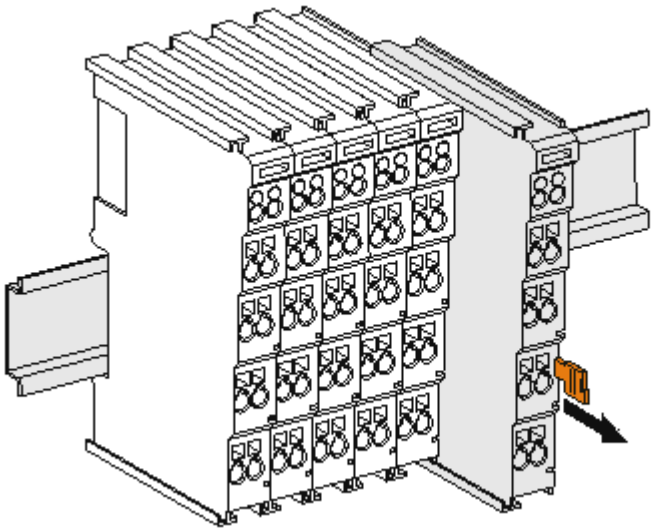


Fig. 16: Disassembling of terminal

Each terminal is secured by a lock on the mounting rail, which must be released for disassembly:

1. Pull the terminal by its orange-colored lugs approximately 1 cm away from the mounting rail. In doing so for this terminal the mounting rail lock is released automatically and you can pull the terminal out of the bus terminal block easily without excessive force.
2. Grasp the released terminal with thumb and index finger simultaneous at the upper and lower grooved housing surfaces and pull the terminal out of the bus terminal block.

3.6 Disposal

Products marked with a crossed-out wheeled bin shall not be discarded with the normal waste stream. The device is considered as waste electrical and electronic equipment. The national regulations for the disposal of waste electrical and electronic equipment must be observed.

3.7 Connection

3.7.1 Connection system

⚠ WARNING

Risk of electric shock and damage of device!

Bring the bus terminal system into a safe, powered down state before starting installation, disassembly or wiring of the bus terminals!

The terminals of ELXxxxx series include electronics and connection level in a single enclosure.

Standard wiring

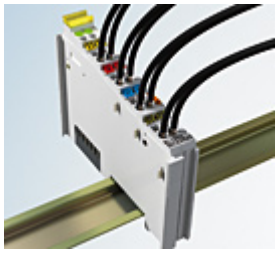


Fig. 17: Standard wiring

The terminals of ELXxxxx series feature integrated screwless spring force technology for fast and simple assembly.

High Density Terminals (HD Terminals)

Fig. 18: *High Density Terminals*

The Bus Terminals from these series with 16 connection points are distinguished by a particularly compact design, as the packaging density is twice as large as that of the standard 12 mm Bus Terminals. Massive conductors and conductors with a wire end sleeve can be inserted directly into the spring loaded terminal point without tools.

Ultrasonically "bonded" (ultrasonically welded) conductors

Ultrasonically “bonded" conductors

It is also possible to connect the Standard and High Density Terminals with ultrasonically "bonded" (ultrasonically welded) conductors. In this case, please note the tables concerning the wire-size width below!

3.7.2 Wiring

⚠ WARNING

Risk of electric shock and damage of device!

Bring the bus terminal system into a safe, powered down state before starting installation, disassembly or wiring of the bus terminals!

Terminals for standard wiring

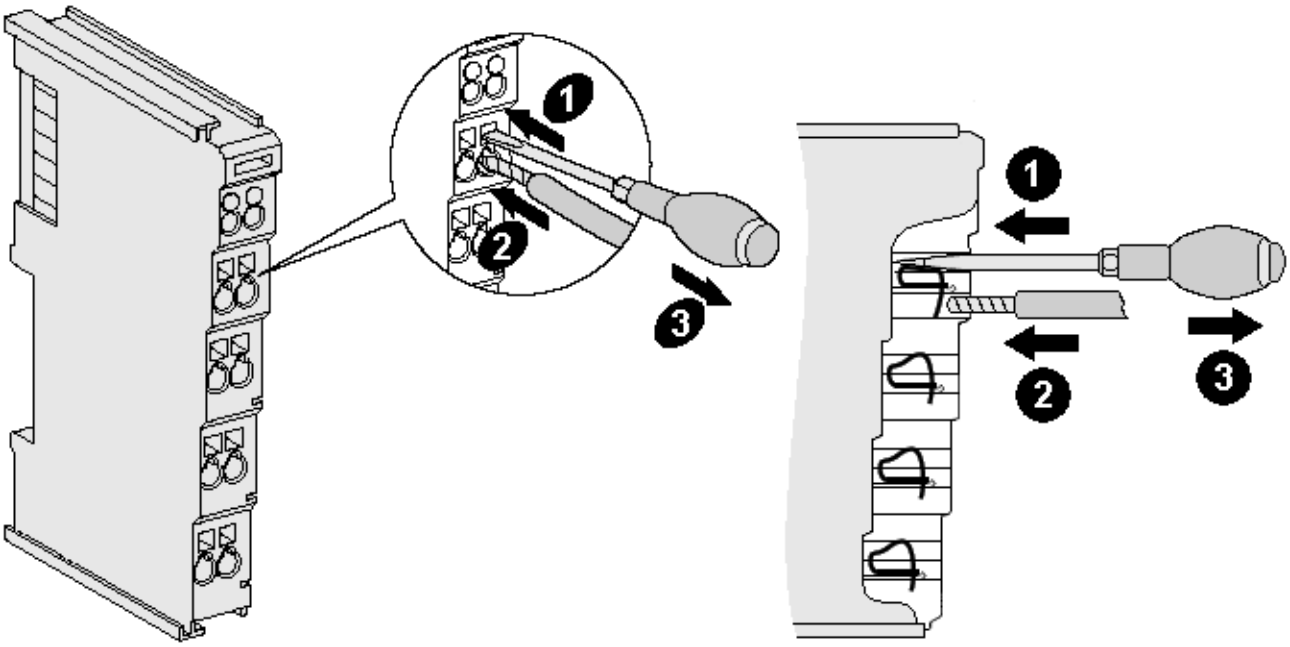


Fig. 19: Connecting a cable on a terminal point

Up to eight terminal points enable the connection of solid or finely stranded cables to the Bus Terminal. The terminal points are implemented in spring force technology. Connect the cables as follows:

1. Open a terminal point by pushing a screwdriver straight against the stop into the square opening above the terminal point. Do not turn the screwdriver or move it alternately (don't toggle).
2. The wire can now be inserted into the round terminal opening without any force.
3. The terminal point closes automatically when the pressure is released, holding the wire securely and permanently.

Observe the requirements for connecting cables and cross sections according to IEC 60079-7 and IEC 60079-11. See the following tables for the suitable wire size width.

Terminal housing	Standard wiring	ELX9560
Wire size width (single core wires)	0.08 ... 2.5 mm²	0.14 ... 1.5 mm²
Wire size width (fine-wire conductors)	0.08 ... 2.5 mm²	0.14 ... 1.5 mm²
Wire size width (conductors with a wire end sleeve)	0.14 ... 1.5 mm²	0.14 ... 1.0 mm²
Wire stripping length	8 ... 9 mm	8 ... 9 mm

NOTICE

Maximum screwdriver width for ELX9560

Use a screwdriver with a maximum width of 2 mm to wire the ELX9560 power supply terminal. Wider screwdrivers can damage the terminal points.

High Density Terminals (HD Terminals) with 16 terminal points

The conductors of the HD Terminals are connected without tools for single-wire conductors using the direct plug-in technique, i.e. after stripping the wire is simply plugged into the terminal point. The cables are released, as usual, using the contact release with the aid of a screwdriver. See the following table for the suitable wire size width.

Terminal housing	High Density Housing
Wire size width (single core wires)	0.08 ... 1.5 mm^2
Wire size width (fine-wire conductors)	0.25 ... 1.5 mm^2
Wire size width (conductors with a wire end sleeve)	0.14 ... 0.75 mm^2
Wire size width (ultrasonically “bonded" conductors)	only 1.5 mm^2
Wire stripping length	8 ... 9 mm

3.7.3 Proper line connection

Always connect only one wire per terminal point.

When using fine-wire conductors it is recommended to connect them with wire end sleeves in order to establish a safe, conductive connection.

In addition, make sure that the pin assignment is correct to prevent damage to the ELX terminals and the connected devices.

3.7.4 Shielding and potential separation

Shielding

Encoder, analog sensors and actors should always be connected with shielded, twisted paired wires!

⚠ CAUTION

Observe installation requirements in areas of potentially explosive atmospheres!

During installation, observe the requirements for cables, shielding and earth potential equalization in areas of potentially explosive atmospheres according to IEC 60079-11, IEC 60079-14 and IEC 60079-25!

⚠ WARNING

Ensure potential separation of the 24 V Ex busbar!

In any case, make sure that the galvanic isolation made by the ELX9560 between the 24 V Ex busbar (power contacts +24 V Ex and 0 V Ex) and other system potentials (if applicable also functional or protective earths) is not removed!

3.7.5 Contact assignment and LEDs

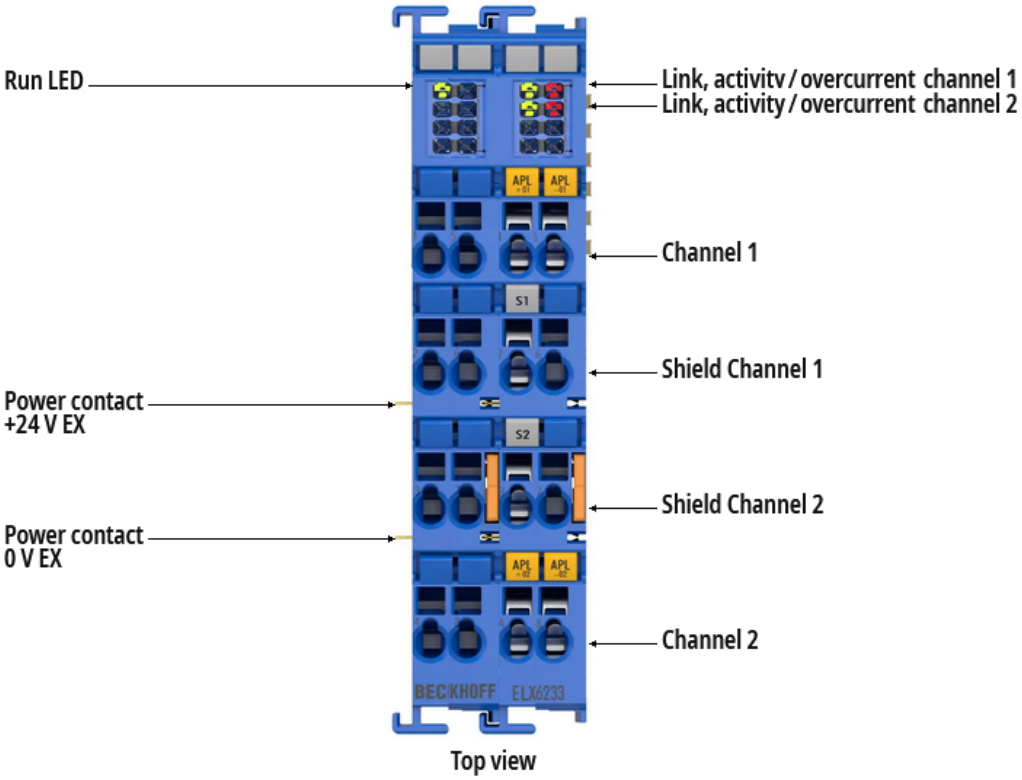


Fig. 20: ELX6233 | Connection and LEDs

ELX6233 | Connection

Terminal point		Description
Name	No.	
	1	not used
	2	not used
	3	not used
	4	not used
	5	not used
	6	not used
	7	not used
	8	not used
APL+01	9	Signal channel 1
S1	10	Screen channel 1
S2	11	Screen channel 2
APL+02	12	Signal channel 2
APL-01	13	Signal channel 1
	14	not used
	15	not used
APL-02	16	Signal channel 2

ELX6233 | LED displays

LED	Color	Meaning	
Run	green	This LED indicates the terminal's operating state:	
		off	State of the EtherCAT State Machine: **INIT** = initialization of the terminal or **BOOTSTRAP** = function for terminal firmware updates
		flashing	State of the EtherCAT State Machine: **PREOP** = function for mailbox communication and different default settings set
		single flash	State of the EtherCAT State Machine: **SAFEOP** = verification of the Sync Manager channels and the distributed clocks. Outputs remain in safe state
		on	State of the EtherCAT State Machine: **OP** = normal operating state; mailbox and process data communication is possible
Link/Act Ch1	green	Link/Activity channel 1	
Overcur. Ch1	red	Overcurrent channel 1	
Link/Act Ch2	green	Link/Activity channel 2	
Overcur. Ch2	red	Overcurrent channel 2	

4 PROFINET controller protocol

4.1 Integration of the TwinCAT PROFINET controller protocol via an ELX6233 interface

The controller protocol is appended directly to the I/O device. Use the ELX323x protocol. If such a terminal is present in the projected EtherCAT segment, the associated adaptor is directly displayed when appending the protocol. If there are several terminals the corresponding one can be selected.

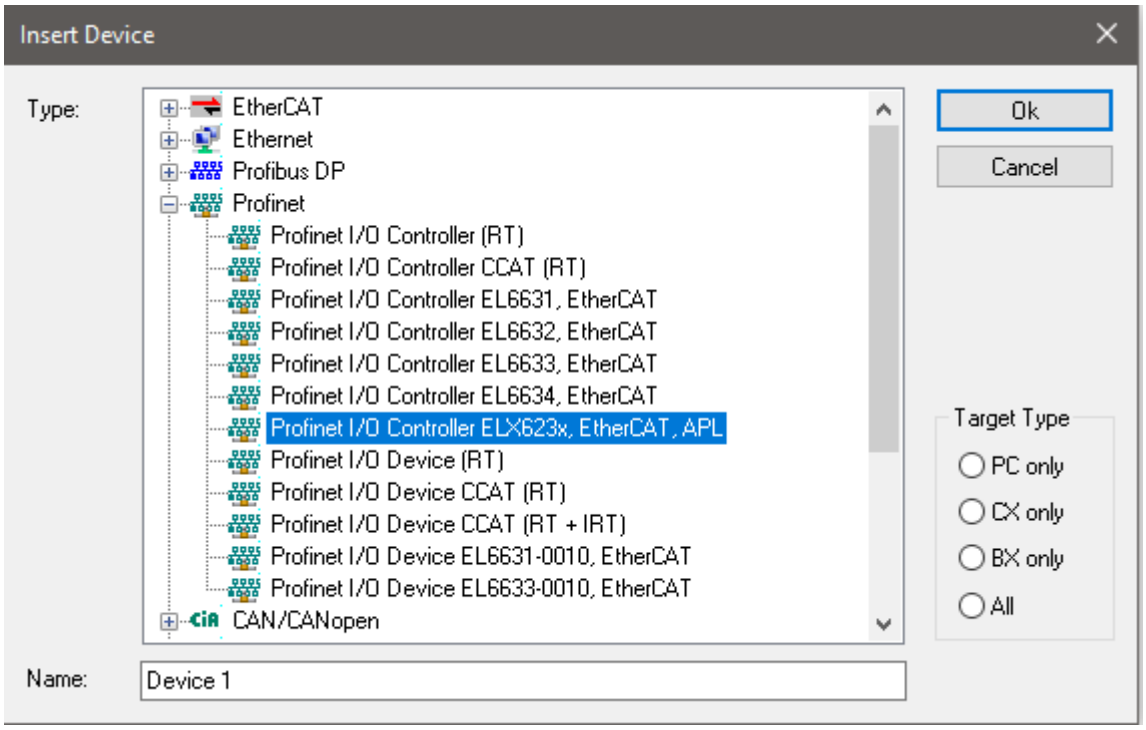


Fig. 21: Selection of the terminal for integrating the protocol

For the operation of several ELX6233 terminals the corresponding PROFINET protocol must be appended several times. If the terminal assignment is to be modified or checked afterwards, this can take place on the *Adapter* tab.

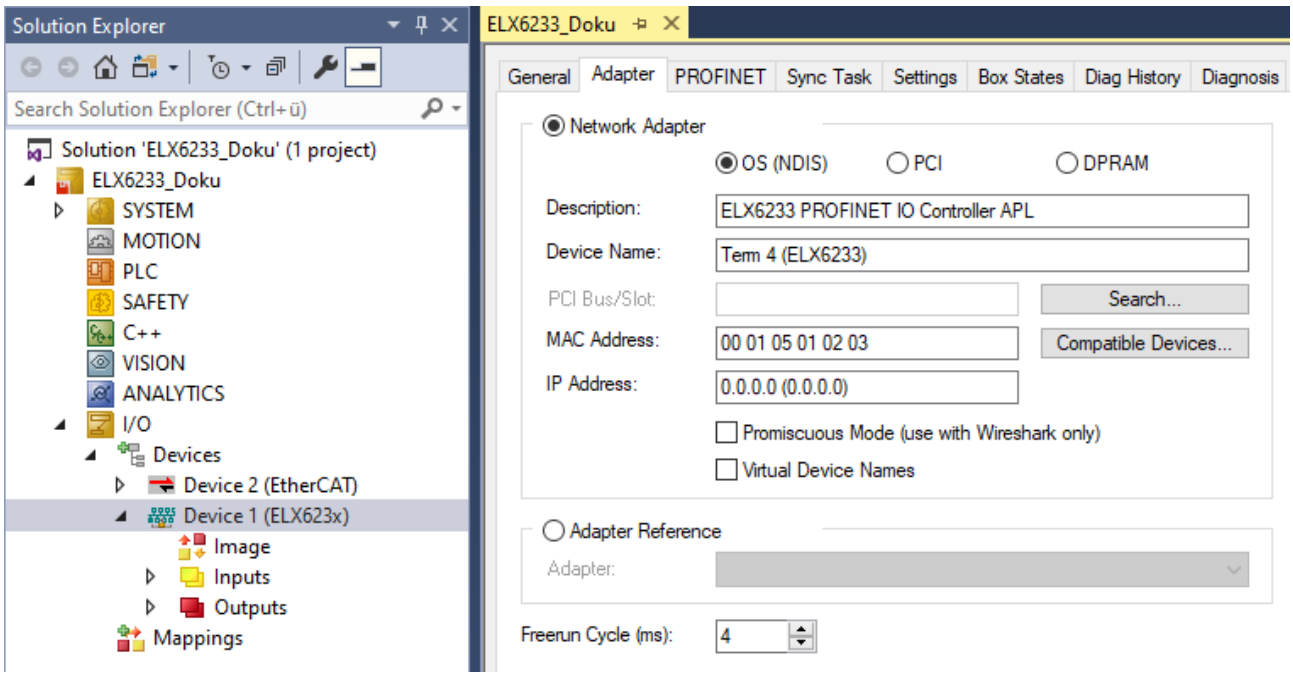


Fig. 22: *Adapter* tab - Changing the terminal assignment

4.2 ELX6233 and PROFIsafe

The ELX6233 can also be used for PROFIsafe in combination with the EL6930 *TwinSAFE Logic Terminal with PROFIsafe Gateway*.

NOTICE

For information on using the ELX6233 with the EL6930, please refer to the following documentation:

- EL6930 - TwinSAFE Logic Terminal with PROFIsafe Gateway: Operating Instructions
- EL9930 - PROFIsafe Segment End Terminal: Operating Instructions
- Application Guide TwinSAFE

4.3 Settings / diagnostics

4.3.1 PROFINET

4.3.1.1 AMS Settings

Protocol AMS NetID text field

This is the NetID via which the PROFINET controller protocol can be reached via AMS.

Protocol AMS PortNo text field

This is the PortNo via which the PROFINET controller protocol can be reached via AMS. This is always fixed to 0xFFFF.

Server AMS NetID text field

This is the NetID to which certain AMS messages (e.g. PN records within the index range 0x1000 - 0x1FFF) are forwarded by the PROFINET driver. Currently this is always the SystemNetId.

Server AMS PortNo text field

This is the PortNo to which certain AMS messages (e.g. PN records within the index range 0x1000 - 0x1FFF) are forwarded by the PROFINET driver. By default this is the PLC Port 802 of runtime system 1.

4.3.1.2 Button Port settings

This feature is presently only enabled for the real-time Ethernet protocol (no ELX6233). With this a second PROFINET port and an intelligent switch can thus be realized with a second network card (Intel chipset). It is intended to repeat this feature x times; however, it is presently limited to one additional port.

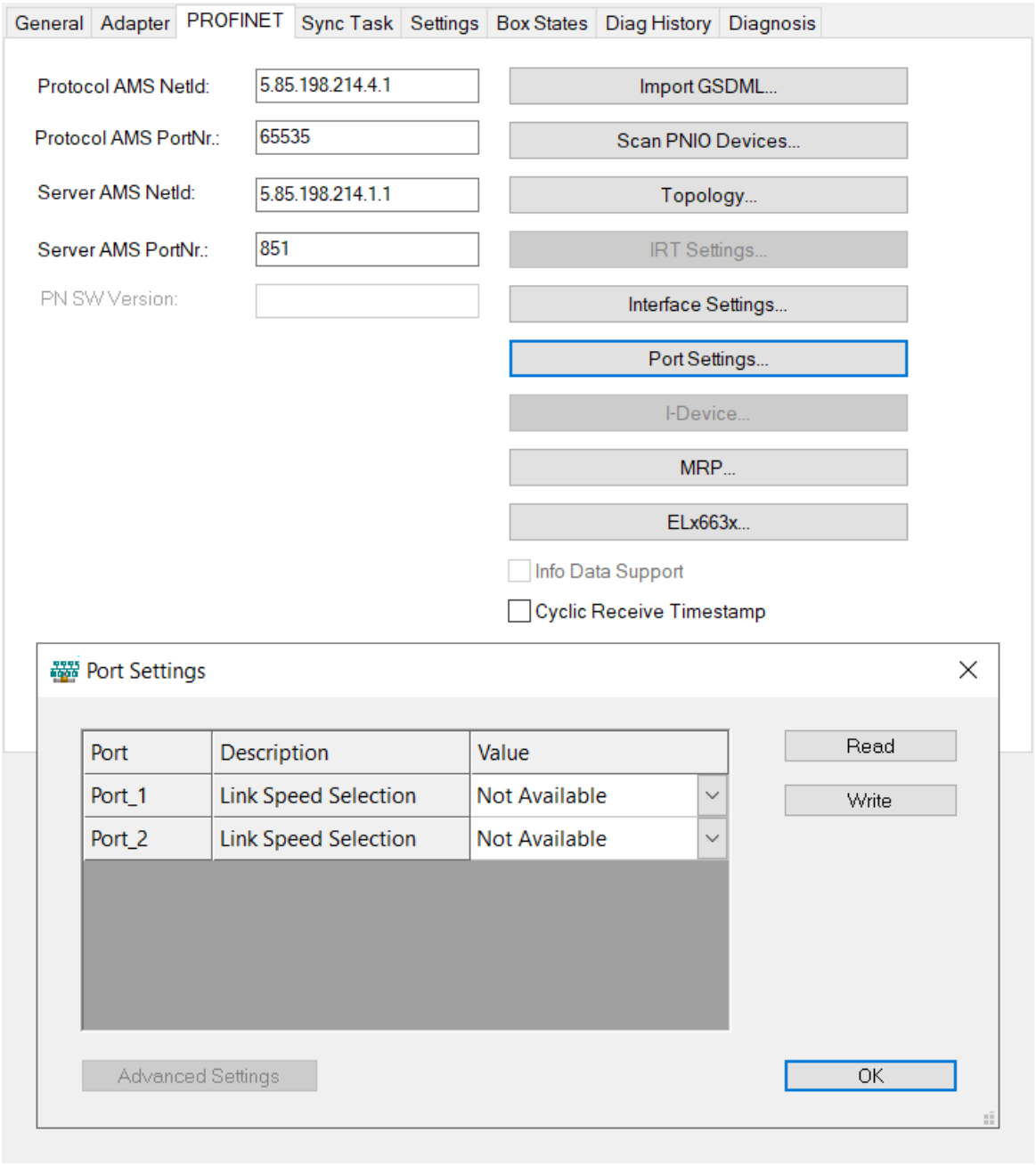


Fig. 23: *PROFINET Port Settings* dialog

In future, the MRP functionality (Media Redundancy Protocol) can also be enabled via this menu. Various settings can be made for this.

4.3.1.3 Button Scan PNIO Devices

This feature is comparable with the *ScanBoxes* feature, which is only available in CONFIG mode.

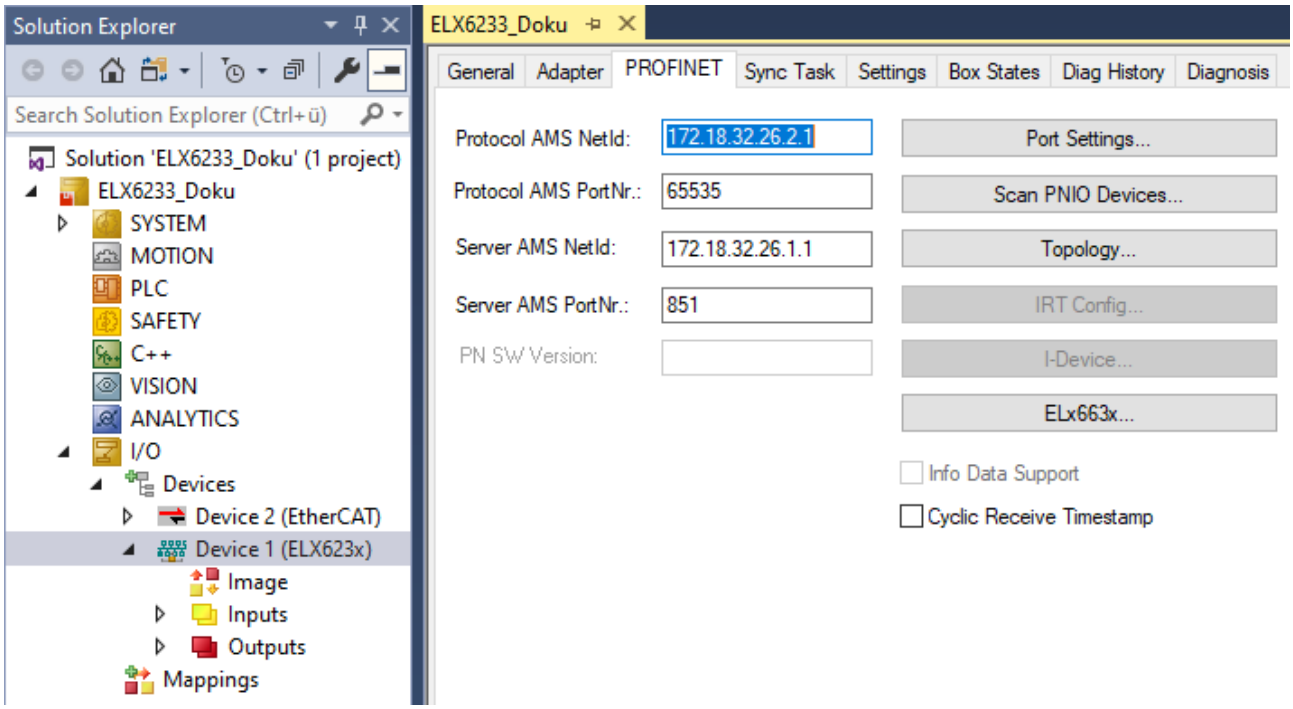


Fig. 24: Scan PNIO Devices

After successful scanning the following dialog opens (if devices were found).

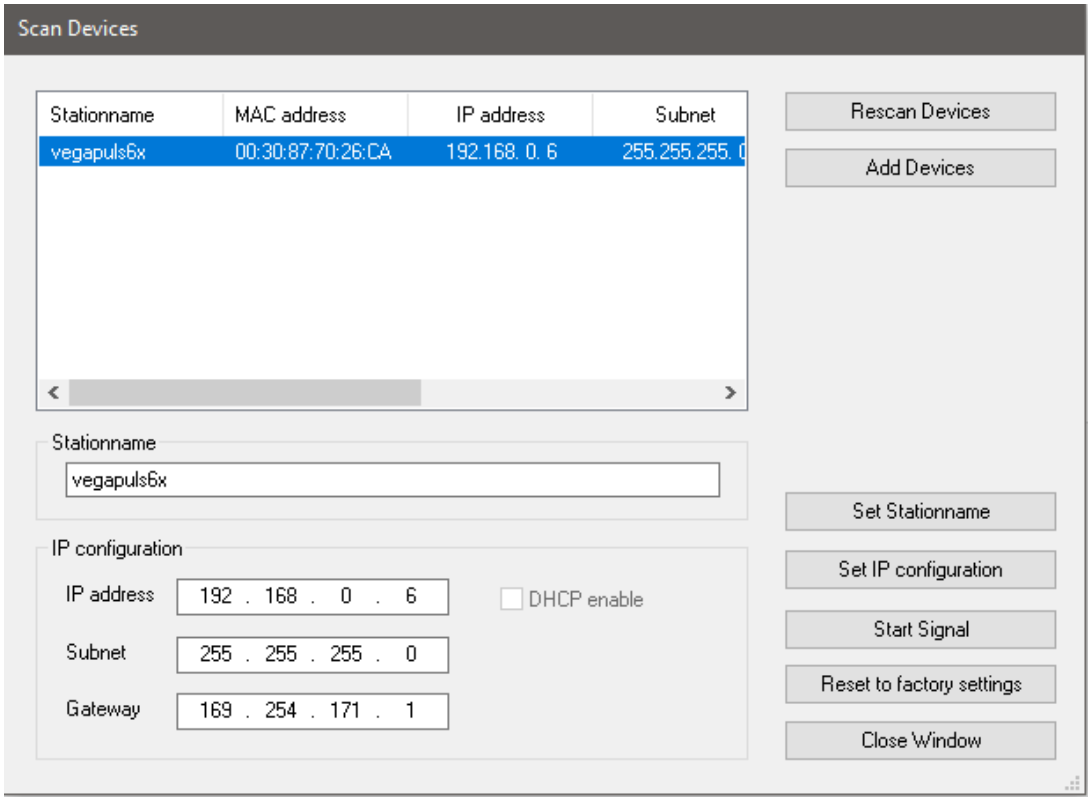


Fig. 25: *Scan Devices* dialog

Various device settings and configurations can be made here. These are adopted only when the corresponding button is explicitly pressed. When setting the name, care must be taken that only PROFINET-compliant characters are used. This also applies to the IP address; only valid combinations of IP and subnet

are to be used. Name and IP are checked for correctness when setting PROFINET devices. If this is not the case, DCP_SET is acknowledged with an error. By pressing the *Rescan* button, any changes that were made can be read back.

In addition the selected device can be signaled. This functionality is PROFINET-specific. The signaling is vendor-specific. However, the standard is that the signal must arrive at a frequency of 2 Hz.
As an example, the Beckhoff BK9103 Bus Coupler signals itself by alternately flashing two LEDs at 2 Hz. This function is very helpful for identifying the devices in this list. Press the button again to stop the flashing. The flashing is stopped by closing the *Scan Devices* window.

Subsequently, one or more devices can be marked with the Ctrl button. Press *Add Devices* to add the selected devices to the project.

Devices GSDML

The associated devices GSDML must be located in the folder
"..\TwinCAT\Io\ProfiNet" (TC2) or
"..\TwinCAT\3.1\Config\Io\Profinet" (TC3)!

Upon pressing *Add Devices*, the following prompt appears:

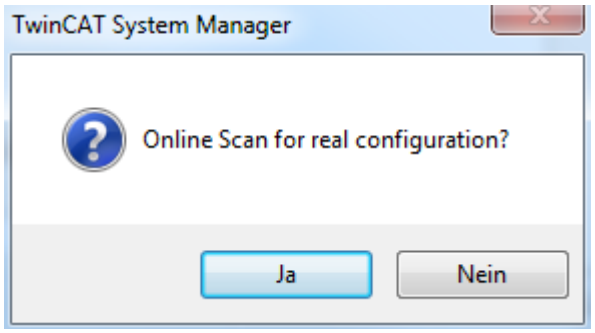


Fig. 26: Confirmation *Add Devices*

***Yes* button**

An attempt is initially made to determine the ModuleIdentNumber of the DAP (Device Access Point) by an implicit read access. If this fails, a corresponding dialog opens with the possible DAPs, which must be selected manually.
After all box modules have been appended, a *Reload Devices* is performed automatically, i.e. the devices (adapters) created are transferred to the PROFINET driver. A distinction is then made as to whether the box is a normal device or a drive with Profidrive support.
In the case of a normal device, the real module configuration (RealIdentificationData) is read out again via an implicit read access. With a Profidrive device, however, the required information is read out via Profidrive access. A Supervisor AR is established for this purpose. The required write accesses can take place within this. The Submodule interface on the DAP is used here as the Parameter Access Point. Parameters are accessed via data record 47, similar to PROFIBUS. When using Sinamics, however, it must be noted that such an access is only permitted from version 4.3 SP2. If an older version is used, a corresponding error message appears and the parameterization must take place manually.

Once the automatic module parameterization has been completed, the prompt to automatically read in the port data appears. Here again, the port interconnection of the individual devices is read out via an implicit read access.
The real port interconnection must be known for various services. These can simply be diagnostic services, but the automatic device start-up also requires this (via alias), or the creation of the IRT planning.
If this dialog is acknowledged with *No* or the read access has failed, such interconnection can also be carried out manually in the TwinCAT project on the individual ports.

If the port interconnection has been successfully generated automatically, in the case of an IRT controller (e.g. configuration on an ELX6233), you will be asked whether all devices (if they support it) should be automatically switched to IRT mode (RTClass3).
If the answer is yes, the cable length on all configured ports is also set to 10 m copper cable. The IRT algorithm requires this information for the calculation of the signal propagation times. The precise cable

length is not so important here (approx. +/-10 m), because the propagation delays tend to be small at 100 Mbit/s (5 ns/m). If automatic switching is not to take place immediately, these points can also be changed later either on the protocol or on the individual devices (on the interface or port submodule).

***No* button**

For each device a check is performed to ascertain whether the GSDML is present in the respective folder (..\TwinCAT\Io\ProfiNet). If this is the case, the list of possible DAPs is read in. A selection dialog is then opened to select the corresponding DAP.
Once the devices have been added to the project, you can then go to the API under the box and add the modules and submodules manually.

4.3.1.4 Button Topology

The offline topology can be compared with the online topology via this dialog.

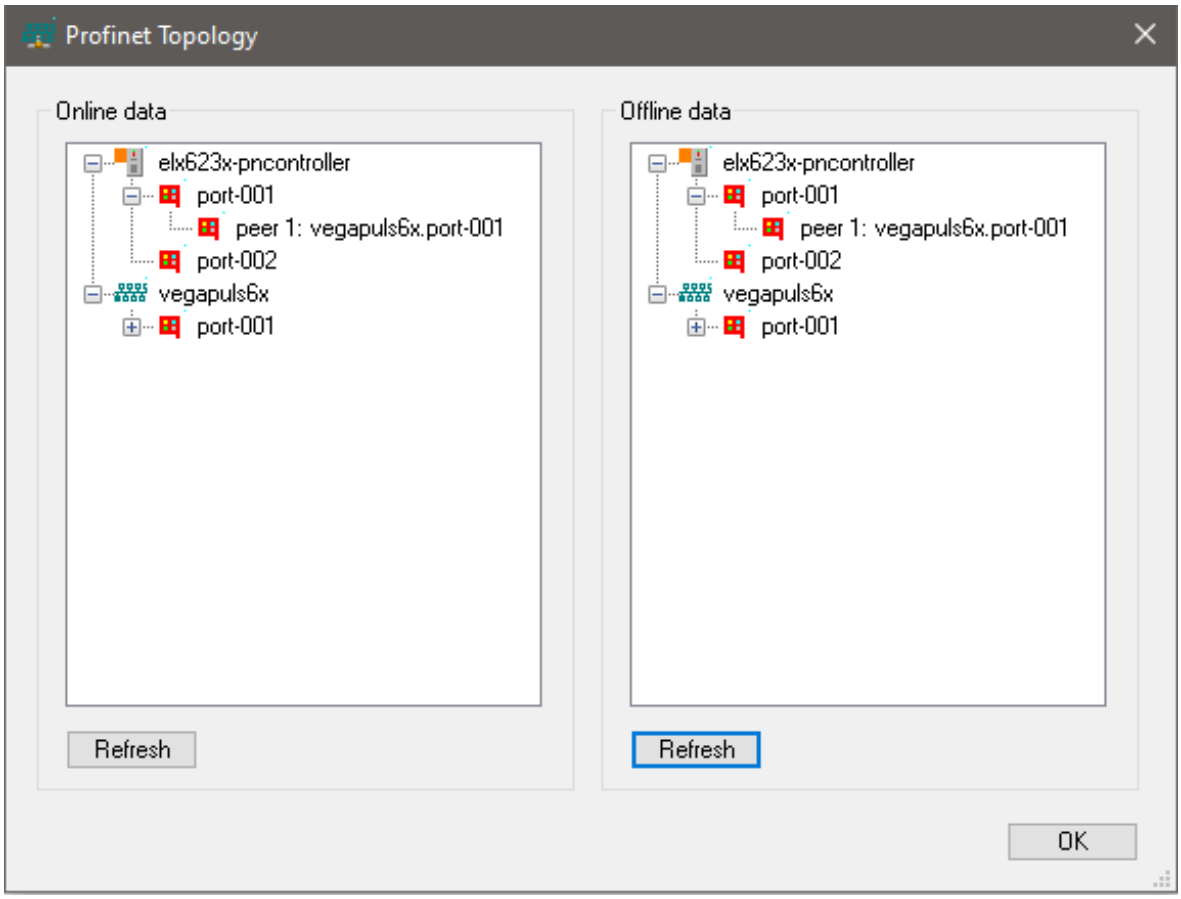


Fig. 27: *PROFINET Topolgy* dialog

It is quite possible for a device to have several partners on a port in the online view. This is the case, for example, if a switch is used in PROFINET that does not support LLDP (protocol for neighborhood ID).

In the offline view, on the other hand, partners may have been assigned that don't exist in the project. This takes place if the reading of the port properties was enabled during scanning and automatic appending. In this case the device has a 'neighbor' that is adopted into the project, but the associated device box is missing in the *.tsm file. On enabling this project the 'neighbor' which does not exist in the .tsm file is ignored in the driver.

4.3.1.5 ELx663x Settings

Fig. 28: *ELx663x Settings* dialog

Enable PROFINET Capture

All PROFINET frames are forwarded to the EtherCAT master via EoE. The DstMac can be used to change the target MAC address of all PROFINET frames to EtherCAT. If this remains unchanged at NULL, the frames are sent to the EtherCAT master in their original format. This can then be used to start an Ethernet capture (e.g. via Wireshark).

Note: As this feature places a considerable load on the E-bus, it should only be enabled for short-term troubleshooting.

Enable PROFINET Device Access

Access to the PROFINET devices is enabled here, i.e. all EoE frames that are not directed to the terminal itself are forwarded to the individual APL ports. This also enables access to web servers of the connected PROFINET devices, for example. This feature is disabled by default, i.e. the integrated firewall blocks access to the individual PROFINET devices.

4.3.2 Task configuration

The PROFINET controller protocol must always be linked to a task. The protocol is also processed with the set task time. Theoretically, the controller can also be processed via a PLC or NC task, for example. However, if a PLC project is stopped (e.g. due to a restart or debugging), the PROFINET part is also stopped. To avoid such a side effect, it is advisable to always create a free-running SyncTask.

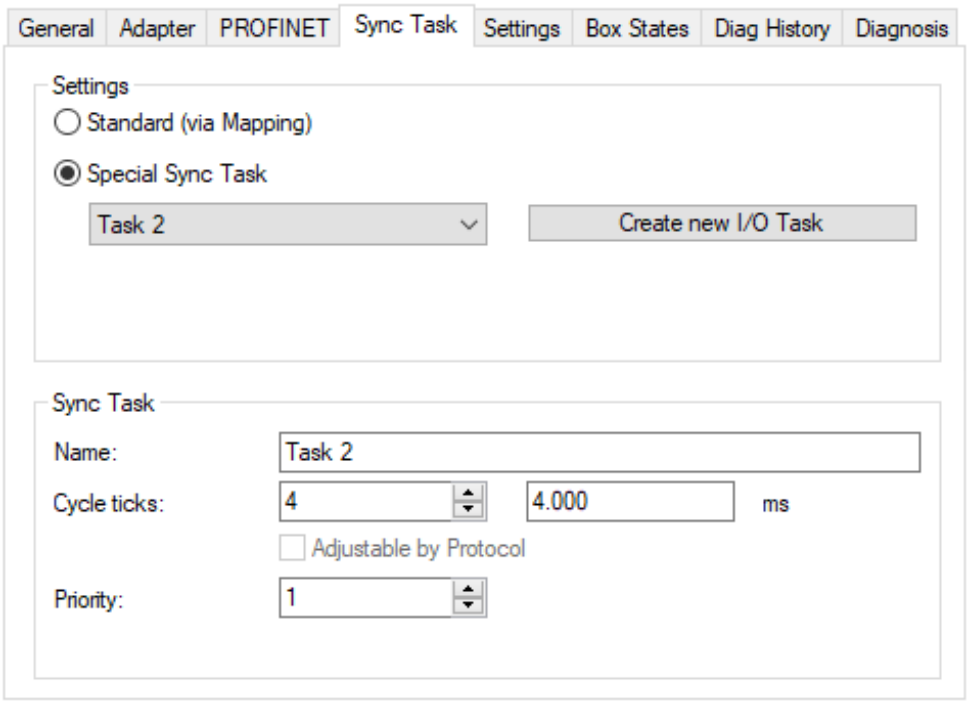


Fig. 29: *Sync Task* tab

Make sure that the task cycle is in a PROFINET cycle. This means that the basic cycle for PROFINET is 31.25 µs. This cycle is then always multiplied by the SendClockFactor (SCF) to obtain the basic cycle. The SendClockFactor is usually set to 32 for RTClass1. This is also the minimum PN cycle for RTClass1 for the Beckhoff PROFINET controller and results in the smallest cycle time of 1 ms. Further reductions take place using a ReductionRatioFactor. This always corresponds to a multiple of the minimum PN cycle. For RTClass1 the smallest cycle must always be doubled (permissible cycle times (for RTC1) with an SCF of 32 are 1, 2, 4, 8, … ,512).

The SCF can and must be reduced in order to achieve faster cycle times for RTClass3 as well. This is presently at least 16 for a Beckhoff IRT controller (EL6632), which corresponds in turn to a basic cycle of 500 µs. If the PROFINET clock is reduced in this way, it must also be ensured that the time of the triggering task is adjusted accordingly.

4.3.3 PROFINET controller - specific settings

Settings that directly affect the controller can be made via the *Settings* tab.

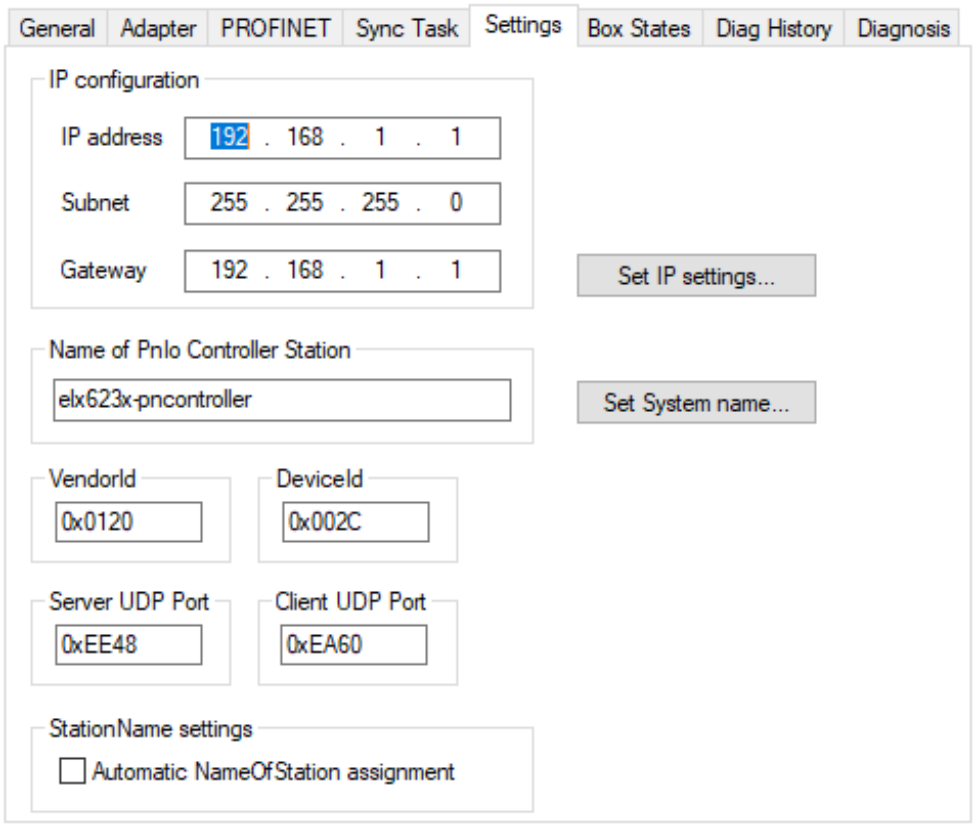


Fig. 30: *Settings* tab

An IP setting can take place here. The selection of the address range need not correspond to the network card settings. The PROFINET communication spreads its own net, which can be selected here. The IP settings shown in the above figure are the default settings. This means that if nothing is changed, the controller uses these settings. The same applies to the controller name (system name). To change both settings, press the corresponding button. A check is made to ascertain that the input is correct (e.g. the format of the controller name must correspond to the PN spec.). These data are then permanently adopted. When changing the subnet or gateway, the settings are also applied to any projected devices. It is also possible to change these settings via a supervisor tool.

In addition the VendorID and DeviceID of the controller can be read out in this dialog. The server and client UDP port employed can also be set here. However, the default settings should be sufficient in most cases.

Furthermore there is a possibility in this dialog to enable an automatic PROFINET start-up following a device exchange (including devices without removable media). For correct functioning the nominal topology must be specified once. On the basis of this information the controller can query the alias names of the individual devices. Every device that supports alias names generates such a name for each of its ports. This is composed of the neighborhood IDs (PortId.ChassisId). If this name is queried, the ‘new’ device answers. If VendorId and DeviceId are correct the device is named with the actual name and a normal PROFINET start-up can subsequently take place. With this mechanism a complete PROFINET system could also start up without having named an individual device beforehand.

4.3.4 Analysis of the box states

There is a collective PROFINET error and a collective PROFINET state directly under the PROFINET controller protocol. Both show the number of devices for which a problem has occurred or for which a diagnosis is available. The error indicates possible problems with the connection establishment or reasons for a termination. The diagnosis provides state information about an existing connection.

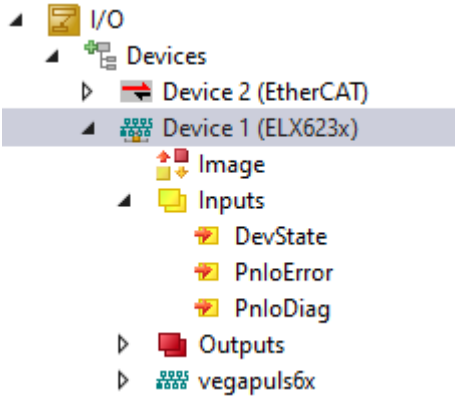


Fig. 31: TwinCAT tree - Inputs for analysis

PnIoError - Number of PROFINET IO devices that have an error
PnIoDiag - Number of PROFINET IO devices that have a diagnosis pending

It is possible to check at a glance which device or box has a problem in the protocol under Box States.

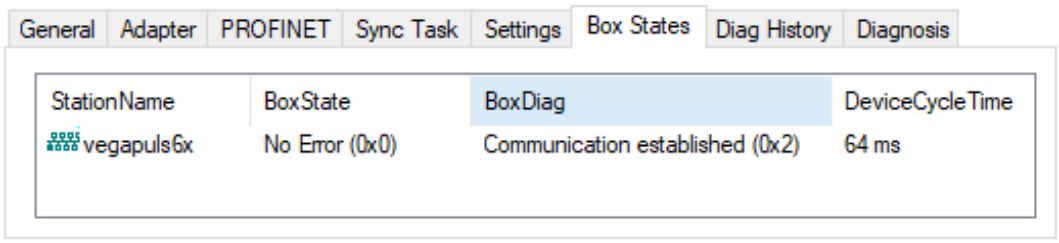


Fig. 32: *Box States* tab

The following error messages are currently displayed via the *PnIoState*.

Number	Text	Description	Remedial action / reason
0	No error	No error	No error
1	PROFINETDevice state machine is in boot mode	PROFINET Device StateMachine is in boot mode	Not an error, wait
2	Device not found	Device does not reply to the Identify Request	Check connection, device connected, has the device been given the correct name?
3	The station name is not unique	The station name is not unique	There are two or more devices with the same PROFINET name in the network. Correct identification is not possible.
4	IP could not set	IP address could not be set	The PROFINET device has refused to set the IP settings for some reason. Check whether the IP settings are correct.
5	IP conflict	An IP conflict has occurred in the network	A possible cause is that several devices have the same IP address.
6	DCP set was not successful	There was no reply or an erroneous reply to a DCP set	Check connection, device connected, has the device been given the correct name?
7	Watchdog error	The connection was interrupted with a watchdog error	Check the cycle time, check the connection, if necessary increase the Watchdog factor.
8	Datahold error	The connection was interrupted with a Datahold error	Frame Data state was invalid for the length of the DataHoldTimer. Restart the device if necessary.
9	RTC3: Sync signal could not started	Only for IRT: The Sync signal could not be started.	Is EtherCAT Sync signal correct or has Sync0 started?
10	PROFINET Controller has a link error	The PROFINET Controller has no link	Check cable and connection.
11	The alias name is not unique	The alias name is not unique	There are two or more devices in the network with the same alias name. This is made up of the neighborhood information (PortId.ChassisId). A correct identification cannot take place.
12	The automatic name assignement isn't possible - wrong device type	The automatic name assignment isn't possible	The expected PROFINET device is not in the projected position (VendorId or DeviceId does not correspond). Hence, no automatic naming and thus no device start is possible.
31	Only for EtherCAT gateways: WC-State of cyclic EtherCAT frame is 1	Only for EL6631: EtherCAT WC State is set to 1	Check the mode on the EtherCAT master + slave (OP?).

As opposed to the State, more than one state can be displayed in the *BoxPnIoDiag*, i.e. the whole thing is bit-coded and up to 16 pieces of information can be displayed. The following states are currently displayed.

0x0000 = No diagnosis
0xXXX1 = IOC-AR is not established
0xXXX2 = IOC-AR is established
0xXXX4 = IOC-AR is established but no ApplReady
0xXXX8 = IOC-AR is established but module difference
0xXX1X = At least one AlarmCR get diagnosis alarm
0xX1XX = At least one InputCR is invalid
0xX2XX = At least one InputCR Provider is in stop
0xX4XX = At least one InputCR Problemindicator is set
0x1XXX = At least one OutputCR is invalid
0x2XXX = At least one OutputCR Provider is in stop
0x4XXX = At least one OutputCR Problemindicator is set

On the one hand information about the state of the IO Controller Single AR is displayed here. In addition, collective states are formed from the Frame Data states of the individual CRs. This applies to the input and output CRs (currently only one CR is possible, in future several). A PROFINET alarm is also displayed in *PnIoDiag*.

Readout via ADS

The Box Status can be read out via an ADS Read.

ADS Read:
NetId = AMSNETID des PROFINET Controllers
Port = BoxPort (0x1000 + BoxId)
Indexgroup = 0xF829
IndexOffset = 0
Length = sizeof(TPnIoDeviceDiagData);

where:

```
typedef struct
{
WORD pnioState;
WORD pnioDiag;
WORD NrOfInputCRs;
WORD NrOfOutputCRs;
WORD reserved[8];
} TPnIoDeviceDiagData, *PTPnIoDeviceDiagData;
```

4.3.5 Diagnosis history on the controller protocol

Logged diagnosis messages from the controller protocol can be read out on the *Diag History* tab. The diagnosis buffer operates as a ring buffer with a current maximum size of 1000 entries.

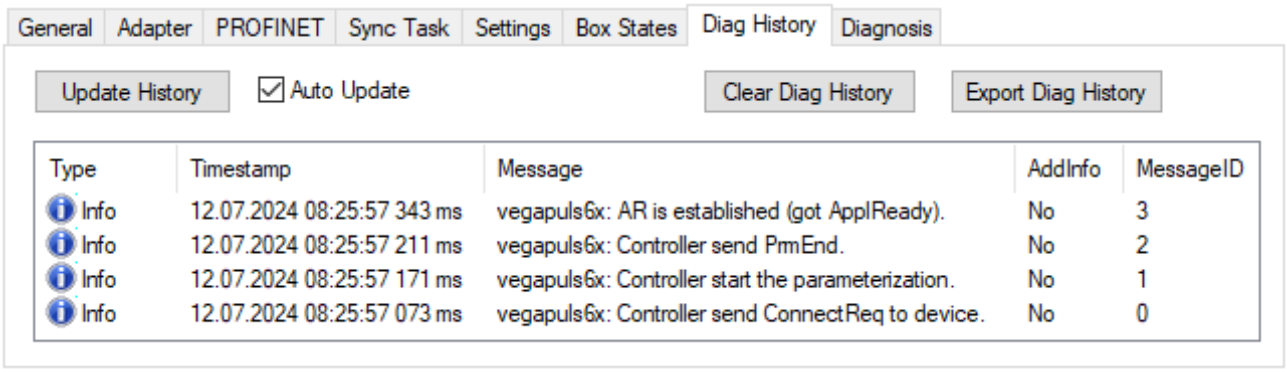


Fig. 33: *Diag History* tab

The possible errors are grouped into three types:

- Info: e.g. information about the connection establishment
- Warning: e.g. PROFINET diagnosis alarms
- Error: e.g. connection interrupted

AddInfo indicates whether additional information about the event is available. If this is marked by “Yes”, the additional information can be fetched and displayed by clicking on the respective message. In the case of a diagnosis alarm (Diagnosis appears), the precise diagnosis information can be fetched at the corresponding level (device, API or module).

The complete diagnosis buffer is cleared by pressing the *Clear Diag History* button.

The displayed messages can be saved in a .TXT file by pressing the *Export Diag History* button.

4.3.6 Diagnosis tab

This tab includes additional tools for monitoring and troubleshooting PROFINET communication.

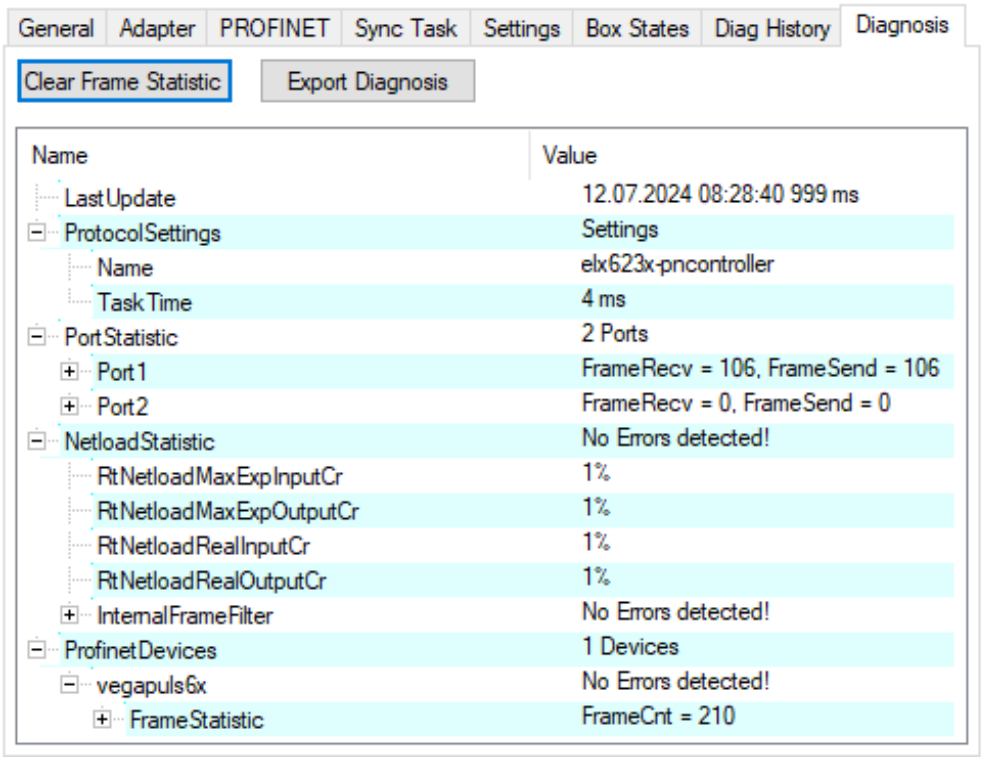


Fig. 34: *Diagnosis* tab

Statistics on the current connection can also be found here.

4.3.7 Cyclic data

There are several cyclic process data directly below the PROFINET controller protocol. These data are only exchanged between the PROFINET driver and the System Manager. They provide general information about the state of the PROFINET communication.

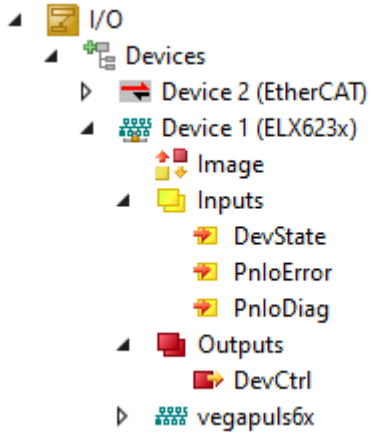


Fig. 35: TwinCAT tree - Inputs for information

The variable *DevState*. contains information about the phys. communication state of the controller, such as the link state or whether the send resources are still sufficient.

The other variables are the collective PROFINET error and the collective PROFINET state. Both show the number of devices for which a problem has occurred or for which a diagnosis is available. This means that the Error variable indicates possible problems when establishing a connection or reasons for an interruption. The diagnosis variable provides state information about an existing connection.

The output variable *DevCtrl* currently has no function.

For further information, please also read the chapter Box States.

4.3.8 Acyclic data

The ADS blocks are used to send acyclic data. These then access the PROFINET record data. So that acyclic data can be read or written, the PROFINET device must be in data exchange mode.

An *ADSReadWrite* is set.

ADS settings

AMSNetID: The AMSNetID of the PROFINET controller

PORT: Port number of the device (take this from the system manager)

Index GROUP: 0x0000_F823

Index OFFSET: 0x0000_0000

```
DATA
typedef struct {
       WORD            RW;
               #define         PN_READ         0
               #define         PN_WRITE        1
       WORD            NrOfAR;
       DWORD           API;
       WORD            Slot;
       WORD            SubSlot;
       PNIO_RECORD     RecordData;
} PNIO_CONFIGRECORD
```

Structure of the record data frame

nRW	nNr	nAPI	nSlot	nSubSlot	nIndex	nLen	nTrans	nReserved	Data (only write)
2 bytes	2 bytes	4 bytes	2 bytes	2 bytes	2 bytes	2 bytes	2 bytes	2 bytes	n bytes

Meaning of data from the record data frame

Designation	Values	Description
nRW	0 – READ 1 - WRITE	read- or write-access
nNr	normally „0“dec	it is possible to put multiple ARs (application releations) to one device (Controller, Supervisor, DeviceAccess). This indicates in which AR the data is exchanged -> normally there is only one AR, in this case zero.
nAPI	normally „0“dec	-> otherwise, the corresponding application profile should be placed here
nSlot	variable	Slot number
nSubSlot	variable	SubSlot number
nIndex	variable	Index number
nLen	variable	READ if nRW = 0: if the value „0“ is used when reading, the request is sent with the maximum buffer size, if nLen ≠ 0, the corresponding length is used. WRITE if nRW = 1: when writing: number of bytes, which follow from or after the “nReserved” word
nTrans	starts with „1“dec	If multiple records are downloaded at once, this transfer sequence number determines the order in which the data is processed.
nReserved	„0“dec	2 byte alignment
Data	variable	Data (from here the „nLen“ for the data length counts (writing only))

Sample:

Send a read request for I&M function 0

nRW	nNr	nAPI	lnSlot	SubSlot	nIndex	nLen	nTrans	nReserved
00 00	00 00	00 00 00 00	00 00	01 00	F0 AF	00 00	01 00	00 00

Make sure that the receive data memory is large enough!

5 Devices at protocol

5.1 Appending PROFINET devices

Select *Append Box* by right-clicking on the protocol. The following dialog then opens:

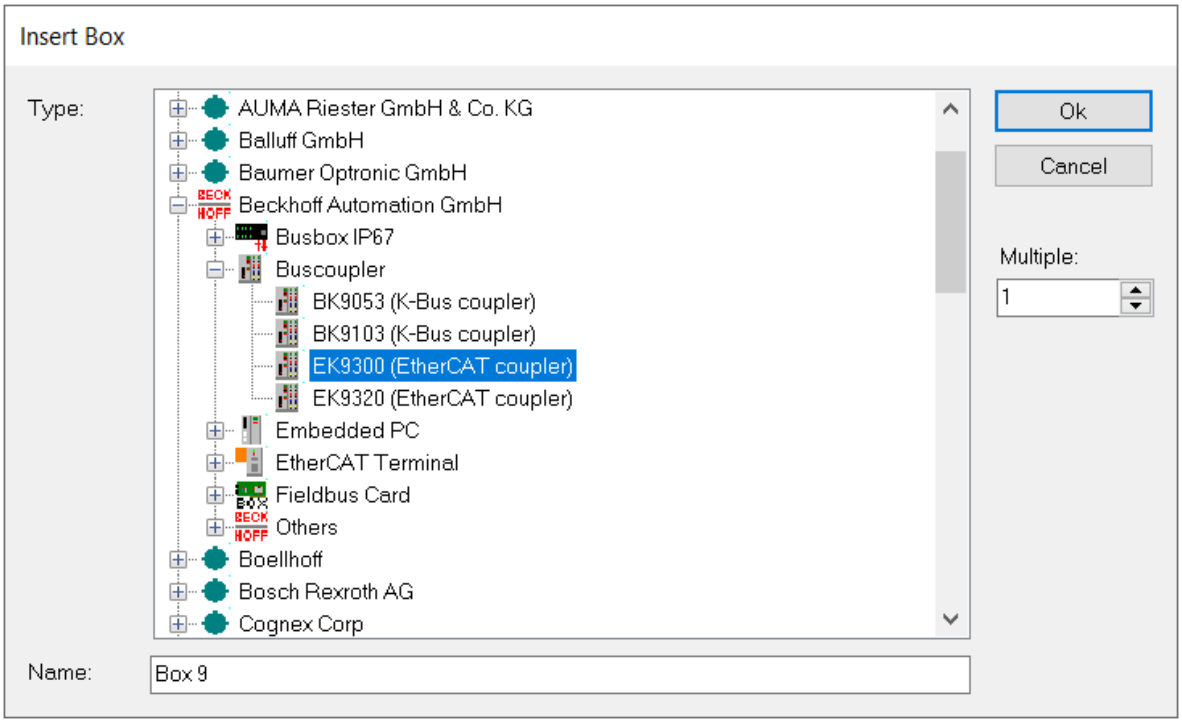


Fig. 36: *Insert Box* dialog

Here you can select different PROFINET devices. For Beckhoff devices, the GSDML is searched for under a defined path:
“..\TwinCAT\IO\PROFINET” (TC2) or
“..\TwinCAT\3.1\Config\Io\Profinet” (TC3).
These should be already present with the TwinCAT installation. If there are several GSDMLs for the same device here, the one with the latest date is taken. If no device description is found, a corresponding error message appears. Either the GSDML is copied into the folder and the menu is opened again, or the same procedure is selected as for the third-party devices. If you click on PROFINET IO Device, an option is offered to navigate to the corresponding GSDML in Windows Explorer. This is then integrated into the project.

The DNS name from the GSDML is taken as the default name. When appending several devices simultaneously, the default name is always supplemented by “-No.” (where No. = 1...n). The name that was assigned (and with which the device also appears in the tree), is at the same time also the “PROFINET Station Name”, i.e. the name that must correspond to the name in the device. The device name can be checked by scanning.

The modules can be appended to the API (Application Profile Interface). The DAP (Device Access Point), which already brings along fixed properties from the GSDML (e.g. process data, interface and port submodules, etc.), is always on Slot 0.
This module is always there and cannot be deleted or shifted. Each further module is assigned to a certain API. The information regarding its identity comes from the GSDML. By default this is always API 0. Alternatively, an API e.g. for the PROFIDRIVE profile or a fieldbus API is also conceivable. By clicking in the API on *Append PROFINET modules…* a device catalog is opened from which the corresponding modules can be selected and appended. If the modules support it (described in GSDML), the submodules can in turn be appended to them in the same way.

5.2 Comparison of nominal and actual configuration

If a connection exists, the project planning can be checked on the “Diagnosis” tab. At this level “Real Identification Data” returns the actually existing modules in an AR, “Expected Identification Data” indicates the expected modules (i.e. those projected in the controller) and “Module Difference” shows the differences to the device found in the nominal-actual comparison.

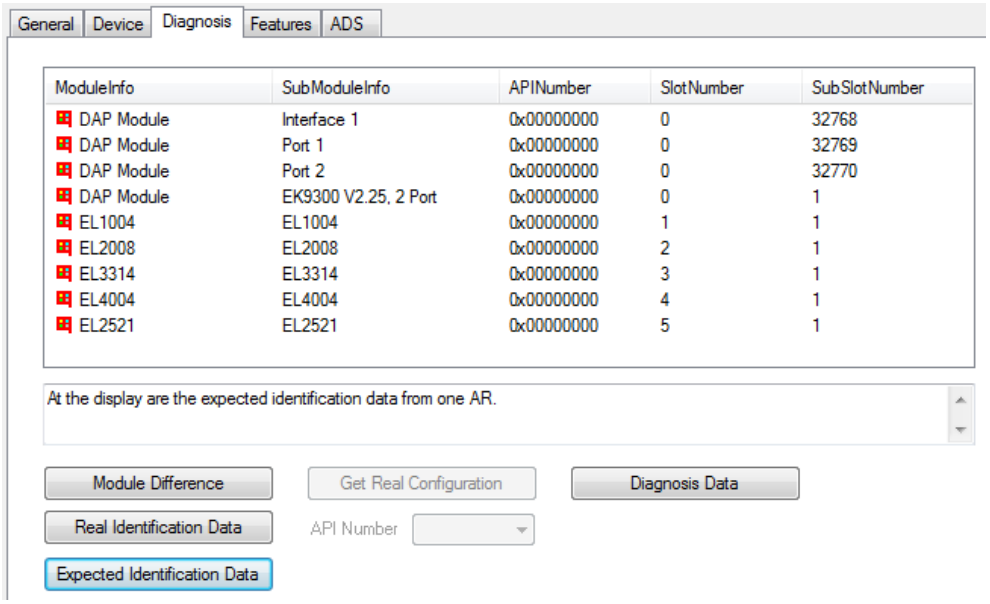


Fig. 37: "Diagnosis" tab, checking the project planning

If you are on the “Diagnosis” tab within the API, you can select the corresponding API about which information is to be obtained. If, for example, the PROFINET device is a drive, then this usually supports the Profidrive profile, which is identified in turn via API 0x3A00. If the Real Identification Data is to be read from this API, for example, then this access takes place via the Profidrive profile.

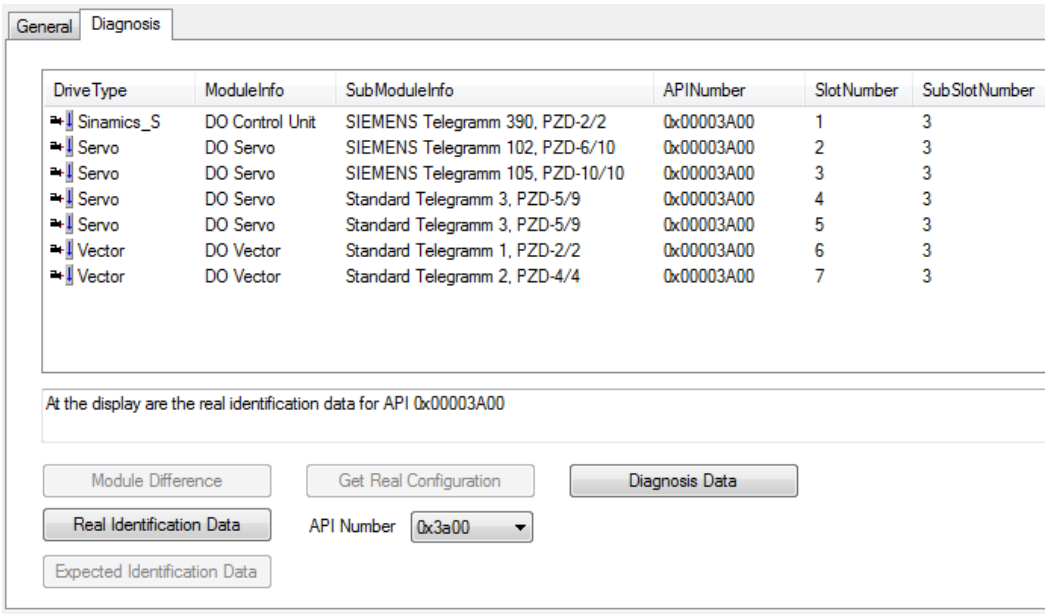


Fig. 38: "Diagnosis" tab, API selection

In addition, the “Get Real Configuration” button becomes active within an API (except for drives). It is possible via this to adopt the read-in data record into the current project. Note that modules that have already been created will be overwritten when doing this. This means that the links are lost, even in the case of previously correctly created modules.

When displaying the module differences, additional information is displayed by marking the message.

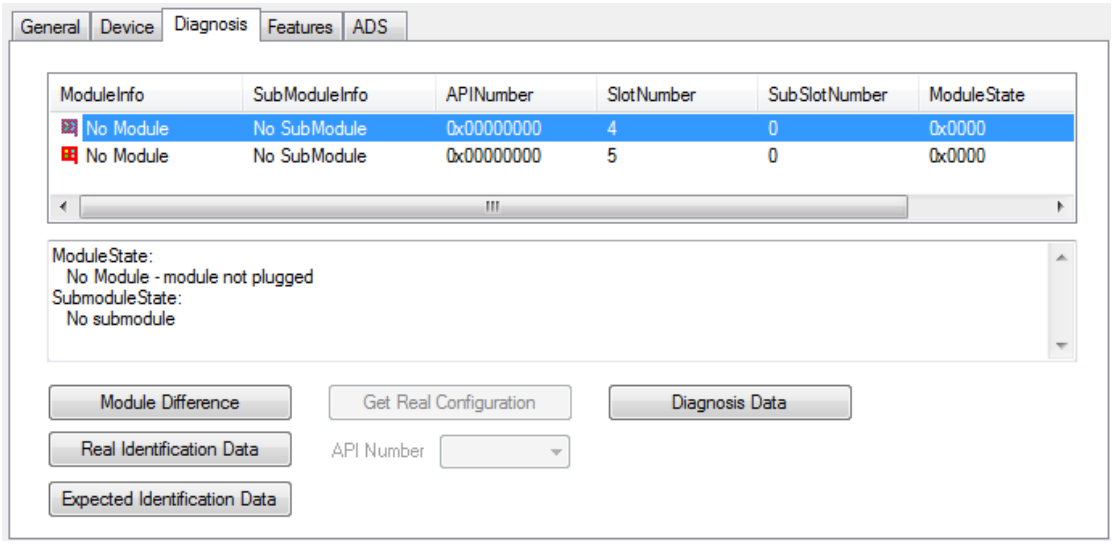


Fig. 39: "Diagnosis" tab, adopt data set into project

Diagnosis Data

The available diagnosis can be read out by pressing the “Diagnosis Data” button. At device level all available diagnosis data for the existing AR is read out here.

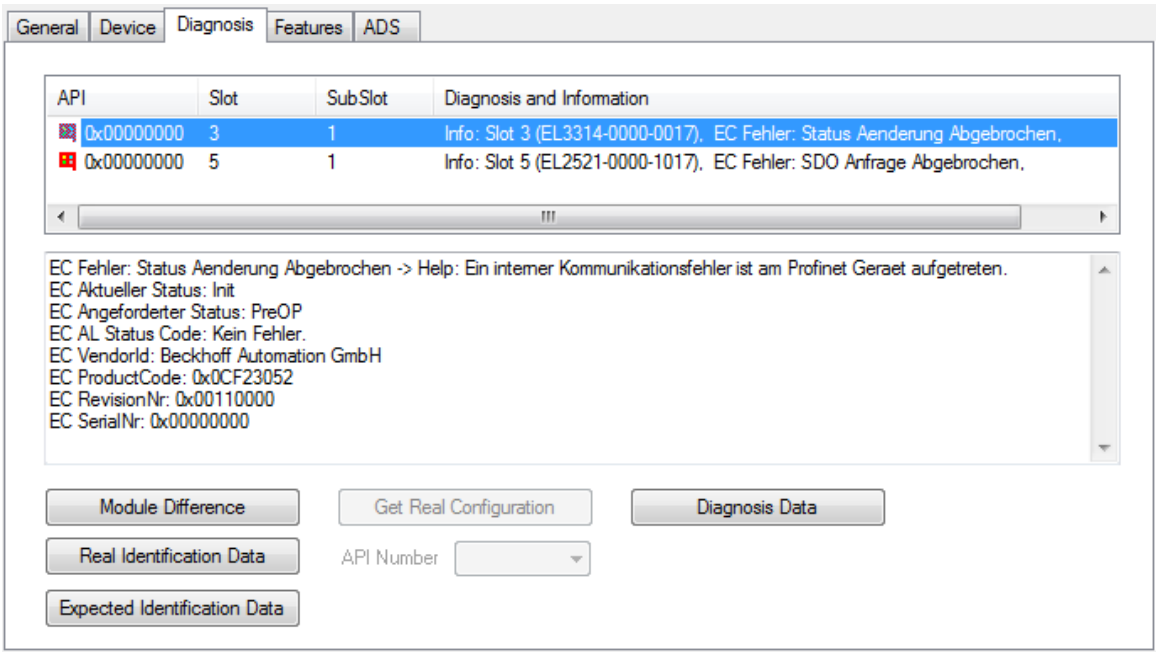


Fig. 40: "Diagnosis", Button Diagnosis Data

A maximum of two diagnosis parameters are displayed in the list; others are marked by “…”. If the individual message is clicked, all available diagnosis information is displayed in the window below.

Cyclic diagnosis via “PnIoBoxState” and “PnIoBoxDiag”

These variables are cyclically exchanged with the process image between the PROFINET driver and the System Manager.

Presently the following error messages are displayed under the PnIoBoxState.

Number	Text	Description	Remedial action / reason
0	No error	No error	No error
1	PROFINET Device state machine is in boot mode	PROFINET Device State Machine is still in the start-up phase	Not an error, wait
2	Device not found	Device does not reply to the Identify Request	Check connection, device connected, was the device called by its correct name?
3	The stationname is not unique	The station name is not unique	There are two or more devices in the network with the same PROFINET name. A correct identification cannot take place.
4	IP could not set	IP address could not be set.	The PROFINET device has rejected the IP settings for some reason. Check whether the IP settings are correct.
5	IP conflict	An IP conflict has occurred in the network.	A possible cause is that several devices have the same IP address.
6	DCP set was not successful	There was no reply or an erroneous reply to a DCP Set.	Check connection, device connected, was the device called by its correct name?
7	Watchdog error	The connection was broken off with a Watchdog error.	Check the cycle time, check the connection, if necessary increase the Watchdog factor.
8	Datahold error	The connection was broken off with a Datahold error.	Frame Data status was invalid for the length of the DataHoldTimer. Restart the device if necessary.
9	RTC3: Sync signal could not started	For IRT only: the Sync signal could not be started.	Is EtherCAT Sync signal correct or has Sync0 started?
10	PROFINET Controller has a link error	The PROFINET controller has no link.	Check cable and connection.
11	The aliasname is not unique	The alias name is not unique	There are two or more devices in the network with the same alias name. This is made up of the neighbourhood information (PortId.ChassisId). A correct identification cannot take place.
12	The automatic name assignment isn't possible - wrong device type	The automatic name assignment is not possible.	The expected PROFINET device is not in the projected position (VendorId or DeviceId does not correspond). Hence, no automatic naming and thus no device start is possible.
31	only for EtherCAT gateways: WC-State of cyclic EtherCAT frame is 1	For EL6631 only: EtherCAT WC State is 1	Check the mode on the EtherCAT master & slave (OP?).

As opposed to the state, more than one status can be displayed in the “PnIoBoxDiag”, i.e. the whole thing is bit-coded and up to 16 pieces of information can be displayed. The following statuses are currently displayed.

0x0000 = No diagnosis
0xXXX1 = IOC-AR is not established
0xXXX2 = IOC-AR is established
0xXXX4 = IOC-AR is established but no ApplReady
0xXXX8 = IOC-AR is established but module difference
0xXX1X = At least one AlarmCR get diagnosis alarm
0xX1XX = At least one InputCR is invalid
0xX2XX = At least one InputCR Provider is in stop
0xX4XX = At least one InputCR Problemindicator is set

0x1XXX = At least one OutputCR is invalid
0x2XXX = At least one OutputCR Provider is in stop
0x4XXX = At least one OutputCR Problemindicator is set

On the one hand information about the status of the IO Controller Single AR is displayed here. In addition, collective statuses are formed from the Frame Data statuses of the individual CRs. The whole thing happens for the input and the output CRs (currently only one is possible; in future the controller will support several CRs). In addition a PROFINET alarm is also displayed in the “PnIoBoxDiag”

5.3 Settings

5.3.1 Project planning of the PROFINET device

When establishing a PROFINET connection the controller always assigns an IP address to the device from its own address space (if the device does not yet have one or if it has a different one). In TwinCAT the next higher address is taken for a device by default (starting from the controller adapter class); the subnet and gateway are the same as those of the controller. Before the actual assignment of the IP address to the device by the controller, an ARP is used to test for a possible address conflict or to check whether the device already has this IP address. If there is a conflict, e.g. that the IP address is already assigned in the network, the IO driver determines this and outputs a corresponding message in the logger window. If there is no reply to the ARP, this means that no device (the projected device included) is using this IP configuration, which in turn results in the controller assigning the IP settings to the device via a DCP_SET. Setting is skipped if it is determined via the ARP that the device sought already has the projected IP address.

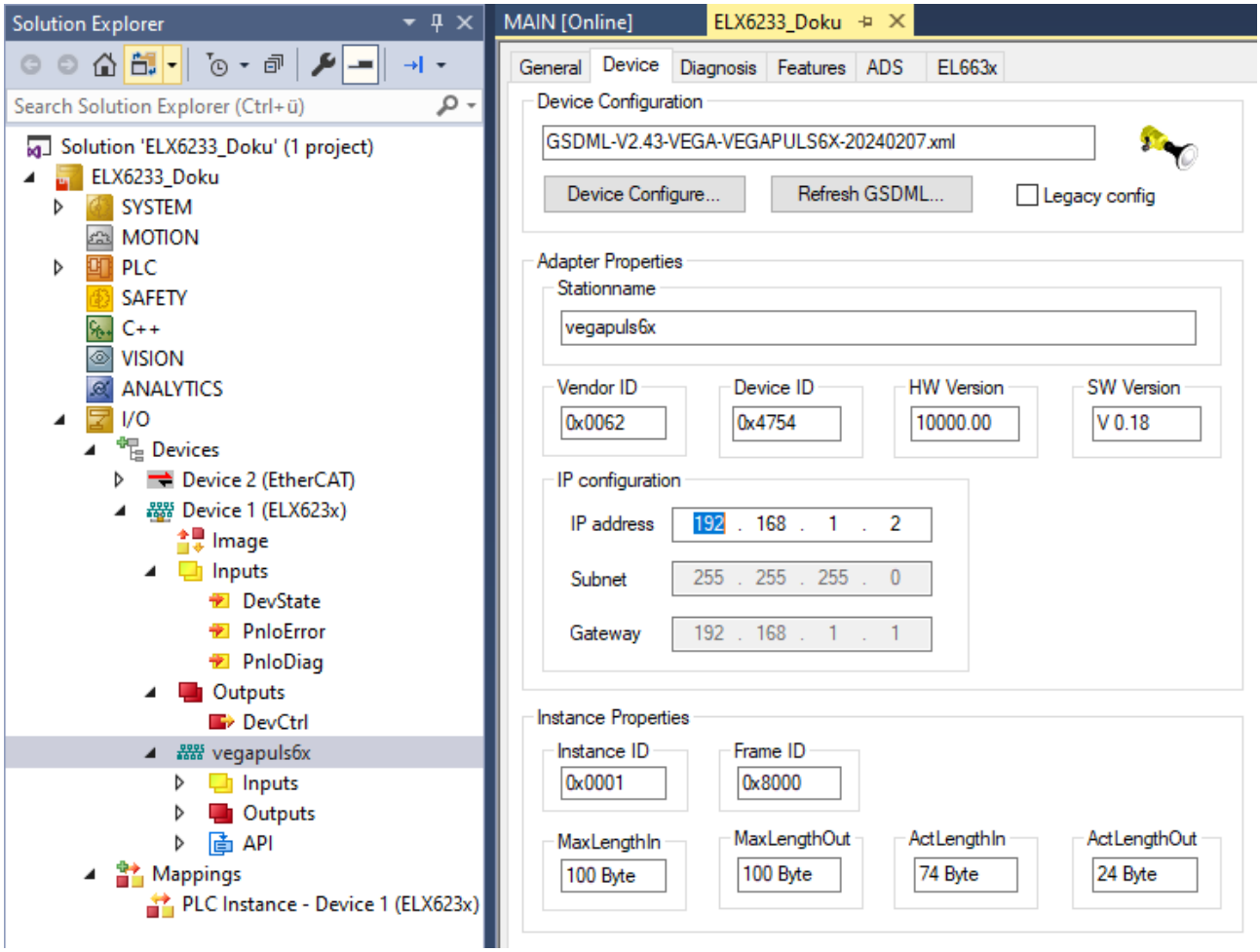


Fig. 41: *Device* tab

In addition the "InstanceID" and the "FrameID" can be changed in this window. However, the default settings are sufficient for most applications. The Instance ID is incorporated into the formation of the UUID object. A change should therefore be made only in exceptional cases. When changing the Frame ID the employed RTClass must be taken into account (e.g. for RTClass1 unicast 0xC000 - 0xFAFF). If the device is on an IRT controller and all devices have been switched automatically to RTClass3, the Frame ID is managed automatically and there is no input option (marked by “Fast Config”).

The current process data length can also be checked in this menu. This means that the MaxLengths indicate which process data size is supported by the corresponding device, while the ActLengths indicate the current process data length (incl. IOPS and IOCS). The corresponding error message appears if the maximum lengths are exceeded on appending further modules/submodules.

Various settings for the cycle time can be made on the “Features” tab. The cycle time of the controller must always correspond to a power of two for RTCLass1, starting at 1 ms (1, 2, 4, 8...). If an incorrect base time has been selected, this is indicated by a corresponding message. For RTClass3 the 1 ms base time can be divided again and again by two (down to min. 31.25 µs). The device cycle time can be changed via the exponent. The minimum is always the Controller CycleTime, unless the minimum cycle time defined in the GSDML is greater than that of the controller. The maximum for RTClass1 is 512 ms. The “SendClockFactor” is fixed to the value 32 (31.25 µs * 32 = 1 ms) as the time base. The "ReductionRatioFactor" also refers to this, i.e. an RRFactor of 4 means a cycle time of 4 ms. The transmission time can be shifted again within a cycle via the phase, i.e. with RR = 4, the phase can be 1 - 4. However, this value is only of importance in the case of a synchronized transmission.

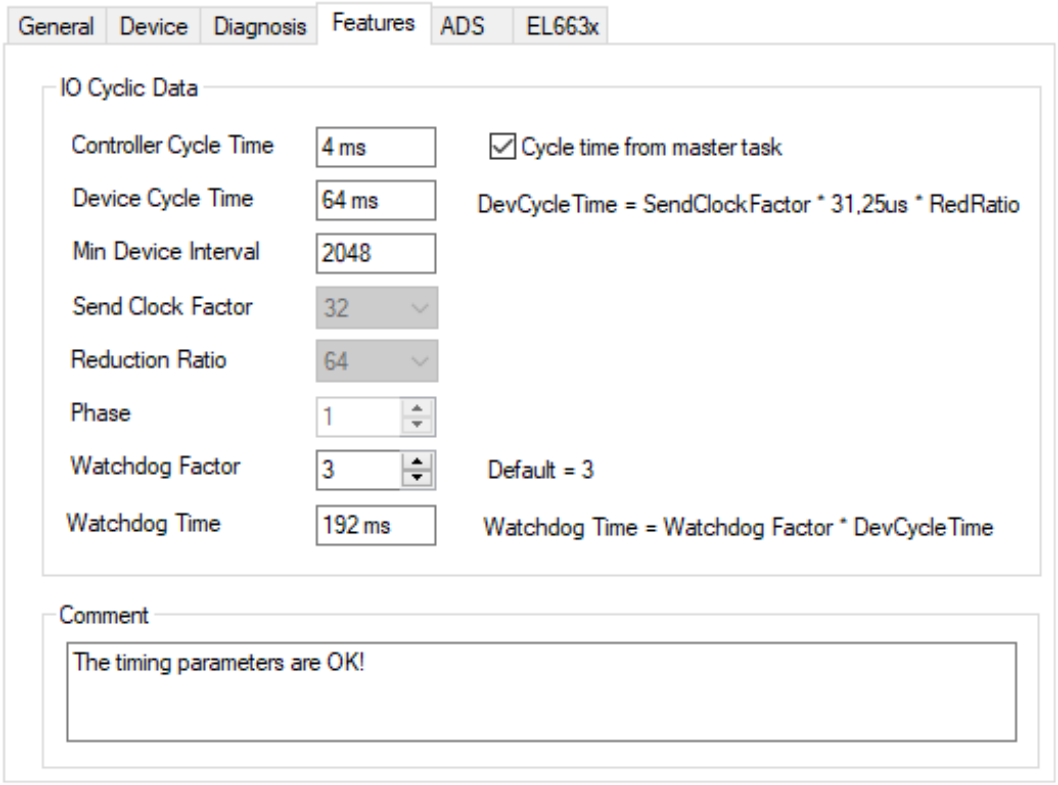


Fig. 42: *Features* tab

The PROFINET Watchdog Factor can also be adjusted here. Each device monitors the input of the cyclic data based on this factor. If the factor is set to the default value (3) this means that, with an RR of 4, three cycles require 12 ms. Hence, a device reacts after 12 ms to missing telegrams (e.g. with an alarm and/or disconnection of the AR). The limits and values are recalculated each time when adjusting the individual factors.

5.3.2 EL663x

If the controller protocol is operated via an EL663x, then an additional menu appears on the devices.

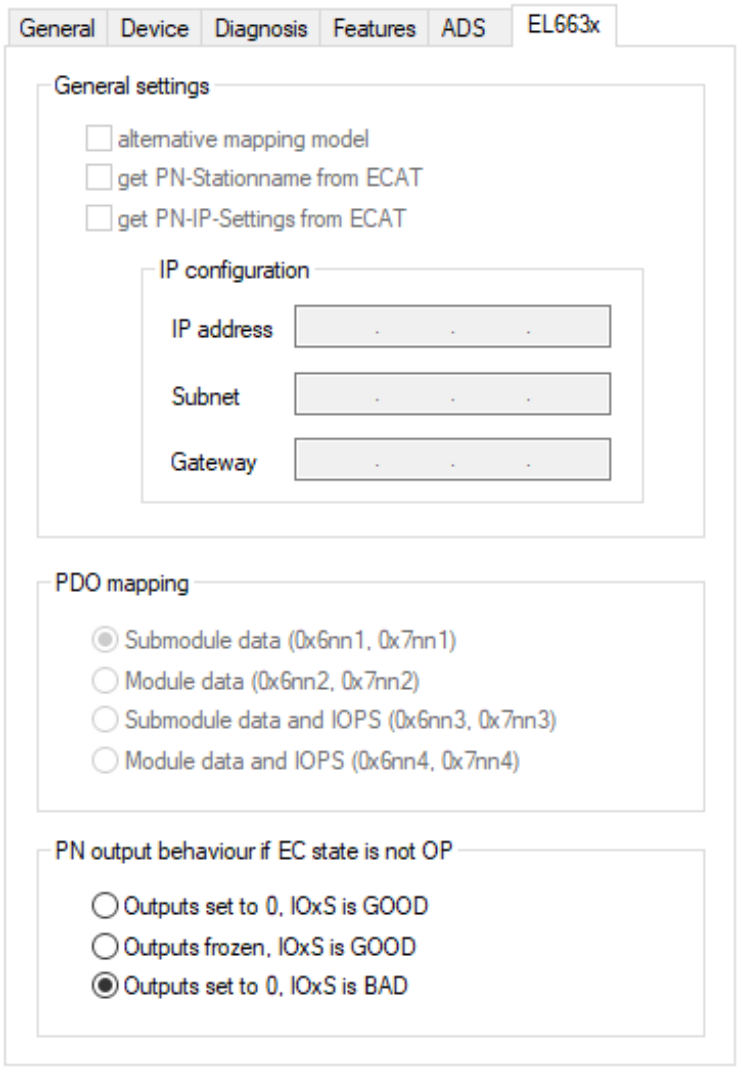


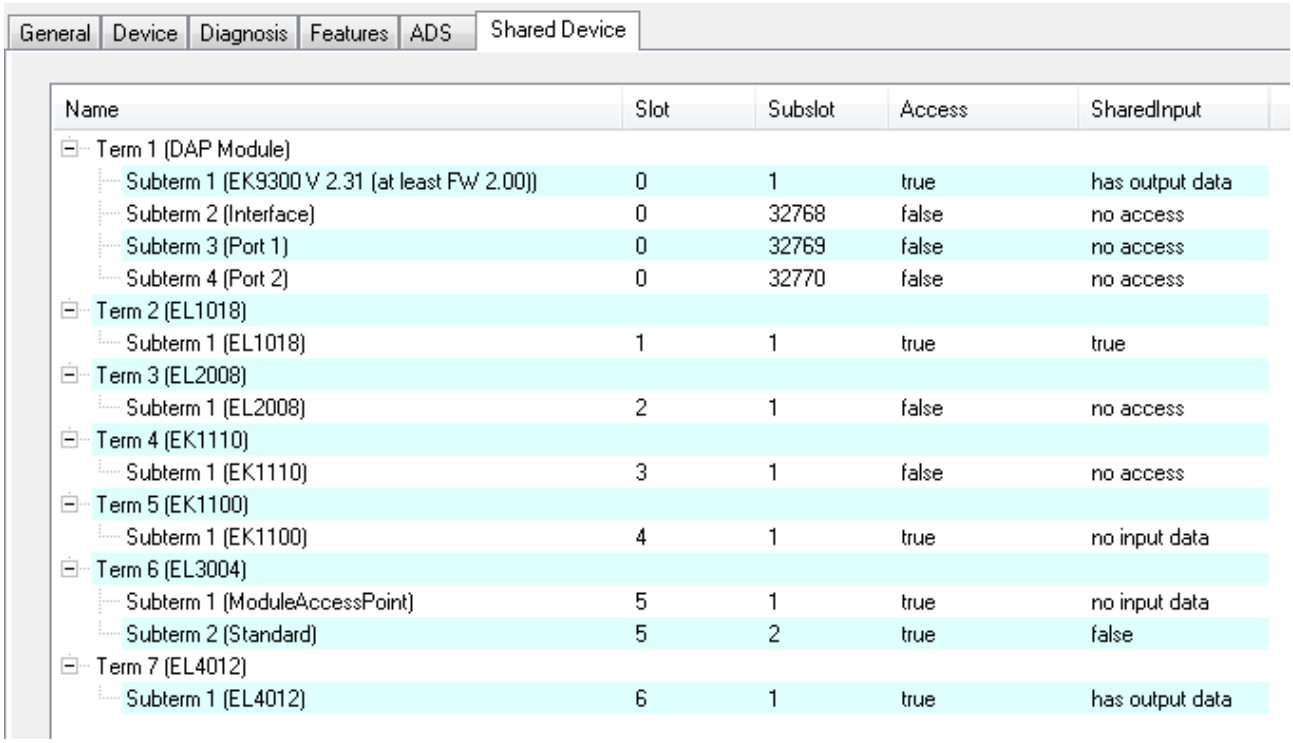
Fig. 43: "EL663x" tab

Currently only the PDO mapping can be selected for the controller. This sets the form in which the PROFINET process data are mapped to the EtherCAT-side PDOs.

5.3.3 Shared Device

The SharedDevice feature is available from TwinCAT 2 build 22.50 or TwinCAT 3 build 4019.

The dialogue appears if the device supports "SharedDevice". The information for this comes from the GSDML.



Name	Slot	Subslot	Access	SharedInput
Term 1 (DAP Module)				
Subterm 1 (EK9300 V 2.31 (at least FW 2.00))	0	1	true	has output data
Subterm 2 (Interface)	0	32768	false	no access
Subterm 3 (Port 1)	0	32769	false	no access
Subterm 4 (Port 2)	0	32770	false	no access
Term 2 (EL1018)				
Subterm 1 (EL1018)	1	1	true	true
Term 3 (EL2008)				
Subterm 1 (EL2008)	2	1	false	no access
Term 4 (EK1110)				
Subterm 1 (EK1110)	3	1	false	no access
Term 5 (EK1100)				
Subterm 1 (EK1100)	4	1	true	no input data
Term 6 (EL3004)				
Subterm 1 (ModuleAccessPoint)	5	1	true	no input data
Subterm 2 (Standard)	5	2	true	false
Term 7 (EL4012)				
Subterm 1 (EL4012)	6	1	true	has output data

Fig. 44: "Shared Device" tab

There is an option here to allow or forbid the controller to access the individual sub-modules. By default the controller may access all sub-modules; if SharedInput is supported it is switched off.

The text messages for SharedInput have the following meanings:

- "not supported" - SharedInput is not supported by the device (info from the GSDML)
- "has output data" - the sub-module has outputs - activation of SharedInput not possible
- "no input data" - the sub-module has no inputs (and also no outputs)
- "no access" - access is blocked
- "true" or "false" - set value for SharedInput

The settings can be changed by double-clicking on the individual sub-modules. If the access to a port or interface sub-module is changed, then it is changed for all ports or interfaces.

5.4 Modules

5.4.1 Diagnosis at module level

The slot number of the modules always corresponds to the position in the tree, i.e. the DAP module always starts with slot number 0 and so on in order. At module level there is an option on the Diagnostic tab to compare the nominal and actual data for the respective module. In addition the existing diagnosis for the module can be read out.

5.4.2 Diagnosis at submodule level

PROFINET currently distinguishes between 4 types of submodule.

- Virtual submodules:
  The virtual submodules are always permanently connected to a module, i.e. when inserting a module the virtual submodules defined with it are also always inserted in the specified subslot. This kind of submodule is presently the commonest method.
- Real submodule:
  Here there is a possibility to select the pluggable submodules from a submodule list and to append them to the module. The necessary information is procured from the GSDML. In TwinCAT a module can be selected from such a list with the right mouse button (provided this is supported by the device).
- Port submodule:
  The physical properties of a network port are reproduced in such a submodule.
- Interface submodule:
  Device-specific properties are defined in the interfaces submodules. These can be, for example, additionally supported protocols, timing properties, supported MIBs etc.

In general the submodules have the same diagnostic properties as the modules, i.e. in this case also it is currently only possible to read out the nominal and actual configuration in TwinCAT. The order of the subslot numbers is not necessarily the same as the order in the TwinCAT project. Hence, for example, the order in DAP always starts with the interface submodule (ISM); however, the subslot number of the ISM is defined in the GSDML and starts at 0x8000. There are 16 possible interfaces (0x8x00), each with up to 256 ports (0x80xx). An ISM is followed by the Port submodule with the aforementioned subslot number.

5.4.3 Interface Submodule

The type of communication can always be set on the interface submodel (at present RTClass1 or RTClass3). The only exception is in the case that a generally valid RTClass was set via the ‘Auto Config...’ menu.

If communication takes place over RTClass3, then the PLL window can additionally be set at the interface.

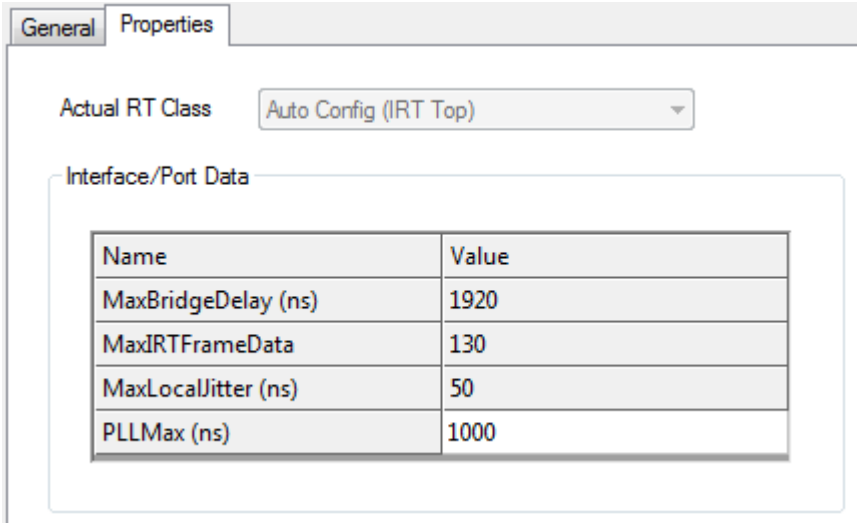


Fig. 45: "Properties" tab, "PLL Window" setting

5.4.4 Port Submodule

Port-specific settings can be made on the ‘Properties’ tab. The menu of possible settings always depends on the RTClass employed.

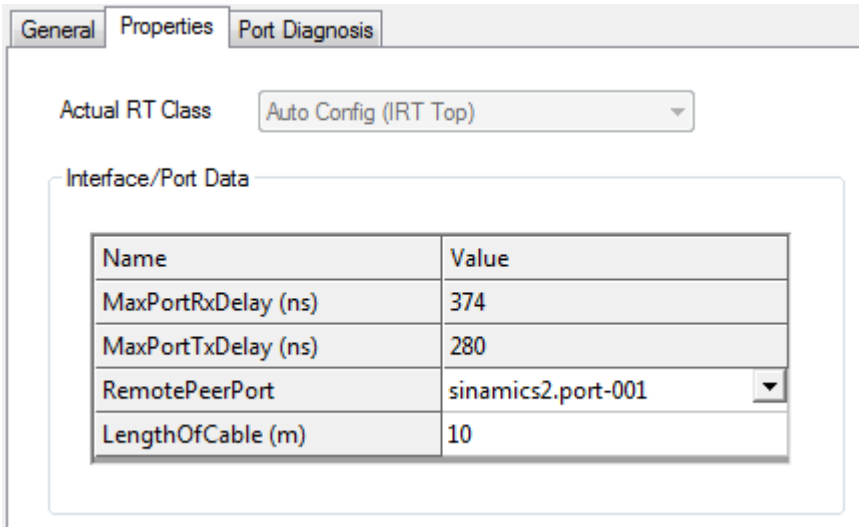


Fig. 46: "Properties" tab

In addition some port properties can be read out.

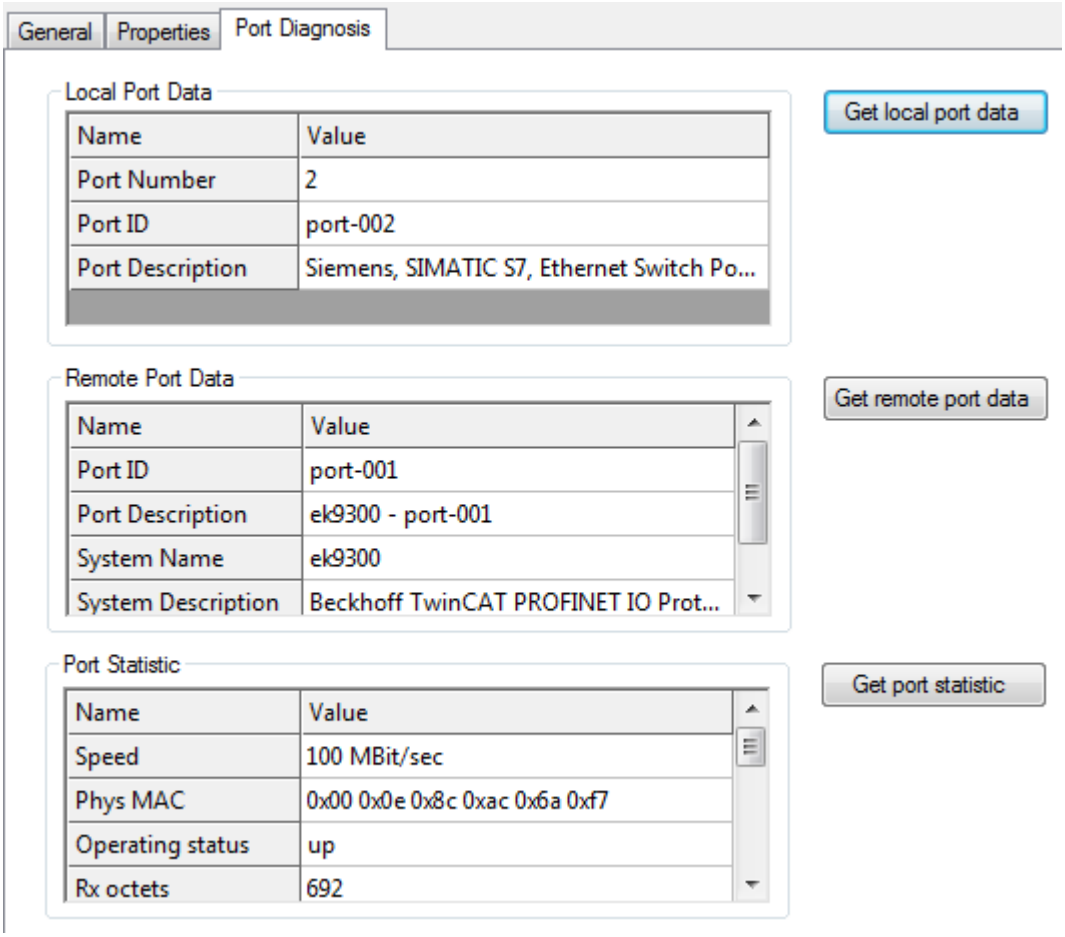


Fig. 47: "Port Diagnosis" tab

The information here is subdivided into local port information and remote port properties. I.e. the LLDP protocol (IEEE Std 802.1AB) is prescribed in PROFINET from Conformance Class A (CCA). The devices exchange neighbourhood IDs via this protocol, so that each port is known to its neighbor. Furthermore, the Simple Network Management Protocol (SNMP) can be used as an aid at this point. On opening the ‘Port

Diagnosis' tab, TwinCAT acts as a Network Management Station (NMS) and collects the required device information via SNMP. In the above illustration, for example, it can be seen that the local Port 1 of the BK9053 is connected to Port 2 of the BK9103. For correct topology recognition it is important that only devices are present in the strand that also support the LLDP protocol (this is also applies to switches!).

5.4.5 Real / virtual submodules

If these submodules have paramétrisation data they will be displayed as shown in the illustration below.

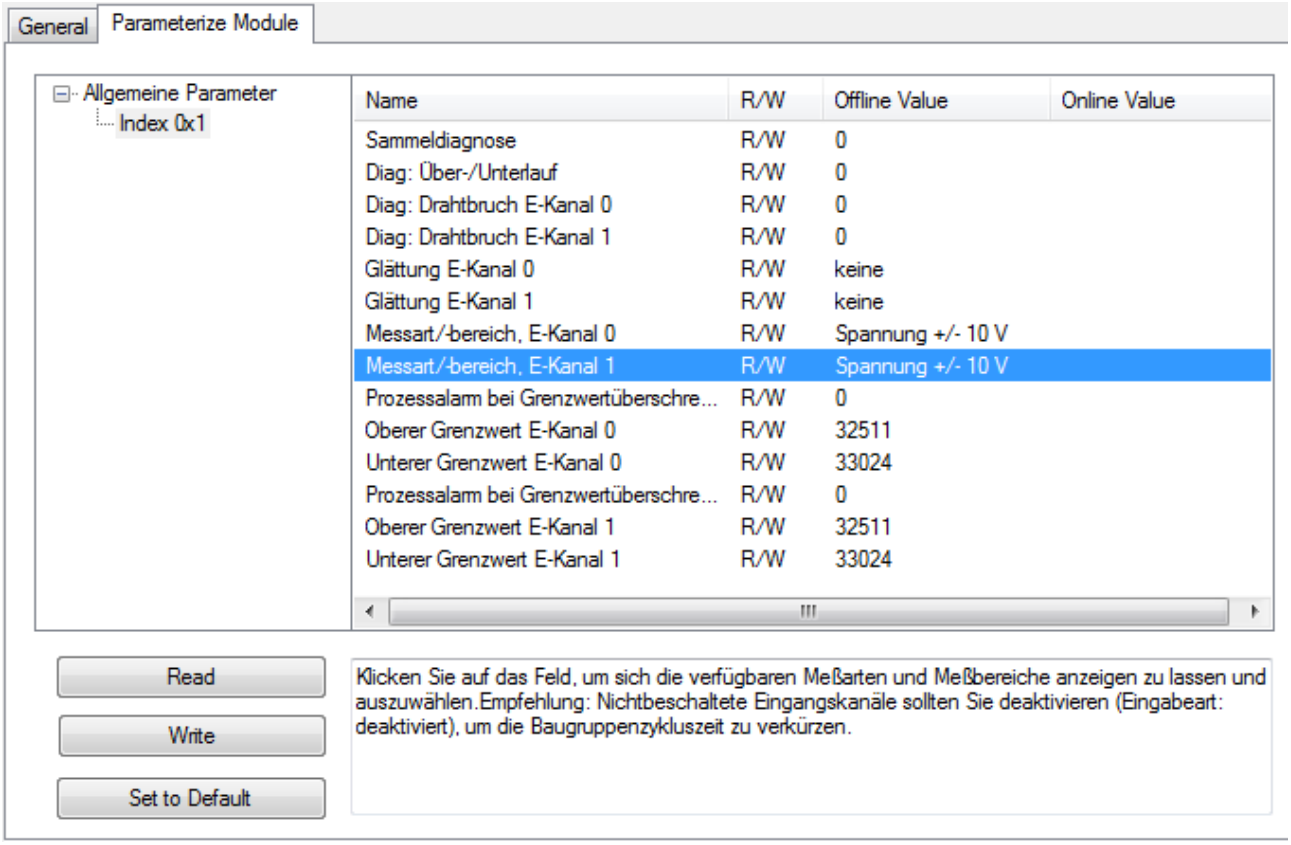


Fig. 48: "Parameterize Module" tab, parameter display

Selection can be made here between the individual indices. The data can be read and/or written depending on the access method. The online values are updated when reading back. If an individual index is marked, then all values within an index will be set to default; if individual values are marked, only these will be reset. Writable values are changed by double-clicking on the respective line.

6 Appendix

6.1 EtherCAT AL Status Codes

For detailed information please refer to the EtherCAT system description.

6.2 Support and Service

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