Industrial networking - network module for multi-protocol

BNI XG1-505-0A5-R067
BNI XG3-302-0B5-R067
BNI XG3-302-1B5-Z067
BNI XG3-508-0B5-R067
BNI XG5-508-0B5-P067
BNI XG5-508-0B5-R067
BNI XG5-538-0B5-R067
BNI XG5-538-1B5-Z067
BNI XG5-508-1B5-Z067
BNI XG5-508-1B5-Z067-C17



english

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1 About this guide

1.1 Validity

This guide describes the integration and configuration of the product lines BNI XG1-..., BNI XG3-... and BNI XG5-...

The following table describes the product variants covered by this guide:

Table 1: Supported product variants

Type Code	Oder Code	Performance Class	IO Port	Housing	Display
BNI XG1-505-0A5-R067	BNI00L1	Entry	8x IO-Link Class A / 16x DI / 8x DO	Plastic	-
BNI XG3-302-0B5-R067	BNI00L7	Standard	16x DI / 16x DO	Plastic	-
BNI XG3-302-1B5-Z067	BNI00L8	Standard	16x DI / 16x DO	Metal	✓
BNI XG3-508-0B5-R067	BNI00L3	Standard	8x IO-Link Class A / 16x DI / 16x DO	Plastic	-
BNI XG5-508-0B5-P067	BNI00L9	Advanced	8x IO-Link Class A / 16x DI / 16x DO	Plastic	-
BNI XG5-508-0B5-R067	BNI00KH	Advanced	8x IO-Link Class A / 16x DI / 16x DO	Plastic	-
BNI XG5-538-0B5-R067	BNI00KJ	Advanced	4x IO-Link Class A / 4x Class B / 12x DI[1] / 12x DO[2]	Plastic	-
BNI XG5-508-1B5-Z067	BNI00K6	Advanced	8x IO-Link Class A / 16x DI / 16x DO	Metal	✓
BNI XG5-508-1B5-Z067-C17	BNI00ML	Advanced	8x IO-Link Class A / 16x DI / 16x DO	Metal	✓
BNI XG5-538-1B5-Z067	BNI00K7	Advanced	4x IO-Link Class A / 4x Class B / 12x DI[1] / 12x DO[2]	Metal	✓

Read this guide and the other applicable documents completely before installing and operating the product.

This guide was created in English. Other language versions are translations of this guide.

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1.2 Other applicable documents

Additional information about this product can be found at www.balluff.com on the product page, e.g. in the following documents:

- Data sheet
- Declaration of Conformity
- Disposal

1 4 additional PNP Type 3 inputs available on pin 2 of the Class B ports, provided that pins 3 and 5 are internally bridged (e.g., when using cable type BCC0FJZ).

2 4 additional PNP outputs available on pin 2 of the Class B ports, provided that pins 3 and 5 are internally bridged (e.g., when using cable type BCC0FJZ)

1.3 Disclaimer

The following description is provided free of charge and is a general application example. The description should support the programming and planning of PLC applications and illustrate possible solutions. The user has no claim to warranty, error correction or updates. In particular, any claims for compensation that could result from the use of this description are excluded. This liability limitation excludes (a) damages due to loss of life, personal injury or harm to health, (b) liability in accordance with the Product Liability Act and © cases of intent. Prior to implementation in systems and machines, please check whether the description provided here is intended for your application. The use of this free description shall be deemed to imply acceptance of the warranty and liability limitation!

1.4 Explanation of the warnings

Always observe the warnings in this guide and the measures described to avoid hazards.
The warnings used here contain various signal words and are structured as follows:

SIGNAL WORD

Type and source of the hazard
Consequences if not complied with
- ► Measures to avoid hazards

The individual signal words mean:

NOTICE

Identifies a danger that could **damage or destroy the product**.

⚠ CAUTION

The general warning symbol together with the signal word CAUTION indicates a hazard which can lead to **slight or moderate injuries**.

⚠ WARNING

The general warning symbol together with the signal word WARNING indicates a hazard which can lead to **death or serious injuries**.

⚠ DANGER

The general warning symbol in conjunction with the signal word DANGER identifies a hazard which, if not avoided, will certainly result in **death or serious injury**.

1.5 Symbols and conventions

- ► Individual instructions are indicated by a preceding triangle.

Action sequences are numbered consecutively:

1. Instruction 1
2. Instruction 2

Numbers unless otherwise indicated are decimals (e.g. 23). Hexadecimal numbers are represented with a preceding 0x (e.g. 0x12AB).

Buttons or selectable menu entries are described in italic and small caps, e.g.Save.

Menu commands are joined with a greater-than sign, e.g. “Settings>Options” stands for the menu command Options from the Settings menu.

Note

Note, tip
This symbol indicates general notes.

1.6 Technical terms and abbreviations used

ADT
Fieldbus Autodetection

BET
Balluff Engineering Tool

BNI
Balluff network interface

C/Q
Switching and communication line

DI
Standard (not safe) digital input port

DID
Device ID

DO
Standard (not safe) digital output port

ECT
EtherCAT[3]

EIP
EtherNet/IP

EMC
Electromagnetic compatibility

F-PLC
Safe controller

F-DI
Safe digital input port

F-DO
Safe digital output port

FE
Functional earth

FW
Firmware

GND
Electrical ground 0 V

GSD(ML)
Generic Station Description Markup Language

I/O
Standard inputs and outputs

n. c.
Not connected

SIO
Standard input/output

3
EtherCAT
EtherCAT© is a registered trademark and patented technology, licensed by Beckhoff Automation GmbH, Germany.

UA
Power supply

US
Sensor supply

ADT
Fieldbus Autodetection

BET
Balluff Engineering Tool

DID
Device ID

I/O
Input/Output

ECT
EtherCAT[Page 3, 3]

EIP
EtherNet/IP

IOL
IO-Link

ISDU
IO-Link-Parameter (Index Service Data Unit)

MBT
Modbus

MQTT
Message Queuing Telemetry Transport

Modbus/TCP
Modbus Transmission Control Protocol

n. c.
Not connected

PNT
Profinet

PS
PROFIsafe

P-Tool
Balluff Safety Plausibility Checking Tool, a Balluff tool for configuration and plausibility checking

SIL(CL)
Safety integrity level

SIO
Standard IO-Mode

UA
Power supply

US
Sensor supply

UA
Actuator supply

US
Sensor supply

PLC
Programmable logic controller

VID
Vendor ID

1.7 Pictures

The illustrations mostly show the device variant BNI XG5-538-1B5-Z067. Product views and pictures in these operating instructions may differ from the specified product.

The screenshots shown for the configuration are taken from the following project planning software as an example:

- **EtherCAT**: TwinCAT System Manager for connecting to a Beckhoff TwinCAT control
- **Profinet**: Siemens HW config
- **Ethernet/IP**: Rockwell RSLogix5000 configuration

2 Safety notes

2.1 Intended use

The IO-Link multiprotocol master serves as decentralized I/O and IO-Link Block for connection to a Profinet, Ethernet/IP or EtherCAT network and is intended for use in industrial applications.

The module may only be operated with an approved power supply. Only approved lines may be connected.

Proper function according to the specifications in the technical data is only assured when the product is used solely as described in the user's guide and the respective documents as well as in compliance with the technical specifications and requirements and only with suitable original Balluff accessories.

Otherwise, there is deemed to be unintended use. Unintended use is not permitted and will result in the loss of warranty and liability claims against the manufacturer.

The product may only be operated in areas with physical access protection to the product and its interfaces and in protected networks (Level 0, see *Cybersecurity*).

2.2 Reasonably foreseeable misuse

The product is not intended for the following applications and areas and may not be used there:

- In safety-oriented applications in which personal safety depends on the device function (for exception see chapter *Use in combination with safety modules (BNI XG5-538-... only)*)
- In explosive atmospheres

2.3 General safety notes

Activities such as **installation**, **connection** and **startup** may only be carried out by qualified personnel.

Qualified personnel are persons whose technical training, cyber security training, knowledge and experience as well as knowledge of the relevant regulations allows them to assess the work assigned to them, recognize possible hazards and take appropriate safety measures.

The **operator** is responsible for ensuring compliance with local safety regulations, maintaining a safe and cyber-secure operating environment, and taking appropriate measures to ensure that a defect in the product will not result in hazards to persons or equipment. This includes assessing cybersecurity risks and implementing the necessary cybersecurity measures for the operation of the machine.

The product must not be opened, modified or changed. If defects and unresolvable faults occur in the product, take it out of service and secure against unauthorized use.

Inadequate isolation of the product may result in damage and malfunction of the product or in the application due to unauthorized access or modification of data and settings or product availability.

BNI modules generally have good chemical and oil resistance. When used in aggressive media (e.g. chemicals, oils, lubricants and coolants) in high concentrations (e.g. due to low water content), the material resistance must be checked in advance for the specific application. In the event of failure or damage to the BNI modules due to these kinds of aggressive media, claims for defects are ruled out.

If BNI XG5-**538**-... modules are to be used in conjunction with Class B isolation, there must be no galvanic connection between US and UA networks. Example: US must not be used to apply a high level to pin 2 of a Class B port.

BNI XG...-**302/505/508**-... modules connect UA/GND and US/GND internally. If galvanic isolation is to be maintained, no mixed operation of BNI XG...-302/505/508-... and BNI XG5-538-... on the same US-UA networks may take place.

If the Class B ports are not to be used galvanically isolated and the system is to behave like an BNI XG5-**508**-..., UA/GND and US/GND must be connected.

2.3.1 Hot surfaces



Fig. 1: Hot Surface

The housing heats up under normal operating conditions. There is a risk of burn injuries. Avoid direct skin contact with the surface.

2.4 Cybersecurity

To operate the product in a cyber secure environment and to ensure the integrity of data, the following measures must be taken:

- Check if the delivered product is an original and unmodified device delivered by Balluff GmbH. For more information, see *Unpacking*.
- Perform a risk analysis with regard to cyber security and, based on the identified risks, plan and implement appropriate security measures for a secure environment for the product.
- Only allow network access to the devices from outside to known and trusted devices and authorized users.
- Only allow authorized personnel physical access to devices from outside.
- Implement an information security management system (ISMS) to manage all information security measures.
- Implement a firewall to separate the machine/ plantnetwork from the network outside the plant/ machine (company network, Internet) in order to prevent incoming connections to the product's network interfaces in particular.

For further information, see:

- BSI IT-Grundschutz Kompendium
- BSI recommendations for OEMs and integrators
- CISA Best Practices for Industrial Control Systems
- NCSC: Secure connectivity principles for Operational Technology
- NIST SP 800-82 Guide to Industrial Control Systems

3 First steps

3.1 Before you begin

WARNING

Before initial operation, please read the *Safety notes*.

NOTICE

The BNI Next Generation Family is continuously developed with new features and bug fixes. Multiple variants are part of this product family — see *Supported product variants*. The latest firmware, release notes, and additional files are always available on the Balluff Update Platform. Firmware can be easily updated through the integrated WebUI or the Balluff Engineering Tool.

3.2 Finding all neccesary information

Before connecting and commissioning the module, please read the safety instructions and guidelines in the manual. Always ensure that all necessary safety precautions are followed.



What's in the box

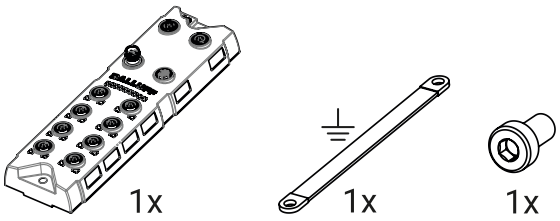
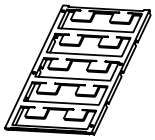


Fig. 1: 1x Balluff network module
1x Ground connector
1x M4 screw

Accessories (to be ordered separately)



BAM01JT
BAM02K3



BAM01C2

Fig. 2: BAM01C2 - Store link
BAM01JT - Store link
BAM02K3 - Store link

3.3 Mounting the module

WARNING

Additional mounting hardware required (not included)
2x M6 screws (length according to your application)
1x M4 screw for grounding point (length according to your application)

First, mount the network module at both mounting holes in its designated position using the specified torque value of max. 3 Nm. Two screws with a maximum diameter of 6 mm are required for this and not included in the box. The length can be chosen according to your application location. Next, the grounding cable must be screwed to both the module and a conductive grounding point using the included M4 screw and a specified torque value of 1.1 Nm to 1.2 Nm.

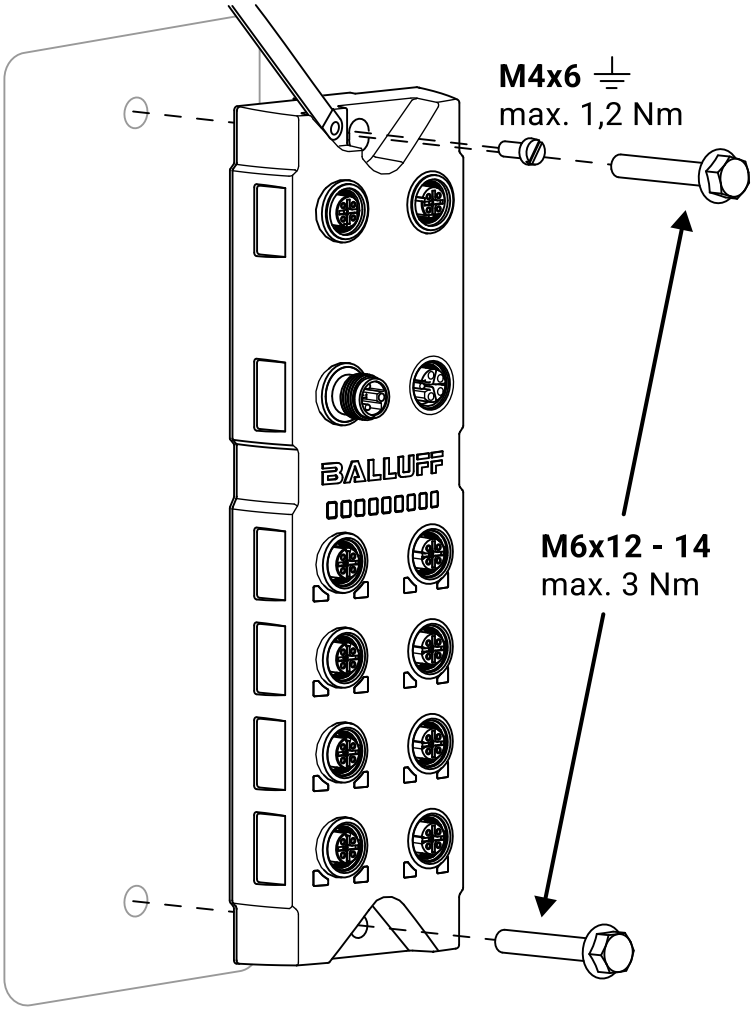


Fig. 3: Suit moments for the installation of module and grounding cable

3.3.1 Main steps for installing the module:

To set up your BNI, follow these steps:

1. Prepare the substrate for installation
2. Position the module at the designated location
3. Screw the module in place through the two mounting holes with M6 screws
4. Tighten the screws to a maximum torque of 3 Nm
5. Attach and tighten the grounding cable with the included M4 screw and a maximum torque of 1.1 Nm to 1.2 Nm
6. Screw the grounding cable to the grounding point in the application

3.3.2 Connecting the module

When connecting the module, please follow the order described below. Always ensure that all cables are securely seated and that the plugs and cable connections are in good condition.

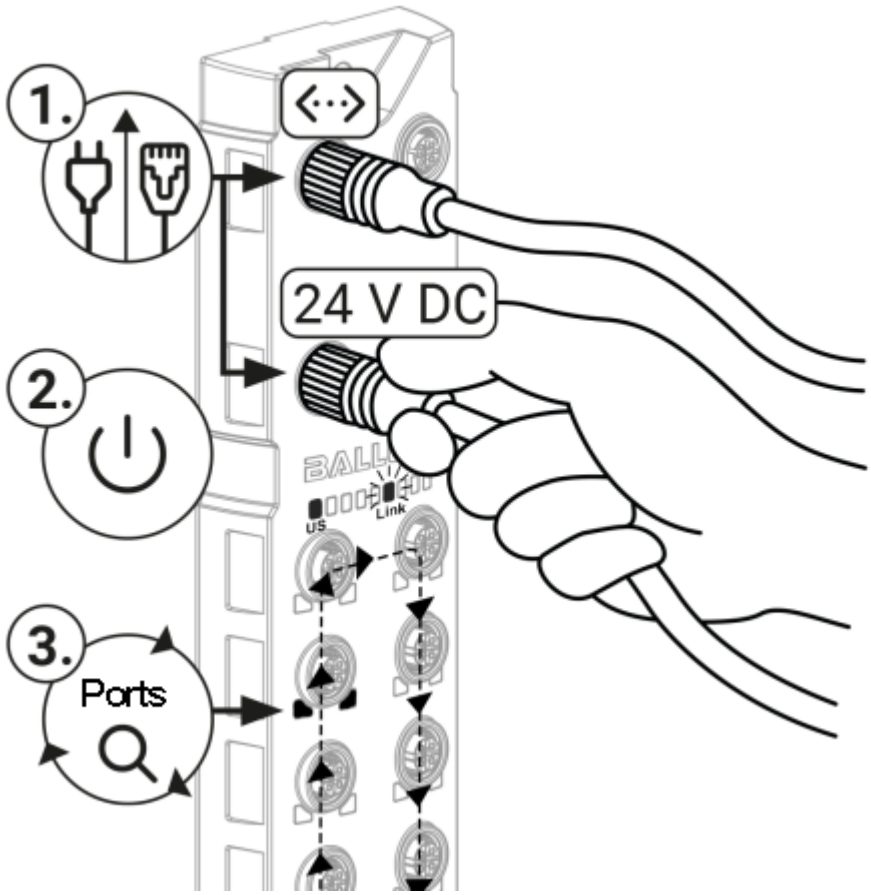


Fig. 4: Connecting the module

Main steps for connecting the module:

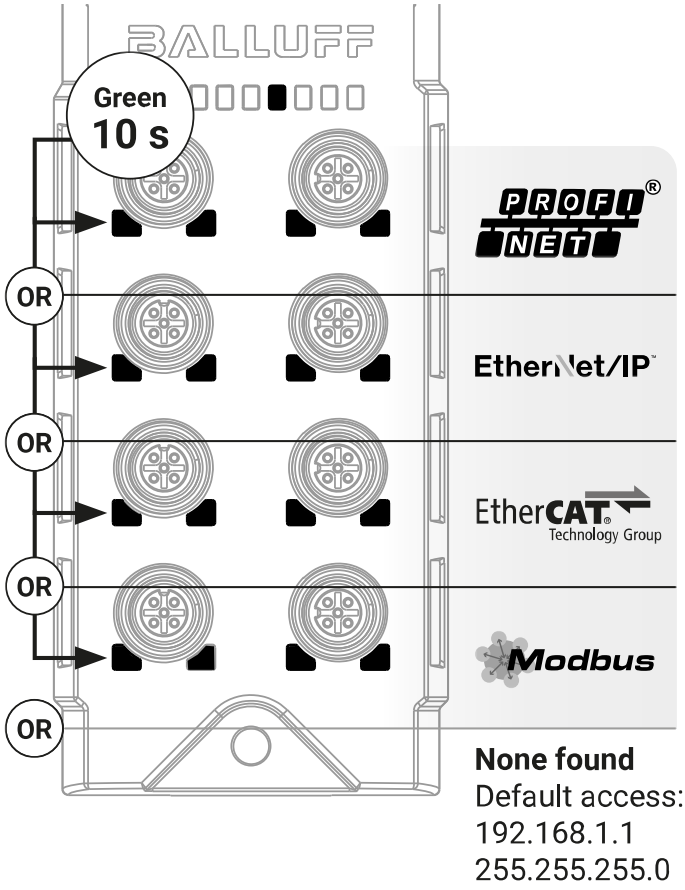
1. Plug in the M12 Ethernet cable and securely tighten the screw connection. Next, connect the unpowered 24V power cable to the module and securely tighten the screw connection. This ensures the IP67 protection class at the connections. The open connections must be covered with caps.
2. Then, activate the 24V power source. The module LEDs US and Link will start to light up.
3. In the area of the device connectors, the LEDs will form a running light in a clockwise direction, indicating the search for an active fieldbus protocol in the connected network.

3.3.3 Selecting the fieldbus protocol

If a supported fieldbus protocol is found in the network, the network module selects it automatically. The chosen fieldbus protocol is visualized for 10 seconds by the respective LED line in the device connector area. Until a protocol is found, the LEDs will form a running light in a clockwise direction. During this autodetection phase, the web interface is always accessible via the default IP address, where a fieldbus protocol can be selected manually. On variants equipped with a display, the fieldbus protocol can also be selected there.

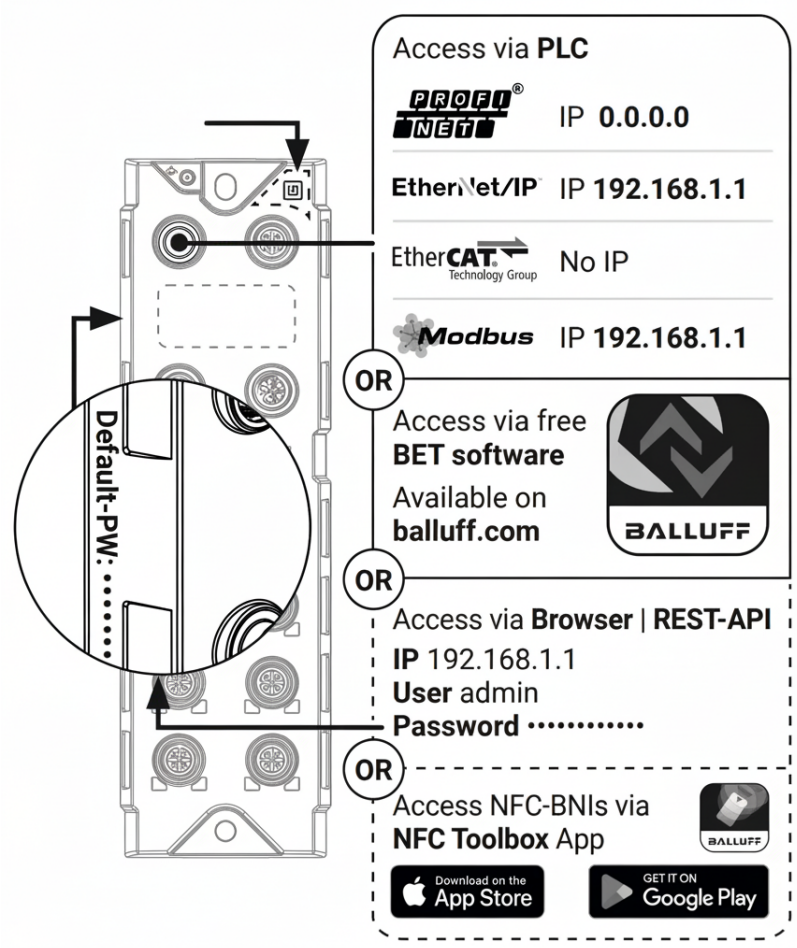
Note

Autodetect cannot detect the *IIoT-Mode*. It must always be selected manually through the WebUI or display.



3.3.4 Comissioning via network and software

There are different ways to start up the module after connecting it. Accessibility via the various fieldbus protocols and interfaces varies, as shown below.



Access via PLC and fieldbus

There are different ways to put the module into operation after connecting it. The accessibility via the various fieldbus protocols and interfaces varies, as shown below.

Fieldbus	Default IP address	Default subnet mask	Gateway
Autodetect	192.168.1.1	255.255.255.0	0.0.0.0
IIoT	192.168.1.1	255.255.255.0	0.0.0.0
Profinet	0.0.0.0	0.0.0.0	0.0.0.0
EtherNet/IP	192.168.1.1	255.255.255.0	0.0.0.0
Modbus/TCP	192.168.1.1	255.255.255.0	0.0.0.0
EtherCAT	IP settings via EoE	IP settings via EoE	IP settings via EoE

Detailed information on integrating the module via fieldbus protocols:

1. *PROFINET Module Basics*
2. *Ethernet/IP integration*
3. *EtherCAT configuration*
4. *Modbus/TCP configuration*

Access via Balluff Engineering Tool (BET)

First, download the free software Balluff Engineering Tool from the Balluff website and install it. Then, open the software and after logging in, click on “Search Devices” on the right side of the bar.

Access via browser with Web UI or the REST API

If EtherCAT was not selected as the fieldbus protocol after powering on, you can access the module via the browser and a REST interface. Use the login credentials found on the side of the module or on the included sticker. Follow these steps:

1. Open the URL 192.168.1.1 in your browser. You may need to change the network settings of your network adapter to the same IP range to gain access.
2. Log in as “admin” with the provided default password.
3. Open the network settings to adjust the fieldbus protocol and network settings.

To access via the REST API, open the REST documentation. There you will find all available endpoints.

Here you will find a detailed documentation of the WebUI chapter *REST API*.

Note

For detailed instructions, refer to the *Installation and connection* and *Startup and operation* sections.

3.3.5 Lost the password or IP settings and need a Factory Reset?

Please refer to chapter *Recovery Mode* how to get back the Factory Settings.

4 Scope of delivery, transport and storage

4.1 Scope of delivery

- IO-Link master
- Screw M4x6
- Grounding strap

Accessories are not included in the scope of delivery and must be ordered separately.

Note

Recommended accessories can be found at **www.balluff.com** on the product page.

4.2 Unpacking

To ensure that the delivered product is an original product of Balluff GmbH, check the following points when unpacking:

- The ISO-9001 label on the packaging must be present and undamaged.
- The information on the nameplate of the device must match the information on the delivery note.

In case of any doubts of the integrity or authenticity of the product, please contact Balluff service.

4.3 Transport

► Transport product to location of use in original packaging.

4.4 Storage conditions

► Store the device in a physically secured location with controlled access.
► Store product in original packaging.
► Observe ambient conditions (see *Ambient and Environmental conditions*).

5 Product information

This section provides information about the product features and specifications.

5.1 Product description

5.1.1 Dimensions

BNI XG1-505-0A5-R067 / BNI XG3-302-0B5-R067 / BNI XG3-508-0B5-R067 / BNI XG5-508-0B5-P067 / BNI XG5-508-0B5-R067 / BNI XG5-538-0B5-R067

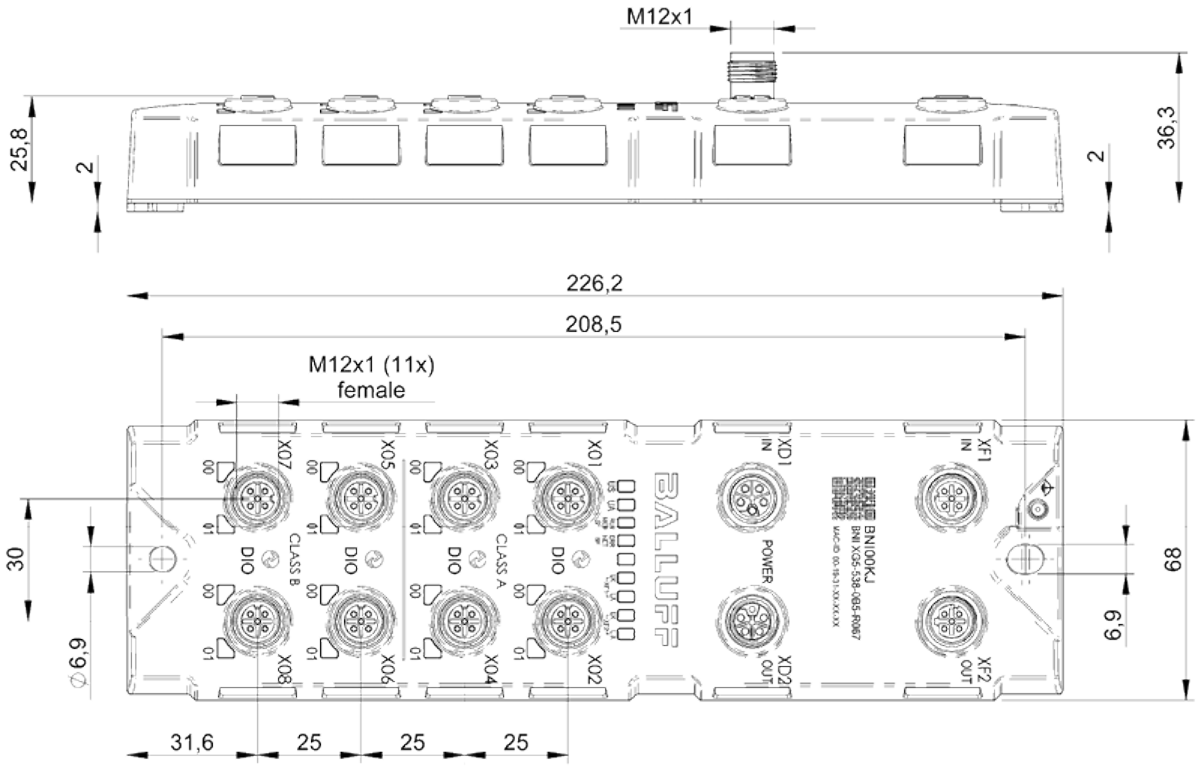


Fig. 1: Dimensions BNI XG1-505-0A5-R067 / BNI-XG3-302-0B5-R067 / BNI-XG3-508-0B5-R067 / BNI XG5-508-0B5-R067 / BNI XG5-538-0B5-R067

BNI XG3-302-1B5-Z067 / BNI XG5-508-1B5-Z067 / BNI XG5-508-1B5-Z067-C17 / BNI XG5-538-1B5-Z067

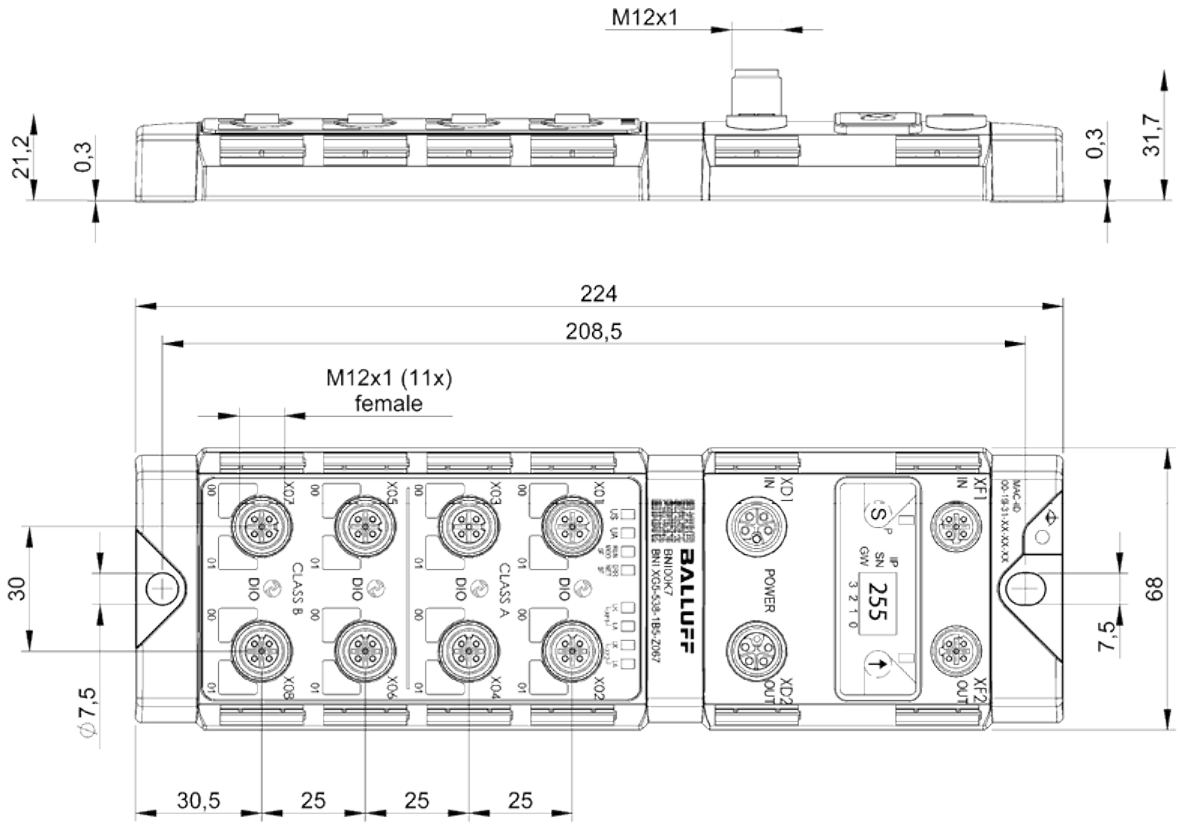


Fig. 2: Dimensions BNI XG3-302-1B5-Z067 / BNI XG5-508-1B5-Z067 / BNI XG5-508-1B5-Z067-C17 / BNI XG5-538-1B5-Z067

5.1.2 Construction

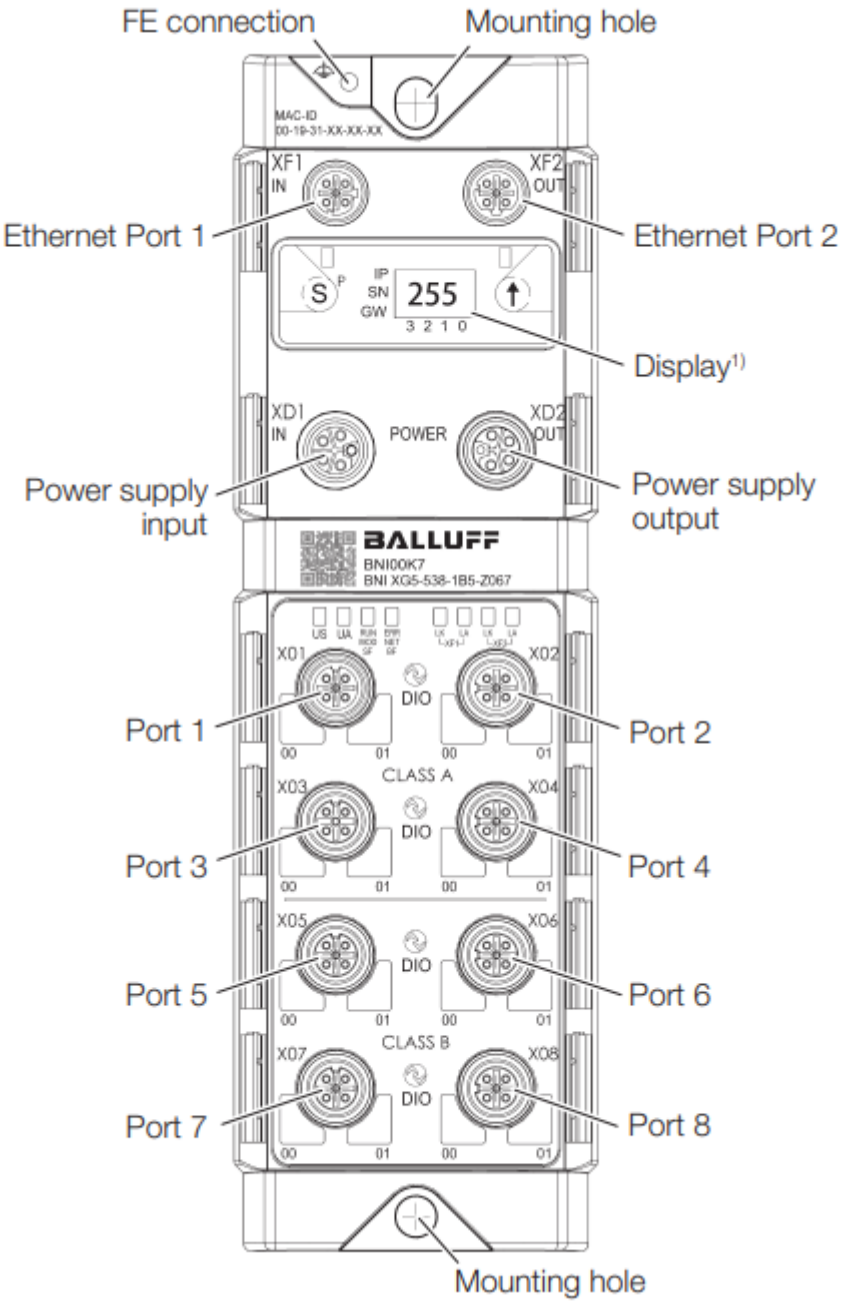


Fig. 3: Device overview

Note

1) Only for BNI XG5-...-1B5-... _variants.

5.1.3 Function

The IO-Link multiprotocol master is a decentralized and configurable gateway that processes and evaluates the input and output signals of standard sensors and actuators as well as process data from connected IO-Link devices.

The data is transmitted via an existing fieldbus interface to a higher-level controller set up by the user for further processing.

A web server is available on the IO-Link master for configuration and diagnostics.

Note

For configuration information, see the configuration guide at **www.balluff.com** on the product page.

Variant	I/O-Port	IO-Link Port	
-	-	Class A	Class B
BNI XG1-505-0A5-R067	-	1…8	–
BNI XG3-302-0B5-R067	1…8	–	–
BNI XG3-302-1B5-Z067	1…8	–	–
BNI XG3-508-0B5-R067	–	1…8	–
BNI XG5-508-0B5-P067	–	1…8	–
BNI XG5-508-0B5-R067	–	1…8	–
BNI XG5-538-0B5-R067	–	1…4	5…8
BNI XG5-508-1B5-Z067	–	1…8	–
BNI XG5-508-1B5-Z067-C17	–	1…8	–
BNI XG5-538-1B5-Z067	–	1…4	5…8

Note

Please check whether IO-Link is supported by your module before using this function. For more information on product variants that support IO-Link, see *Supported product variants*.

5.1.4 Display elements

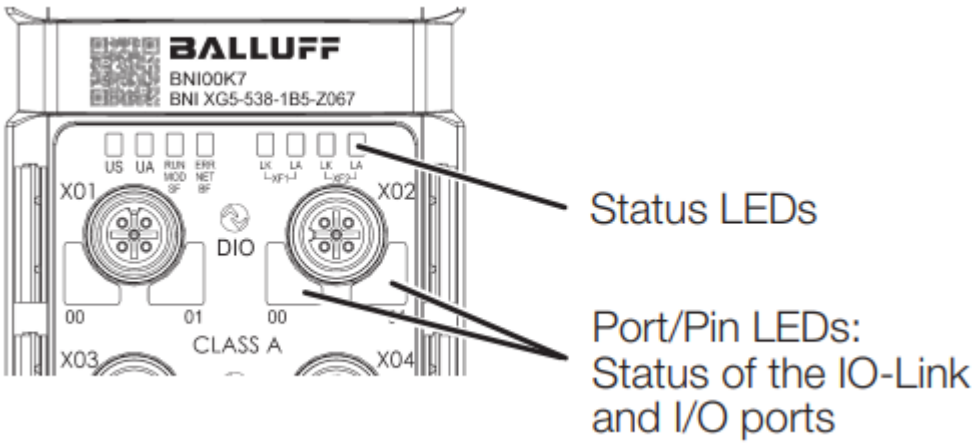


Fig. 4: Display elements

Note

For flashing behavior in autodetect mode, see *Startup*.

Status LEDs

Note

Specified voltage level according to DIN EN 61131.

Power supply

LED	Signal	Meaning
US	Green, static	Input voltage OK
	Red flashing	Input voltage too low (< ~20.5 V DC)
UA	Green, static	Output voltage OK
	Red flashing	Output voltage too low (< ~20.5 V DC) or too high (> ~28.7 V DC)
	Red, static	No output voltage present (< ~10.4 V DC)

Profinet communication

LED	Signal	Meaning
SF	Off	No error
	Red, static	Watchdog timeout; channel, general or extended diagnostics present; system error
	Red flashing	DCP signal service started via bus.
BF	Off	No error
	Red, static	Low speed of physical link; or no physical link
	Red flashing	No data exchange or no configuration

Ethernet/IP communication

LED	Signal	Meaning
MOD	Green flashing	Incorrect or no module configuration
	Green, static	Module in progress.
	Red flashing	Fixed bus cycle not possible
	Red-Green Flashing	Starting sequence
NET	Off	Module has no IP address.
	Green flashing	Module has an IP address, but no connection established.
	Green, static	Connection is established.
	Red flashing	Connection timeout
	Red-Green Flashing	Starting sequence

EtherCAT communication

LED	Signal	Meaning
RUN	Off	Device is in INIT state.
	Green flashing	Device is in PRE-OPERATIONAL state.
	Green slowly flashing	Device is in SAFE-OPERATIONAL state.
	Green, static	Device is in OPERATIONAL state.
ERR	Off	No errors
	Red flashing	Invalid configuration
	Red slowly flashing	Local error
	Red, fast flashing	Application watchdog timeout
	Red, static	Error in application

Modbus/TCP communication

LED	Signal	Meaning
RUN	Green slowly flashing	Module is ready to establish a connection.
	Green, static	Connection is established.
	Yellow, fast flashing	Existing connection has been lost.

Ethernet Ports

LED	Signal	Meaning
LA	Off	No data transfer and data reception
	Green, flashing	Send and receive data with connected device.
LK	Off	Ethernet connection is not yet established.
	Green, static	Ethernet connection established with another device.

Port/Pin LEDs

LED number	Assignment
LED 0	Pin 4
LED 1	Pin 2

Port/Pin LEDs Standard Port

Signal	Meaning
Off	State of input or output pins is 0
Yellow, static	State of input or output pins is 1
Both LEDs red flashing	Short circuit of sensor supply between pin 1 and pin 3
Red, static	Short circuit at output on pin 2/4 against pin 3
Red, static	No high signal at diagnostic input
Red, static	24 V input signal on configured output (actuator warning)

Port/Pin LEDs IO-Link Port

Signal	Meaning
Green, static	IO-Link connection active
Green flashing	No IO-Link connection or incorrect IO-Link device
Green, fast flashing	IO-Link: Preoperate during data storage
Red, fast flashing	Validation failed / incorrect configuration of the IO-Link data length
Red, fast flashing	Data storage failed / incorrect device for data storage
Red, static	IO-Link: Short circuit of pin 4 against pin 3

5.1.5 Labeling

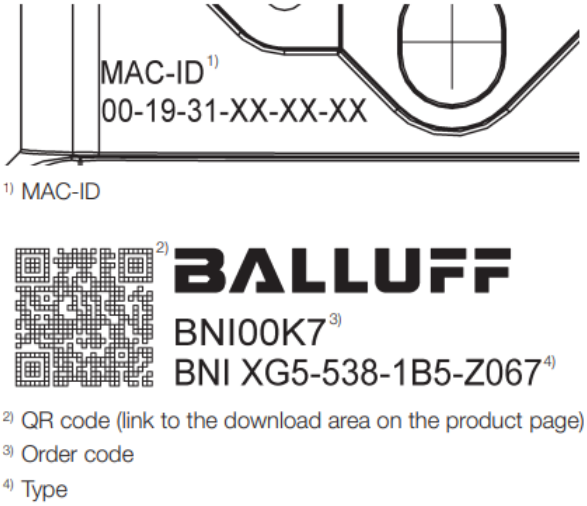


Fig. 5: Labeling (example)

Note

Only for BNI XG...-...-Z067(-C17) _variants.

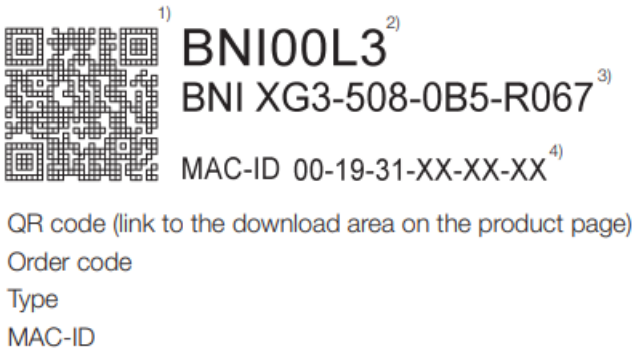


Fig. 6: Labeling (example)

Note

Only for BNI XG...-...-R067 _variants.

5.1.6 Symbol on product

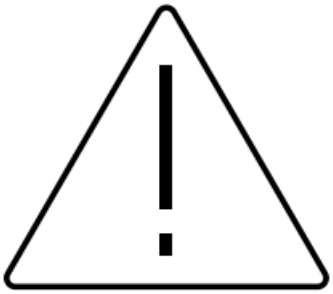


Fig. 7: Symbol

WARNING

General warning sign
► Observe the additional approval-related and safety-related information in the product documentation.

5.2 Technical data

The specifications are typical values for 24 V DC at room temperature.

The product is immediately ready for use.

Note

For performance data for UL, *UL Requirements*.

Note

Further data can be found at **www.balluff.com** on the product page.

5.2.1 Ambient and Environmental conditions

Ambient temperature	
BNI XG...-...-P067	−40...+70 °C
BNI XG...-...-R067	−40...+70 °C
BNI XG...-...-Z067(-C17)	−5...+70 °C (without display function: −25...+70 °C)
Storage temperature	
BNI XG...-...-P067	−40...+70 °C
BNI XG...-...-R067	−40...+70 °C
BNI XG...-...-Z067(-C17)	−25...+70 °C
Protection class (in screwed state)[1]	
BNI XG...-...-P067	IP68, IP69K
BNI XG...-...-R067	IP68, IP69K
BNI XG...-...-Z067(-C17)	IP67
Operation	Indoor
Altitude	≤ 2000 m (above sea level)
Relative humidity	≤ 85% (≤ 70°C)
Pollution degree	2

5.2.2 Electrical data

Operating voltage Ub	18...30 V DC, as per EN 61131-2
Residual ripple	< 1%
Input current at 24 V[2]	130 mA
Overvoltage category	SELV/PELV, Overvoltage category II

5.2.3 Electrical connection

Connection (power supply IN/OUT)	M12, L-coded, 5-pin, 1 × plug, 1 × socket
Input/output ports	M12, A-coded, 5-pin, 8 × socket

1 Not assessed by UL.
2 Modul self power consumption without any load on outputs (Pin 2, Pin 4) or any sensor connected (Pin 1)

5.2.4 Interface

Ethernet

Ethernet Port	2 × 10Base/100Base-Tx
Connection for Ethernet Port	M12, D-coded, 2 × socket
Cable types as per IEEE 802.3	Shielded twisted pair min. STP CAT 5 / STP CAT 5e
Data transmission rate	10/100 Mbit/s
Max. cable length	100 m
Flow control	Half-duplex/full-duplex (IEEE 802.33x-Pause)

Note

The device may only be connected to internal Ethernet networks, without external connection or influence from TNV.

OT-Protocols/ Fieldbus Technologies

The following table summarizes the supported OT protocols and fieldbus technologies of the available product variants.

For EtherCAT, the implemented sub-protocols are listed in brackets.

Product Variant	PROFINET	Ether-Net/IP	Mod-bus/TCP	EtherCAT	EtherCAT Fast Hot Connect	IIoT
BNI XG1... product family						
BNI XG1-505-0A5-R067	✓	✓	✓	✓ (CoE, EoE, AoE, FoE)	✓ (CoE, EoE, AoE, FoE)	✓
BNI XG3... product family						
BNI XG3-302-0B5-R067	✓	✓	✓	✓ (CoE, EoE, FoE)	✓ (CoE, EoE, FoE)	✓
BNI XG3-302-1B5-Z067	✓	✓	✓	✓ (CoE, EoE, FoE)	✓ (CoE, EoE, FoE)	✓
BNI XG3-508-0B5-R067	✓	✓	✓	✓ (CoE, EoE, AoE, FoE)	✓ (CoE, EoE, AoE, FoE)	✓
BNI XG5... product family						
BNI XG5-508-0B5-P067	✓	✓	✓	✓ (CoE, EoE, AoE, FoE)	✓ (CoE, EoE, AoE, FoE)	✓
BNI XG5-508-0B5-R067	✓	✓	✓	✓ (CoE, EoE, AoE, FoE)	✓ (CoE, EoE, AoE, FoE)	✓
BNI XG5-538-0B5-R067	✓	✓	✓	✓ (CoE, EoE, AoE, FoE)	✓ (CoE, EoE, AoE, FoE)	✓
BNI XG5-508-1B5-Z067	✓	✓	✓	✓ (CoE, EoE, AoE, FoE)	✓ (CoE, EoE, AoE, FoE)	✓
BNI XG5-508-1B5-Z067-C17	✓	✓	✓	✓ (CoE, EoE, AoE, FoE)	✓ (CoE, EoE, AoE, FoE)	✓
BNI XG5-538-1B5-Z067	✓	✓	✓	✓ (CoE, EoE, AoE, FoE)	✓ (CoE, EoE, AoE, FoE)	✓

PROFINET supports Fast Startup (FSU) and is implemented according to the specification *IO-Link Integration – Edition 2 Specification for PROFINET Version 1.1 (February 2020)*.

EtherNet/IP supports QuickConnect (QC).

EtherCAT supports the sub-protocols CoE, EoE, AoE, and FoE and is implemented according to the specification *EtherCAT Modular Device Profile Part 6220: IO-Link Master (ETG.5001.6220 S (D) V1.0.5)*.

In IIoT mode, only the IIoT protocols described in the following chapter are available.

IT-Protocols

The following table summarizes the supported IT protocols and services of the available product variants.

The symbols ✓ and ✕ indicate whether a function is supported.

Product Variant	WebUI	REST API	REST API (Parsed Data)	MQTT	MQTT (Parsed Data)	MQTT Write	OPC UA
BNI XG1… product family							
BNI XG1-505-0A5-R067	✓	✓	✕	✓	✕	✓	✕
BNI XG3… product family							
BNI XG3-302-0B5-R067	✓	✓	✓	✓	✓	✓	✕
BNI XG3-302-1B5-Z067	✓	✓	✓	✓	✓	✓	✕
BNI XG3-508-0B5-R067	✓	✓	✓	✓	✓	✓	✕
BNI XG5… product family							
BNI XG5-508-0B5-P067	✓	✓	✓	✓	✓	✓	✓
BNI XG5-508-0B5-R067	✓	✓	✓	✓	✓	✓	✓
BNI XG5-538-0B5-R067	✓	✓	✓	✓	✓	✓	✓
BNI XG5-508-1B5-Z067	✓	✓	✓	✓	✓	✓	✓
BNI XG5-508-1B5-Z067-C17	✓	✓	✓	✓	✓	✓	✓
BNI XG5-538-1B5-Z067	✓	✓	✓	✓	✓	✓	✓

The REST API is implemented according to the specification *JSON Integration for IO-Link Version 1.0.0 (March 2020)*.

OPC UA is implemented according to the specification *OPC Unified Architecture for IO-Link Companion Specification Release 1.0 (December 1, 2018)*.

MQTT Write is only available when the module operates in IIoT mode.

Sensor- and Actuator Ports

Ports, Connectors	Port1…Port8 (X01…X08)
Connector Type	M12, A-coded, 5-pin, 8 × socket
Supported Functions[3](see table below)	IO-LinkDigital InputDigital Output
Max. cable length for IO-Link	20 m

[3] Supported Functions

The following table summarizes the supported port functions and capacities of the available product variants.

The symbols ✓ and ✕ indicate whether a function is supported. Numbers in brackets indicate the maximum number of available channels or ports.

3 *(see table under the reference)*

Product Variant	Class A/B SIO	IO-Link[4]	Digital Input[5]	Digital Output[6]
BNI XG1… product family				
BNI XG1-505-0A5-R067	Ports 1…8: Class A	✓ (8)	✓ (16)	✓ (8)
BNI XG3… product family				
BNI XG3-302-0B5-R067	Ports 1…8: SIO	✕ (0)	✓ (16)	✓ (16)
BNI XG3-302-1B5-Z067	Ports 1…8: SIO	✕ (0)	✓ (16)	✓ (16)
BNI XG3-508-0B5-R067	Ports 1…8: Class A	✓ (8)	✓ (16)	✓ (16)
BNI XG5… product family				
BNI XG5-508-0B5-P067	Ports 1…8: Class A	✓ (8)	✓ (16)	✓ (16)
BNI XG5-508-0B5-R067	Ports 1…8: Class A	✓ (8)	✓ (16)	✓ (16)
BNI XG5-538-0B5-R067	Ports 1…4: Class A, Ports 5…8: Class B	✓ (8)	✓ (12)[10]	✓ (12)[11]
BNI XG5-508-1B5-Z067	Ports 1…8: Class A	✓ (8)	✓ (16)	✓ (16)
BNI XG5-508-1B5-Z067-C17	Ports 1…8: Class A	✓ (8)	✓ (16)	✓ (16)
BNI XG5-538-1B5-Z067	Ports 1…4: Class A, Ports 5…8: Class B	✓ (8)	✓ (12)[10]	✓ (12)[11]

[4] IO-Link	
Protocol Version	1.1.4
Transmission rates	COM1 = 4.8 kBaud COM2 = 38.4 kBaud COM3 = 230.4 kBaud
Sensor supply (on Pin 1)	
BNI XG1… product family	24 Volt, max. 500 mA
BNI XG3… product family	24 Volt, max. 2 A
BNI XG5… product family	24 Volt, max. 2 A

[5] Digital Input	
Compliance	IEC 61131-2
Input Type	PNP (Sinking)
Charactheristic	Type 3
Nominal Input Voltage	24 V DC

4 *(see table under the reference)*
5 *(see table under the reference)*
6 *(see table under the reference)*
10 4 additional PNP Type 3 inputs available on pin 2 of the Class B ports, provided that pins 3 and 5 are internally bridged (e.g., when using cable type BCC0FJZ).
11 4 additional PNP outputs available on pin 2 of the Class B ports, provided that pins 3 and 5 are internally bridged (e.g., when using cable type BCC0FJZ)

[6] Digital Output	
Compliance	IEC 61131-2
Output Type	PNP (Sourcing), High Side Switch
Nominal Output Voltage	24 V DC
Protection	Short-circuit and overload protection
Max. Output Current	(see table below)

Max. Output Current on…	Pin 2	Pin 4
BNI XG1… product family	n/a	250 mA[7]
BNI XG3… product family	2 A	2 A
BNI XG5… product family	up to 4 A[8]	up to 2 A[9]

Max. Output Current per port	
Class A	4 A
Class B	6 A

Note

The total current of the outputs on Ports' Pin2 and Pin4 (powered by UA line) must not exceed 16 A.
The total current of the outputs on Ports' Pin1 (powered by US) must not exceed 16 A.

Note

For the detailed pin assignment per device variant, including Class A/B differences and configurable current limit options, see the *pin assignment tables* in the installation and connection chapter.

5.2.5 Materials

Housing material	
BNI XG…-…-P067	Plastic, stainless steel inserts
BNI XG…-…-R067	Plastic, stainless steel inserts
BNI XG…-…-Z067(-C17)	Zinc die cast, nickel-plated

7 Design of digital output for general use/resistor operation, Pilot Duty only
8 Output max. current limit is configurable: 1000 mA, 2000 mA, 3000 mA, 4000 mA
9 Output max. current limit is configurable: 1000 mA, 2000 mA

5.2.6 Mechanical features

Installation info	
Installation	2-hole screw mounting
Ground strap fastening	Screw M4
Dimensions (W × H × D)	
BNI XG...-...-P067	68 × 226.2 × 38.3 mm
BNI XG...-...-R067	68 × 226.2 × 38.3 mm
BNI XG...-...-Z067(-C17)	68 × 224 × 32 mm
Weight	
BNI XG...-...-P067	approx. 570 g
BNI XG...-...-R067	approx. 570 g
BNI XG...-...-Z067(-C17)	approx. 660 g

5.2.7 Approvals and designations

Note

Additional information on directives, approvals and standards can be found at **www.balluff.com** on the product page.

EtherCAT® is a registered trademark and patented technology, licensed by Beckhoff Automation GmbH, Germany.

CE

The CE Mark verifies that our products meet the requirements of the current EU Directive.

UL Requirements

Cleaning

Clean the product only with dry cloth or cloth dampened only with water!

UL certificate

- File: E319845
- Enclosure rating: Type 1
- Ambient temperature:
  +50 °C (BNI XG...-...-R067)
  +50 °C (BNI XG...-...-P067)
  +45 °C (BNI XG...-...-Z067[-C17])

The power supply has to be an isolated type or SELV type.

The device may only be connected to internal Ethernet networks that do not extend beyond the building and are not exposed to TNVs.

Power ratings

Power Ratings	
Power input, nominal rated voltage 24 V DC	130 mA maximum consumption 16 A including all output loads
Power output, nominal rated voltage 24 V DC	max. 16 A
Digital input, nominal rated voltage 24 V DC	max. 30 mA/pin (point)
Digital output, nominal rated voltage 24 V DC	Class A IO-Link Port 0.5 A/port (point) Pilot Duty 4 A/port (point) Resistive /General use 16 A or less per device

Cable sizes

Power supply cable

Listed or R/C cable (CYJV2/8) with M12 female thread and L-coded plug rated 24 V minimum, 16 A minimum for all models. S, SJ, SO, ST, SV, or R/C (AVLV2) listed cable marked or specified on the UL Style Page as suitable for external connections, rated 300 V minimum, 14 AWG minimum, unless marked with the maximum load current and overcurrent protection for the cable in accordance with the table below.

Mains connection cable

Listed or R/C cable (CYJV2/8) with an M12 L-coded threaded plug and a voltage rating of at least 24 V and at least 16 A for all models. Listed S, SJ, SO, ST, SV or R/C cable (AVLV2) marked or specified on the UL Style Page as suitable for external connections, rated 300 V minimum and 14 AWG minimum, unless marked with the maximum load current and overcurrent protection for the cable in accordance with the table below.

Communication cable

Listed or R/C cable (CYJV2) with A, B, or D-coded male or female threads, as applicable, for connection to Article 9, M12 plug rated 24 V minimum and 1 A minimum. R/C (AVLV2), marked or specified on the UL Style Page as suitable for external connections, cable rated 28 AWG minimum and 300 V minimum.

Input/output cable

Listed or R/C (CYJV2) cord assembly with threaded male A-coded M12 connector rated 24 V minimum, 4 A minimum. R/C (AVLV2) marked or specified in UL style page as suitable for external interconnection Cord rated 300 V minimum, 20 AWG minimum unless marked with maximum load current and overcurrent protection for the cord in accordance with table below

Cable conductor size, AWG	14	14	16	18	20	22	24	26	28	30
Overcurrent protection maximum amperage [amps]	16	12	8	5.6	5	3	2	1	0.8	0.5
Maximum load [amps]	16	9	8	5.6	4	2.4	1.6	0.8	0.6	0.4

6 Communication interfaces

6.1 Ports and services

This topic lists the network services and ports used by the device. The information helps network planners and cybersecurity professionals understand the device's communication requirements, configure firewalls, and plan secure network architectures.

Those tables show the interfaces and services on OSI Level 2 and OSI Level 3 depending on the configuration of the product, through which the device can be accessed.

Note

Packet filtering
Packets are processed based on their importance for network operation. Due to various security-related packet filters, some packets directed to the CPU of the switch may be discarded. As a result, not all ICMP packets may reach the CPU and therefore may remain unanswered.

6.1.1 General interfaces and services

The following table shows the general interfaces and services that are available on all fieldbuses.

Note

For EtherCAT, these interfaces are also available but tunneled via Ethernet over EtherCAT (EoE).

Table 1: General interfaces and services

Interface[1]	Protocol Type	Transport Protocol & Port	Direction[2]	Port state[3]	Description
Web client - WebUI and REST API	HTTP	TCP/80	IN / OUT	Closed	Access to user interface via username and password. Rate limiting with timeout is implemented.
Web client - WebUI and REST API	HTTPS (SSL/TLS)	TCP/443	IN / OUT	Open	TLS v1.3. Secure transport and access to UI via username and password. Default: self-signed certificate. FW 1.4.0: customer can upload own certificate chain. Rate limiting with timeout is implemented.
SNTP Client	UDP	UDP/123	IN	Closed	Activated via WebUI/REST API when configuring a time server.
MQTT Client	MQTT / MQTTS	OS-dependent (e.g. 1883 / 8883)	OUT	Closed	MQTT or MQTTS with TLS. Broker ports configurable (1883 / 8883 with TLS). Client port chosen by OS. MQTTS should be preferred. Communication is encrypted, but server/broker validation depends on configuration. FW 1.4.0: customer can upload certificates and enable broker validation.

6.1.2 PROFINET

The table below shows the interfaces and services for PROFINET.

1 Interfaces/Services supported by the device
2 Traffic direction relative to the device.
3 **Port state** – Default (factory) state of the port/service. Values are shown as Closed or Open. The suffix (Fixed), as in Open (Fixed), indicates that the open state cannot be disabled.

Table 2: PROFINET interfaces and services

Interface / Service	Protocol Type	Transport Protocol & Port	Direc-tion[Page 32, 2]	Port state[Page 32, 3]	Description
PROFINET RPC Server (PNIO)	UDP	UDP/34964	IN	Open (Fixed)	Main RPC server port. Receives connect/write/read/control calls from IO controller.
PROFINET RPC Server (RPC)	UDP	UDP/49152 (per instance)	IN	Open (Fixed)	Secondary RPC server port for parallel AR connections.
PROFINET RPC Client	UDP	UDP/53248 (0xD000)	OUT	Open (Fixed)	Local UDP binding for outgoing alarm notifications.
SNMP Agent	UDP	UDP/161	IN	Open	Provides MIB-II and LLDP-MIB (IEEE 802.1AB + PROFINET) via SNMP. Required for PROFINET compliance (IEC 61158).
PROFINET RT - Cyclic Data	PROFINET RT	EtherType 0x8892, Frame-ID 0x8000-0xBFFF	IN / OUT	Open (Fixed)	Cyclic I/O data exchange between IO device and IO controller.
PROFINET RTA - Alarms	PROFINET RT	EtherType 0x8892, Frame-ID 0xFC01 / 0xFE01	IN / OUT	Open (Fixed)	Acyclic alarm PDUs (RTA Class 1), raw Ethernet frames.
PROFINET DCP - Configuration	PROFINET DCP	EtherType 0x8892, Frame-ID 0xFEFC-0xFEFF	IN / OUT	Open (Fixed)	Device configuration and diagnostics.
PROFINET LLDP - Topology	LLDP	EtherType 0x88CC	IN / OUT	Open (Fixed)	Topology discovery via LLDP multicast.
PROFINET MRP - Ring Redundancy	MRP	EtherType 0x88E3	IN / OUT	Open (N/A)	Media Redundancy Protocol for ring topologies.
VLAN Tagging	IEEE 802.1Q	EtherType 0x8100	IN / OUT	Open (Fixed)	VLAN tagging required for prioritized PROFINET RT traffic.
ARP / ACD	ARP	EtherType 0x0806	—	Open (Fixed)	Address resolution and collision detection.

6.1.3 EtherNet/IP

The table below shows the interfaces and services for EtherNet/IP.

Table 3: EtherNet/IP interfaces and services

Interface / Service	Protocol Type	Transport Protocol & Port	Direction[Page 32, 2]	Port state[Page 32, 3]	Description
EtherNet/IP Encapsulation (TCP)	CIP	TCP/44818	IN	Open (Fixed)	TCP server for explicit messaging.
EtherNet/IP Encapsulation (UDP)	CIP	UDP/44818	IN	Open (Fixed)	UDP server (broadcast/unicast).
EtherNet/IP I/O	CIP	UDP/2222	IN	Open (Fixed)	Cyclic process data communication.
Ethernet/IP LLDP	LLDP	—	—	N/A	Layer 2 topology discovery.
DHCP Client	UDP	UDP/68	IN	Open	Only active if DHCP mode enabled.
BOOTP	UDP	UDP/68	—	N/A	Only active in BOOTP mode.
ARP / ACD	ARP	EtherType 0x0806	—	Open (Fixed)	Address resolution and collision detection.

6.1.4 Modbus

The table below shows the interfaces and services for Modbus.

Table 4: Modbus interfaces and services

Interface / Service	Protocol Type	Transport Protocol & Port	Direction[Page 32, 2]	Port state[Page 32, 3]	Description
Modbus	TCP	TCP/502	—	Open (Fixed)	Modbus communication.

6.1.5 EtherCAT

The table below shows the interfaces and services for EtherCAT.

Table 5: EtherCAT interfaces and services

Interface / Service	Protocol Type	Transport Protocol & Port	Direction[Page 32, 2]	Port state[Page 32, 3]	Description
EtherCAT (AoE, EoE, CoE, cyclic)	Layer 2	—	—	Open (N/A)	All EtherCAT protocols operate on Layer 2.
EtherCAT	EtherCAT	EtherType 0x88A4	IN / OUT	Open (Fixed)	EtherCAT datagrams. IoT protocols can be tunneled via EoE.

7 Installation and connection

7.1 Preparing for installation

The product is delivered with a default password which is printed on the side of the device. When mounted, the default password is no longer visible.

► Note the default password and store it in a secure location.

7.2 Installation

i Note

For dimensions, (see *Dimensions*).

- Fasten the module with 2 M6 screws and a maximum tightening torque of 3 Nm the mounting holes (see *Device overview*).

7.3 Electrical connection

7.3.1 Requirements for complying with the protection classes

For complying with the protection class (see *Ambient and Environmental conditions*), all plugs and caps must be properly connected and the tightening torque of 0.6 Nm must be observed (see data sheets of connectors and caps).

7.3.2 Power supply

i Note

NOTICE
Unwanted voltage dips
Non-separated electric circuits of the power supplies for sensor and actuator can lead to unwanted voltage dips of the sensor supply when switching actuators.

- Fuse the power supplies for sensors and actuators separately.
- Make sure that the power supply of the device is sufficiently dimensioned to cover start-up and peak currents and design the fuse protection concept accordingly.

i Note

- Power supply of sensor/bus and actuator may only be established via a separate power source.
- The total current for the sensor and actuator supply must not exceed 16 A each.
- The external circuits that are connected to this device must be disconnected from the mains voltage or dangerous voltage by reinforced or double insulation and must satisfy the requirements of SELV/PELV (Class III).
- For UL: Observe cable requirements and power supply requirements (see *UL Requirements*)!

i Note

Only for BNI XG1-505-0A5-R067 : Outputs are supplied via US.
The actuator supply UA is only looped through, nothing on the circuit board is supplied by UA (UA diagnostics are nevertheless available).

7.3.3 Top view of M12 plug (left) and socket (right)

Power IN

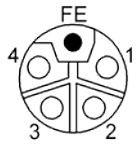


Fig. 1: M12 socket (L-coded, with FE)

Power OUT

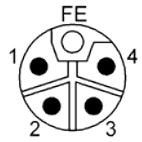


Fig. 2: M12 plug (L-coded, with FE)

7.3.4 Pin assignment

Pin	Signal	BNI XG...-302/505/508-...	BNI XG...-538-...
1	L+ (US+)	Module/sensor supply +24 V	
2	2L− (UA−)	Electrical ground 0 V	Separate power supply (−)
3	L− (US−)		Electrical ground 0 V
4	2L+ (UA+)	Actuator supply +24 V	Separate power supply (+)
5	FE	Functional earth	

Note

Only for BNI XG1-505-0A5-R067 : Outputs are supplied via US.
The actuator supply UA is only looped through, nothing on the circuit board is supplied by UA (UA diagnostics are nevertheless available).

Note

Only for BNI XG5-538-...: Pin 2 and Pin 3 are galvanically separated.

7.3.5 Ethernet interface

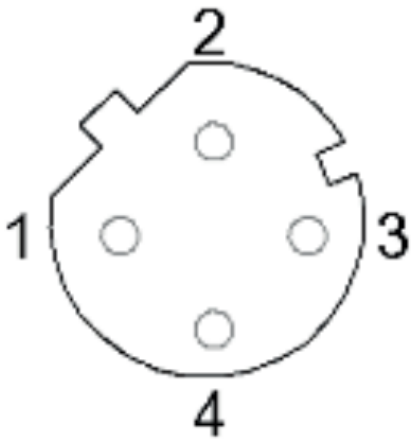


Fig. 3: Top view of M12 socket, D-coded

Pin assignment

Pin	Signal	Description
1	Tx+	Transmit Data +
2	Rx+	Receive Data +
3	Tx−	Transmit Data −
4	Rx−	Receive Data −

7.3.6 I/O-Port

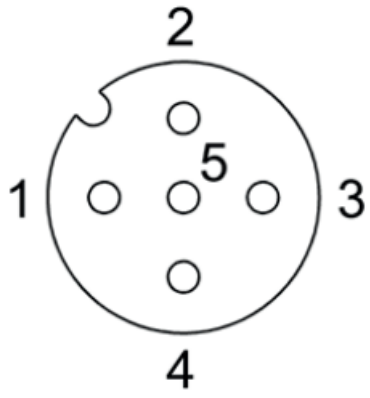


Fig. 4: Top view of M12 socket, A-coded

7.3.7 Pin assignment BNI XG1-505-0A5-R067

Pin	Signal			
	Class A			
1	L+ (US+)	+24 V, 0,5 A		
2	I (DI)	Input		
3	L− (US−)	Electrical ground 0 V		
4	C/Q (SIO/IO-Link)	Input / Output (0,25 A) / IO-Link		
5	n. c.			

7.3.8 Pin assignment BNI XG3-302-...-...

Pin	Signal			
1	L+ (US+)	+24 V, 2 A		
2	I/O (DI/DO)	Input / Output (2 A)		
3	L− (US−)	Electrical ground 0 V		
4	I/O (DI/DO)	Input / Output (2 A)		
5	n. c.			

7.3.9 Pin assignment BNI XG3-508-...-...

Pin	Signal			
	Class A			
1	L+ (US+)	+24 V, 2 A		
2	I/O (DI/DO)	Input / Output (2 A)		
3	L− (US−)	Electrical ground 0 V		
4	C/Q (SIO/IO-Link)	Input / Output (2 A) / IO-Link		
5	n. c.			

7.3.10 Pin assignment BNI XG5-...-...-...

Pin	Signal			
	Class A		Class B	
1	L+ (US+)	+24 V, 2 A	L+ (US+)	+24 V, 2 A
2	I/O (DI/DO)	Input / Output (4 A)[1]	2L+ (UA+)	P24 (4 A)[1,2]
3	L− (US−)	Electrical ground 0 V	L− (US−)	Electrical ground 0 V
4	C/Q (SIO/IO-Link)	Input / Output (2 A)[3] / IO-Link	C/Q (SIO/IO-Link)	Input/Output (2 A)[3] / IO-Link
5	n. c.		2L− (UA−)	N24 (Electrical ground 0 V)

7.3.11 Overview

Variant	I/O-Port	IO-Link Port	
-	-	Class A	Class B
BNI XG1-505-0A5-R067	-	1…8	–
BNI XG3-302-0B5-R067	1…8	–	–
BNI XG3-302-1B5-Z067	1…8	–	–
BNI XG3-508-0B5-R067	–	1…8	–
BNI XG5-508-0B5-P067	–	1…8	–
BNI XG5-508-0B5-R067	–	1…8	–
BNI XG5-538-0B5-R067	–	1…4	5…8
BNI XG5-508-1B5-Z067	–	1…8	–
BNI XG5-508-1B5-Z067-C17	–	1…8	–
BNI XG5-538-1B5-Z067	–	1…4	5…8

Note

- For the digital sensor inputs, see the directive on inputs EN 61131-2, type 3.
- The total current of the outputs must not exceed the total current of the module of 16 A.
- Unused ports must be covered with caps to ensure compliance with the protection class (see *Ambient and Environmental conditions*).
- Daisy chain: If BNI XG5-538-... master and BNI XG3/XG5-302/508-... or BNI XG1-505-... master are used in a line, it must be ensured that the galvanic isolation is removed. BNI XG3/XG5-302/508-... and BNI XG1-505-... masters connect both earth potentials. A BNI XG5-538-... master in the same line is then no longer galvanically electrically supplied!
- **Only for BNI XG1-505-0A5-R067:** All IO-Link outputs are supplied via the sensor voltage (US).
- **Only for BNI XG...-302/508-...** : All outputs are supplied via the actuator supply (UA).
- **Only for BNI XG5-538-...** :
  - If the separate power supply 2L+ is removed, the Class A outputs (Port 1…4) are deactivated.
  - With a separate galvanic supply, the correct reference potential must be used as the input signal, as inputs on pin 2 have a reference to pin 5. If US is used as the input signal, this results in undefined

1 adjustable to 1 A, 2 A, 3 A and 4 A (from FW 1.2) taking into account the total current of 16 A and the maximum total current of 4 A on the electronic ground of a port <
2 with switching option
3 adjustable to 1 A and 2 A (from FW 1.2) taking into account the total current of 16 A and the maximum total current of 4 A on the electronic ground of a port

behavior.
- All outputs on the upper ports (ports 1…4) and the outputs on pin 4 on the lower ports (ports 5…8) are supplied by US. Only the outputs of pin 2 on the lower ports are supplied via UA. In order to emulate the behavior of the 508 master, there is currently a software switch-off of the pin 2 outputs when UA drops out. This behavior is the default but can be changed. See your fieldbus configuration section for details on how to change this.
- The master can also be used without galvanic isolation, in which case it behaves like a 508 master (if the software shutdown is accordingly configured).

Note

Please check whether IO-Link is supported by your module before using this function. For more information on product variants that support IO-Link, see *Supported product variants*.

7.3.12 Grounding

To counteract EMC interference, the functional earth connection must be used.

- Connect the earth terminal to the functional earth (FE) of the machine.

Note

The FE connection between the housing and the machine must have a low impedance and be as short as possible.
► Use the grounding strap included in the scope of delivery (tightening torque: 1.1…1.2 Nm).

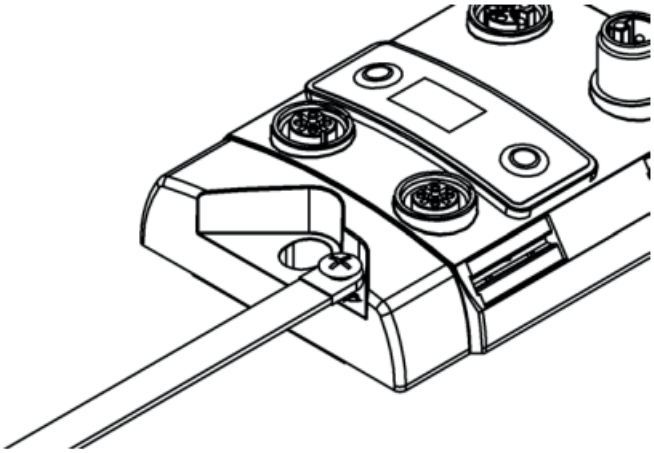


Fig. 5: Ground connection

7.4 Cable routing

7.4.1 Cable length

- The Ethernet cable may be max. 100 meters long.
- The IO-Link cable may be max. 20 meters long.
- The standard IO cable may be max. 30 meters long.
- The power cable cable may be max. 30 meters long.

7.5 Use in combination with safety modules (BNI XG5-538-... only)

These products are remote fieldbus modules with four Class A ports and four Class B ports (per IEC 61131-9).

Note

The Class A ports and Pins 1,3 and 4 on the Class B ports are not suitable for use in safety applications.

7.5.1 Product description

Description	Order code	Class A-Ports	Class B-Ports
BNI XG5-538-0B5-R067	BNI00KJ	4	4
BNI XG5-538-1B5-Z067	BNI00K7	4	4

7.5.2 Port overview and pinning

Class A ports (Ports 0...4)

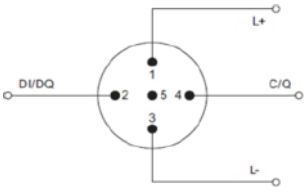


Fig. 6: Connector diagram for Class A ports.

Pinning

- Pin 1: L+ (US+), +24 V, 2 A
- Pin 2: I/O (DI/DO), Input / Output (4 A)
- Pin 3: L− (US−), Electrical ground 0 V
- Pin 4: C/Q (SIO/IO-Link), Input / Output (2 A) / IO-Link
- Pin 5: n. c.

Remarks

In this type, the functions of Pins 2 and 5 are not specified. Pin 2 is usually connected to another digital channel.

Class B ports (Ports 5...7)

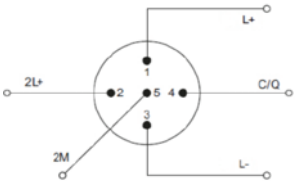


Fig. 7: Connector diagram for Class B ports.

Pinning

- Pin 1: L+ (US+), +24 V, 2 A
- Pin 2: 2L+ (UA+), P24 (4 A)

- Pin 3: L− (US−), Electrical ground 0 V
- Pin 4: C/Q (SIO/IO-Link), Input/Output (2 A) / IO-Link
- Pin 5: 2L− (UA−), N24 (Electrical ground 0 V)

Remarks

This type provides an additional supply voltage and is suitable for connecting devices that have a higher current requirement. Here, Pins 2 and 5 provide an additional galvanically isolated supply voltage.

Note

The pin configuration and diagnostics for devices with Class B properties are identical to the configuration described in these instructions.

By maintaining all the specifications in the corresponding user's guide and safety instructions Pins 2 and 5 of the Class B port on these modules can be safety switched off using a higher level safety logic (e.g. safety relay). The devices are therefore suitable for turning off actuators which are powered solely by these pins for use in safety applications.

7.5.3 Safety function

The safe state of the Class B ports is no voltage on Pins 2 and 5. Turn-off must be done by the higher level safety logic (externally).

The fieldbus modules are constructed internally so that because of fault exclusions (see DIN EN ISO 13849-2) no external voltages can reach the galvanically isolated Pins 2 and 5 on the Class B port. This applies both to the IO-Link interface communication and for the external voltage supplies. The modules do not have their own safety logic or safety diagnostics.

Note

- Turning off actuators over the IO-Link interface is not suitable for safety functions within the safety chain.
- The actuators must be suitable for this type of safe turn-off and must if appropriate also have galvanic isolation.

Accordingly the actuator-voltage supplies must be configured according to the principles of safe (potential-) isolation in order to prevent cross fault (per EN.IEC 60204-1, DIN EN ISO 13849-2). Within the safety chain of the safety application both potentials (24 V and 0 V) of the actuator-voltage supplies must always be isolated using the higher level safety logic.

Note

The use of power supplies other than SELV/PELV can result in a hazard to the user and compromising of the functional safety.

7.5.4 Example of an application description

The safety function of the safe turn-off is implemented for example using the following signal chain: Safe switches/sensors (e.g. E-Stop) – safety logic (e.g. safety relay – fieldbus module with Class B ports – actuator(s). All elements must be suitable for use in the implemented safety function.

When the safe switch/sensor (e.g. E-Stop) is actuated, Pins 2 and 5 on the Class B ports are safely isolated from the supply voltage (two-pin) by the safety logic and switched potential-free.

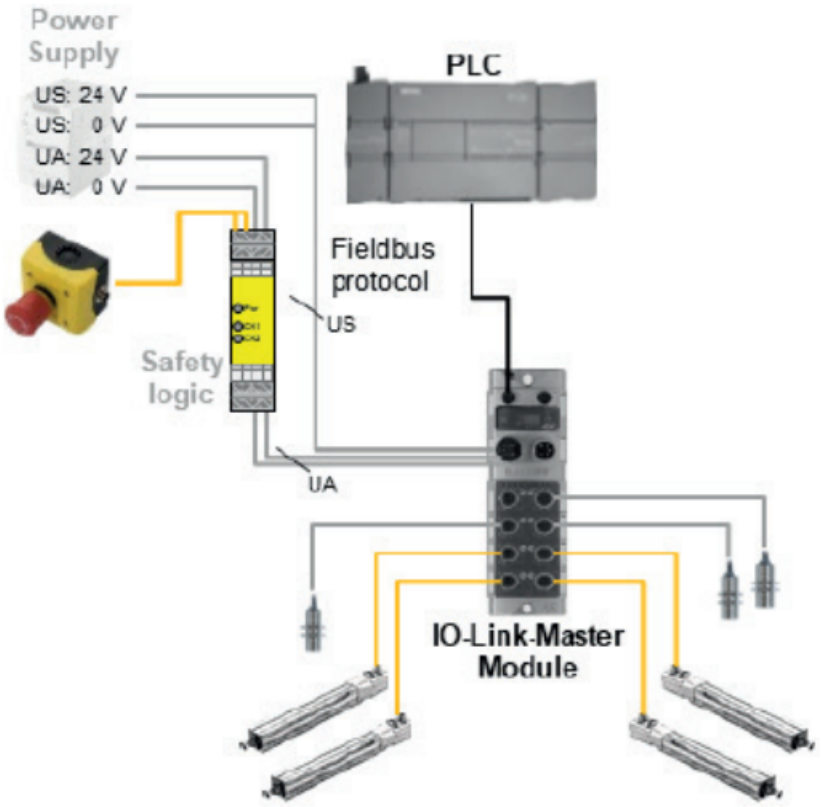


Fig. 8: Schematic diagram of safety chain

The voltage supplies US/UA provide power to the Class A and Class B ports of the module galvanically isolated and independent of each other:

7.5.5 Segment assignment for the voltage supplies

Description	Order code	Signal	Class A Port 1, 2, 3, 4	Class B Port 5, 6, 7, 8
BNI XG5-538-0B5-R067 / BNI XG5-538-1B5-Z067	BNI00KJ / BNI00K7	US (24 V/GND)	Pins 1, 3 Pins 2, 4[4]	Pins 1, 3, 4
		UA (P24/N24)		Pins 2, 5

7.5.6 Inspections

The inspection interval for the function test of the safety function to be documented turning off the actuator-voltage(s) depends on the requirements for the safety function of the higher level system, but must be performed no later than every 12 months.

Note

It is recommended that the inspection be automatically carried out by the higher level system. If this is not possible, we recommend automatically providing the user with a reminder for the inspection. If this is not possible either, performance of the inspection must be specified in the process instructions for the higher level system.

4 When UA is turned off the Class A outputs are also deactivated via software (not safe).

8 Startup and operation

8.1 Startup

DANGER

Uncontrolled system movement
When starting up, if the network module is part of a closed loop system whose parameters have not yet been set, the system may perform uncontrolled movements. This could result in personal injury and equipment damage.
Please mind the following safety instructions:

- Persons must keep away from the system's hazardous zones.
- Startup must be performed only by trained technical personnel.
- Observe the safety instructions of the equipment or system manufacturer.

To start up the system, proceed as follows:

1. Check connections for tightness and correct polarity. Replace damaged connections.
2. Turn on the system.

Note

Check for the correct values, especially after replacing the BNI or after repair by the manufacturer.

8.1.1 Autodetect Mode

Note

Default in Fieldbus protocol: Autodetect.

Search fieldbus

As soon as the network module is initialized, it starts in autodetect mode and searches for the connected fieldbus system.

The outer port/pin LEDs light up in sequence.

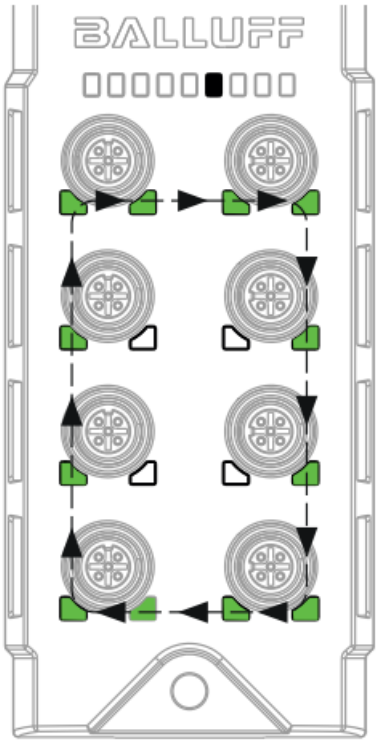


Fig. 1: Search fieldbus

Fieldbus system detected

If the fieldbus system is detected, the port/pin LEDs in a row light up green for 10 seconds. If no field bus is detected, the default address is used.

Row	Port/Pin-LEDs of the Ports	Meaning
1	1/2	Profinet
2	3/4	Ethernet/IP
3	5/6	EtherCAT
4	7/8	Modbus/TCP

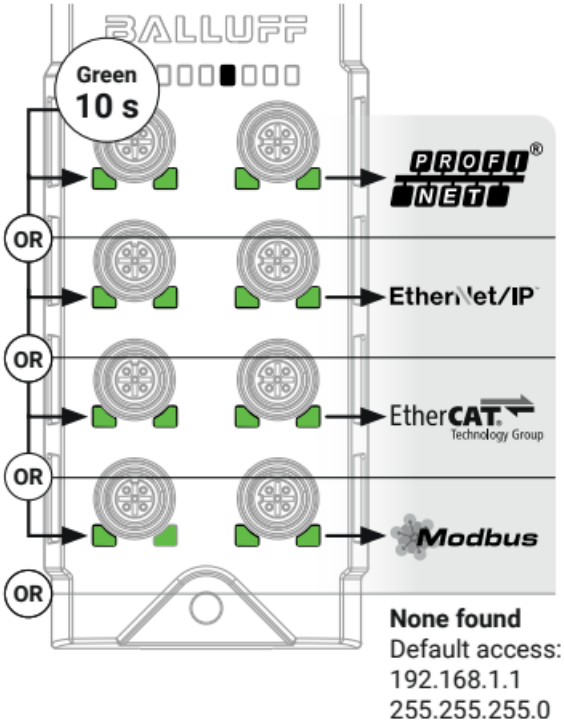


Fig. 2: Fieldbus system detected

Note

For additional information, see Configuration guide at **www.balluff.de** on the product page.

8.1.2 Recovery Mode

In certain situations, standard configuration methods (e.g., WebUI, BET) may be inaccessible due to the following reasons:

- The device is locked because the password has been forgotten.
- The EtherCAT protocol has been selected on a device without a display, and the device must be reverted to standard Ethernet operation.
- The IP configuration has been lost or is unknown and must be restored to default settings.

In such cases, performing a factory reset is required. As the device is not equipped with a physical push button, the procedure described below must be followed to restore the factory settings.

Before you begin

Make sure that:

- The device is powered off before starting the recovery sequence.
- You have access to a power supply that can provide 6 V ±0.5 V.
- The device is connected through an ethernet cable to a computer.

Steps

To restore the factory settings via Recovery Mode:

1. Power the device with 6 V ±0.5 V at startup for about 30 seconds.

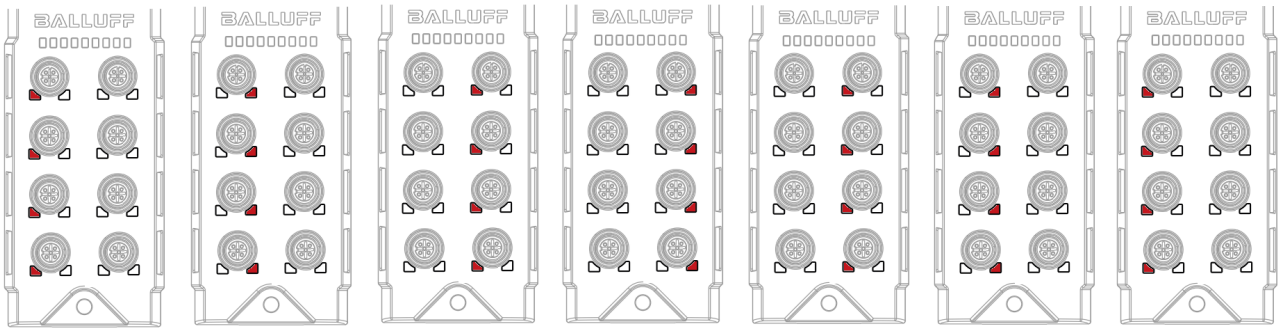


Fig. 3: Recovery Mode Activated

⇒ Recovery Mode is indicated by a left-to-right running light sequence on the port LEDs, illuminated in red.

2. Open a web browser and go to the device's fixed IP address, **192.168.1.1** (SubNetMask **255.255.255.0**).

   The webserver provides exactly one page showing the factory reset option.

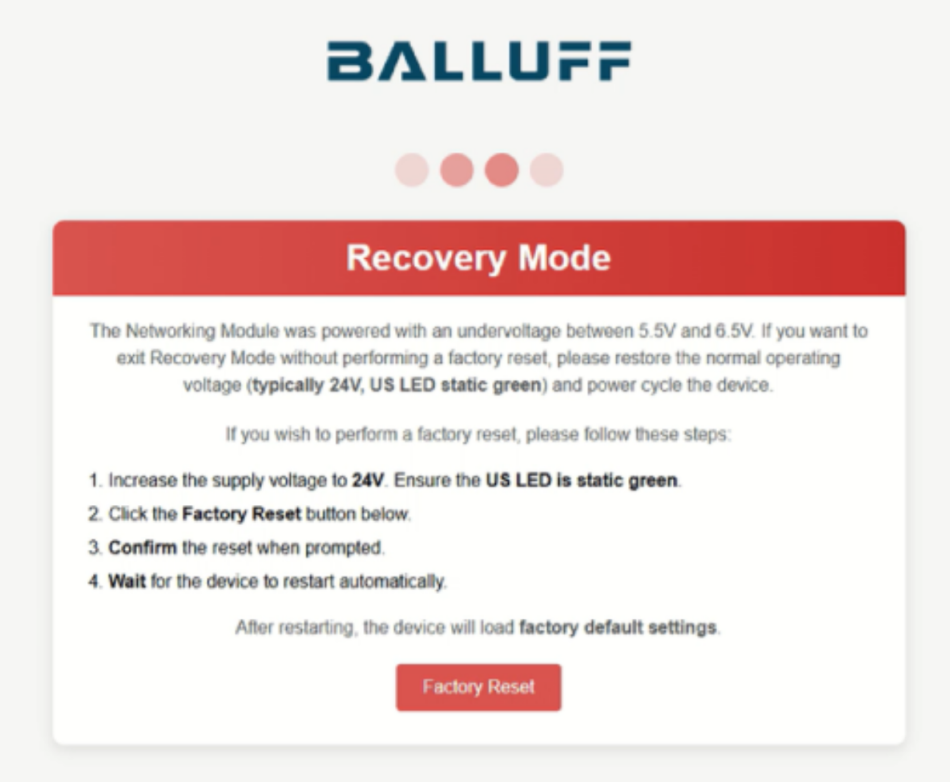


Fig. 4: Recovery Mode Web UI

> **Note**
>
> Although the Web UI text advises using an adjustable power supply, a fixed 6 Volt supply together with a separate 24 Volt supply is also a viable alternative. Its step "1. Increase the supply voltage…" is not required — skip it and continue with the next step.

3. Click *Factory Reset*.



Fig. 5: Recovery Mode Confirmation

⇒ A dialog opens, asking to confirm the factory reset.

4. Confirm the dialog.

CAUTION

All data will be lost
All settings and configurations will be set to their factory default values.

⇒ The factory reset is executed and the device reboots.

5. After the reboot, power the device again with nominal voltage (24 Volt) and restart it with a power cycle.

⇒ The device is now operating with IP address **192.168.1.1** in autodetect mode.

8.2 Operation

CAUTION

Danger of burns from hot surfaces
The housing heats up under normal operating conditions.
There is a risk of burn injuries.
- Avoid direct skin contact with the surface.

8.2.1 Operating notes

- Regularly check function of the BNI and all associated components.
- Take the BNI IO-Link master out of service whenever there is a malfunction.
- Regularly check for available firmware and security updates.
- Regularly review user accounts, access permissions and security-related settings.
- Secure the system against unauthorized use.
- Check fasteners and retighten if needed.

8.3 Cleaning

Note

For UL requirements, *UL Requirements*.

The product may only be cleaned when switched off.

Note

Only for BNI XG5-508-0B5-P067:
The product can be cleaned in a washdown process and is resistant to numerous alkaline, neutral and acidic cleaning media based on peroxyacids and amines with and without chlorine for the food and beverage industry.

For cleaning with Topactive OKTO, a maximum concentration of 1% is recommended. Higher concentrations may cause discoloration of the potting compound on the rear side of the device.
For further information, see ECOLAB certificate at **www.balluff.com** on the product page.

8.4 Maintenance

The product is maintenance-free.

Depending on the operating conditions, it may be necessary to regularly check and, if necessary, retighten the tightening torques of the plugs and caps to maintain the protection classes (see *Electrical connection*).

9 Configuration

9.1 Before you begin

To operate the device in a cybersecure environment, take the following measures before commissioning:

- ► Change default user and add a strong password. Secure the password in a safe location.
- ► Check if the device is running the latest firmware version. If not, update the firmware to the latest version that fits your needs.

9.2 General settings

- *Display* (general network settings)
- *WebUI/web interface* (network- and port configuration, IIoT, Firmware Update)

9.3 Fieldbus integration

The following configuration guides are available for the supported fieldbus protocols:

- *Protocols*
- *PROFINET Module Basics*
- *Ethernet/IP integration*
- *EtherCAT configuration*
- *Modbus/TCP configuration*
- *Display*
- *WebUI/web interface*

9.4 IIoT integration

The following configuration guides are available for the supported IIoT protocols:

- *OPC-UA integration*

9.5 Terminology, acronyms

- *Terminology*

9.6 Post-commissioning measures

In order to maintain a secure environment, take the following measures after commissioning:

- ► Create a backup of the device configuration and store it in a secure location.

9.7 Display

9.7.1 General

With the installed display the address is displayed directly on the devices.

Note

This chapter applies solely to device variants with display.

The following address types are possible:

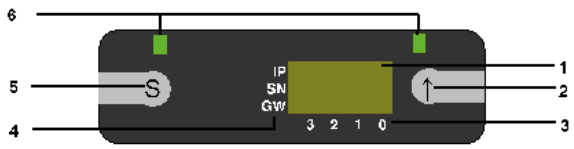
- IP address
- Subnet mask
- Gateway address

Each address consists of 4 octets.

The display also shows information about the update of the hardware and firmware.

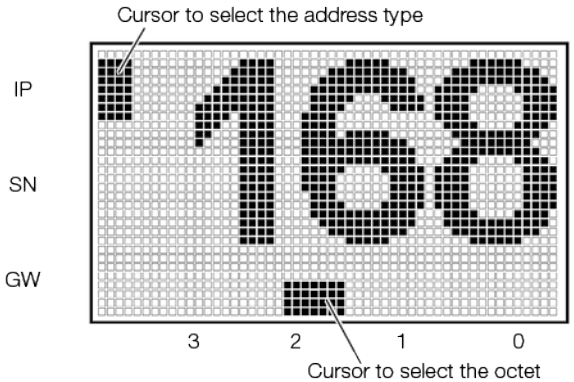
The display has a lock function which can be activated from the system control. Editing is no longer possible if the lock is set.

9.7.2 Control and display



1	Display
2	Arrow button
3	Octet cursor
4	Address type cursor
5	Set button
6	LEDs

9.7.3 Display information



IP:	IP address	3	First octet
SN:	Subnet address	2	Second octet
GW:	Gateway address	1	Third octet
		0	Fourth octet

9.7.4 Design and symbols

In the following diagrams, a number of symbols are used to describe the display functionality:

Table 1: Explanation of symbols

Symbol	Meaning
	Current state
	Switch
	Press the Set button briefly
	Press the Set button for several seconds (≥ 3 s)
	Press the arrow button briefly

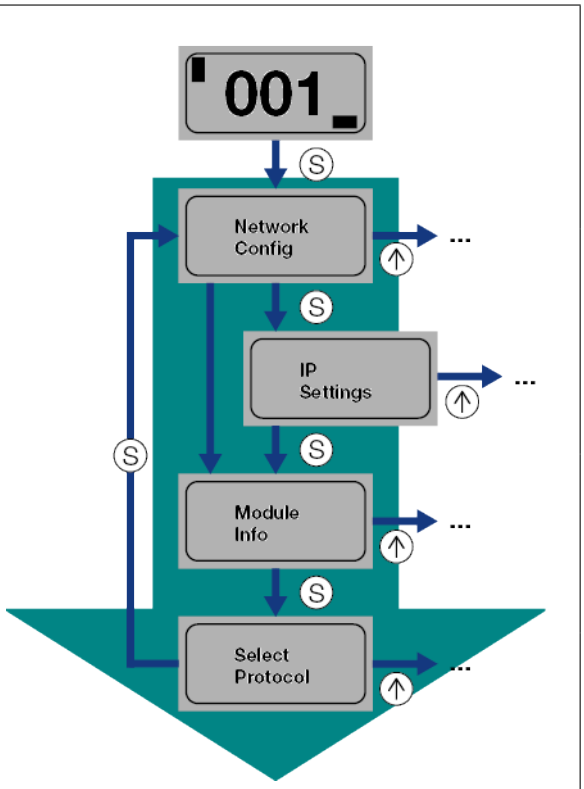
9.7.5 Startup sequence

Table 2: Startup sequence

Sequence step	Displayed information	Description
1	Module Name	
2	Hardware Version	
3	Firmware Version	
4	Selected Protocol	
5	4th octet of IP address (for ECT: Station Alias)	

9.7.6 Main menu

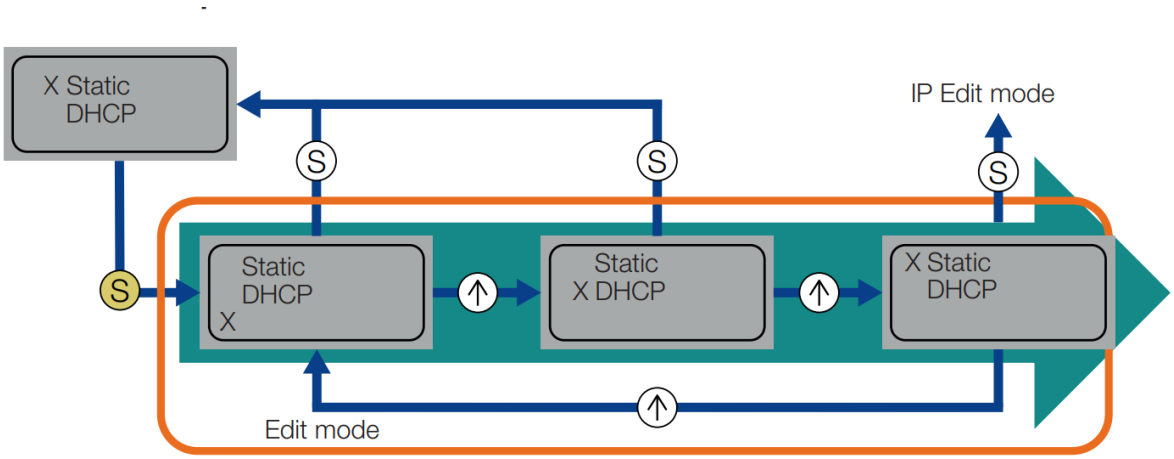
Table 3: Main menu

Standard view 4th octet of the IP address	
Menu: Network Config	
Menu: IP Settings[1]	
Menu: Module İnformation	

To navigate the main menu:

- Press the Set button briefly to scroll through the main menu.
- Press the arrow button to bring up the menu.

9.7.7 IP Setup



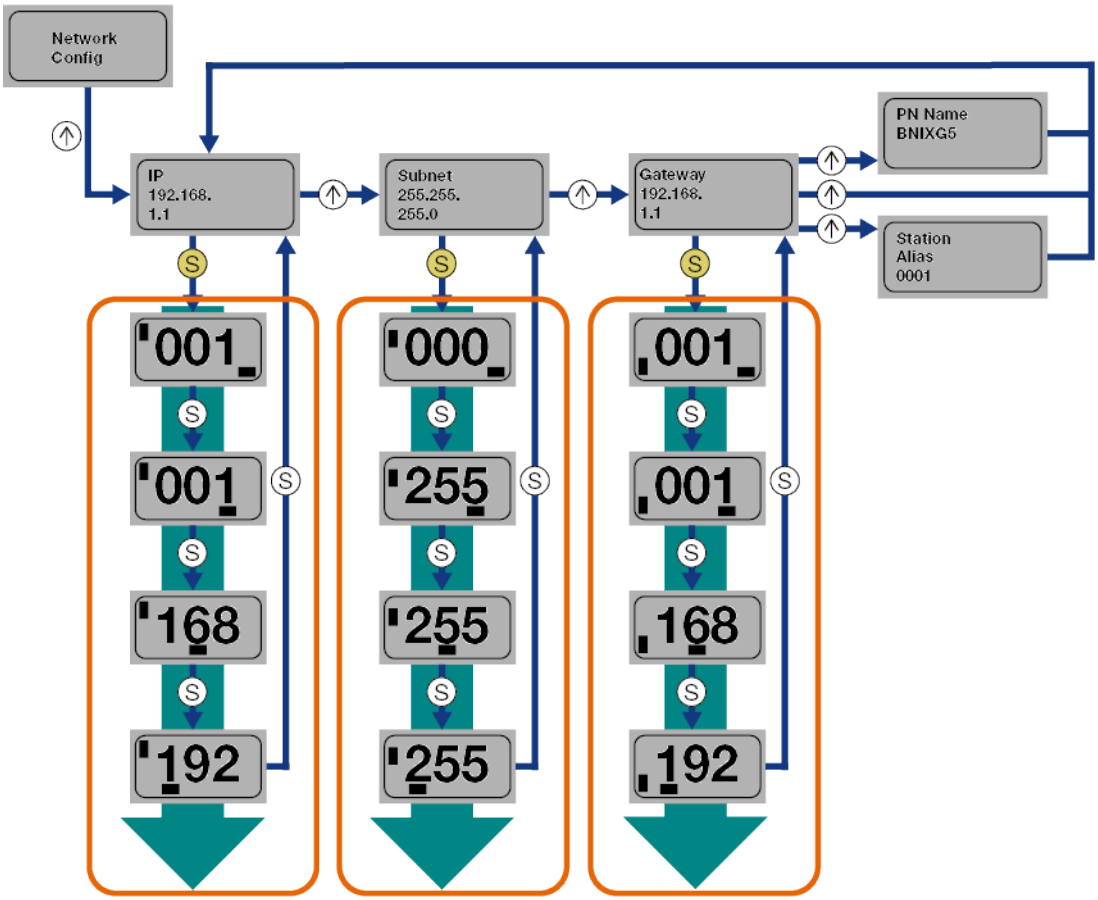
To navigate the IP Setup menu:

- Press the Set button for several seconds to bring up Edit mode.

1 only available for Ethernet/IP

- Press the arrow button briefly to configure the preferred value.

9.7.8 Network Config



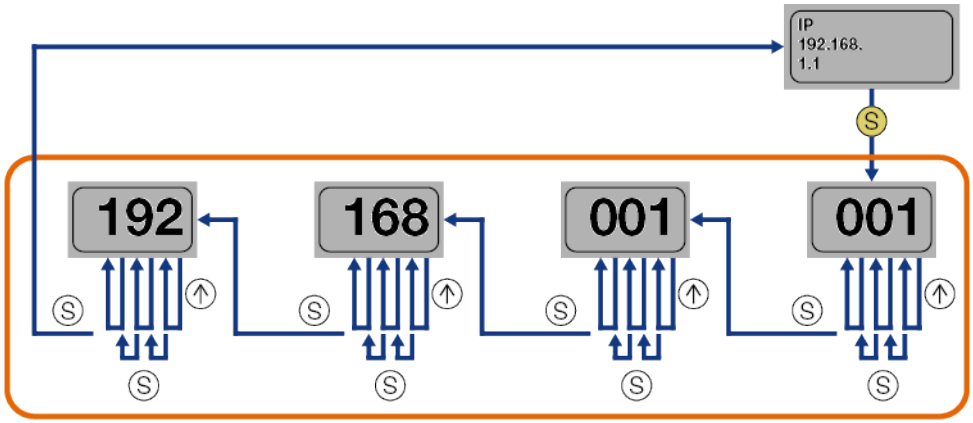
Note

- The *PN Name* setting is only available for Profinet.
- The *Station Alias* setting is only available for EtherCAT.

To navigate the Network Config menu:

- Press the Set button for several seconds to bring up Edit mode.
- Press the arrow button briefly to configure the preferred value.
- Press the arrow button for several seconds to bring up the Quick Program mode.
- Press the Set button briefly to save the value entered and scroll to the next octet. The 4th octet marks the start of the editing process.
- Press the Set button briefly to save the full address entered when editing the first octet. The entered value appears immediately on the IP overview display.
- Manual changes to IP, subnet or gateway lead to an automatic change of the IP Setup to static.

9.7.9 Edit mode



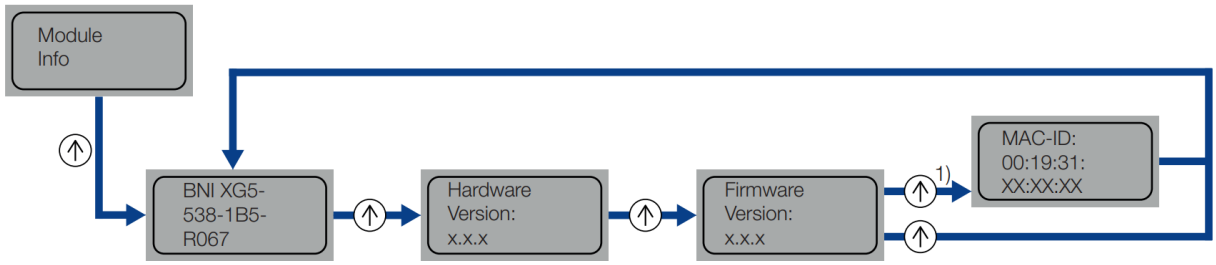
To navigate in Edit mode:

- In the Network Config menu select IP/subnet or gateway address.
- Hold down the Set button to change to Edit mode.
- Press the arrow button briefly to change the number.
- Briefly press the Set button to go to the next position.
- After the last position briefly press the Set button to go to the next octet of the address or to apply the new number after the last octet.

Note

The module must be restarted to work with the new configuration.

9.7.10 Module information



Note

The *MAC-ID* information is not available for EtherCAT.

To navigate the Module Information menu:

- Press the arrow button briefly to scroll through the *Module Information* menu.

The information displayed is the product name, module updates and MacID.

9.7.11 Select protocol in the display

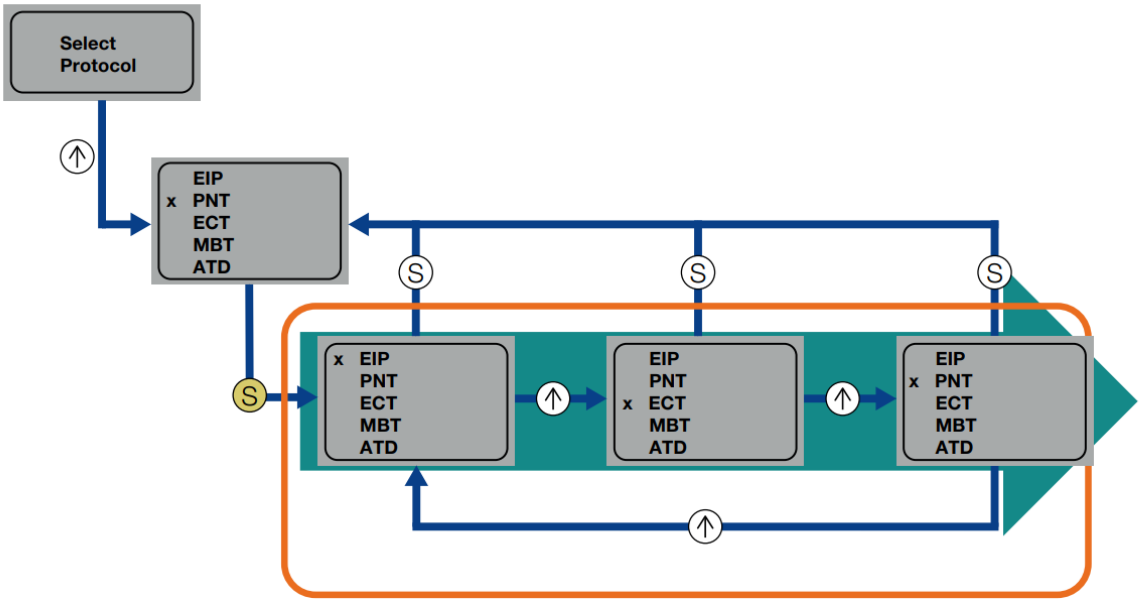


Fig. 1: Select protocol in the display

- Press the Set button for several seconds to activate Edit mode.
- Press the arrow button to adjust the selection.
- Press the Set button briefly to confirm the current selection.

The current network protocol set is displayed for information.

9.7.12 General information

- Hold down the arrow button to scroll quickly in Edit mode.
- If no button is pressed for more than 10 seconds, the display returns to the standard display (4th octet of the IP address). Unsaved changes may be lost.
- Differences between the new configuration and the configuration with which the module works are displayed with an unequal symbol. In this case the display returns to the standard display after 5 seconds.
- The display flashes in Edit mode. The display flickers in Fast Scroll mode.
- The LED function of the display LEDs can be defined specific to the user by setting several bits in the process data outputs (see bit layout in *Standard output data*).
- The plc-lock function can also be used by setting a bit in the process data outputs (see bit layout in *Standard output data*).

Note

Edit mode cannot be selected in the display if in the process data inputs the plc-lock is set by a bit (see bit layout in Standard output data).

9.8 WebUI/web interface

9.8.1 General

The network module includes an integrated web interface for accessing detailed device information and for configuration.

Prerequisites

To use this web interface, it must be ensured that the module has been integrated in the network correctly. To do this, the IP subnet of the network module must be accessible from the PC on which the browser is being operated.

Browser

The web interface is compatible with newer versions of Google Chrome, Firefox or MS Edge.

Note

For more detailed version information, see the data sheet at www.balluff.com on the product page.

Connection setup

- To establish a connection with the web interface, enter the IP address of the BNI module in the browser's address bar.
  ⇒ WebUI starts with the homepage, which displays the most important device information (see *Homepage*).

9.8.2 Navigation bar

In the top window area, there is a navigation bar which enables you to switch between the different dialogs of the web interface by clicking on the corresponding icons:

- Homepage (see *Homepage*)
- Condition monitoring (see *Condition Monitoring*)
- Diagnosis (see *Diagnosis*)
- Settings (see *Settings*)
- Notifications (see *Notifications*)
- User menu (see *User profile*)

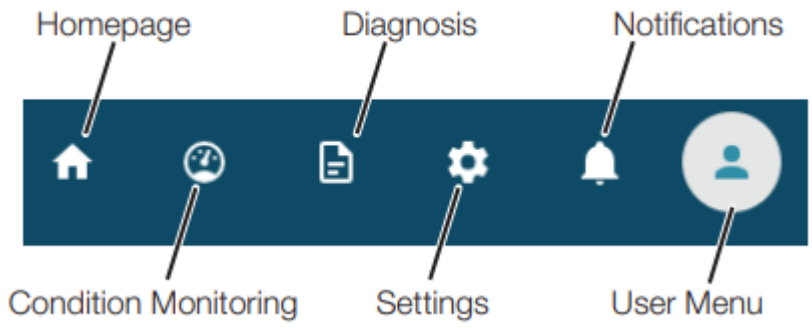


Fig. 2: Navigation bar

Note

Hover the mouse over the different icons to see the corresponding names.

9.8.3 User profile

Click on the user icon



to open a user menu:

- Select *Help* to view device-specific information and documents (see chapter *Information/documents*).
- Select the national flag/language to make a language selection (see chapter *Language selection*).
- With *Login* a user logs in (see *Logging in and logging out*).

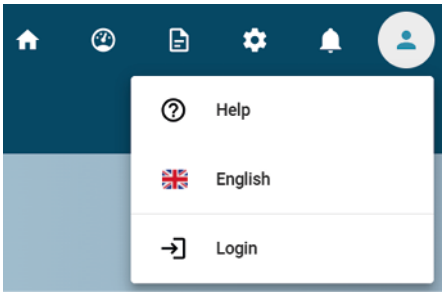


Fig. 3: User menu (not logged in)

When logged in, users with the *ADMIN* role can also see the user management (see *User menu (logged in)*).

Users with the *EXPERT* or *USER* role will see the entry *Edit profile* here instead, through which the respective profile can be viewed and, if relevant, edited.

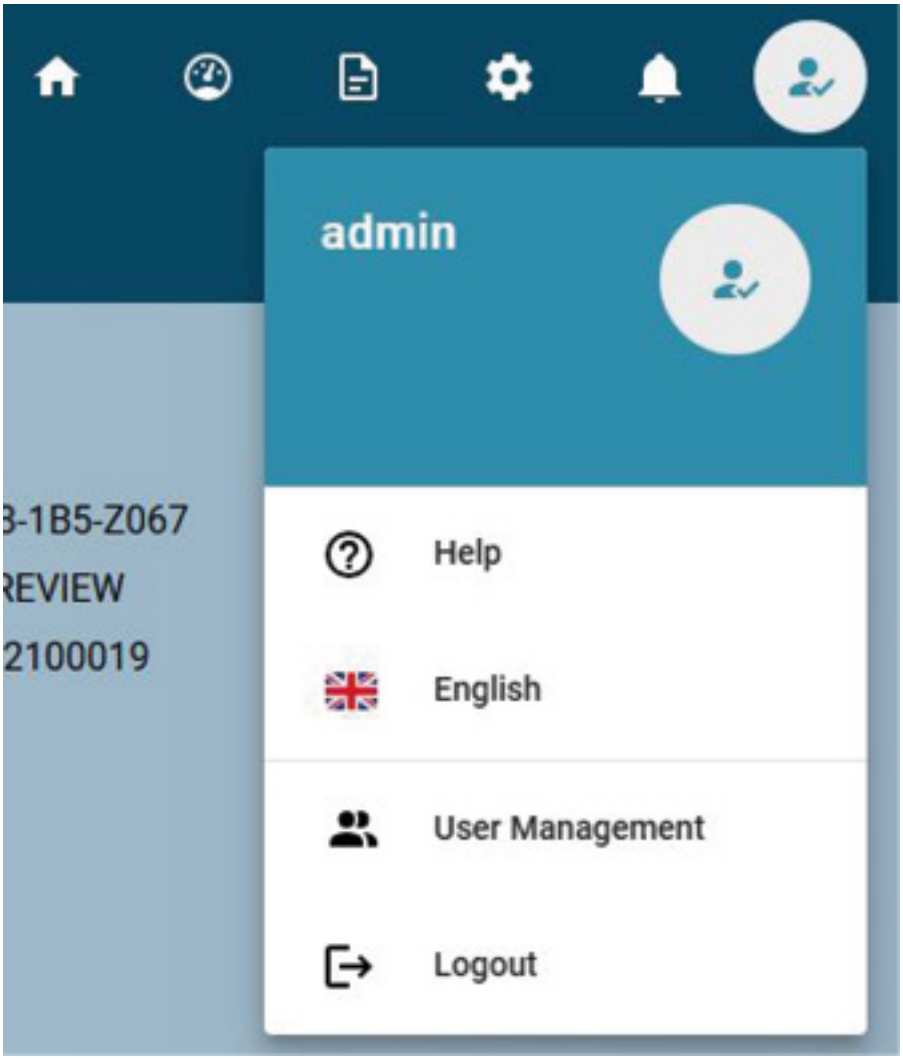


Fig. 4: User menu (logged in)

Information/documents

Click on *Help* > *About* to view device-specific information and documents.

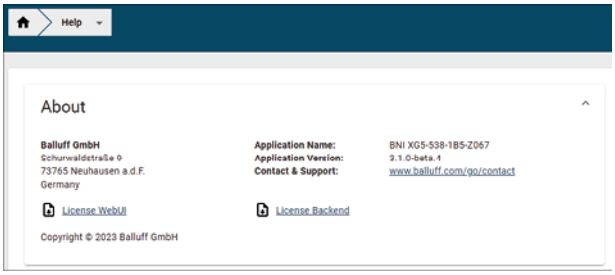


Fig. 5: User menu: *Help* > *About*

Use the dropdown menu under *Online documents* to select different online documents, such as manuals, and click on them to open in a new window.

Language selection

The languages German and English are supported. Click on the language German or English to select the language.

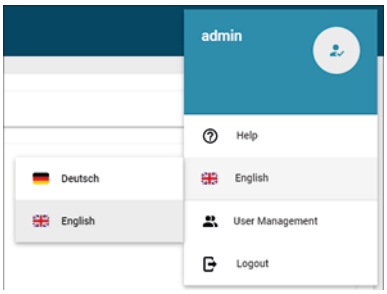


Fig. 6: User menu: *Language selection*

User Management (ADMIN)

Select *User Management* to open a view of the stored users. Information on the user status (*active*/*inactive*), the user name, user information, password and its confirmation in hidden view, as well as the user's role is specified.

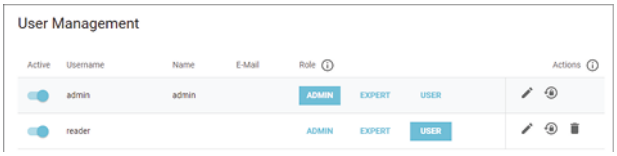


Fig. 7: User Management

Authorizations are role-dependent:

Table 4: User rights

Authorization	ADMIN	EXPERT	USER
Read device parameters	X	X	X
Write device parameters	X	X	–
Adding users	X	–	–
Deleting users	X	–	–

Click on the pen icon to edit fields and buttons.



Fig. 8: Pen icon

Click on the information icon in the password field to open a dialog box and view the requirements for a secure password.



A user with the *ADMIN* role can delete users with the *EXPERT* or *USER* role by clicking on the recycle bin icon.

Note

The default user *admin* can only be deleted if another user with *admin* rights exists.

Click on + (*Add new user*) to add new users and confirm with



after entering the corresponding information.

Edit profile (EXPERT/USER)

Users with the *EXPERT* or *USER* role can view and, if relevant, change their profile via *Edit profile*. Only the relevant profile is displayed. *EXPERTs* and *USERs* can only change their own user information as well as their own password, but not their role or name. *EXPERTs* and *USERs* cannot make any profile deletions.

Logging in and logging out

Note

Several PCs can access the network module with read access at the same time (without login). However, parallel accesses can result in response delays.

To make configuration settings on the network module via the web interface, you must first log in with the *EXPERT* or *ADMIN* role. Logging in with the *USER* role activates further dialogs in view-only mode. The user icon indicates the current status.

Table 5: User icon

Not logged in	Logged in
	

Login

1. Login (see *User menu (not logged in)*) opens the login dialog.

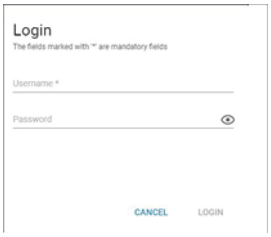


Fig. 9: Login dialog

2. Enter the login details and click on *LOGIN*.

Note

Logging in is required when notifications request it or when selecting functionalities that cannot be used without logging in.

Each device has its own default password for the *admin* user. It is printed on the side of the device and is only used for the first login, or it is required when the network module is reset to factory settings.

As soon as the password for the *admin* user is changed, it is no longer possible to log in with the printed default password.

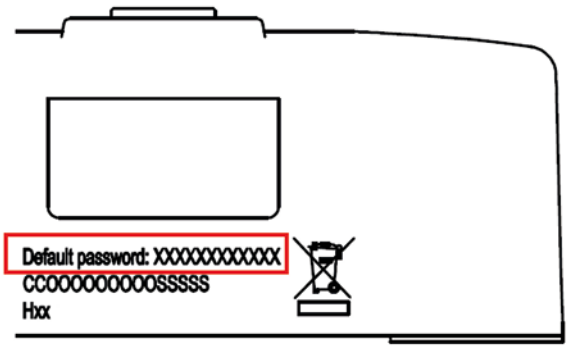


Fig. 10: Default password on the side of the device (example)

Note

On a new device it is possible to log on within 60 minutes after the device starts with the *admin* user and a random or blank password if no login has already been carried out on the new device.

Log out

- Log out with *Logout* (see *User menu: Language selection*).

  Note

  If there is no interaction with the WebUI for more than five minutes, the user will be logged out automatically.

9.8.4 Homepage

The homepage shows information about the network module itself and its network activity. It also shows whether the configuration lock has been activated via the control unit (PLC).



Fig. 11: WebUI – Homepage

Port overview/configuration

Note

Please check whether IO-Link is supported by your module before using this function. For more information on product variants that support IO-Link, see *Supported product variants*.

If an IO-Link device is connected to one of the configured IO-Link ports, the module data at the ports and the device data are displayed in buttons on the left-hand side of the figure. After one of these buttons is selected, the corresponding port dialog opens. The default value of the displayed DeviceAlias is adapted to the labeling on the front.
The port numbering always starts at 1, even if the labeling on the front has a different port designation depending on the product variant. This is due to the relevant definition of port numbering in the IO-Link specification and the IO-Link/JSON specification (JSON Integration for IO-Link, Karlsruhe, 2020). The designation of the front label is reflected in the process data layout as well as in the description file (GSD).

Device Status

Note

Please check whether IO-Link is supported by your module before using this function. For more information on product variants that support IO-Link, see *Supported product variants*.

Some devices (including from external providers) supply the device status defined in the IO-Link Spec. In this case, it is displayed on the home screen. On the homepage, details can be called up by clicking on the icon in the port (see Fig. 8-13). Products that do not supply the device status show a gray control box here.

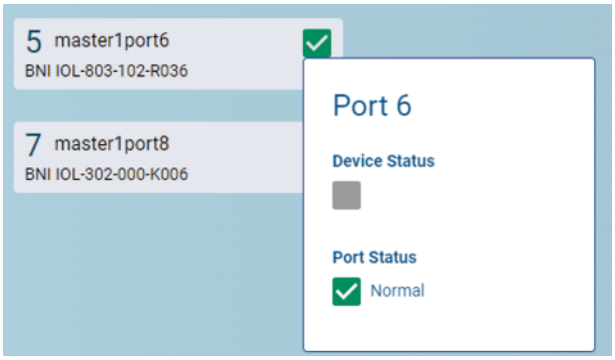


Fig. 12: Device Status

Opening the port dialog

- Click on the corresponding port field to select the desired IO-Link Port.

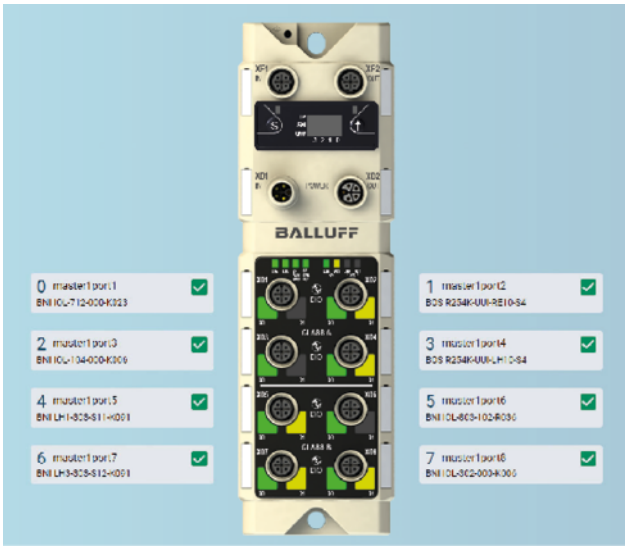


Fig. 13: Selecting the IO-Link port in the breadcrumb

- Alternatively, select the target port via the breadcrumb navigation in the header.

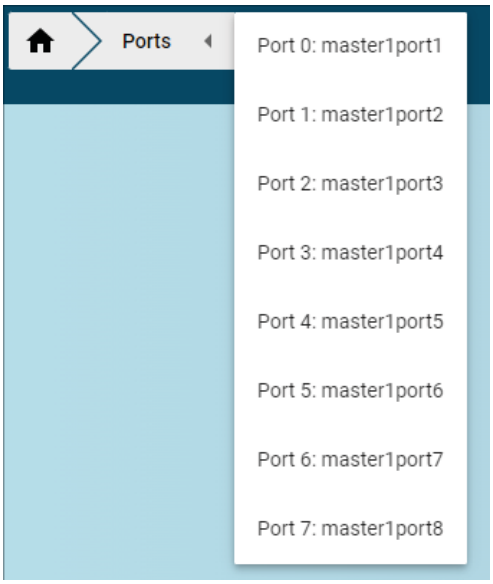


Fig. 14: Selecting the IO-Link port in the breadcrumb navigation

Note

The IO-Link device data is only displayed if the port is configured as an IO-Link port (can be identified by the green port LED).

Ports dialog

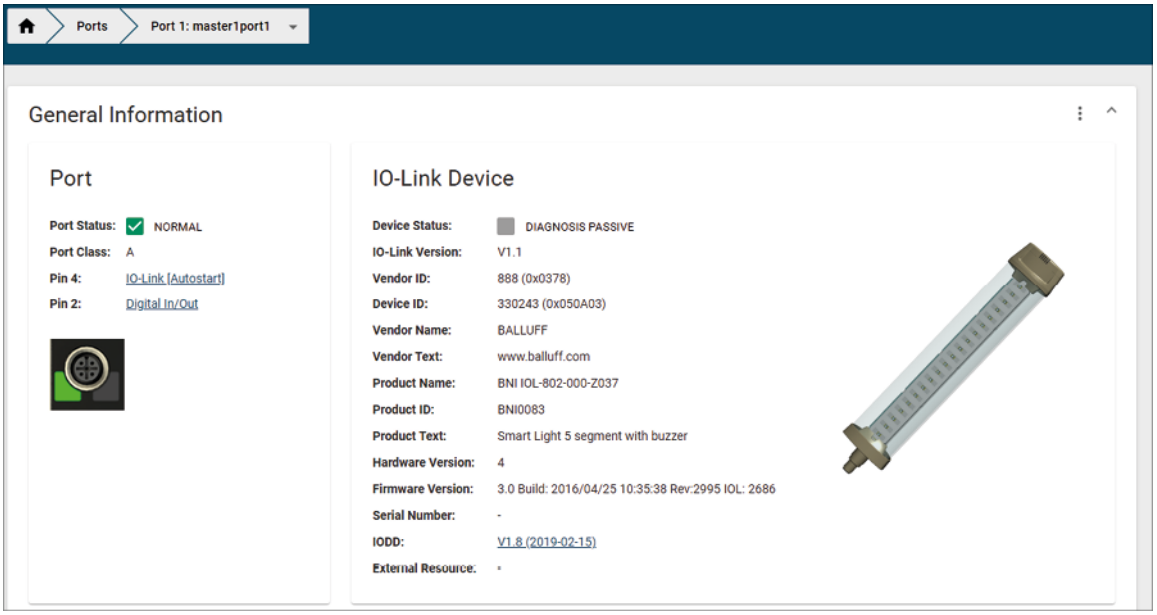


Fig. 15: Ports dialog

Click on the expand symbol of a closed tab page to view e.g. information on relevant ISDU parameters. Information that is not currently required can be hidden by clicking on the collapse symbol .

General Information

Under *General Information*, you can find manufacturer information as well as other general information on the current module. Under *IODD*, you can see whether a suitable IODD for the IO-Link device connected to this port is uploaded to the network module.



Fig. 16: IODD

If this is not the case, click on *Upload IODD* to access the *Settings* tab page. Based on the connected IO-Link devices, the corresponding device description can be selected for upload.

Note

Please check whether IO-Link is supported by your module before using this function. For more information on product variants that support IO-Link, see *Supported product variants*.

Process data

Under *Process Data*, interpreted data is only shown if a suitable IODD is saved. To display the data more clearly, information from the device's IODD is used here. So, in *IODD Interpretation*, you can see not only the input data of the example sensor as a hexadecimal number, but also interpreted under *Input* and provided with corresponding labels from the IODD.

In the *Set process data area*, the output process data of an IO-Link device can be set manually. The *Validity Qualifier* can be used to specify whether the process data should be marked as valid or invalid (PD valid).

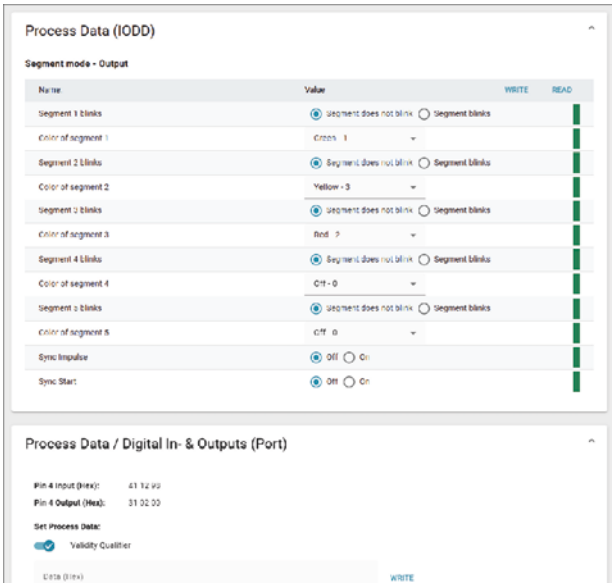


Fig. 17: IODD Interpretation

Parameter (IODD)

Note

Please check whether IO-Link is supported by your module before using this function. For more information on product variants that support IO-Link, see *Supported product variants*.

Note

The Parameter (ISDU) tab page is only displayed if a suitable IODD is uploaded for the IO-Link device connected to the selected port. *Upload IODD* , see *General Information*.

Under *Parameter (IODD)*, the device identification data of the IO-Link device is displayed in a table when the *Identification* tab page is selected (e.g. *Dialog view after clicking on Read all or, for each subindex, on Read*). The corresponding texts are saved in the IODD.

The input values can either be read out from the IO-Link device individually for a subindex by clicking on *Read* or for the entire tab page via *Read all*. A successful request is indicated by a green bar on the right-hand edge of the relevant table row.

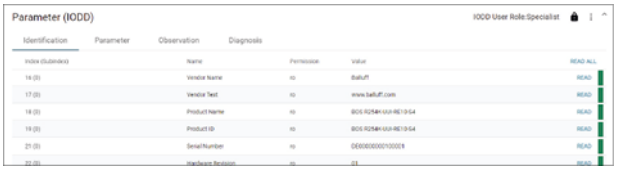


Fig. 18: Dialog view after clicking on Read all or, for each subindex, on Read

The *Application Specific Tag* is an application-specific field in IO-Link devices and, in the current example (see *Application Specific Tag*), can either be read out from the IO-Link device with *Read* or can be individually configured by clicking on the gray input field with the same name and described with *Write* (provided the required write authorization exists). It is also possible to enter a company-internal device name in this field.



Fig. 19: Application Specific Tag

If the IODD of the IO-Link device at the currently selected port also has parameters, these are also displayed in the form of a table (see *Ports dialog figure*). Similarly to the process for device identification data, parameter values and associated texts from the saved IODD can be configured, depending on the parameter, via *Read* or *Read all*.

If available, click on the icon to open a dropdown list and select a value or select a value within a specific range and confirm with *Write*.

If there is no *Read* button next to subindices, these indices cannot be processed individually, but only as a complete index.

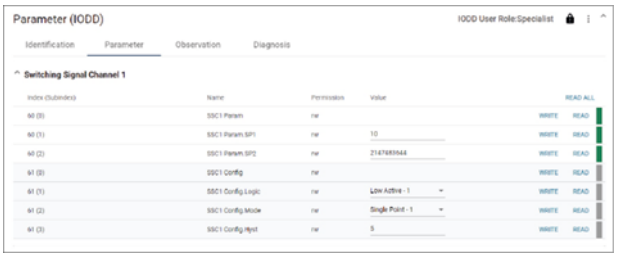


Fig. 20: *Ports* dialog: Extract from the parameter list of an IO-Link device with uploaded IODD after clicking on *Read all* or *Read* for individual subindices

Note

Each changed value must be written individually by clicking on Write !

ISDU Parameter

Note

Please check whether IO-Link is supported by your module before using this function. For more information on product variants that support IO-Link, see *Supported product variants*.

Configuration parameters of the IO-Link device can be read and written via the *ISDU Parameter* option. The parameter indices and subindices of the IO-Link device follow the IO-Link conventions and are described in the corresponding user's guide.

Parameter indices and subindices can be entered both in decimal and hexadecimal format, while data can only be entered in hexadecimal format.

An input is confirmed with *Set* or can be rejected with *Delete*.

Events

Under *Events*, you can see whether there is a diagnosis event from the IO-Link device.

The events can be displayed in ascending or descending order. The list of events can be updated via further options of the *Events* card or can be downloaded in CSV format.

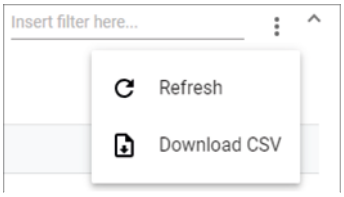


Fig. 21: Further options of the *Events* tab page

LEDs

The LEDs of the network module display information on the current process data and the module status. The meanings of the LEDs can be viewed in a legend.

Opening the LED legend

- At the *LED legend*, click on *OPEN*.

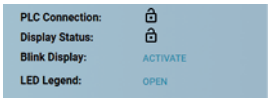


Fig. 22: Opening the LED legend

⇒ The legend appears.

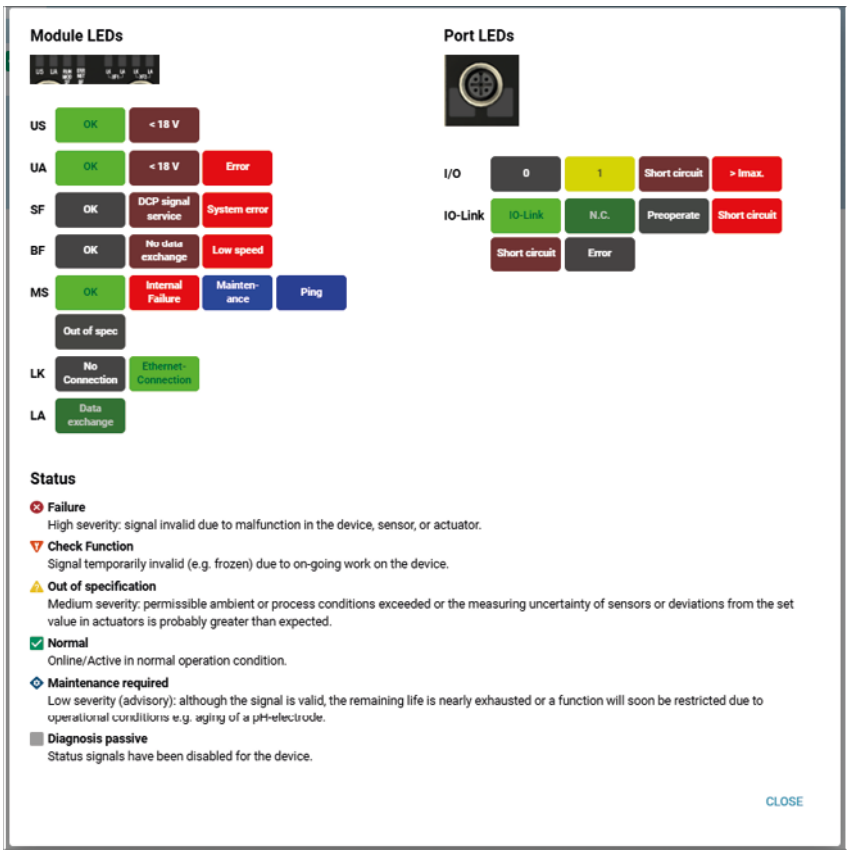


Fig. 23: LED legend

9.8.5 Condition Monitoring

Note

This function is only available for XG5 devices.

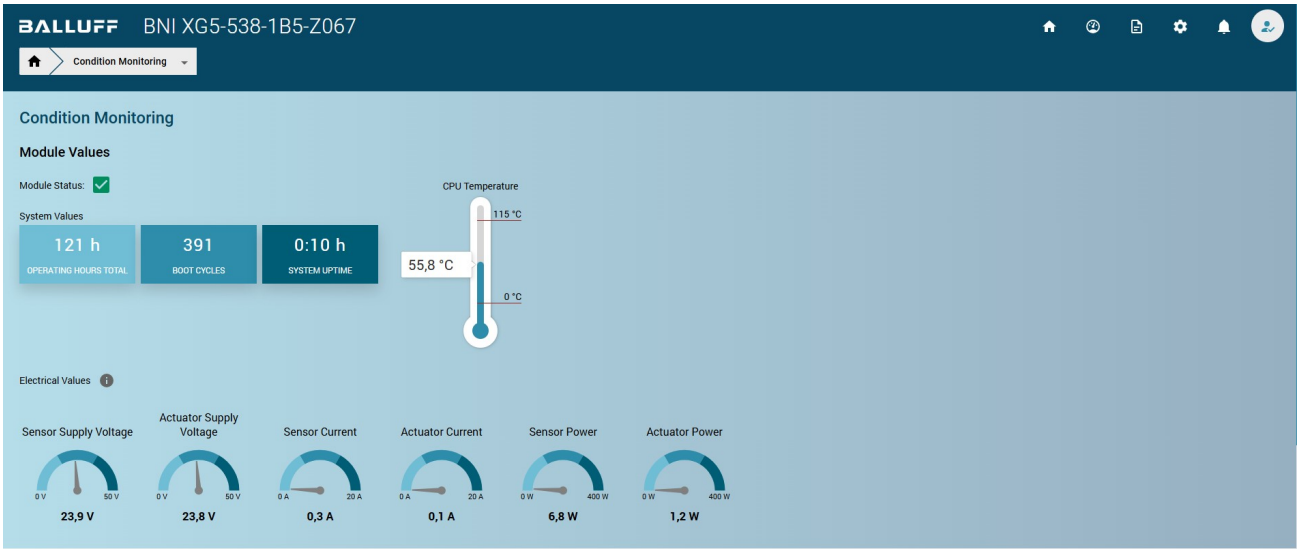


Fig. 24: Condition Monitoring

Click on the corresponding icon in the navigation bar (see *Navigation bar*) to open the *Condition Monitoring* dialog.

Module values

In the top section, you can see the condition monitoring values of the module that are not port-specific. These values relate to the entire module and are refreshed automatically every 10 seconds.

Electrical values

The table on the *Electrical Values* tab shows the available values for current consumption and power draw at the individual pins of the different ports.

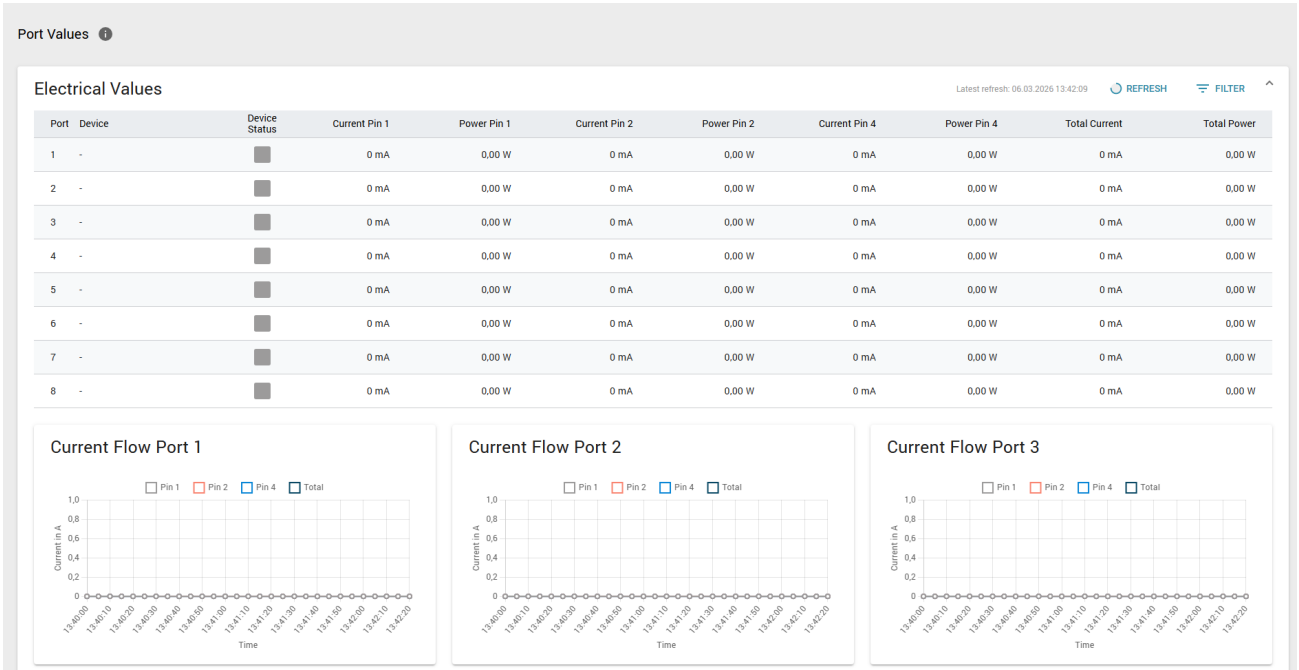


Fig. 25: Electrical Values

9.8.6 Diagnosis

Click on the corresponding icon in the navigation bar (see *Navigation bar*) to open the *Diagnosis* dialog. The *Diagnosis* dialog provides general service information about the device and a logging function.

The *Status* tab page contains information for all service requests, while the *Activity Log* tab page contains a table view of the log information. The information can be printed as a PDF by clicking on the printer icon (e.g. for a service request).

Note

If you have a specific question about a specific case, save or print this website as a PDF file and send it to us for technical support. You can find the corresponding contact details at www.balluff.com.

Information

Via the *Information* item, you can view information about the device, such as the browser version used or the system operating time.

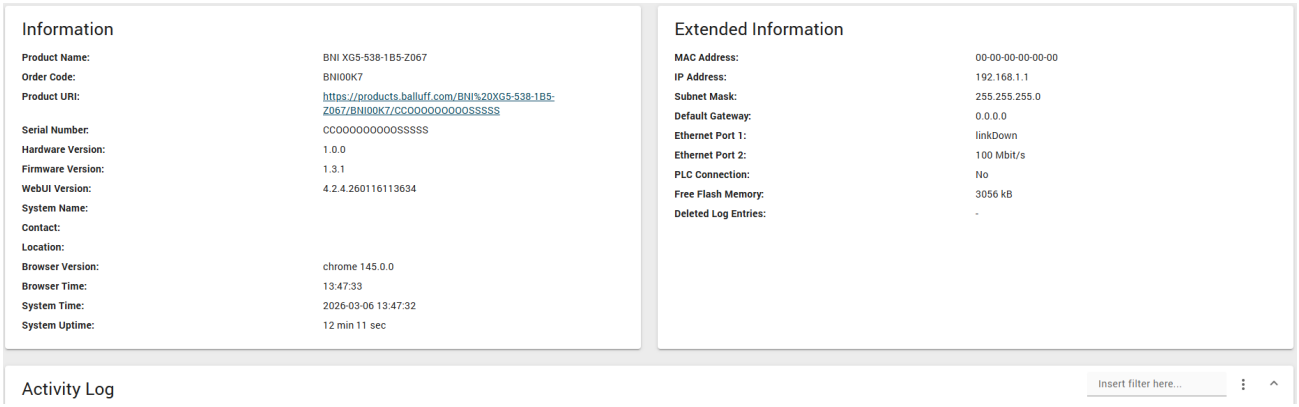


Fig. 26: Information

Activity log

The *Activity log* displays events in their chronological order and is an important tool for detailed troubleshooting in plants.

The expanded *Activity Log* tab page provides a table view of the log information, which can be sorted by number. The log information consists of a severity indicator, a date stamp, information on the origin, and the log message itself.

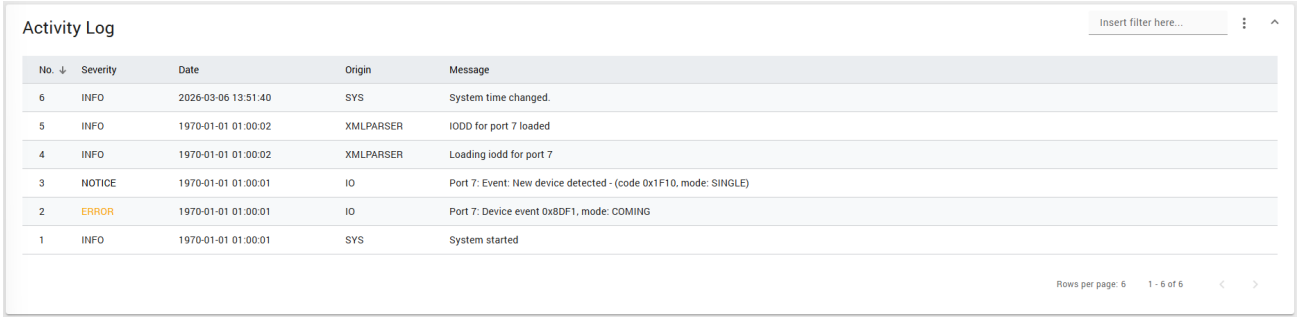


Fig. 27: Activity log

Events are classified via the *Severity* column:

- Internal error (Emergency, Alert, Critical)

  The network module has detected an internal defect (hardware or software) that should not normally occur. If this happens, the module must be serviced or replaced.

- External error (Error, Warning)

  The network module has detected a potentially impermissible event that is affecting the module from an external source. Troubleshooting within the system may be necessary.

- Event (Informational, Notice)

  The network module has detected a significant normal operating event (such as configuration actions via the web interface and other configuration interfaces, which are recorded) and reports it.

Under additional options (⋮), you can access further actions for the log (the log entries are stored in a ring buffer):

- *Refresh*
- *Download CSV*
- *Clear*

9.8.7 Settings

The *Settings* dialog enables the configuration of connected modules and IO-Link devices. Click on the corresponding icon in the navigation bar (see *Navigation bar*) to open the *Settings* dialog.

Note

Changing and saving settings as well as implementing restarts and resetting to factory defaults can only be performed by users with corresponding authorizations (*ADMIN* , *EXPERT*).

General settings

General settings such as the name of the module, the module time and security configurations can be made under *General*.

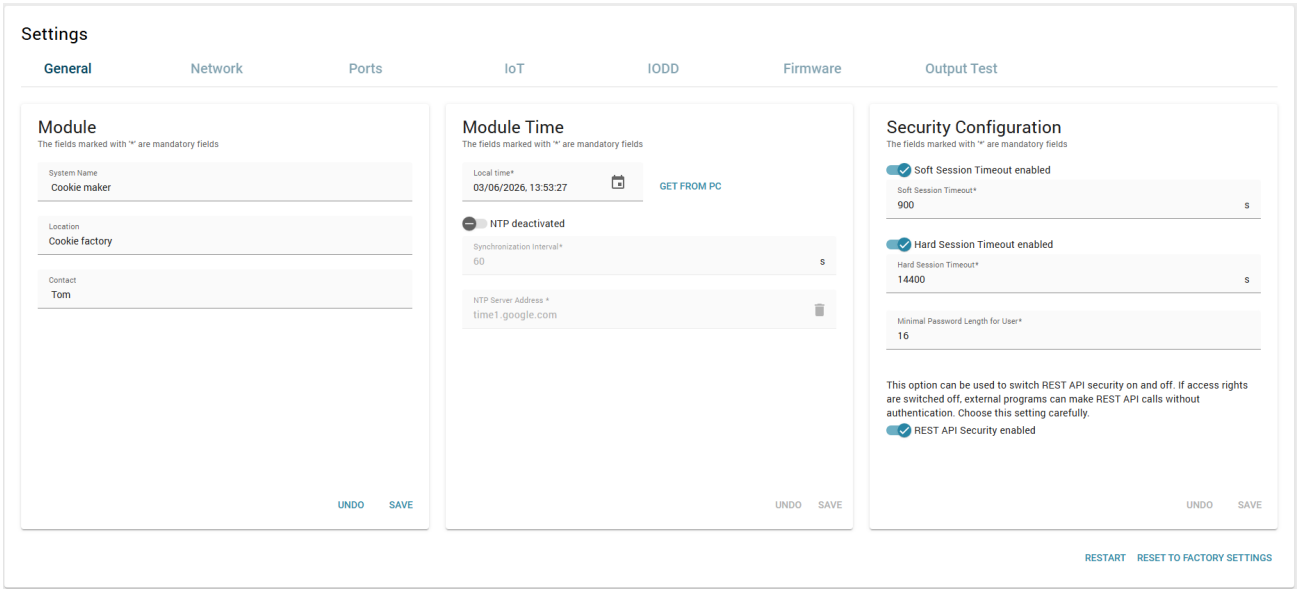


Fig. 28: *General* tab

Settings can be applied by clicking on *SAVE* and permanently stored in the device.

RESTART restarts the module (like switching the power supply off and on).

RESET TO FACTORY SETTING completely deletes the configuration saved in the device and then performs a reboot. The device is reset to the delivery state.

Manually setting the module time

1. Under *General* > *Module time*, either click on the calendar icon or use the *Set from PC* dialog to transfer the current browser time to the network module.
2. Apply the settings with *SAVE*.

> **Note**
>
> The module time is not permanently stored. After a reset, reboot or power, the time will be reset to the factory setting.

Retrieve module time automatically

An NTP server can be configured from which the time is automatically retrieved.

- Under *General* > *Module time*, select the option *NTP server activated*.
- Under *Synchronization interval*, select how often the time is retrieved from the NTP server.
- Enter the IP address of the NTP server under *NTP server address* (internal URLs are not supported).
- Apply the settings with *SAVE*.

Making security configurations

The following security settings for the REST API interface can be made using the security configurations.

Soft Session Timeout
: Defines the time in seconds after which a user is logged out in the event of inactivity.

Hard Session Timeout
: Defines the time in seconds after which a user is logged out, even if they are active.

Minimum Password Length
: Defines the minimum required password length for newly created users.

Rest API Security
: Activates or deactivates authentication when using the REST API directly. If deactivated, it is no longer necessary to log in and send the session token and cookies with a request. All requests have the rights of the *ADMIN* user.

Make network settings

Under *Network*, the *IP Address*, *Subnet Mask* and *Gateway Address* fields can be reset separately via the *FACTORY DEFAULT* button (see *Security Management*).

The *Storage* setting can be used to select how long the new network configuration should be valid.

Permanent
: Saves the settings after a restart.

Temporary
: Saves the settings until the next restart (factory setting).

The factory settings then apply.

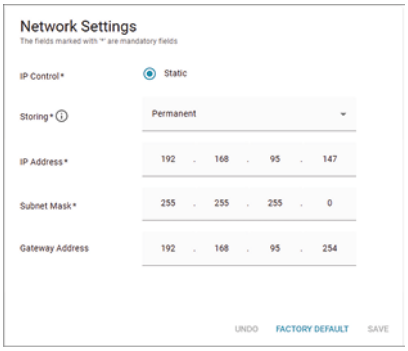


Fig. 29: Network settings

Security Management

Security Management can be used to enable or disable unencrypted and encrypted communication with the web server using HTTP(S).

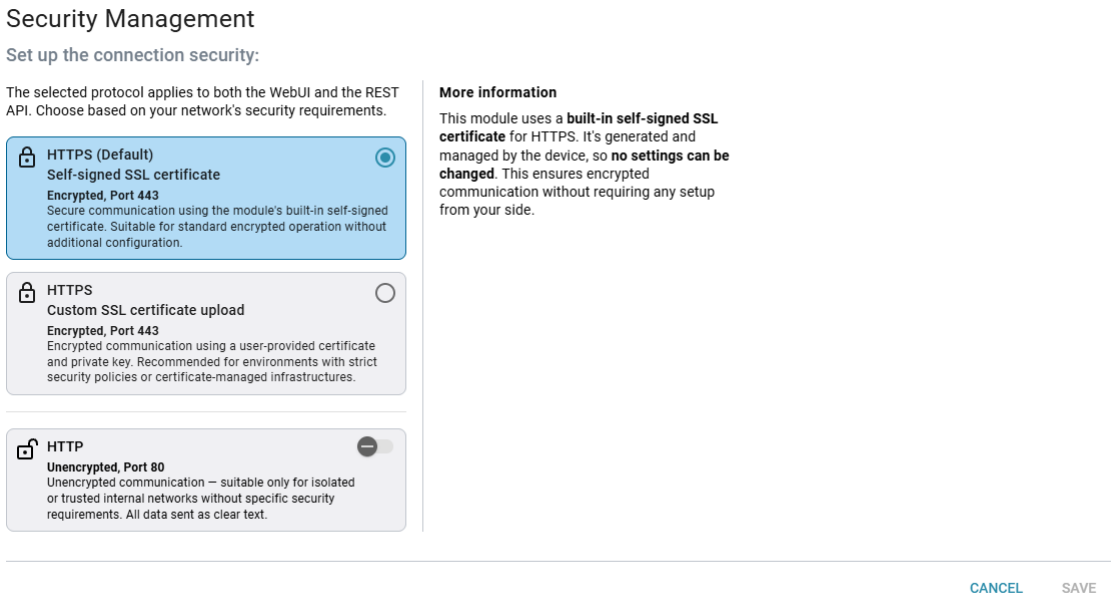


Fig. 30: security management

Note

If the connection between the web browser and the BNI is made via a HTTPS connection, the BNI provides a self-signed certificate that must be imported into the web browser. When the connection is opened, a warning appears in the web browser which must be accepted. After accepting, the certificate is imported.
If the IP address changes, the old certificate may have to be deleted and the new one imported. Once the certificate has been imported, the WebUI opens. A warning symbol appears in the URL bar, but this can be ignored.

Change protocol

The active fieldbus protocol can be viewed and changed in the section Fieldbus Protocol.

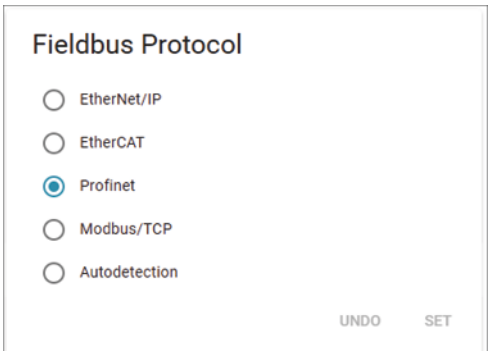


Fig. 31: Change protocol

I/O ports

Via the *I/O Ports* dialog, the ports of a module can be displayed and configured.

Select *Set configuration for all ports* to set the IO-Link *[Autostart]*, *Digital In* and *Digital Out* configuration modes to the desired mode for all ports.

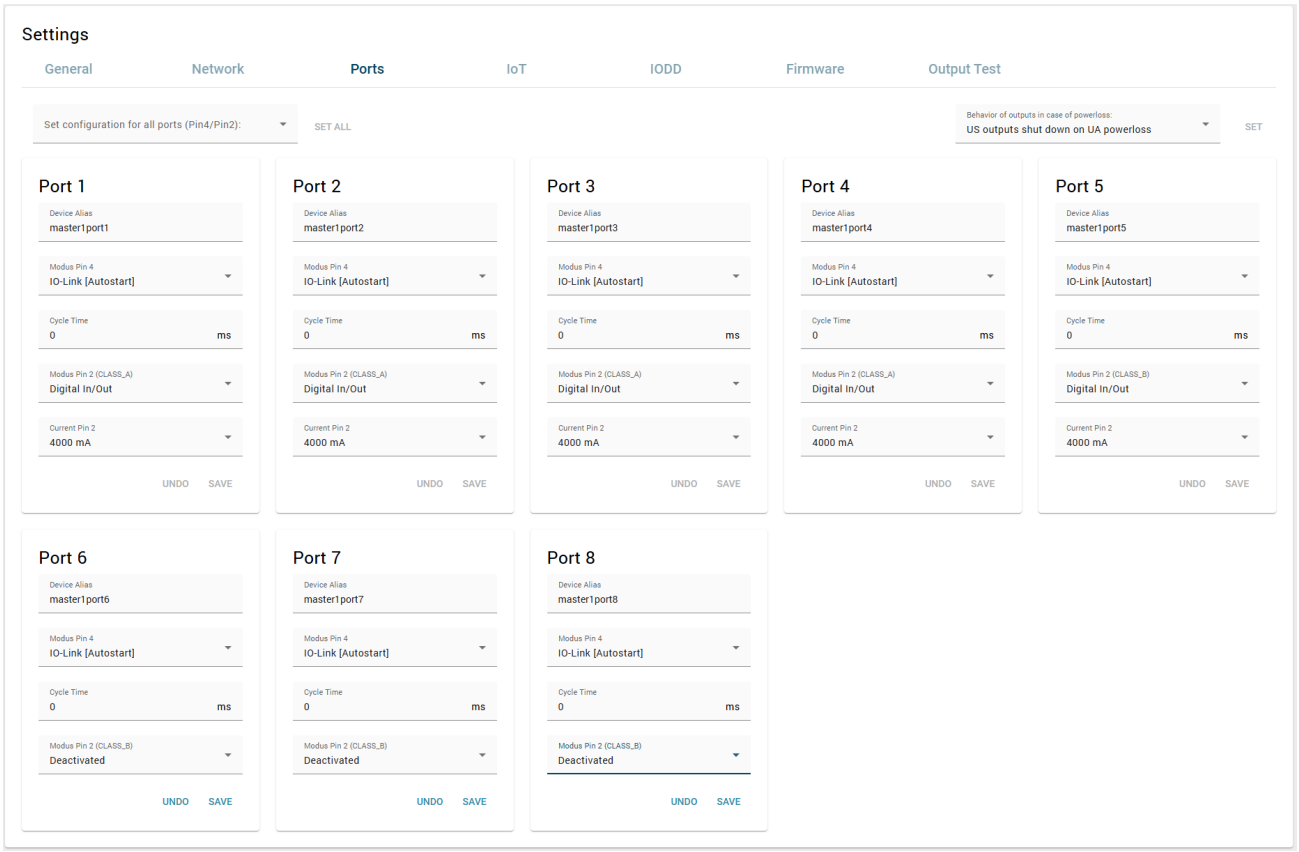


Fig. 32: IO Ports settings

Click on *SET ALL* to open a dialog window in which the action can be confirmed or canceled. With a corresponding selection, the message *I/O port configuration(s) successfully saved* appears in the bottom part of the website.

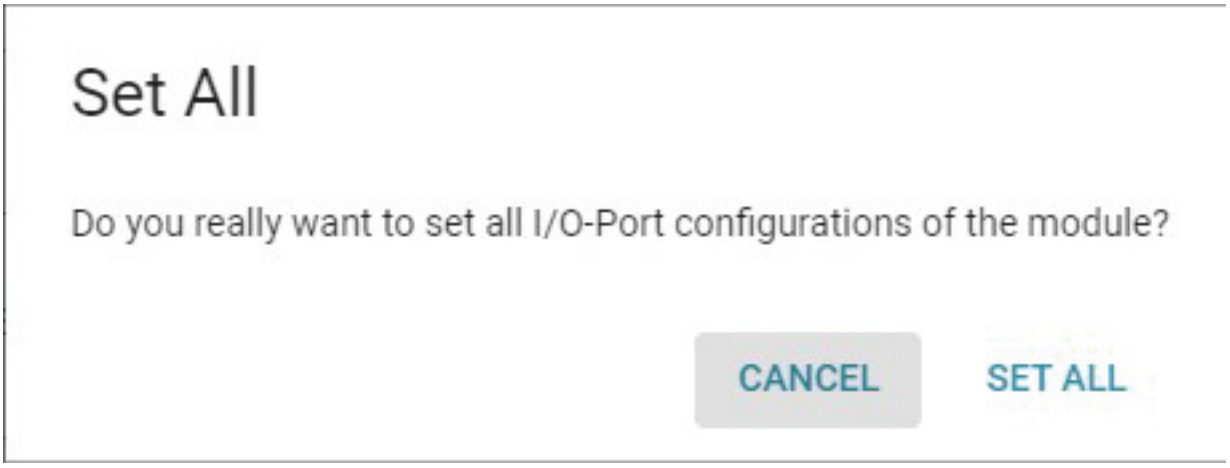


Fig. 33: Set All dialog

The ports can also be configured individually. The inputs are confirmed with SAVE or reset with UNDO.

The following parameters can be configured (see *IoT/IIoT*):

Device Alias
name of the device that shows what function the sensor executes (e.g. *rear left end switch*, *temperature at boiler floor*, etc.)

Modus Pin 4
selection of the actuation (e.g. *Deactivated*, *IO-Link [Manual]*, *IO-Link [Autostart]*, *Digital in* or *Digital out*. Depending on the selection, further dialog fields open, which require an input (e.g. when the *IO-Link [Manual]* option is selected).

Validation and Backup
Settings see *Validation & Backup*.

Cycle Time
if the *IO-Link [Manual]* or *IO-Link [Autostart]* options are selected for point Modus Pin 4, the desired communication cycle can be set by selecting the corresponding value from the dropdown list.

Modus Pin 2 (CLASS_A)
selection of the options *Digital in* or *Digital out*.

Current pin 2
Maximum current at which the pin switches off. Can only be configured if the pin is configured as an output.

Current pin 4
Maximum current at which the pin switches off. Can only be configured if the pin is configured as an output.

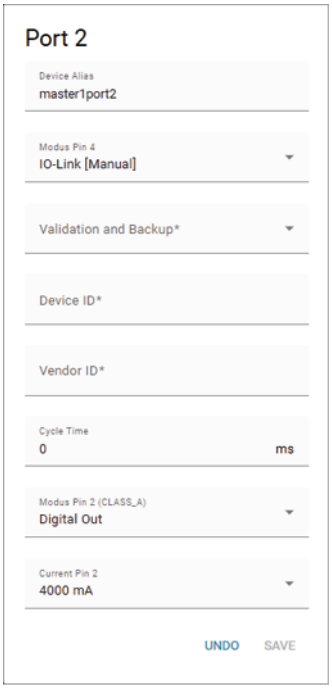


Fig. 34: Modus Pin 4 selection options dialog and Port 2: Configuration dialog of the IO-Link [Manual] option

Note

Automatic Shutdown of Pin 1 Power on Port Deactivation:
If a port is configured to deactivate Pin 2 and Pin 4, the power supply on Pin 1 is automatically shut down.

UA Configurable behavior

The behavior allows the IO-Link master outputs to be influenced in the event of a sudden loss of actuator voltage UA.

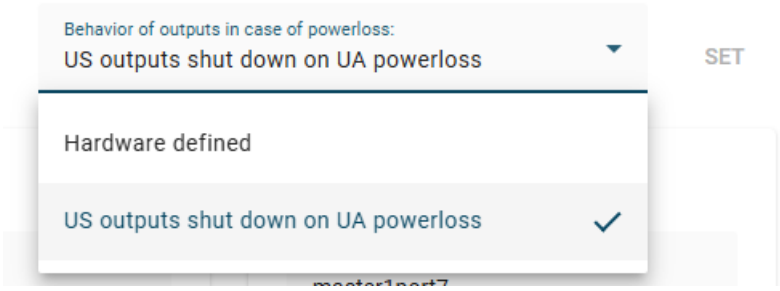


Fig. 35: UA Configurable behavior

There are two selection options:

US outputs shut down on UA powerloss
All active outputs on Pin 2 and Pin 4 are automatically switched off in the event of a UA voltage drop.

Hardware defined
Only all active Pin 2 outputs of the Class B ports are switched off in the event of a UA voltage drop. All other outputs remain in their current state.

Note

Only available for the XG5-538-...-variants.

IoT/IIoT

The IoT settings of the device can be made via the IoT dialog.

- MQTT
- REST API
- OPC UA

In this manual, the acronyms **IIoT** (Industrial Internet of Things) and **IoT** (Internet of Things) used.

MQTT client settings

The BNI features an MQTT interface that allows parameters and product information to be called up. The BNI acts as an MQTT client whose messages are sent cyclically. For events, the BNI sends messages to an MQTT broker (PUBLISH). Other MQTT clients, e.g. applications that store data in an external database, can subscribe to topics provided via the MQTT broker (SUBSCRIBE).

The data sent via MQTT can be used, for example:

- for Condition Monitoring
- as an interface to Track&Trace applications
- for further processing in the cloud

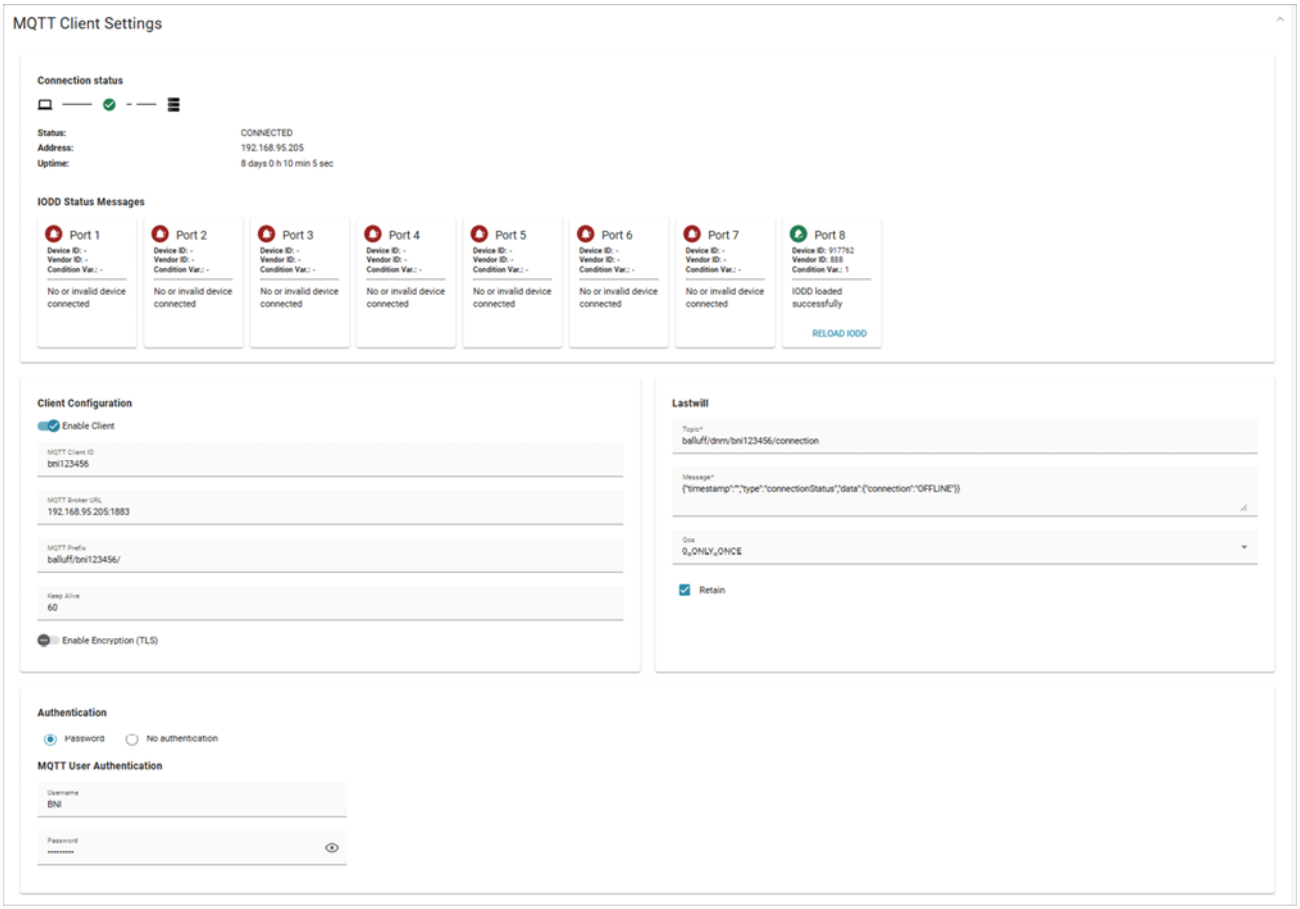


Fig. 36: MQTT client settings

Connection status

The following information can be viewed:

- *Status*: Indicates whether the client is connected or there is an error.

- *Address*: Displays the address of the broker to which the client is currently connected.
- *Uptime*: Displays the elapsed time in seconds since the connection was established.

IODD status messages
Indicates whether the correct IODD could be found and loaded for each device and which value is used for any condition variable. The correct IODD is required to send parsed IO-Link data.

In addition, the IODD can be reloaded manually if a change to one of the ports or the condition variable is not detected.

Client configuration
The following settings can be made:

- *Enable Client* Enables or disables the client.
- *MQTT Client ID* Defines the client ID that will be used for the connection.
- *MQTT Broker URL* Defines the address of the broker. In addition, an individual port can be specified separated by a colon, e.g. 192.168.1.42:1234. If no port is specified, port *1883* is used by default when TLS is deactivated and port *8883* is used when TLS is activated.
- *MQTT Prefix* Defines a prefix to be placed in front of each MQTT topic (e.g. *{prefix}/identification*).
- *Response Topic* Defines the MQTT topic on which the device publishes command response messages.
- *Keep Alive* Defines the MQTT keep alive time in seconds.
- *Enable encryption (TLS)* Defines whether TLS should be used for MQTT communication.

Lastwill
Allows a message to be configured that is to be sent automatically when the client disconnects from the broker. The following settings can be made:

- *Topic*: Defines the topic of the message.
- *Message*: Defines the content of the message.
- *QoS*: Defines the QoS (Quality of Service) level at which the message is sent.
- *Retain*: Sends the message with or without the retain flag.

Note

All available topics and the content of the individual messages can be found in the MQTT AsyncApi specification (see downloads at www.balluff.com on the product page).

Authentication
The following settings can be made:

- *Password*: Authentication is done with password and username.
- *No authentication*: The client logs on to the broker anonymously.

MQTT Message Configuration

Publishing

Among other things, the process data of the connected sensors or the status of the digital inputs and outputs can be sent via MQTT.

In the default state, all message formats described in the *AsyncApi* specification are sent cyclically.

This behavior can be adjusted in the *MQTT Message Configuration* dialog, for example so that messages are sent only when a change occurs or at a fixed interval.

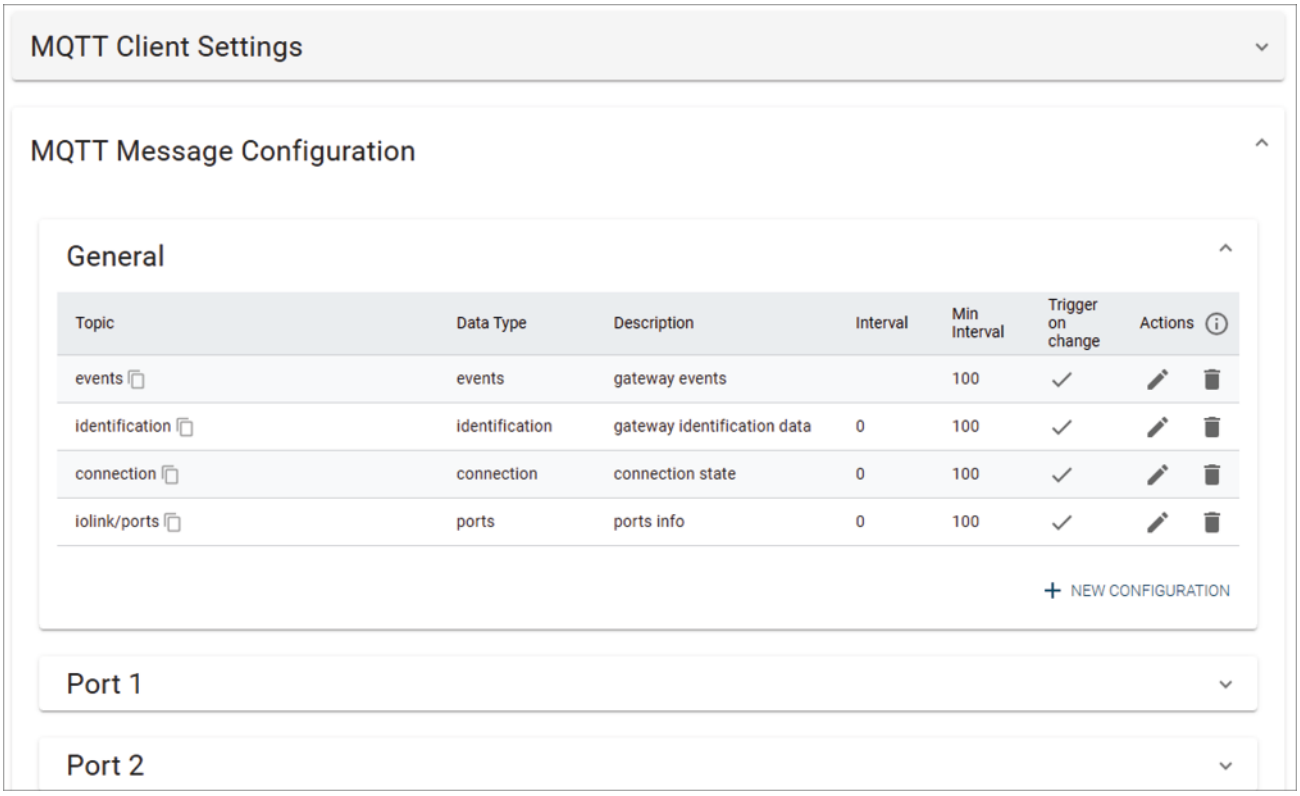


Fig. 37: MQTT Message Configuration

The following settings can be made:

General
Enables configuration of general, port-independent messages, e.g. the sender of the master identification data.

Port 1…8
Enables configuration of port-specific messages, e.g. sending the identification data of a connected IO-Link device or its process data.

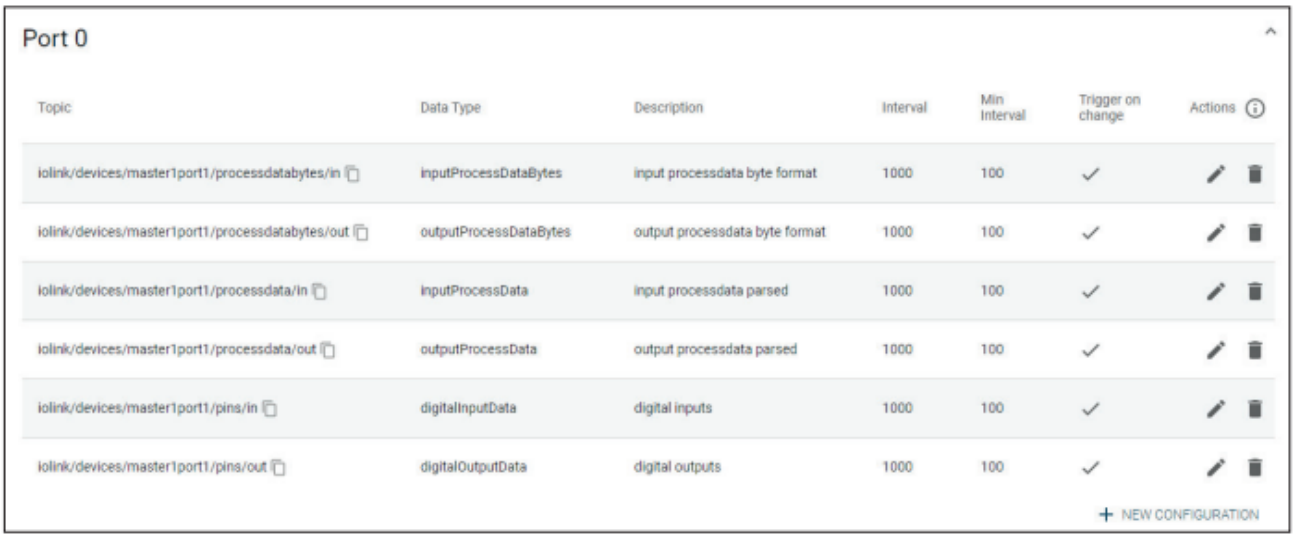


Fig. 38: configure port-specific messages

The following can be configured for each message to be sent:

Topic
Defines the topic under which the message is published. If the *Generate topic automatically* option is activated, user input is ignored and the default path specified in the *AsyncApi* is used.

DataType
Defines the type of message. The individual types are described in the *AsyncApi* specification, the *operation ID* listed there corresponds to the data type to be selected here.

Description
Defines a description text for the configured message. It is used only as an overview and has no other function.

Interval
Defines the fixed interval for sending a message. Either an interval or the *Trigger on change* option must be set.

Min. interval
Defines a minimum interval for sending between two messages.

Example:

The measured value of a connected sensor changes every millisecond. A minimum interval of 100 milliseconds is configured. This means that a message is sent every 100 milliseconds, even though the value changes more frequently.

Trigger on change
If active, a message is sent whenever a change occurs. Either this option or an interval must be set.

Note

- Each message type can only be configured once per port.
- The message types deviceEvents and events cannot be configured with a fixed interval.

Subscribing

In addition to the messages sent by the BNI, it is also possible to subscribe to messages from other MQTT clients. The BNI can then react to these messages, for example by changing the output state of a digital output or the process data of a connected IO-Link device.

See the *AsyncApi* specification for the available subscription topics and the corresponding message content. Subscription topics can be configured in the same way as publish topics.

Responses or error messages for received commands are sent to the topic configured in the *Response Topic* field of the *MQTT Client Settings* dialog.

The subscription feature is available only in fieldbus mode *IoT*. It is not available in other fieldbus modes.

CAUTION

If a subscription topic is configured, any client that can publish to this topic can send messages to the BNI and potentially change output states or process data. To protect the BNI against unauthorized access, configure access control on the MQTT broker and allow only trusted clients to send messages to the BNI.

OPC UA Server settings

To access the data, the OPC UA server must first be enabled in the Web UI. To do this, log in to the device, navigate to **Settings**, and click on the **IoT** tab. At the bottom of the page, you will find the collapsed section "**OPC UA Server Settings**" Open this section to enable or disable the server.

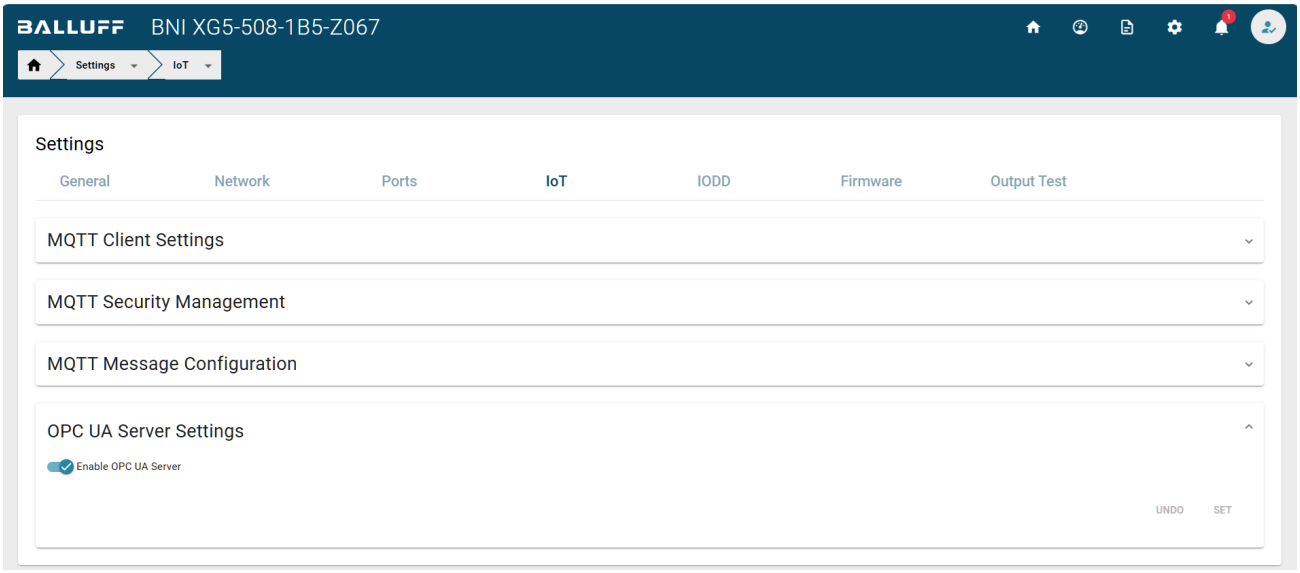


Fig. 39: Enable/disable OPC UA Server

Note

More information and examples can be found in chapter *OPC-UA integration*

REST API settings

Regarding to Rest Api, no configuration available.

Note

For detailed information how to use Rest Api, please refer to chapter *REST API*

IODD

Note

Please check whether IO-Link is supported by your module before using this function. For more information on product variants that support IO-Link, see *Supported product variants*.

Via the *IODD* dialog, device description files for IO-Link devices (IODDs) and the associated device images can be uploaded to the network module so that a more detailed illustration of the connected IO-Link devices can be provided in the *Ports* dialog.

Connected IO-Link devices

Note

Please check whether IO-Link is supported by your module before using this function. For more information on product variants that support IO-Link, see *Supported product variants*.

When IO-Link devices are connected and IO-Link ports are activated, the dialog shows a table with information on the IO-Link devices. The table can be updated by clicking on the refresh icon .

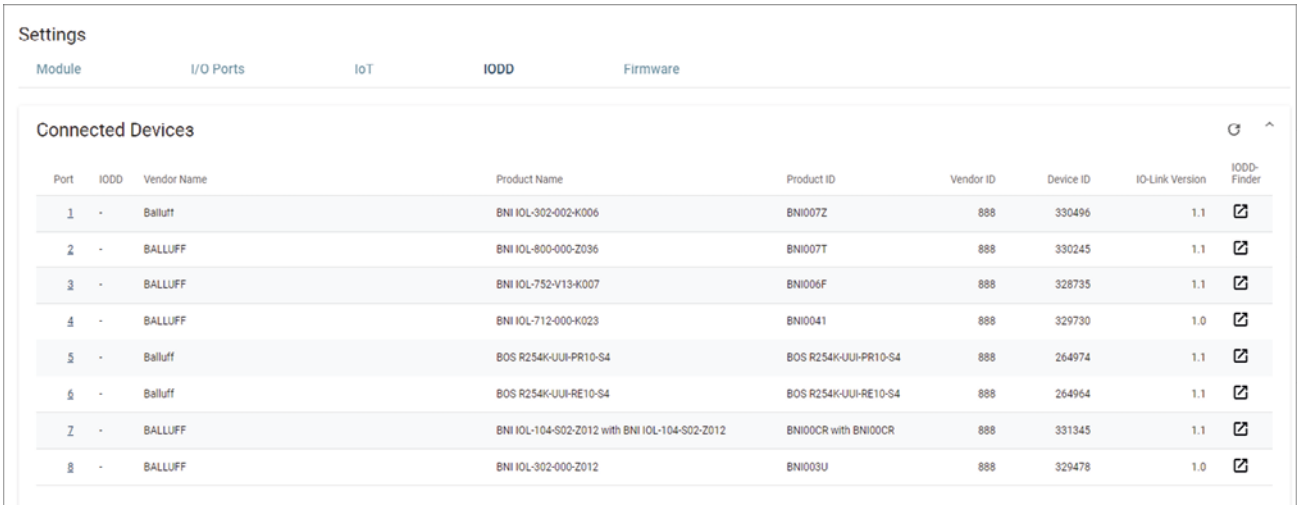


Fig. 40: Connected IO-Link devices

Available IODDs

Note

Please check whether IO-Link is supported by your module before using this function. For more information on product variants that support IO-Link, see *Supported product variants*.

The available IODDs are listed under *Available IODDs* and can be removed by clicking on the recycle bin icon, if necessary.

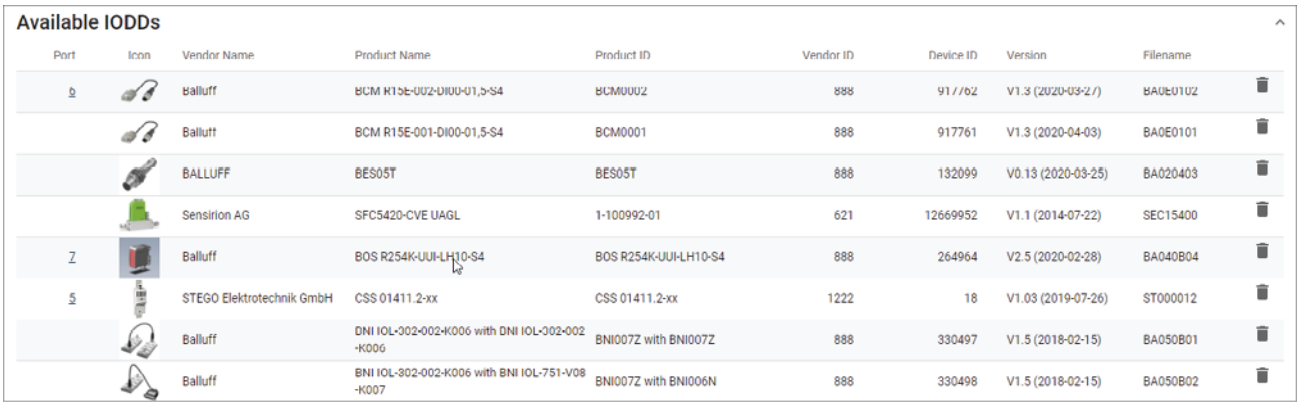


Fig. 41: Available IODDs

An IODD can be uploaded via the *Choose an IODD to upload dialog* between the two tab pages.

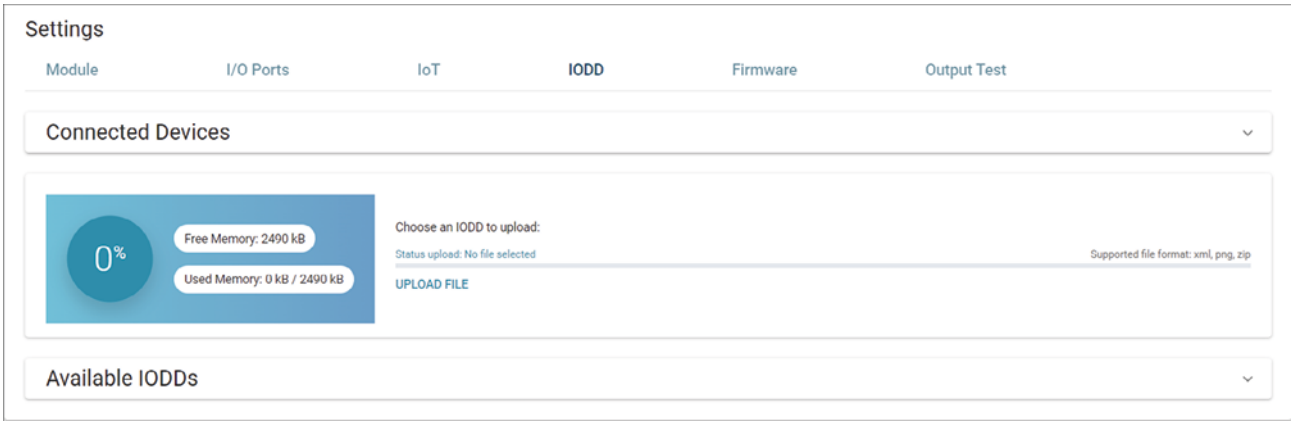


Fig. 42: Upload IODD

In order for the automatic assignment of IODDs to connected IO-Link devices to work, the files must be named according to a specific scheme. This is done automatically in the background for IODD files. If an individual image file is selected for upload via *UPLOAD FILE*, which does not meet the naming requirements, a dialog will open with a corresponding message.

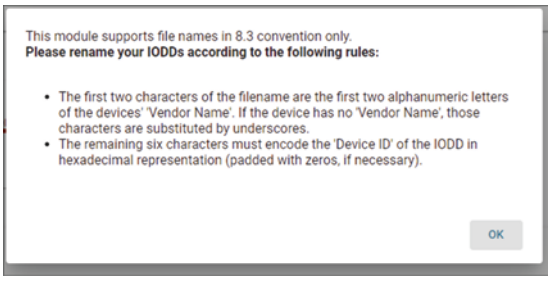


Fig. 43: Info message

The *Connected IO-Link devices* bar also displays help in the form of a list of currently connected IO-Link devices as well as the associated, required IODD file name (column *IODD Filename*).

Note

Always upload ZIP files with the IODD contents as provided by the IODD Finder so that all images are automatically renamed.

Firmware

Under *Firmware* you can see which version of the firmware is being used and when it was uploaded. Via *Firmware Upload*, you can upload a different firmware version. The installation starts after uploading the firmware file. Only files in bff format are supported.

You can check for firmware updates online via *CHECK FOR A NEW VERSION* and install an update directly.



Fig. 44: Firmware view

9.8.8 Notifications

Clicking on the corresponding icon in the navigation bar (see chapter *Navigation bar*) opens the notifications.

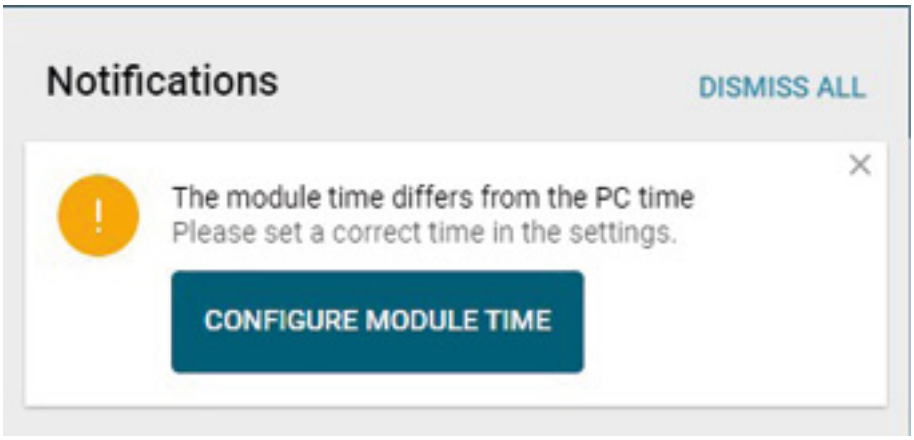


Fig. 45: Notification: Module time

The notification history can be deleted with *Dismiss all*.

9.8.9 REST API

Via the REST API interface, identification data, process data and configuration settings of the network module and other connected devices can be requested and modified. The REST API interface is used by the user interface of the web interface for communication with the module.

The specification of the REST API implemented in the module is stored in YAML files in the device and can be downloaded via *Help > Documents* or viewed and tested via *Help > Api documentation*.

The present module supports the following REST APIs:

- Generic REST API for Balluff devices and applications. Base path of the REST API in the module: **http://[ip-address]/api/balluff/v1/**
- The REST API *(JSON for IO-Link)* standardized by the IO-Link community. Link to the official documentation (JSON for IO-Link) in the IO-Link Integration area. *JSON Integration for IO-Link* (ZIP file).

  Base path of the REST API in the module: **http://[ip-address]/iolink/v1/**
- Detailed endpoint described in Please go to Balluff Update Platform and download the API_Description_BNI_XGx-xxx-xx5.zip file

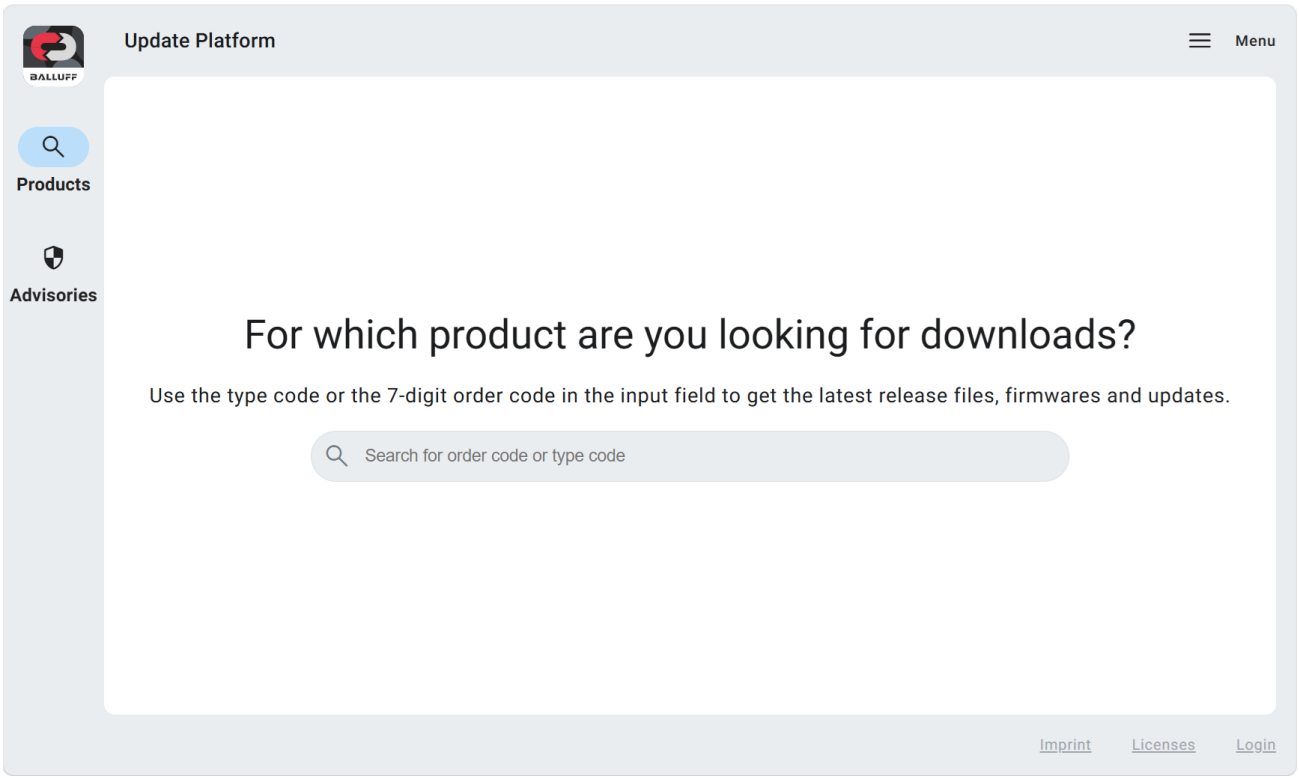


Fig. 46: BUP - Balluff Update Platform

After the product is selected, download the documentation

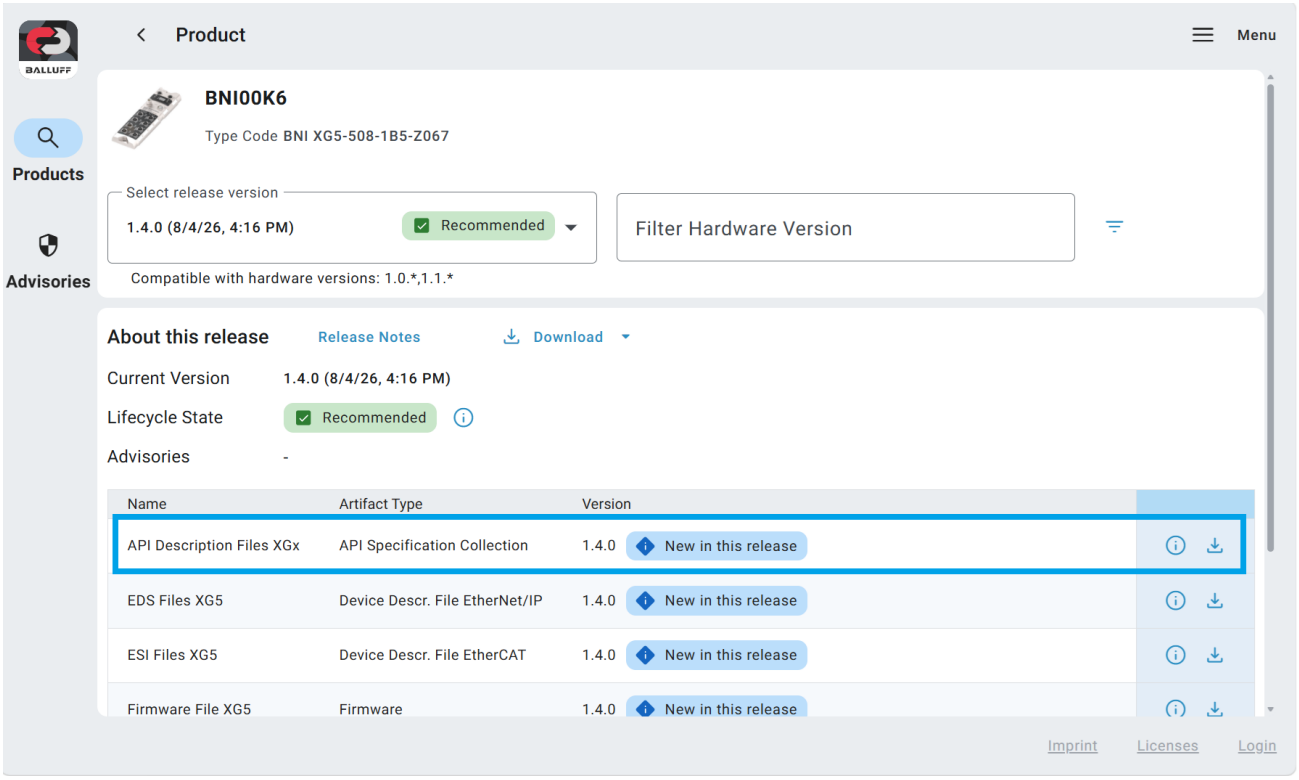


Fig. 47: API (Rest Api) documentation including .yaml files

Note

The specification JSON for IO-Link REST API describes a functionality for process data and parameters, which requires IODD support. This functionality is also not fully implemented in the current version.
The module only supports uploading of IODDs. Writing/reading process data or parameters with their names is not supported.

Note

Please check whether IO-Link is supported by your module before using this function. For more information on product variants that support IO-Link, see *Supported product variants*.

Some examples below explain how REST-API is applied.

Registration and authentication are required for some calls.

REST Login

Login is possible by entering the following address: **http://[ip-address]/api/balluff/v1/users/login**.

A JSON object is also specified, in which, as shown below, a user name and password are specified (see *Logging in and logging out*):

```
{
  "username": "[username]",
  "password": "[password]"
}
```

If the login was successful, a bearer token is returned, e.g.:

```
{
  "bearer": " 7euh07tdfawjej"
}
```

In addition, a cookie is set that must be sent with each request, e.g.:

```
{
  "JSESSIONID": "fgaa74a4fa2xdfg"
}
```

This token can now be used to perform methods that require authentication. For this, a corresponding request must be equipped with the following headers:

- `Authorization: Bearer 7euh07tdfawjej`
- `Cookie: JSESSIONID fgaa74a4fa2xdfg`

Requesting the device identification of the module

The device identification data of a network module can be requested via the following address:

- http://[ip-address]/api/balluff/v1/identification
- http://[ip-address]/iolink/v1/masters/1/identification

In the event of a successful request, an answer is supplied in the form of a JSON object with properties such as the vendorID, the serial number or the firmware revision of the respective network module.

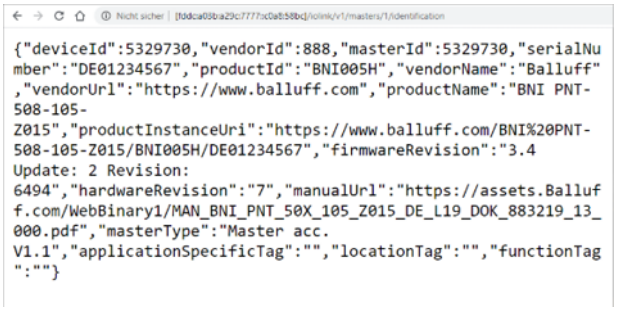


Fig. 48: Requesting the device identification

Requesting port information

All relevant configuration and status data for all IO ports of a module can be requested via:

http://[ip-address]/api/balluff/v1/ports/information



Fig. 49: Requesting the port identification

Requesting an IO-Link device parameter (applicationSpecificTag)

Note

Please check whether IO-Link is supported by your module before using this function. For more information on product variants that support IO-Link, see *Supported product variants*.

Device-specific parameters can be requested via the following addresses:

- http://[ip-address]/api/balluff/v1/devices/identification
- http://[ip-address]/iolink/v1/devices/[deviceAlias]/identification

A request via the generic REST API is the bulk version of the identical request via *JSON for IO-Link*.

In the case of a request via *JSON for IO-Link*, a *deviceAlias* is also specified. This corresponds to the device designation that must be configured previously. The standard device designation is *Port_Xyz*, with *yz* representing the port number (e.g. *Port_X00*).

In the case of successful execution, a JSON object with parameters such as *vendorID*, *productName* and *applicationSpecificTag* is supplied as a response.

Setting an IO-Link device parameter (applicationSpecificTag)

Note

Please check whether IO-Link is supported by your module before using this function. For more information on product variants that support IO-Link, see *Supported product variants*.

Note

A login is required to use this call (see *REST Login*).

Device-specific parameters for connected IO-Link devices can be set via the following address:

http://[ip-address]/iolink/v1/devices/{deviceAlias}/parameters/{index}/value

The *deviceAlias* corresponds to the device designation of the IO-Link device (e.g. *Port_X00*). The *index* reflects the ISDU parameter variable to be set in the IO-Link device. In the case of the *applicationSpecificTag*, this would be the value 24.

To set values, a JSON object must also be specified, in which corresponding parameters and values are specified as in the following example:

```
{ "value": [
49,
50,
51,
52,
53,
54
]}
```

In the case above, parameter 24 (*applicationSpecificTag*) was described with the ASCII string `"123456"`.

Successful execution is not confirmed in the form of a JSON object, but with a Code 204 (*Successful operation*).

Setting a master parameter (sysName)

Note

A login is required to use this call (see *REST Login*).

A master parameter, such as *SysName*, can be set via the following address: http://[ip-address]/api/balluff/v1/

A JSON object with the corresponding information must also be specified:

```
{
  "sysName": "[SysName]"
}
```

Successful execution is not confirmed in the form of a JSON object, but with a Code 204 (*Successful operation*).

Note

If you are unable to implement your application case with the examples listed below and the information from the specifications for the REST APIs, please contact Balluff with a description of your application case.
You can find the contact details at www.balluff.com.

9.9 Protocols

9.9.1 Automatic detection of the protocol

On delivery, the network module is in autodetect mode. This mode actively monitors the network to identify the bus type used. A green running light on the IO-Link ports indicates the active detection process.

As soon as the module has successfully identified the network type, the corresponding port LEDs quickly light up green. The assignment of the LEDs to the various fieldbus protocols can be found in *LED assignment to fieldbus protocols*. After successful detection, the device restarts automatically and can then be accessed via the detected fieldbus protocol.

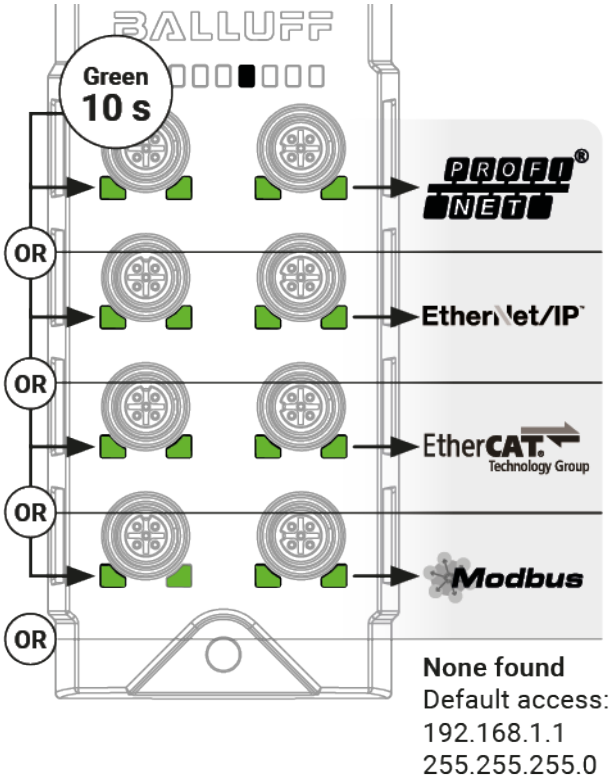


Fig. 50: LED assignment to fieldbus protocols

To put the module back into autodetect mode, either the display (see chapter *Select protocol in the display*) or the WebUI (see *Change protocol*) can be used.

In autodetect mode, the device can be reached at any time via the IP address 192.168.1.1 with subnet mask 255.255.255.0.

9.9.2 Manually select protocol

For devices with a display, the protocol is selected manually via the integrated display (see chapter *Select protocol in the display*).

The table below shows other options for manually selecting the protocol for devices without a display.

From Autodetect

To switch from Autodetect (ATD) to PNT, EIP, ECT, MBT, use the following options:

- Automatic detection
  OR
- Set manually via:
  - IP assignment via WebUI
  - Changeover via WebUI (see *Change protocol*)

From PNT

To switch from Profinet (PNT) to ATD, EIP, ECT, MBT, use the following options:

- IP assignment via DCP (BET, Proneta)
- Changeover via WebUI (see *Change protocol*)

From EIP

To switch from EtherNet/IP (EIP) to ATD, PNT, ECT, MBT, use the following options:

- IP assignment per TCP/IP object or per WebUI (see *Make network settings*)
- Changeover via WebUI (see *Change protocol*)

From ECT

To switch from EtherCAT (ECT) to ATD, PNT, EIP, MBT, use the following options:

- Activate EoE (see *Set up*)
- Changeover via WebUI (see *Change protocol*)
- Changeover via CoE (see *Change protocol for set ECT*)

From MBT

To switch from Modbus/TCP (MBT) to ATD, PNT, EIP, ECT, use the following options:

- IP assignment via WebUI (see *Make network settings*)
- Changeover via WebUI (see *Change protocol*)

9.9.3 WebUI default settings

The protocol can also be selected via the WebUI (see *Change protocol*). By default, the WebUI can be reached via the IP address 192.168.1.1.

Note

The following settings are assigned at the factory:
- Protocol: Autodetect
- IP address: 192.168.1.1
- Subnet mask: 255.255.255.0

If the protocol is changed, the IP parameters are reset to the default value of the respective protocol, as shown in the following table:

Table 6: Default values of the respective protocols

Protocol	Default IP adress	default subnet mask
Autodetect	192.168.1.1	255.255.255.0
Profinet	0.0.0.0	0.0.0.0
EtherNet/IP	192.168.1.1	255.255.255.0
Modbus/TCP	192.168.1.1	255.255.255.0
EtherCAT	IP settings via EoE	IP settings via EoE

9.9.4 Change protocol for set ECT

Proceed as follows if ECT is already set and the protocol should be changed.

1. Select CoE object *Fieldbus Information* (0xF502).

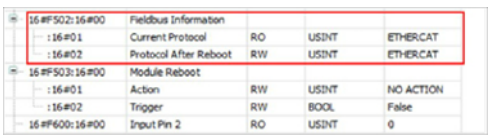


Fig. 51: Select CoE object *Fieldbus Information*

2. Select and set the desired protocol in the object *Protocol After Reboot*.

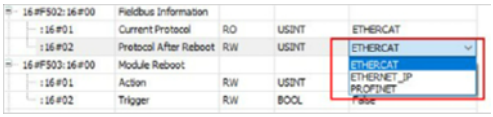


Fig. 52: Select protocol in the object *Protocol After Reboot*

Then the module must be restarted as follows:

1. Select CoE object *Module Reboot* (0xF503).



Fig. 53: Select CoE object *Module Reboot*

2. Set object *Action* to *Reboot*.



Fig. 54: Object *Action*

3. Set object *Trigger* to *True*.

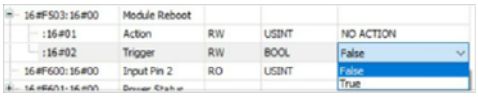


Fig. 55: Object *Trigger*

9.10 PROFINET Integration

Note

The following instructions and screenshots are based on the Siemens TIA Portal and illustrate the general procedure for configuring a PROFINET device. Many engineering tools follow the same basic principles (device selection, IP addressing, GSDML/device parameters, mapping of I/O data), but menu structures, terminology, and individual steps may differ. If you are using a different tool, apply the described concepts accordingly and consult the vendor-specific documentation as needed.

9.10.1 Set Up Initial PROFINET Device Connection

This topic describes how to set up the default configuration for a PROFINET device within the TIA portal. This task is considered as a first step in a configuration process because it validates the connection between the TIA portal and the PROFINET device and enables users to do further configuration steps.

Prerequisites

Please make sure that the following prerequisites are met before you start with the configuration:

- A PROFINET-capable PLC (IO-Controller) and a PROFINET device (IO-Device), both powered on.
- A physical Ethernet connection between the engineering PC, the PLC, and the PROFINET device.
- The TIA Portal software installed, supporting the used PLC and PROFINET device.
- Basic knowledge of the TIA Portal and PROFINET device configuration.
- The required GSDML file for integrating the PROFINET device into the TIA portal.

Installing the GSDML File

Note

The GSDML files are available in two languages at www.balluff.com.

The PROFINET device data required for project planning is stored in Generic Station Description Markup Language (GSDML) files. The data modules of a network module are displayed in the project planning software itemized by subslots.

The GSDML file provides the possible data modules (input or output of different data widths). To configure the network modules, the corresponding data modules are assigned to a subslot.

Note

Outdated GSDML versions may not be compatible with the latest FW version.

In order to assign the data modules to subslots, you need to install the GSDML file of the PROFINET device. You can install the GSDML file in TIA Portal with the project open or not.

Before you begin

Make sure that:

- The GSDML file of the PROFINET device is available on your engineering PC.

Steps

To install the GSDML file in TIA Portal:

1. Extract the GSDML file into a separate directory on your hard disk.
2. Open the GSD management.

   In the toolbar, select *Options > Manage general station description file (GSD)*.

   ⇒ The *Manage general station description files* dialog opens.
3. Select the GSDML file.

   Under *Source path:*, navigate to the folder containing the GSDML file.

   ⇒ The GSDML file is displayed in the *Content of imported path* table.
4. Install the GSDML file.

   Activate the checkbox for the GSDML file and click *Install*.

   ⇒ The GSDML file is installed. The progress is displayed. Once finished, the successful installation is confirmed.
5. Click *Close* to leave the *Manage general station description files* dialog.

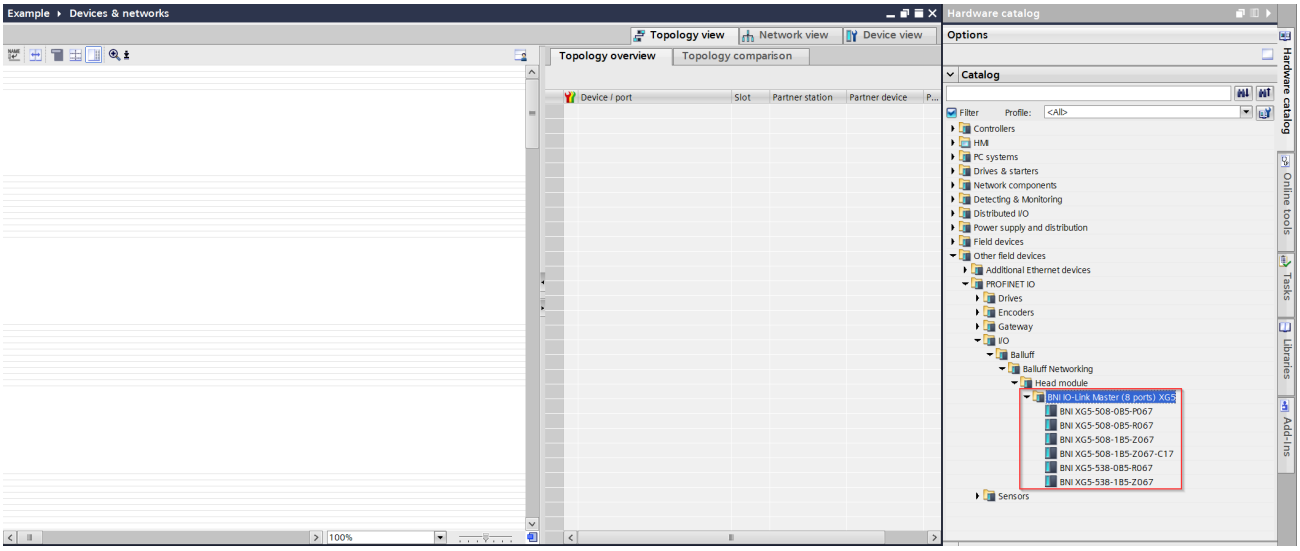


Fig. 56: PROFINET device in the hardware catalog

⇒ The *Hardware catalog* is updated and the PROFINET device is available under *Other field devices* > *PROFINET IO* > *IO*. The PROFINET device is now ready for further configuration.

Adding the PROFINET Device to the Project

Add the PROFINET device to the TIA Portal project and connect it to the PLC.

Before you begin

Make sure that:

- The TIA Portal project and the PLC are set up accordingly for PROFINET.
- The GSDML file of the PROFINET device has been installed.
  - See: *Installing the GSDML File*.

Steps

To add the PROFINET device to the project in TIA Portal:

1. Open the *Network view*.
2. Open the *Hardware catalog*.
3. Place the PROFINET device.

   Select the PROFINET device, keep the left mouse button pressed, drag the PROFINET device to the *Network view*, and drop it to place it.
4. Draw the network connection between the PROFINET device and the PLC via drag and drop.

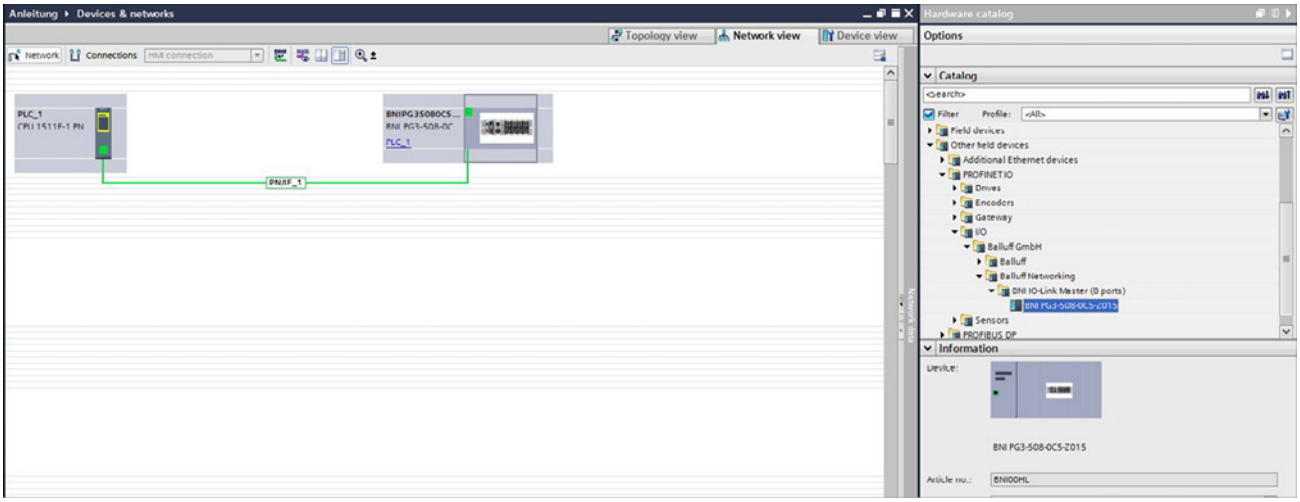


Fig. 57: PROFINET device in TIA

⇒ The PROFINET device is added to the topology and connected to the PLC via PROFINET.

Assigning a PROFINET Device Name and IP Address

All PROFINET devices are addressed in PROFINET via a unique PROFINET device name and IP address.

Before you begin

Make sure that:

- The PROFINET device has been added to the project.
  - See: *Adding the PROFINET Device to the Project*.

Steps

To assign the PROFINET device name and IP address in TIA Portal:

1. In the *Network view*, click the PROFINET device port.

   ⇒ The *Properties* tab opens.
2. Click *PROFINET interface [X1]*.

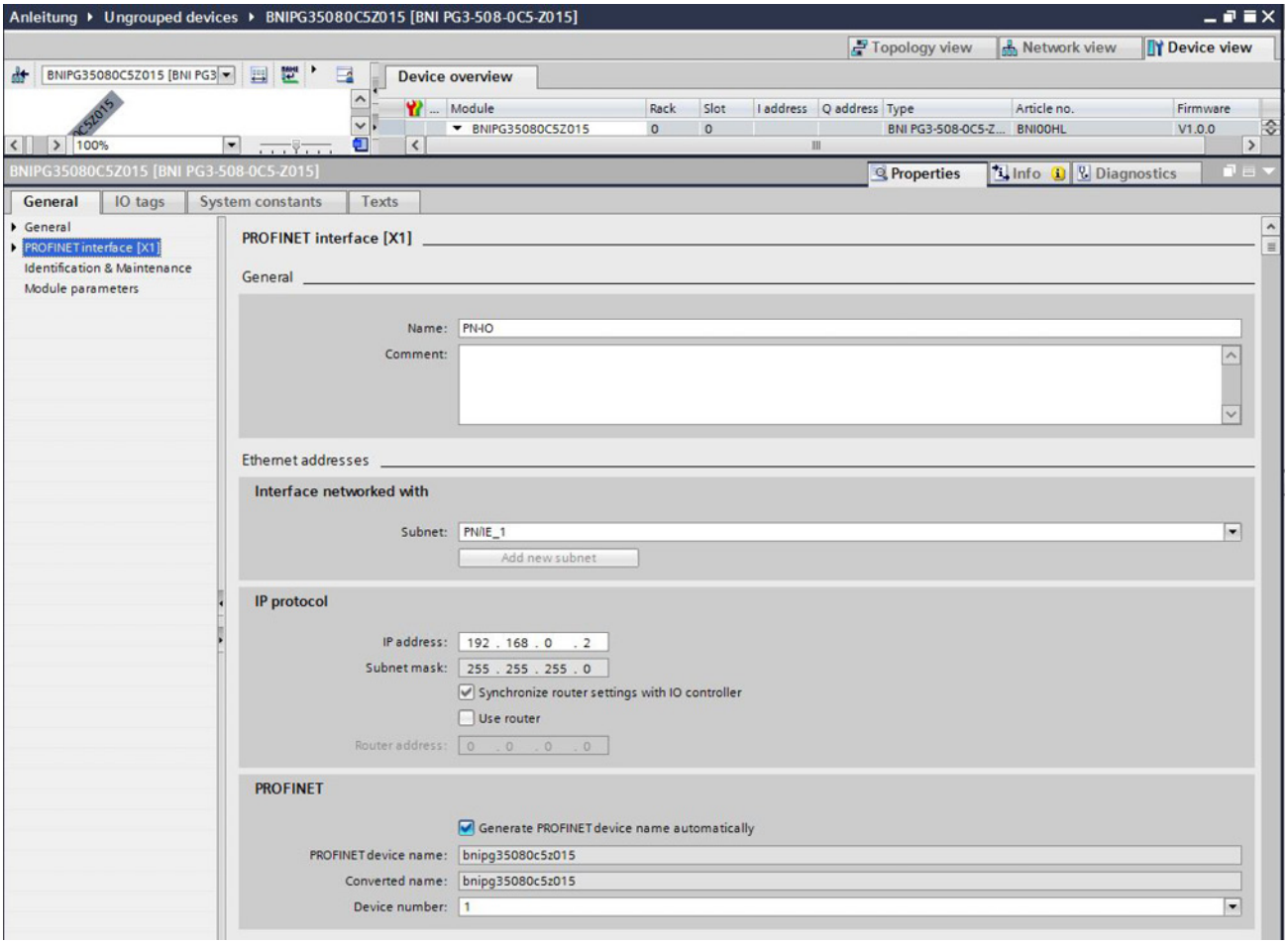


Fig. 58: PROFINET address

⇒ The communication parameters of the PROFINET device are displayed.

3. Optional: Change the default IP address.

   Under *IP protocol*, change the default settings for the IP address.

4. Optional: Change the default PROFINET device name.

   Under *PROFINET*, change the default settings for the PROFINET device name.

Establishing a PROFINET Device Connection

The PROFINET device name assigned offline must be assigned to the PROFINET device in the field.

Before you begin

Make sure that:

- The PROFINET device name has been configured in the project.
  - See: *Assigning a PROFINET Device Name and IP Address*.
- The PROFINET device is connected to the engineering PC and powered on.

Steps

To assign the PROFINET device name to the PROFINET device in TIA Portal:

1. Open the *Assign PROFINET device name* dialog.

   In the *Device overview*, right-click the PROFINET device and select *Assign device name*.

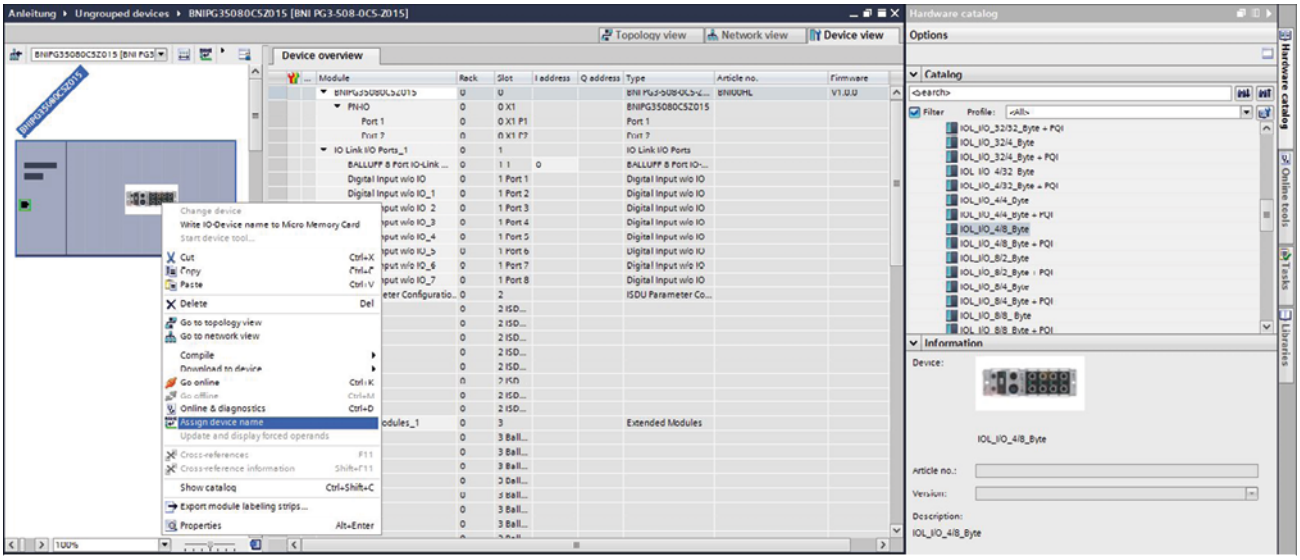


Fig. 59: Establishing the PROFINET device relationship

⇒ The *Assign PROFINET device name* dialog opens.

2. Select the previously assigned device name.

   Under *Configured PROFINET device* > *PROFINET device name*, select the previously assigned device name.

   The identification takes place via the MAC address or via the *Flash LED* function. This function causes the SF-LED on the module to flash three times at a frequency of 1 Hz.

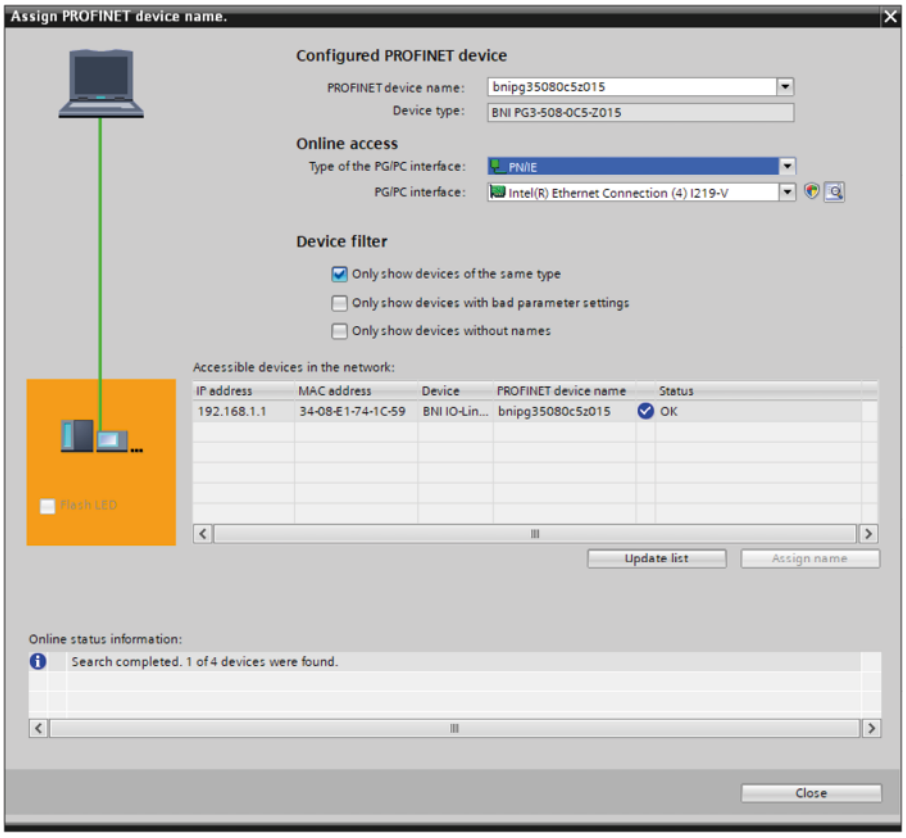


Fig. 60: Selecting the PROFINET device name

3. Click *Update list*.

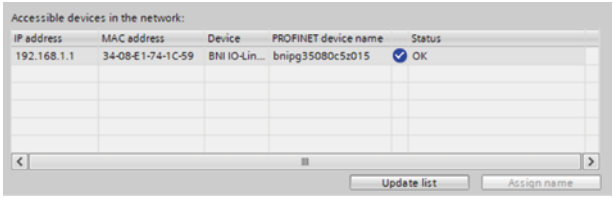


Fig. 61: List of found PROFINET devices

⇒ All PROFINET devices matching the PROFINET device name are displayed in the list.

4. Click *Assign name* to assign the desired PROFINET device name to the selected, found device.

> **Note**
>
> The PROFINET device name must match the name that was previously configured (see chapter *Assigning a PROFINET Device Name and IP Address*).

Testing the PROFINET Device Configuration

To test the PROFINET device connection, load the default configuration into the PROFINET device and go online in TIA Portal.

Before you begin

Make sure that:

- The PROFINET device has been added to the project and has been assigned a PROFINET device name and IP address.
  - See: *Assigning a PROFINET Device Name and IP Address*.
- The PROFINET device name has been assigned to the PROFINET device in the field.
  - See: *Establishing a PROFINET Device Connection*.

Steps

To test the PROFINET device configuration in TIA Portal:

1. Compile the program.

   In the toolbar, click the *Compile* icon.

2. Start the download.

   In the toolbar, click the *Download to device* icon.

   The *Load Preview* dialog opens.

3. Select the appropriate actions in the dropdowns of the *Load Preview* dialog.
4. Click *Load*.
5. Confirm the following dialog by clicking *Finish*.

   The PROFINET device configuration is loaded to the physical PROFINET device.

6. Go online.

   In the toolbar, click the *Go online* icon.

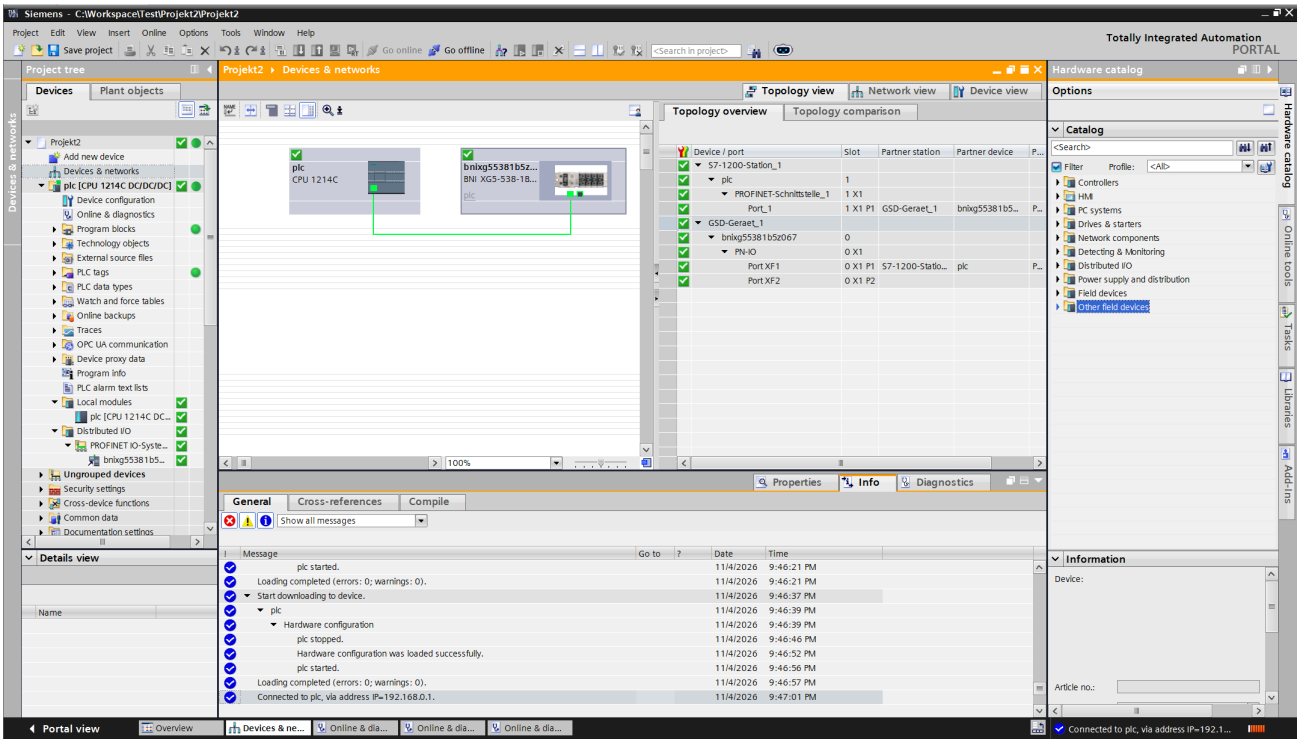


Fig. 62: Successfully integrated PROFINET device with active communication

⇒ Green checkmarks on all devices in the topology indicate successful integration and active communication.

The device's Web user interface is available by entering the device's IP address in your web browser's address bar.

Note

The bus error should be reset at the PROFINET device. If the PROFINET device continues to report a bus error, this could be because the PROFINET device relationship has not been established. The following remedies are possible:

- Via *Target system > Ethernet > Ethernet subscriber > Browse*, scan the network and check whether the PROFINET device is reporting under the correct PROFINET device name and IP address.
- If necessary, change the IP address or the PROFINET device name.
- Assign the PROFINET device name to the PROFINET device again and download the configuration.

9.10.2 PROFINET Module Basics

This chapter describes how the device's GSDML maps onto PROFINET slots, subslots, modules, and submodules. The illustrations are taken from the *Totally Integrated Automation Portal (TIA Portal)* and from SIMATIC Manager (Siemens AG) and are for reference only.

The BNI XG5-538-1B5-Z067 (order code BNI00K7) is used as the reference device throughout this chapter, consistent with the rest of this documentation. Other variants use the same slot/subslot/module/submodule model but may offer a different number of ports or a different set of modules per slot (for example, whether a Safety Hub module is available).

Device Model

TIA represents the device model as follows:

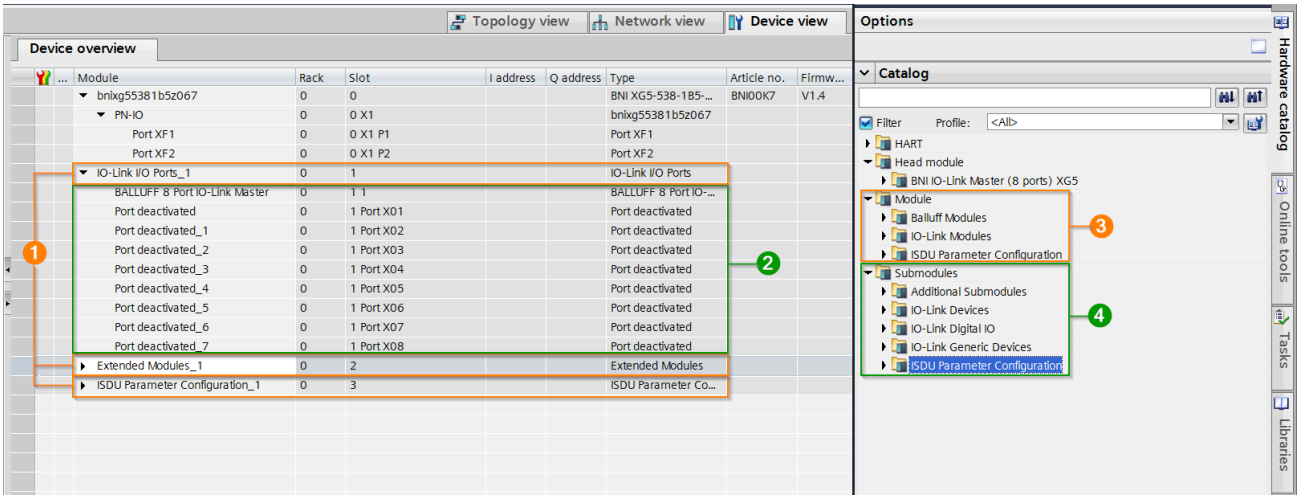


Fig. 63: The device model in TIA

Table 7: Legend

No.	Description
1	Slots
2	Subslots
3	Modules
4	Submodules

Slot Layout

The PROFINET device uses four slots (0–3). Slot 0 is the fixed head module and represents the BNI device itself. The PROFINET interface (PN-IO) is nested beneath it as subslot X1, and the two device ports are nested beneath the interface as subslots X1 P1 and X1 P2:

Table 8: Slot 0 layout

Module			Slot
Head module (BNI device)			0
	PN-IO (PROFINET interface)		0 X1
		Port XF1 (Port 1)	0 X1 P1
		Port XF2 (Port 2)	0 X1 P2

Slot 1 is mandatory and pre-assigned the *IO-Link I/O Ports* module by default. It represents the IO-Link interface: the IO-Link Proxy and the eight IO-Link ports are mapped as subslot 1 and subslots X01 to X08:

Table 9: Slot 1 layout

Module		Slot
IO-Link I/O Ports		1
	IO-Link Proxy (BALLUFF 8 Port IO-Link Master)	1 1
	Port 1	1 X01
	Port 2	1 X02
	Port 3	1 X03
	Port 4	1 X04
	Port 5	1 X05
	Port 6	1 X06
	Port 7	1 X07
	Port 8	1 X08

Slot 1 supports three module variants:

- IO-Link I/O Ports
- IO-Link I/O Ports (w/o IO)
- IO-Link I/O Ports (w/o IO) with Safety Hub and ISDU

Refer to *Port Modules* for more information on configuring the port modules.

Slots 2 and 3 are optional and are not assigned a module by default.

Slot 2 represents the extended modules. Refer to *Extended Modules* for more information on configuring the extended modules.

Slot 3 represents the ISDU parameter configuration modules; each subslot represents an IO-Link port. Refer to *ISDU Module* for more information on configuring the ISDU modules.

9.10.3 Configuring Modules

The following modules can be assigned and configured:

- Port module / IO-Link module (slot 1): Configures the IO-Link master and its eight ports. Each port can be assigned a submodule for a generic or preconfigured IO-Link device, or for digital input/output, together with port-level IO-Link parameters such as port mode, validation and backup, and the port quality index (PQI).
- Extended Modules (slot 2): Optional Balluff-specific submodules that add diagnostic and configuration functionality beyond the basic port I/O, for example port/device event monitoring, network module settings, device alias configuration, IoT settings, and user management settings.
- ISDU Parameter Configuration (slot 3): Submodules that write ISDU parameters to the connected IO-Link devices automatically whenever the PROFINET connection is established.

Port Modules

Slot 1 supports three module variants:

IO-Link I/O Ports
: The standard variant. The eight ports are mapped as subslots, and the module itself provides 1 input byte and 1 output byte for the digital Pin 2 I/O of all eight ports, so no additional submodules are needed to use basic Pin 2 digital I/O.

IO-Link I/O Ports (w/o IO)
: The same eight ports as *IO-Link I/O Ports*, but the module itself provides no input/output bytes ("w/o IO" = without IO data). To map Pin 2/4 digital I/O instead, use the *Input Pin 2*, *Input Pin 4*, *Output Pin 2* and *Output Pin 4* submodules, or the compact *Inputs Pin 4 / Pin 2 - Port Mapping* and *Outputs Pin 4 / Pin 2 - Port Mapping* submodules.

IO-Link I/O Ports (w/o IO) with Safety Hub and ISDU
: Same as *IO-Link I/O Ports (w/o IO)*, but the number of port subslots is doubled: each port gets a second subslot for a

safe communication, in addition to the subslot for its standard IO-Link submodule. Use this variant to integrate Balluff Safety Hub IO-Link devices (see *Integrating Safety-Hub*).

The following types of submodules are available for the subslots of the IO-Link modules in slot 1:

- Digital Input/Output: Support basic digital input and output functionality for the ports, allowing direct mapping of Pin 2/4 signals.
- IO-Link Generic Devices: Allow the integration of generic IO-Link devices by providing the necessary submodule for communication and configuration.
- Preconfigured IO-Link Devices from Balluff: Provide ready-to-use submodules for specific Balluff IO-Link devices, simplifying integration and configuration.

The submodules can be assigned to each of the 8 subslots. The subslots represent the ports.

Digital Input and Digital Output Submodules

In order to configure the port pins to input or output, the corresponding submodule *Digital Input* or *Digital Output* must be dragged to the port. Pin 4 of the port is fixed by which submodule is used (input for *Digital Input*, output for *Digital Output*); Pin 2 is configured separately through the submodule's own parameters.

Parameters

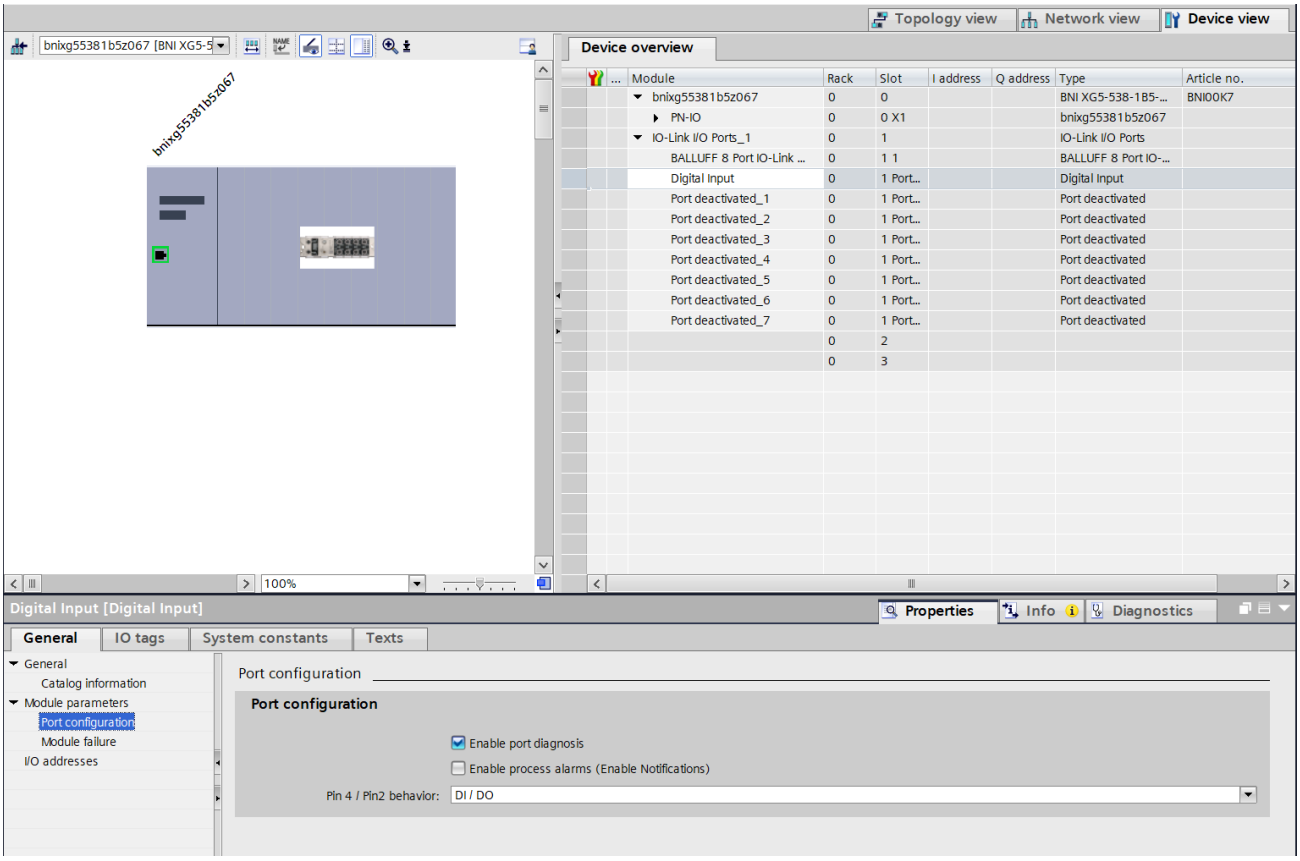


Fig. 64: Digital Input port configuration

Enable port diagnosis
Activates or deactivates the diagnostic messages of the port (static muting).

Enable process alarms
Maps single-shot events (notifications) to process alarms.

Pin 4 / Pin2 behavior

Pin 4 is fixed by the submodule used and cannot be changed. This setting only defines the behavior of Pin 2.

The following settings are possible (identical for *Digital Input* and *Digital Output*, the first part of the name reflects the plugged submodule):

- *DI/DO / NC*: Pin 2 deactivated.
- *DI/DO / DI*: Pin 2 digital input.
- *DI/DO / DO*: Pin 2 digital output.
- *DI/DO / Power*: Continuous voltage (actuator supply) on Pin 2.

> **Note**
>
> XG1 devices have no outputs to Pin 2.

Input Processdata

Where the Pin 2 and Pin 4 input data actually appears depends on which slot 1 module variant is plugged (see *Port Modules*):

- *IO-Link I/O Ports* (with IO): Pin 2 of all 8 ports is combined into the module's own input byte, one bit per port. Each plugged *Digital Input* submodule additionally provides its own **1 input byte** for Pin 4 of that port: `0x00` means low, any non-zero value (any bit set) means high.
- *IO-Link I/O Ports (w/o IO)*: Neither the module nor the *Digital Input* submodule provide any process data (the submodule still only exposes the parameters above). Pin 2 and Pin 4 of all 8 ports must instead be read via the *Input Pin 2* and *Input Pin 4* submodules (or the combined *Inputs Pin 4 / Pin 2 - Port Mapping* submodule) in slot 2.

Output Processdata

The same applies to outputs:

- *IO-Link I/O Ports* (with IO): Pin 2 of all 8 ports is combined into the module's own output byte, one bit per port. Each plugged *Digital Output* submodule additionally provides its own **1 output byte** for Pin 4 of that port: `0x00` means low, any non-zero value (any bit set) means high.
- *IO-Link I/O Ports (w/o IO)*: Neither the module nor the *Digital Output* submodule provide any process data. Pin 2 and Pin 4 of all 8 ports must instead be written via the *Output Pin 2* and *Output Pin 4* submodules (or the combined *Outputs Pin 4 / Pin 2 - Port Mapping* submodule) in slot 2.

Digital Input with IO-Link Parametrization

Digital Input with IO-Link Parametrization is a special variant of the *Digital Input* submodule for IO-Link SIO devices. Its parameters and process data are identical to the regular *Digital Input* submodule described above.

In normal operation, the port behaves exactly like a regular digital input. However, when the PLC program uses the `IOL_CALL` function block to send an ISDU request to the device on that port, the port is automatically switched to IO-Link Autostart, the ISDU request is carried out, and the port then falls back to digital input operation. This allows occasional ISDU access (for example reading or writing a device parameter) on a port that is otherwise used as a plain digital input.

IO-Link Generic Devices Submodules

> **Note**
>
> Please check whether IO-Link is supported by your module before using this function. For more information on product variants that support IO-Link, see *Supported product variants*.

The *IO-Link Generic Devices* submodules let a port exchange cyclic process data with any IO-Link device, independently of a specific device profile. A submodule is available for every combination of input and output process data length from 0 to 32 bytes (for example 1, 2, 4, 6, 8, 10, 16, 24, or 32 bytes), covering pure input, pure output, and combined input/output data. Each length combination is available both with and without the port quality index (PQI), see *Port Quality Index (PQI)*.

Input and Output Processdata

Submodule names follow a naming pattern that encodes process data direction and length, with an optional PQI suffix:

`IOL_I_<length>_Byte`
: Input only. *length* is the number of input bytes, for example `IOL_I_01_Byte` for 1 input byte.

`IOL_O_<length>_Byte`
: Output only. *length* is the number of output bytes, for example `IOL_O_01_Byte` for 1 output byte.

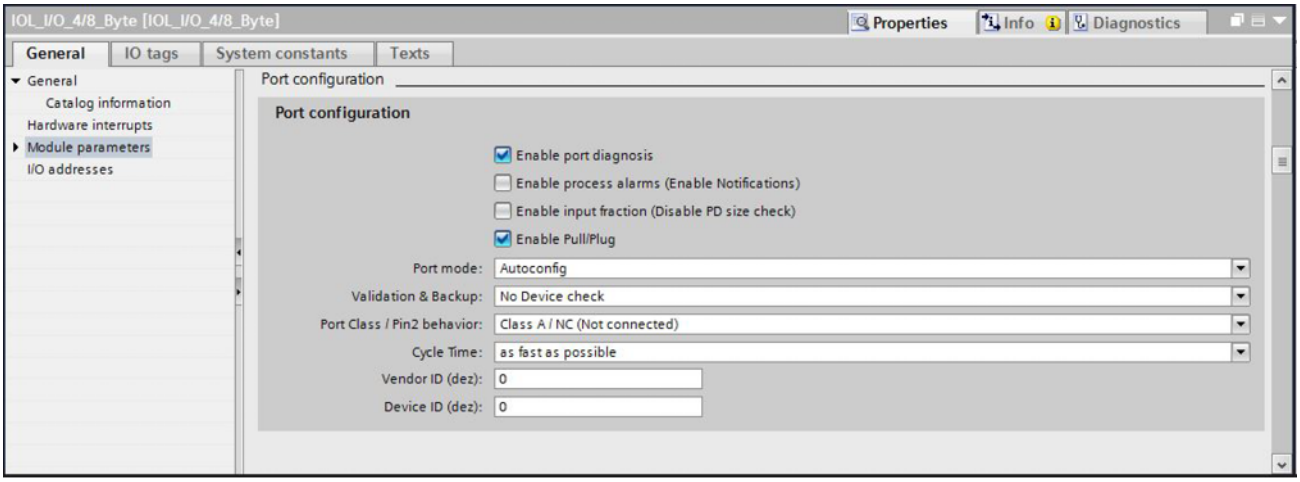
`IOL_I/O_<in>/<out>_Byte`
: Input and output. *in* and *out* are the number of input and output bytes, for example `IOL_I/O_08/08_Byte` for 8 input bytes and 8 output bytes.

Append `+ PQI` to any of the names above to select the variant that also includes the port quality index (PQI), for example `IOL_I_01_Byte + PQI`. See *Port Quality Index (PQI)* for more information about the port quality index.

Select the submodule whose input/output length matches the process data size of the connected IO-Link device (see the device's IODD or manual) and drag it to the corresponding port subslot.

Parameters

In the network module properties, the IO-Link parameters of the respective port can be changed.



Note

IO-Link configuration:
If the connected IO-Link device provides outputs, Pin 2 at the corresponding port must be configured as an output (see *Port Quality Index (PQI)*). Does not apply to XG1 devices.

The following parameters can be set:

Enable port diagnosis
: Activates or deactivates the diagnostic messages of the port (static muting).

Enable process alarms
: Maps single-shot events (notifications) to process alarms.

Enable input fraction
: Defines whether the input process data length of the connected IO-Link device is strictly checked against the configured submodule's input length.

  - Disabled (default): The device's input data length must be greater than or equal to the submodule's input length, otherwise a process data mismatch diagnosis is raised.
  - Enabled: This check is skipped, so the device may provide less input data than the configured submodule length without raising a diagnosis.

> **Note**
>
> Only affects input process data. Output process data length is always checked.

Enable Pull/Plug
Defines how the loss or return of a connected IO-Link device is reported: via PROFINET diagnosis (disabled), or via Pull/Plug (add/remove submodule), which triggers the PLC's diagnostic interrupt OB82 (enabled).

Port mode
Defines the mode of the port.

The following settings are possible:

- *Deactivated*: Switches the port off.
- *Set Port Config*: Enables some settings to be changed manually, e.g. Cycle Time. Corresponds to the IO-Link master port mode *IO-Link Manual*.
- *Autoconfig*: Activates IO-Link and the data exchange between master and device. Corresponds to the IO-Link master port mode *IO-Link Autostart*.

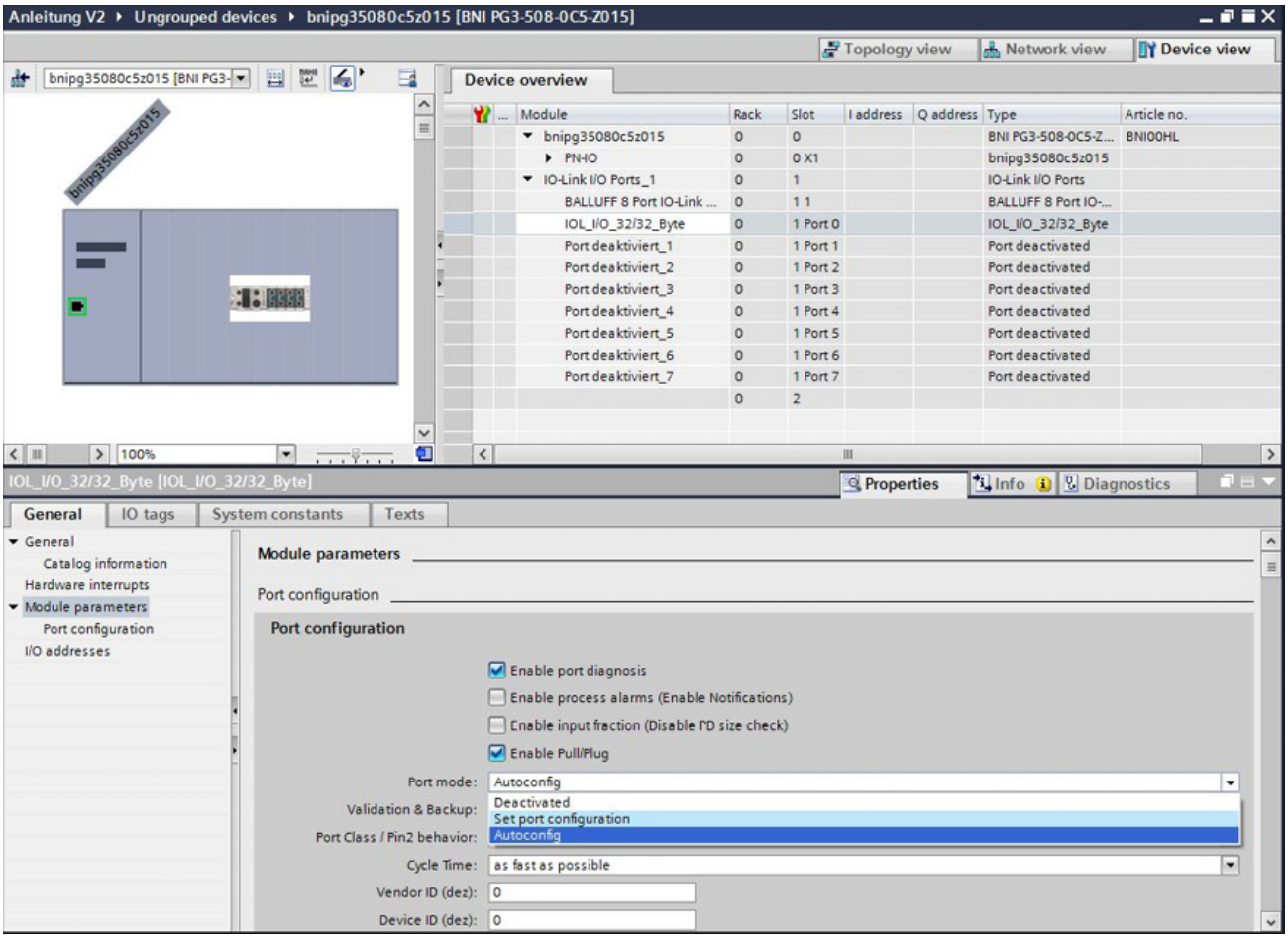


Fig. 65: Port Configuration – Port Mode

> **Note**
>
> Port mode must be set to *Set Port Config* to enable Validation & Backup (data storage), Vendor ID and Device ID.

Validation & Backup
Used to identify specific or individual device types with which a data exchange should take place.

The following settings are possible:

- *No Device Check*: Validation is deactivated and every device is accepted.
- *Compatibility Device V1.0*: Only devices according to IOL specification 1.0 are accepted. No data storage, only validation active.
- *Compatibility Device V1.1*: Only devices according to IOL specification 1.1 are accepted. No data storage, only validation active.
- *Compatibility Device V1.1 Backup and recovery*: Only devices according to IOL specification 1.1 are accepted. Data storage with upload and download, with validation.
- *Compatibility Device V1.1 Recovery*: Only devices according to IOL specification 1.1 are accepted. Data storage only with download (Master to Device), with validation.

Use together with *Vendor ID* and *Device ID* to restrict validation to a specific device type.

Vendor ID
The decimal vendor ID of the IO-Link device expected at this port. Used together with *Validation & Backup* to restrict validation to devices from a specific vendor.

Device ID
The decimal device ID of the IO-Link device expected at this port. Used together with *Validation & Backup* to restrict validation to this specific device type.

Port Class / Pin2 behavior
Pin 4 behavior is always defined by the submodule plugged into the port. This setting only defines the behavior of Pin 2.

The following settings are possible (identical for Class A and Class B ports):

- *Class A/B / NC*: Pin 2 deactivated.
- *Class A/B / DI*: Pin 2 digital input.
- *Class A/B / DO*: Pin 2 digital output.
- *Class A/B / Power*: Continuous voltage (actuator supply) on Pin 2.

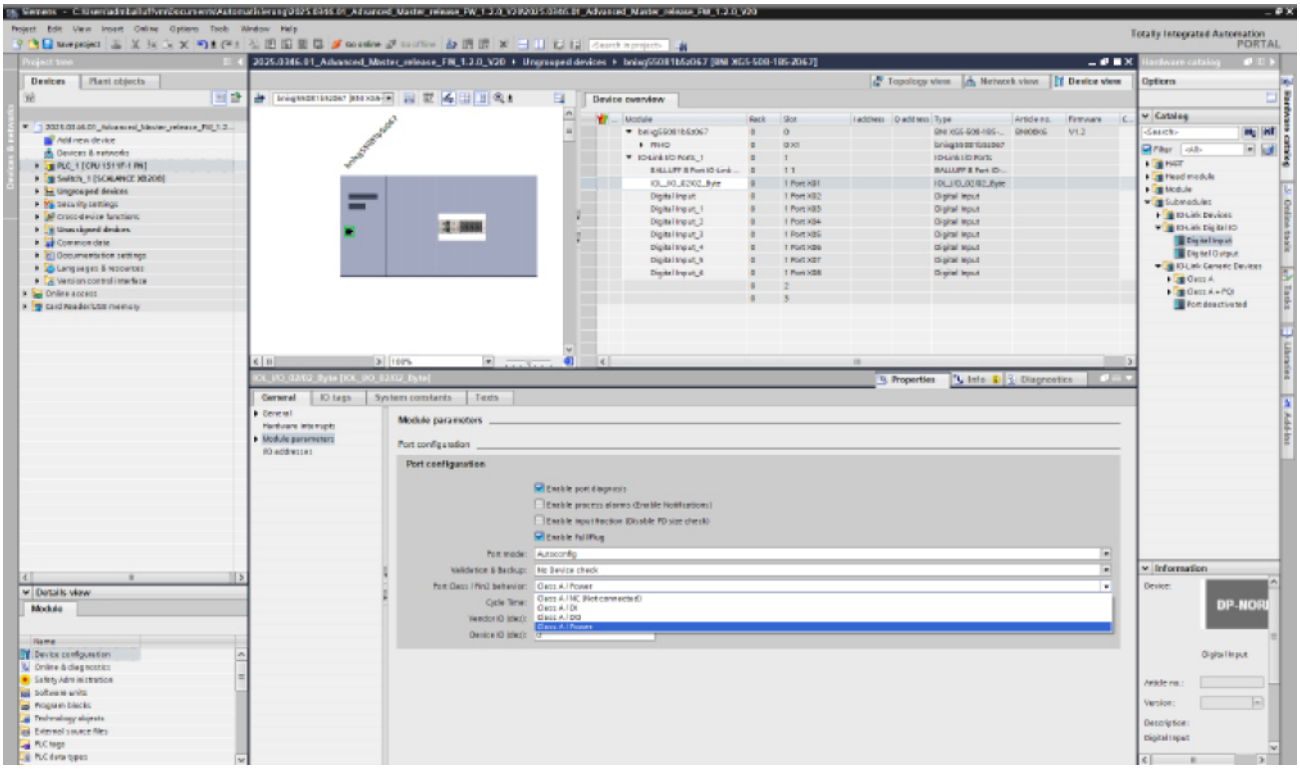


Fig. 66: Port Configuration – Pin 4 / Pin 2 Behavior

> **Note**
>
> Class B only available for devices with Class B property.

Cycle Time
: Makes it possible to influence the IO-Link communication speed, using the drop-down menu.

Port Quality Index (PQI)

Network modules are available with and without PQI. The PQI is 1 byte long and contains various information about the respective port status. This information can be found at the end of the input data of the submodule of a port for each bit.

The “Port Qualifier Information” (PQI) is a 1-byte status value that reports the status of an IO-Link port and the connected device.

Table 10: Port Qualifier Information (PQI) – Bits

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Device Process Data validity	Port/Device error indication	Device communication	Port operation (“1”)	Reserved (“0”)			
PQ	DevErr	DevCom	Port active	–			

The flags have the following meaning:

PQ

Value	Description
0	Process data from device invalid
1	Process data from device valid

DevErr

Value	Description
0	No errors/warnings
1	Errors/warnings occurred.

DevCom

Value	Description
0	No device available
1	Device available

PortActive

Value	Description
0	Port deactivated.
1	Port activated.

Note

Specification coverage: PQI is implemented according to *IO-Link Integration for PROFINET* (PI Order No. 2.832, Version 1.1 Edition 2, clause 7.3.4.2, Table 22). That specification additionally defines bit 2 (*NewPar* – a new Data Storage backup object became available after a Device parameter upload) and bit 3 (*SubstDev* – a substitute Device with a different serial number was detected). Both flags are currently not supported by this device family and are therefore always reported as reserved (“0”).

IO-Link Devices Submodules

The *IO-Link Devices* submodules provide ready-to-use, preconfigured submodules for specific Balluff IO-Link devices (for example sensors, IO-Link hubs, and BIS RFID devices) from the device catalog, identified by their exact product name, for example *BNI IOL-709-000-XXXX*.

Note

For Balluff Safety Hub IO-Link devices, use the *IO-Link I/O Ports (w/o IO) with Safety Hub and ISDU* module variant instead (see *Integrating Safety-Hub*).

Input and Output Processdata

Unlike the generic submodules (see *IO-Link Generic Devices Submodules*), where the process data length must be selected manually, the input and output process data length of a device catalog submodule is tailored exactly to the selected device, so no manual length matching is required.

Parameters

The parameters of a device catalog submodule contain the port configuration parameters (see *Parameters*) as well as the ISDU parameters of the selected device, taken from its IODD. This allows the device to be parameterized directly from the engineering tool for easy commissioning.

The ISDU parameters are forwarded to the device as ISDU write accesses and written to the device:

- each time the IO-Link device is reconnected
- for a new connection with the PLC

Usage

This section describes how to add a preconfigured IO-Link device submodule to a port.

Before you begin

Make sure that:

- The GSDML file of the PROFINET device has been installed.
  - See: *Set Up Initial PROFINET Device Connection*.
- The IO-Link device to be used is connected to the port.

Steps

To add a preconfigured IO-Link device submodule in TIA Portal:

- In the hardware catalog, select the desired device by its exact product name and drag it to the corresponding port subslot (slot 1).

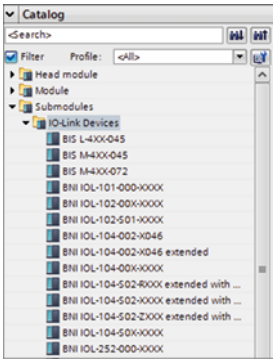


Fig. 67: Select devices

⇒ The device parameters appear in the module parameters of the corresponding port and can be selected.

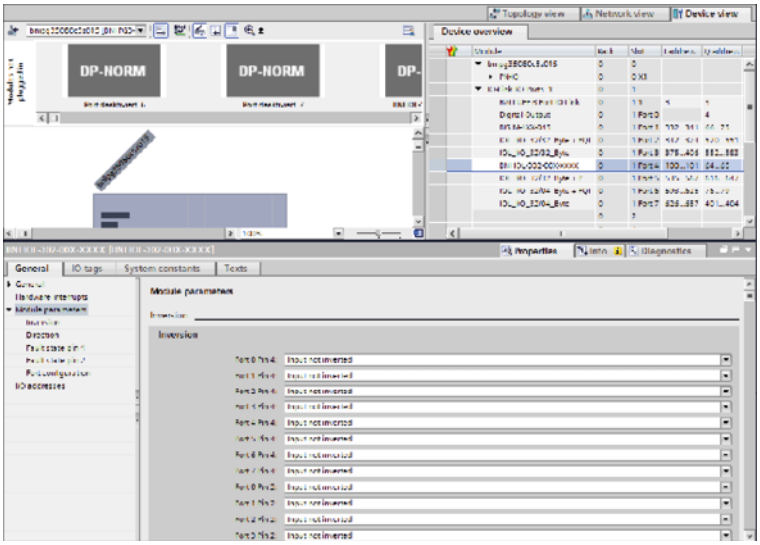


Fig. 68: Parameters of the selected device

Extended Modules

In this chapter the modules are descriped which can be plugged into the extended slots of the device. Note that not all modules are available for all variants.

Input Pin 4

This module maps pin 4 of each port to an input bit, independently of the network module configured in slot 1.

Note

The *IO-Link I/O Ports (w/o IO)* module must be plugged into slot 1 (the port head slot) for this module to provide data.

Parameters

This module has no parameters.

Input Processdata

This module provides **1 input byte**, one bit per port.

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Port 8	Port 7	Port 6	Port 5	Port 4	Port 3	Port 2	Port 1

Output Processdata

This module has no Output Processdata.

Input Pin 2

This module maps pin 2 of each port to an input bit, independently of the network module configured in slot 1.

Note

The *IO-Link I/O Ports (w/o IO)* module must be plugged into slot 1 (the port head slot) for this module to provide data.

Parameters

This module has no parameters.

Input Processdata

This module provides **1 input byte**, one bit per port.

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Port 8	Port 7	Port 6	Port 5	Port 4	Port 3	Port 2	Port 1

Output Processdata

This module has no Output Processdata.

Output Pin 4

This module maps pin 4 of each port to an output bit, independently of the network module configured in slot 1.

Note

The *IO-Link I/O Ports (w/o IO)* module must be plugged into slot 1 (the port head slot) for this module to take effect.

Parameters

This module has no parameters.

Input Processdata

This module has no Input Processdata.

Output Processdata

This module provides **1 output byte**, one bit per port.

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Port 8	Port 7	Port 6	Port 5	Port 4	Port 3	Port 2	Port 1

Output Pin 2

This module maps pin 2 of each port to an output bit, independently of the network module configured in slot 1.

Note

The *IO-Link I/O Ports (w/o IO)* module must be plugged into slot 1 (the port head slot) for this module to take effect.

Note

XG1 devices have no outputs to Pin 2.

Parameters

This module has no parameters.

Input Processdata

This module has no Input Processdata.

Output Processdata

This module provides **1 output byte**, one bit per port.

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Port 8	Port 7	Port 6	Port 5	Port 4	Port 3	Port 2	Port 1

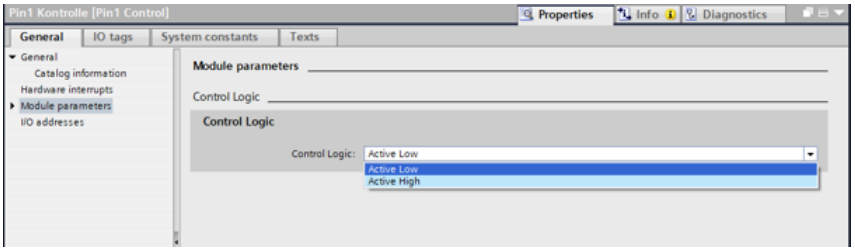
Pin1 Control

With this submodule, Pin 1 of each port can be switched off via process data.

Parameters

This module has one parameter.

Parameter	Description	Default
Control Logic	Defines whether a set output bit switches Pin 1 off or on	0 – Active Low



There are two selection options:

- Value 0 – Active Low (default)
  - Output bit = 1 -> Pin 1 is OFF
  - Output bit = 0 -> Pin 1 is ON
- Value 1 – Active High
  - Output bit = 1 -> Pin 1 is ON
  - Output bit = 0 -> Pin 1 is OFF

Input Processdata

This module has no Input Processdata.

Output Processdata

This module provides **1 output byte**. Each bit switches Pin 1 of the corresponding port according to the configured *Control Logic* parameter.

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Port 8	Port 7	Port 6	Port 5	Port 4	Port 3	Port 2	Port 1

Outputs Pin 4 / Pin 2 - Port Mapping

This module maps the Pin 4 and Pin 2 output command bits of all 8 ports into a compact 2-byte block instead of separate per-pin bytes. A set Pin 2 bit drives the port's IQ output, and a set Pin 4 bit drives the port's CQ output. The mapped bits are only applied when the port's IOPS is good and the connection is in RUN, and only take effect on ports where the corresponding *Output Pin 4*/*Output Pin 2* module allows it.

Note

The *IO-Link I/O Ports (w/o IO)* module must be plugged into slot 1 (the port head slot) for this module to take effect.

Parameters

This module has no parameters.

Output Processdata

This module provides **2 output bytes**, 2 bits (Pin 4, Pin 2) per port, 4 ports per byte.

Byte 0	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	Port 4 Pin 2	Port 4 Pin 4	Port 3 Pin 2	Port 3 Pin 4	Port 2 Pin 2	Port 2 Pin 4	Port 1 Pin 2	Port 1 Pin 4

Byte 1	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	Port 8 Pin 2	Port 8 Pin 4	Port 7 Pin 2	Port 7 Pin 4	Port 6 Pin 2	Port 6 Pin 4	Port 5 Pin 2	Port 5 Pin 4

Input Processdata

This module has no Input Processdata.

Inputs Pin 4 / Pin 2 - Port Mapping

This module maps the Pin 4 and Pin 2 input state bits of all 8 ports into a compact 2-byte block instead of separate per-pin bytes. A set Pin 2 bit reflects the port's IQ/readback logic, and a set Pin 4 bit reflects the port's SMI input validity/data check. Each bit is only effective on ports where the corresponding *Input Pin 4*/*Input Pin 2* module allows it.

Note

The *IO-Link I/O Ports (w/o IO)* module must be plugged into slot 1 (the port head slot) for this module to provide data.

Parameters

This module has no parameters.

Input Processdata

This module provides **2 input bytes**, 2 bits (Pin 4, Pin 2) per port, 4 ports per byte.

Byte 0	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	Port 4 Pin 2	Port 4 Pin 4	Port 3 Pin 2	Port 3 Pin 4	Port 2 Pin 2	Port 2 Pin 4	Port 1 Pin 2	Port 1 Pin 4

Byte 1	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	Port 8 Pin 2	Port 8 Pin 4	Port 7 Pin 2	Port 7 Pin 4	Port 6 Pin 2	Port 6 Pin 4	Port 5 Pin 2	Port 5 Pin 4

Output Processdata

This module has no Output Processdata.

Pin 1 Short Circuit Detection

If a short circuit is detected at a port on pin 1, the corresponding bit is set to 1.

Parameters

This module has no parameters.

Input Processdata

This module provides **1 input byte**, one bit per port.

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Port 8	Port 7	Port 6	Port 5	Port 4	Port 3	Port 2	Port 1

Output Processdata

This module has no Output Processdata.

Pin 4/2 Actuator Ground Short Circuit Detection

If a short circuit is detected at a port on the pin, the corresponding bit is set to 1.

Parameters

This module has no parameters.

Input Processdata

This module provides **2 input bytes**: Byte 0 reflects Pin 4 short circuit status and Byte 1 reflects Pin 2 short circuit status, one bit per port.

Byte 0	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	Port 8 Pin 4	Port 7 Pin 4	Port 6 Pin 4	Port 5 Pin 4	Port 4 Pin 4	Port 3 Pin 4	Port 2 Pin 4	Port 1 Pin 4

Byte 1	Bit 7 (15)	Bit 6 (14)	Bit 5 (13)	Bit 4 (12)	Bit 3 (11)	Bit 2 (10)	Bit 1 (9)	Bit 0 (8)
	Port 8 Pin 2	Port 7 Pin 2	Port 6 Pin 2	Port 5 Pin 2	Port 4 Pin 2	Port 3 Pin 2	Port 2 Pin 2	Port 1 Pin 2

Output Processdata

This module has no Output Processdata.

Pin 4 IO-Link Short Circuit Detection

If an IO-Link short circuit is detected at a port on pin 4, the corresponding bit is set to 1. The port must be configured to IO-Link.

Parameters

This module has no parameters.

Input Processdata

This module provides **1 input byte**, one bit per port.

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Port 8 Pin 4	Port 7 Pin 4	Port 6 Pin 4	Port 5 Pin 4	Port 4 Pin 4	Port 3 Pin 4	Port 2 Pin 4	Port 1 Pin 4

Output Processdata

This module has no Output Processdata.

Pin 4/2 Actuator Warning Detection

If pin 2/4 of connection x (where x is a number between 1 and 8) is configured to:

- OUTPUT (Pin 2/4)
  - If the voltage is low and an external voltage is applied, the bit is set to true.
  - If high-controlled (UA is missing; therefore the output is physically low) and an external voltage is applied, the bit is set to true.
- POWER (Pin 2)
  - If UA is missing and external voltage is applied, the bit is set to true.

Parameters

This module has no parameters.

Input Processdata

This module provides **2 input bytes**: Byte 0 reflects Pin 4 warning status and Byte 1 reflects Pin 2 warning status, one bit per port.

Byte 0	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	Port 8 Pin 4	Port 7 Pin 4	Port 6 Pin 4	Port 5 Pin 4	Port 4 Pin 4	Port 3 Pin 4	Port 2 Pin 4	Port 1 Pin 4

Byte 1	Bit 7 (15)	Bit 6 (14)	Bit 5 (13)	Bit 4 (12)	Bit 3 (11)	Bit 2 (10)	Bit 1 (9)	Bit 0 (8)
	Port 8 Pin 2	Port 7 Pin 2	Port 6 Pin 2	Port 5 Pin 2	Port 4 Pin 2	Port 3 Pin 2	Port 2 Pin 2	Port 1 Pin 2

Output Processdata

This module has no Output Processdata.

Detection for Short Circuit and Actuator Warning

If an error with the following modules occurs, the corresponding bit is set to *true*:

- Pin 1 Short Circuit Detection
- Pin 4/2 Actuator Warning Detection
- Pin 4/2 Actuator Ground Short Circuit Detection
- Pin 4 IO-Link Short Circuit Detection

Parameters

This module has no parameters.

Input Processdata

This module provides **1 input byte**, one bit per port.

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Port 8	Port 7	Port 6	Port 5	Port 4	Port 3	Port 2	Port 1

Output Processdata

This module has no Output Processdata.

IO-Link Device Diagnosis Disable

Note

Please check whether IO-Link is supported by your module before using this function. For more information on product variants that support IO-Link, see *Supported product variants*.

If this function is configured, the IO-Link diagnosis remains activated for all ports and can be deactivated for the desired ports by setting the bit for the respective port.

Parameters

This module has no parameters.

Input Processdata

This module has no Input Processdata.

Output Processdata

This module provides **1 output byte**, one bit per port.

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Port 8	Port 7	Port 6	Port 5	Port 4	Port 3	Port 2	Port 1

IO-Link Communication

> **Note**
>
> Please check whether IO-Link is supported by your module before using this function. For more information on product variants that support IO-Link, see *Supported product variants*.

Bit status for each IO-Link port, i.e. feedback on whether communication has been established.

Parameters

This module has no parameters.

Input Processdata

This module provides **1 input byte**, one bit per port.

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Port 8	Port 7	Port 6	Port 5	Port 4	Port 3	Port 2	Port 1

Output Processdata

This module has no Output Processdata.

IO-Link PD Valid

> **Note**
>
> Please check whether IO-Link is supported by your module before using this function. For more information on product variants that support IO-Link, see *Supported product variants*.

Bit status for each IO-Link Port, i.e. feedback whether the process data at the corresponding port are set to Valid.

Parameters

This module has no parameters.

Input Processdata

This module provides **1 input byte**, one bit per port.

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Port 8	Port 7	Port 6	Port 5	Port 4	Port 3	Port 2	Port 1

Output Processdata

This module has no Output Processdata.

Module Diagnosis Disable

The *Diagnostics Deactivated* module allows various diagnostic messages sent by the module to be suppressed.

To deactivate the diagnostic messages:

- Plug the *Diagnosis Disable* module into the extended modules (see *Configurations of the Diagnosis Disable module*).

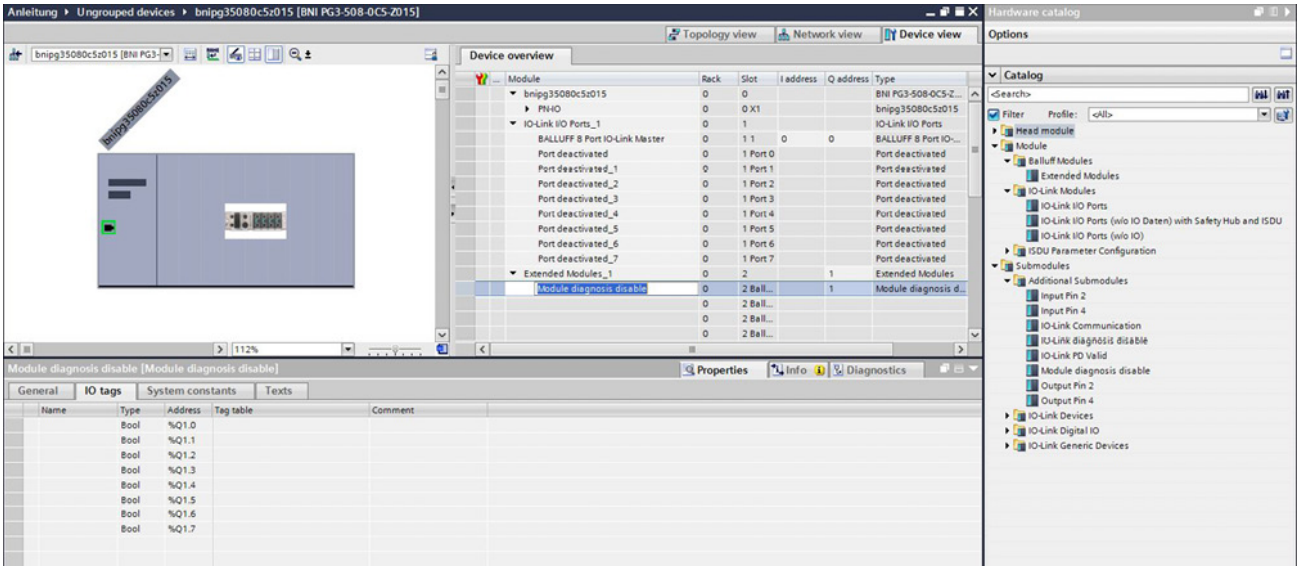


Fig. 69: Plugged-in Diagnosis Disable module

Parameters

This module has no parameters.

Input Processdata

This module has no Input Processdata.

Output Processdata

This module provides **1 output byte**. The table below shows the individual bit fields and their possible values.

Table 11: Configurations of the Diagnosis Disable module

Bit position	Value 0	Value 1
Bit 0	Global diagnostics activated.All diagnostics are sent.	Global diagnostics deactivated.All diagnostics from the module to the controller are suppressed. If diagnostics are already pending, they are deleted.
Bit 1	UA diagnostics activated.UA diagnostics are sent.	UA diagnostics deactivated.All UA diagnostics from the module to the controller are suppressed. If UA diagnostics are already pending, they are deleted.
Bit 2	reserved	reserved
Bit 3	reserved	reserved
Bit 4	reserved	reserved
Bit 5	reserved	reserved
Bit 6	reserved	reserved
Bit 7	reserved	reserved

Pending diagnostics can be deleted at runtime by toggling the bit.

Port Event Pending

If an event is pending for a port, the corresponding bit is set to 1. If no event is pending for the port, the bit is set to 0. If multiple events were pending for a port, all of them must be cleared before the bit is reset to 0.

Parameters

This module has no parameters.

Input Processdata

This module provides **1 input byte**, one bit per port.

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Port 8	Port 7	Port 6	Port 5	Port 4	Port 3	Port 2	Port 1

Output Processdata

This module has no Output Processdata.

IO-Link Device Event Pending

If an IO-Link device event is pending at a port, the corresponding bit is set to 1. If no IO-Link device event is pending for the port, the bit is set to 0. If multiple events were pending for the port, all of them must be cleared before the bit is reset to 0.

Parameters

This module has no parameters.

Input Processdata

This module provides **1 input byte**, one bit per port.

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Port 8	Port 7	Port 6	Port 5	Port 4	Port 3	Port 2	Port 1

Output Processdata

This module has no Output Processdata.

Station Diagnosis

This module combines the diagnostic bits of several other Extended Modules — plus dedicated supply-voltage (US/UA) status bits — into a single 3-byte diagnostic block, instead of requiring each individual diagnostic module to be plugged in separately.

Parameters

This module has no parameters.

Input Processdata

This module provides **3 input bytes**.

Byte 0	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	Reserved	UA overvoltage	UA undervoltage	UA no voltage	Reserved	Reserved	US overvoltage	US undervoltage

Byte 1	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	Pin 4 IO-Link short circuit	Pin 2 actuator-supply warning	Pin 4 actuator-supply warning	Reserved	Reserved	Pin 2 actuator-ground short circuit	Pin 4 actuator-ground short circuit	Pin 1 short circuit

Byte 2	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	Reserved	Reserved	IO-Link device event pending	PD invalid summary	Reserved	Reserved	Reserved	Port event pending

Byte 1's bits mirror the *Pin 1 Short Circuit Detection*, *Pin 4/2 Actuator Ground Short Circuit Detection*, *Pin 4/2 Actuator Warning Detection*, and *Pin 4 IO-Link Short Circuit Detection* modules; Byte 2's bits mirror the *Port Event Pending* and *IO-Link Device Event Pending* modules, plus a summary PD-invalid bit.

Output Processdata

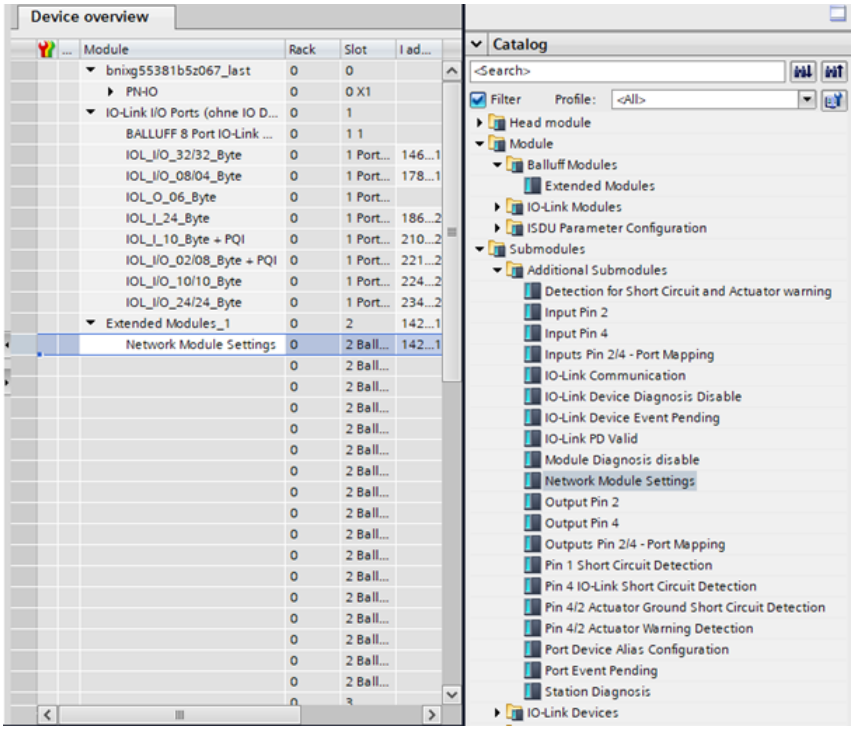
This module has no Output Processdata.

Network Module Settings

Note

This module is only available for the XG5-538-...-variants.

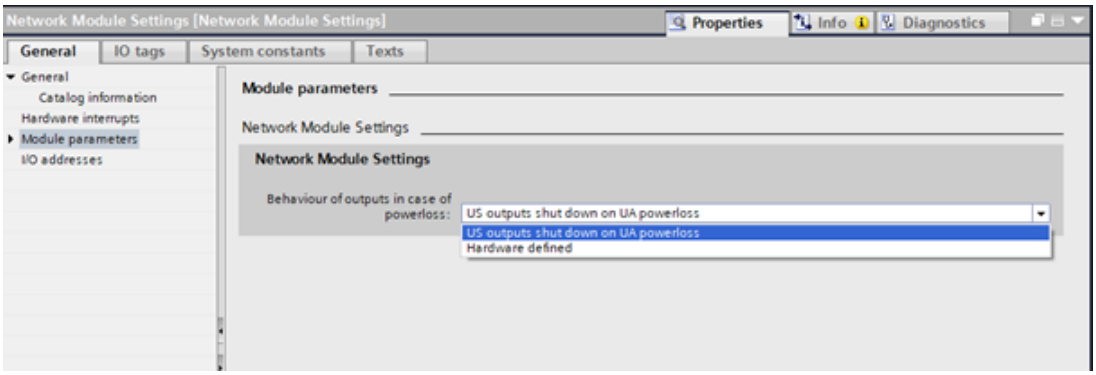
The network module settings module in the extended Balluff PROFINET submodules allows the behavior of the IO-Link master outputs to be influenced in the event of a sudden loss of actuator voltage UA. The configured setting is **saved permanently** — the module can be inserted, configured, and afterwards removed; the setting will be retained.



Parameters

This module has one parameter.

Parameter	Description	Default
UA Power Setting	Defines what happens to active outputs on Pin 2 and Pin 4 when UA voltage is lost	0 – US Outputs shutdown on UA powerloss



There are two selection options:

- Value 0 – US Outputs shutdown on UA powerloss

  All active outputs on Pin 2 and Pin 4 are automatically switched off in the event of a UA voltage drop. This matches the behavior of a XG5-508-... master, even though Pin 2 and Pin 4 of Class A output ports are supplied by US, and Pin 4 of Class B ports are supplied by UA.

- Value 1 – Hardware Defined

  US powered outputs will not be switched off in the event of a UA voltage drop. All outputs remain in their current state. Only Class B Pin 2 outputs are physically supplied by UA and will therefore be shut down.

Input Processdata

This module provides **4 input bytes** reflecting the currently active value of the *UA Powerloss behavior Setting* parameter.

Table 12: Port Qualifier (PQI) – Bits

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 0	Reserved				Read Value Enum UA Powerloss Behavior			
Byte 1	Reserved							
Byte 2	Reserved							
Byte 3	Reserved							

Output Processdata

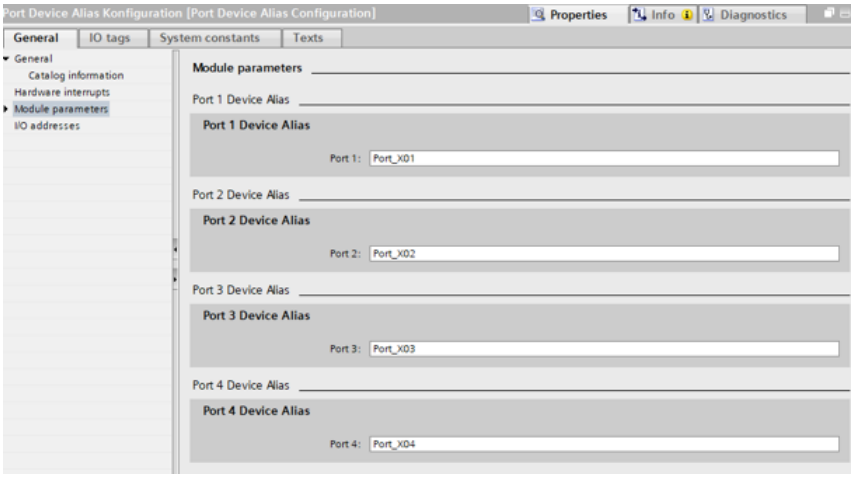
This module has no Output Processdata.

Port Device Alias Configuration

With this submodule, an individual device alias can be assigned to each port. The device alias is used by the REST API and is shown in the WebUI.

Note

Since the device alias is saved permanently, this module can be removed from the configuration again after it has been configured successfully.



Parameters

This module has 8 parameters, one device alias per port (max. 32 characters each).

Parameter	Description	Default
Port 1 Device Alias	Device alias for Port 1	`Port_X01`
Port 2 Device Alias	Device alias for Port 2	`Port_X02`
Port 3 Device Alias	Device alias for Port 3	`Port_X03`
Port 4 Device Alias	Device alias for Port 4	`Port_X04`
Port 5 Device Alias	Device alias for Port 5	`Port_X05`
Port 6 Device Alias	Device alias for Port 6	`Port_X06`
Port 7 Device Alias	Device alias for Port 7	`Port_X07`
Port 8 Device Alias	Device alias for Port 8	`Port_X08`

Input Processdata

This module provides **8 input bytes**, one status byte per port, reporting the result of the alias assignment for that port.

Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
Port 1	Port 2	Port 3	Port 4	Port 5	Port 6	Port 7	Port 8

Each status byte can have the following values:

Value	Description
`0`	SUCCESS
`1`	TOO_LONG
`2`	NOT_UNIQUE
`255`	ERROR

Output Processdata

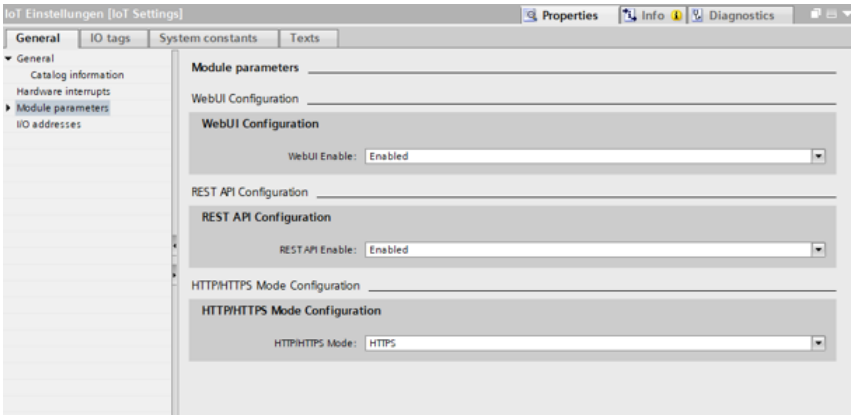
This module has no Output Processdata.

IoT Settings

With this submodule, the WebUI, the REST API, and the HTTP/HTTPS transfer protocol can be enabled or disabled.

Note

Since the settings are saved permanently, this module can be removed from the configuration again after it has been configured successfully.



Parameters

This module has 3 parameters.

Parameter	Description	Default
WebUI Enable	Enables or disables the WebUI	`1` – Enabled
REST API Enable	Enables or disables the REST API	`1` – Enabled
HTTP/HTTPS Mode	Defines which transfer protocol is used	`2` – HTTPS

There are two selection options for *WebUI Enable* and *REST API Enable*:

- Value 0 – Disabled
- Value 1 – Enabled

There are four selection options for *HTTP/HTTPS Mode*:

- Value 0 – None
- Value 1 – HTTP
- Value 2 – HTTPS
- Value 3 – HTTP and HTTPS

Note

The three parameters depend on each other. If *REST API Enable* or *HTTP/HTTPS Mode* is set to disabled/none, *WebUI Enable* is forced to disabled as well. If *WebUI Enable* is set to enabled, *REST API Enable* is forced to enabled; if no transfer protocol is active in this case, HTTPS is enabled automatically.

Input Processdata

This module provides **5 input bytes**, reflecting the currently active values.

Byte 0	Byte 1	Byte 2	Byte 3	Byte 4
WebUI Status	Reserved	REST API Status	Transfer Protocol	Reserved

WebUI Status and *REST API Status* can have the following values:

Value	Description
`0`	Disabled
`1`	Enabled

Transfer Protocol can have the following values:

Value	Description
0	None
1	HTTP
2	HTTPS
3	HTTP and HTTPS

The reserved bytes (Byte 1 and Byte 4) are always 0.

Output Processdata

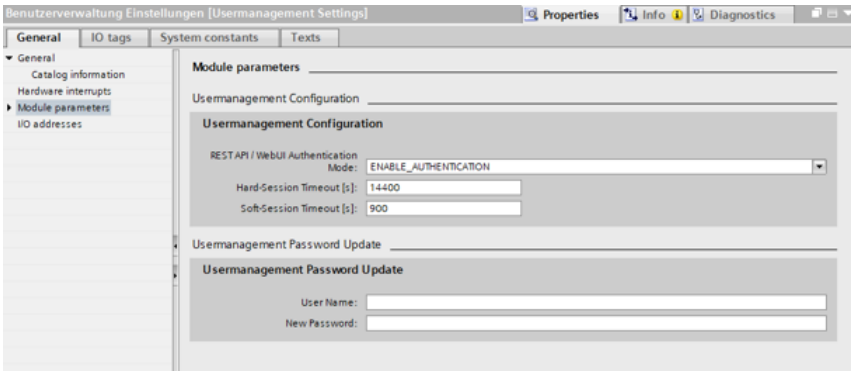
This module has no Output Processdata.

User Management Settings

With this submodule, the authentication mode and session timeouts for the BNI user management can be configured, and the password of an existing user can be updated.

Note

The configured authentication mode and session timeouts are saved permanently. This module can be removed from the configuration again after it has been configured successfully.



Parameters

This module has 2 parameter records.

User Management Configuration

Parameter	Description	Default
Authentication Mode	Defines the REST API / WebUI authentication mode	2 – Enable Authentication
Hard-Session Timeout [s]	Session timeout in seconds	14400
Soft-Session Timeout [s]	Session timeout in seconds	900

There are two selection options for *Authentication Mode*:

- Value 0 – Disable REST API Authentication (WebUI authentication remains active)
- Value 2 – Enable Authentication

User Management Password Update

Note

This module can only update the password of an already existing user. It is not possible to create a new user through this module.

Parameter	Description	Default
User Name	User name of the existing user whose password is updated (max. 64 characters)	*(empty)*
New Password	New password for the given user (max. 255 characters)	*(empty)*

Input Processdata

This module provides **9 input bytes**, reporting the result of the last password update.

Byte 0-7	Byte 8
User Id	Status

User Id (Byte 0-7) contains the resulting user Id, zero-padded if shorter than 8 characters, on a successful password update. On failure it is usually all zeros, though for some failures after the user has been found it may still be returned together with the error status; for *User Not Found* it is always cleared to zero.

Status (Byte 8) can have the following values:

Value	Description
0	OK
1	User Not Found
2	Invalid Input
3	Operation Failed

Output Processdata

This module has no Output Processdata.

ISDU Module

With ISDU parameterization via GSDML, the connected IO-Link devices can be configured via the parameters of the corresponding submodules when establishing a connection with PROFINET.

The parameters are transferred when the BNI establishes the connection with the controller and are then forwarded directly to the corresponding IO-Link devices as ISDU write accesses. When an IO-Link device is unplugged and plugged in, the ISDU parameters configured in advance and transmitted by the controller are written again.

Parameters

The following settings exist for the ISDU parameterization:

- *Reset to factory defaults*: Resets the ISDU parameters to factory settings. The ISDU parameters can then be reset.
- *Start block parameterization*: Starts the check of several parameters of a device. The parameters are checked for plausibility only at the end of the complete parameterization.
- *End block parameterization*: Ends the check of the parameters of a device. Setting the parameter is mandatory if *Start block parameterization* has been selected.

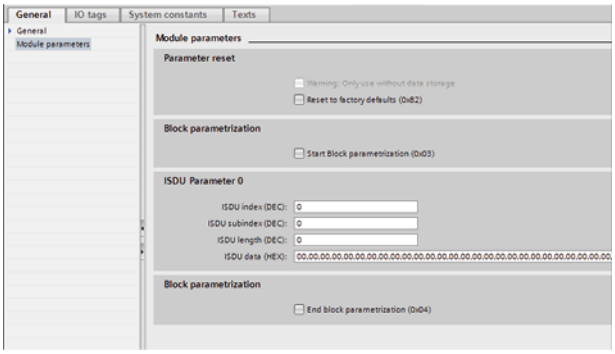


Fig. 70: Set ISDU parameterization

In addition, each submodule provides a fixed number of ISDU parameter entries (*Index*, *Subindex*, *Length*, and *Data*), one per parameter to be written to the IO-Link device. Six ISDU Parameter Configuration submodules are available, differing only in the number of entries they provide:

Submodule	ISDU parameter entries
ISDU 1 Parameter	1
ISDU 4 Parameter	4
ISDU 8 Parameter	8
ISDU 16 Parameter	16
ISDU 32 Parameter	32
ISDU 64 Parameter	64

Select the submodule that provides enough entries for the number of ISDU parameters to be written to the connected device.

Input Processdata

This module has no Input Processdata.

Output Processdata

This module has no Output Processdata.

Usage

This section describes how to configure ISDU parameterization via GSDML for a port.

Before you begin

Make sure that:

- The GSDML file of the PROFINET device has been installed.
  - See: *Set Up Initial PROFINET Device Connection*.
- An IOL submodule has been plugged into the desired port (slot 1).
  - See: *Port Modules*.
- An IO-Link device is connected to the port.

Steps

To carry out ISDU parameterization in TIA Portal:

1. Insert the *ISDU parameter configuration* module into slot 3.

2. Select one of the six ISDU Parameter Configuration submodules (see Parameters above) that provides enough entries for the connected device, and insert it into the subslot that corresponds to the port to be parameterized.

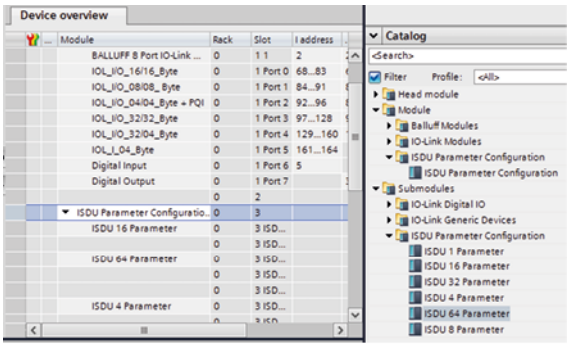


Fig. 71: Select submodule

The subslots of the ISDU Parameter Configuration module correspond to the IO-Link ports in the same order: the first port's submodule corresponds to the first ISDU subslot, the second port's submodule to the second ISDU subslot, and so on.

> **Note**
>
> Unlike the IO-Link ports in slot 1, where the first subslot is reserved for the IO-Link Proxy itself (shifting the port subslots by one), the ISDU Parameter Configuration module in slot 3 has no such offset: its subslots map directly to the ports, in the same order.

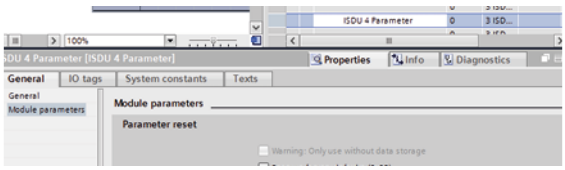


Fig. 72: Assignment position submodule = port number

3. Enter the ISDU parameters in the corresponding fields.

> **Note**
>
> Regardless of the submodule used, only the parameters that are entered are written to the IO-Link device (condition: length > 0). When the connection is established, all parameters are transferred to the BNI.
> **Example**
> ISDU 64 parameter is plugged in and 5 ISDU parameters are described.
> - All 64 parameters are transferred when the connection is established.
> - Only the 5 described ISDU parameters are transferred to the device.

9.10.4 Advanced Configuration

Using the IOL_CALL Function Block

To be able to write or read out the ISDU data of connected IO-Link devices during operation, the common programming interfaces of the control manufacturers provide corresponding function modules or libraries.

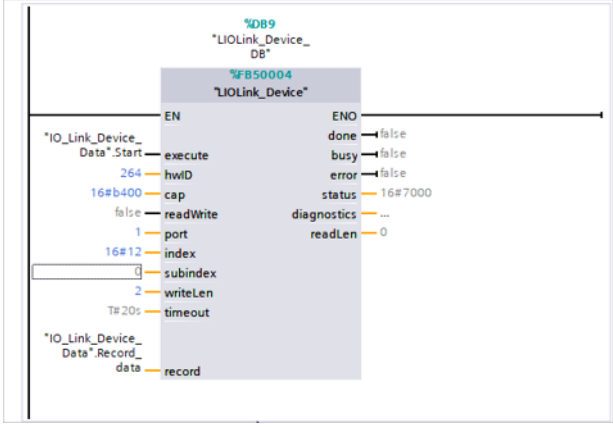


Fig. 73: Function module

REQ (execute)

Use Request to start the action in order to write or read data.

ID (hwID)

The ID is permanently declared by the master via the hardware configuration.
This can be found under *System constants* in the hardware identification.

- Select the hardware ID of the module *IO-Link_I_O_Ports_1~BALLUFF_8_Port_IO-Link_Master*



Fig. 74: Hardware configuration: System constants

CAP Value (cap)

This is assigned by the manufacturer. For Balluff products, it is the value 0xB400.

Read/Write (read/write)

The command is defined here. To read data, it must be a 0; to write data, it must be a 1.

Port (port)

Here you select the port to which the device has been connected. The master numbered as 0 and the ports are numbered from 1…8.

Index (index)

This is the index of the IO-Link subscriber being read out or written. This can be found in the user's guide for the IO-Link device.

SubIndex (subindex)

The sub-index is defined by the data to be processed. This can also be found in the operating instructions for the connected IO-Link device.

LEN (writeLen)

This is the length of the data. This can also be found in the parameter data in the user's guide for the IO-Link device.

RECORD_IOL_DATA (record)

A data module is used for communication. The structure must be established in Array of Bytes. The data to be changed is written into this array.

DONE_VALID (done)
Confirms the successful request to read or write data.

BUSY (busy)
Shows the working state of the module.

ERROR (error)
If an error occurs in the function, it is reported here.

STATUS (status)
Error status of the function

IOL_STATUS (diagnostics)
Describes the current status or an error.

RD_LEN (readLen)
Shows how many bytes were read by the module.

The *IOL_Call* function module composes a telegram that is transferred to the master via acyclic services. The following settings are required for this:

Table 13: Telegram settings

Diagnosis address	CAP access
The diagnosis address of module *IO-Link_I_O_Ports_1~BALLUFF…_* is used.	0xB400

The telegram set-up is described in the table below.

Table 14: Telegram set-up

Range	Size in bytes	Value	Definition
Call – Header	1	0x08	0x08 for Call, fix
	1	0	IOL Master
		1…63	Port number
		64…255	reserved
	2	65098	FI_Index, IO-Link Header is following
IO-Link Header	1	0…255	Task
			2 = Write
			3 = Read
	2	0…32767	IO-Link Index
		65535	Port Function
	1	0…255	IO-Link Subindex
Data range	232		Range of data to be written or read

Read

To be able to read out data, the master must be sent a read task for the corresponding slot/index/subindex.

For this, the telegram must be adapted accordingly (slot, index) and entered at *Task* 0x03 for *reading*. The telegram can then be sent to the corresponding module via write command.

The module reads the data from the IO-Link device.

The data can be fetched by reading with the same telegram.

Write

To be able to write data, the network module must be sent a write task for the corresponding slot/index/subindex.

For this, the telegram must be adapted accordingly (slot, index) and entered at *Task* 0x02 for *writing*. The telegram can then be sent to the corresponding module via write command.

Integrating Safety-Hub

Note

Please check whether IO-Link is supported by your module before using this function. For more information on product variants that support IO-Link, see *Supported product variants*.

When project planning for PROFINET devices, a device is mapped as a modular system, which has a headslot and several data modules. The illustrations used here are taken as examples from the *Totally Integrated Automation Portal (TIA Portal)* project planning software and from the SIMATIC Manager from Siemens AG and are for illustrative purposes only.

The necessary settings depend on the application and are the responsibility of the user. The Safety Hub device (BNI IOF-329-P02-Z038 or BNI IOF-329-P02-Z092) must always be connected via a compatible Balluff network module.

The Safety Hub device is a special case of the *IO-Link Devices Submodules*: instead of a single submodule, it requires a dedicated slot 1 module variant and a pair of submodules per port (one for secure communication, one for standard communication), as described below.

Placing the Safety Hub Module on Slot 1

The GSDML file provides the data modules available for the respective network module.

Before you begin

Make sure that:

- The GSDML file of the PROFINET device has been installed.
  - See: *Set Up Initial PROFINET Device Connection*.

Steps

- Select module *IO-Link I/O ports (w/o IO data) with Safety Hub and ISDU* in the hardware catalog and drag and drop it to slot 1.

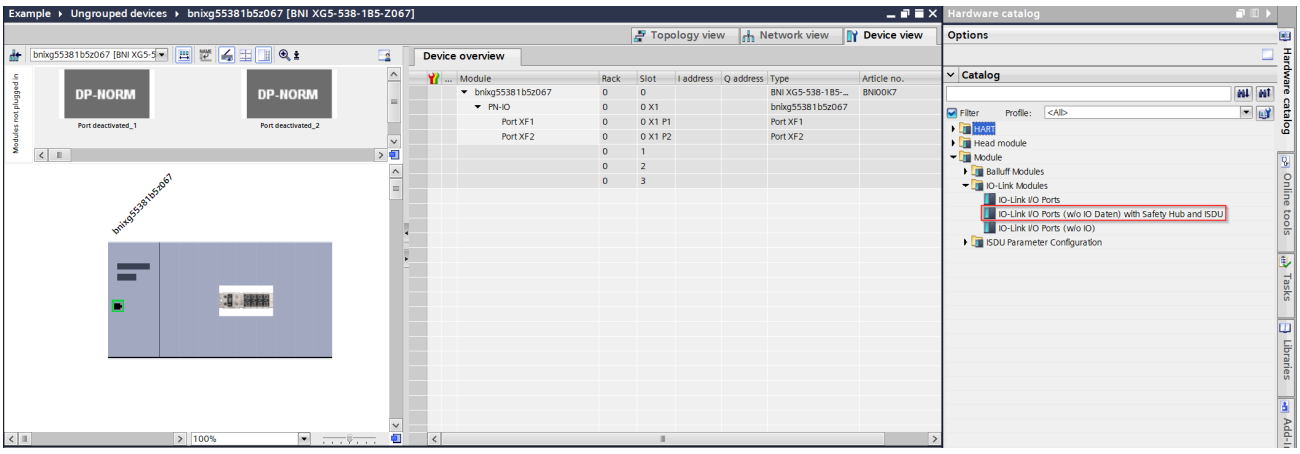


Fig. 75: Select module *IO-Link I/O ports (w/o IO data) with Safety Hub and ISDU*

⇒ The module is placed on slot 1. The list of port subslots is automatically doubled, as the secure IO-Link IO module consists of one sub-module each for secure and standard communication.

Assigning a Safety Hub Device to a Port

The device data for the secure I/O module can be found in the *Safety Hub* submodule folder of the project planning software.

Before you begin

Make sure that:

- The *IO-Link I/O Ports (w/o IO data) with Safety Hub and ISDU* module has been placed on slot 1.
  - See: *Placing the Safety Hub Module on Slot 1*.
- A Safety Hub device (BNI IOF-329-P02-Z038 or BNI IOF-329-P02-Z092) is connected to the port.

Steps

1. Delete the default *Port deactivated* and *Empty submodule* entries for the port.

   ⇒ The port's subslot pair is empty and ready for the new submodules.

2. From the *Safety Hub* submodule folder, drag the secure I/O submodule matching the connected device to the upper free slot (1), and drag the *Standard I/O* submodule to the slot below (2).

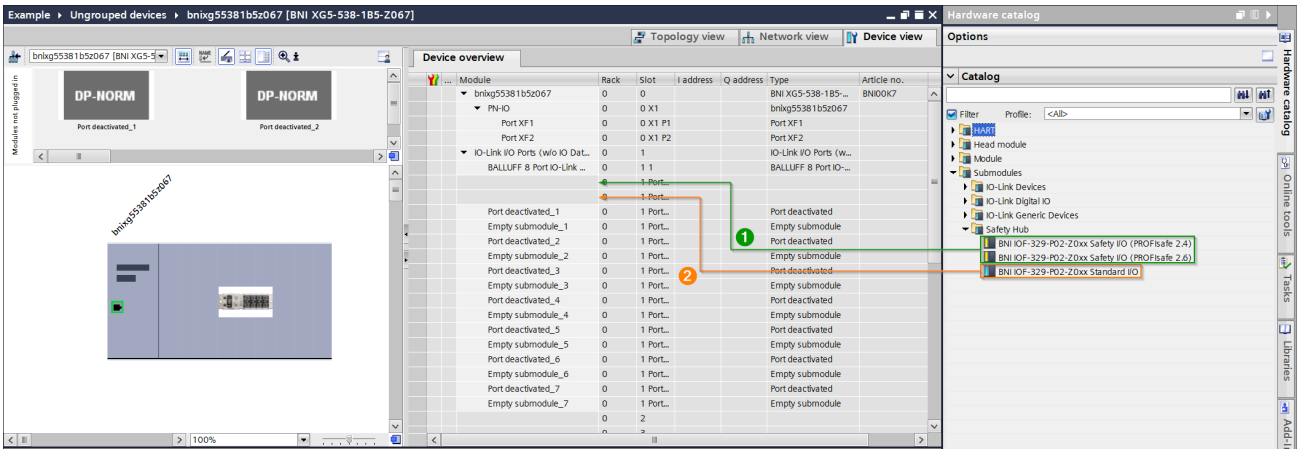


Fig. 76: Safety Hub submodules in the hardware catalog: (1) secure I/O submodule to the upper slot, (2) standard I/O submodule to the lower slot

Two secure I/O submodules are available, differentiated by PROFIsafe version: *Safety I/O (PROFIsafe 2.4)* and *Safety I/O (PROFIsafe 2.6)*.

Note

Which secure I/O submodule to use, and whether a BNI IOF-329-P02-Z038 or BNI IOF-329-P02-Z092 device is required for your application, depends on your safety concept. Consult the Safety Hub product documentation to determine the correct variant.

⇒ The secure and standard I/O submodules appear in the device overview under the port's subslots.

Note

For further configurations, see the Safety Hub guide.

Note

After integrating and configuring the module, the master must be restarted!

Ring Topology

The network module also supports the ring topology with media redundancy, which is enabled via the Media Redundancy Protocol (MRP). For this, the module and the MRP master (Managed Switch, CPU, etc.) must be in the same topology instance.

With the ring topology, it is possible to establish a redundant system. I.e. in normal operation, one side of the ring line from the MRP master is deactivated. If the line is damaged or capped at one place in the ring, the deactivated branch is activated again and there are two linear topologies.

Activating Ring Topology

Before you begin

Make sure that:

- The module and the MRP master (Managed Switch, CPU, etc.) are in the same topology instance.
- The PROFINET network is physically wired as a ring.
- The PROFINET device has been added to the project and connected.
  - See: *Set Up Initial PROFINET Device Connection*.

Steps

To activate the ring topology in TIA Portal:

- Set the media redundancy role to *Client* (the default setting is *Non-subscriber*).

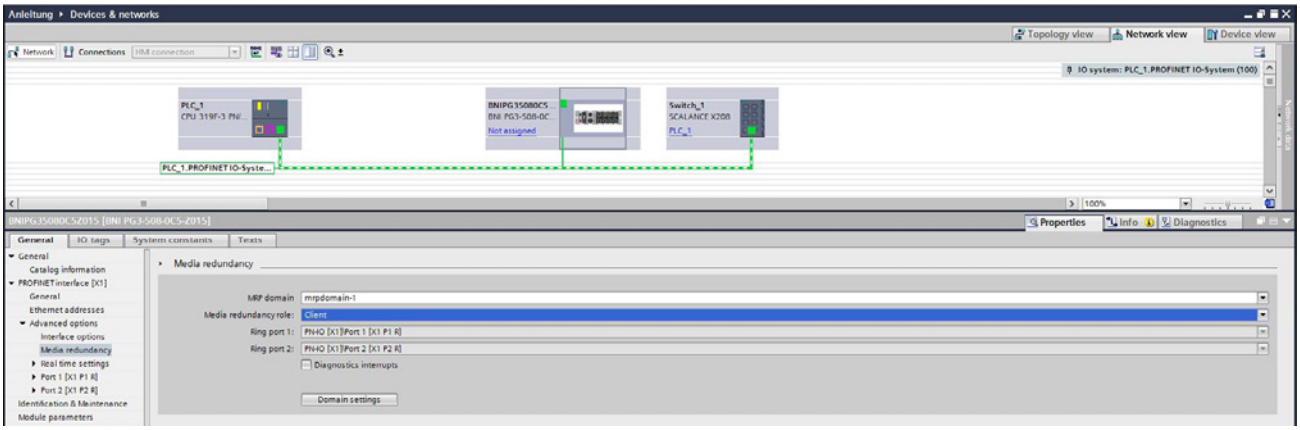


Fig. 77: Ring topology

To ensure uninterrupted operation, the watchdog time should be greater than 200 milliseconds, as the MRP master requires some time to activate the second line. If the watchdog time is less than the switching time of the MRP master, this will cause a communication breakdown.

The watchdog time is calculated from the “Update time” and the *Accepted update cycles* without *IO data* factor.

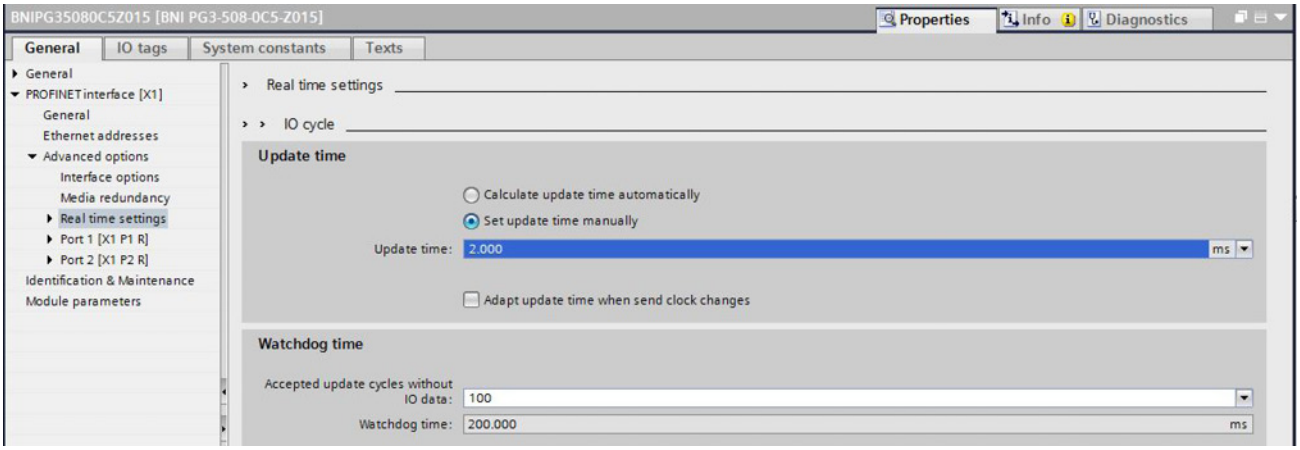


Fig. 78: “Update time” setting

Device Replacement without Exchangeable Medium

The modules also support simple device replacement in LLDP mode (Link Layer Discovery Protocol).

Activating Device Replacement without Exchangeable Medium

Before you begin

Make sure that:

- The connected devices support LLDP (Link Layer Discovery Protocol).
- The PROFINET network is physically wired, and the wiring matches the intended topology.
- The PROFINET device has been added to the project and connected.
  - See: *Set Up Initial PROFINET Device Connection*.

Steps

To activate device replacement without exchangeable medium in TIA Portal:

1. In the CPU hardware configuration, activate the *Support device replacement without exchangeable medium* checkbox.

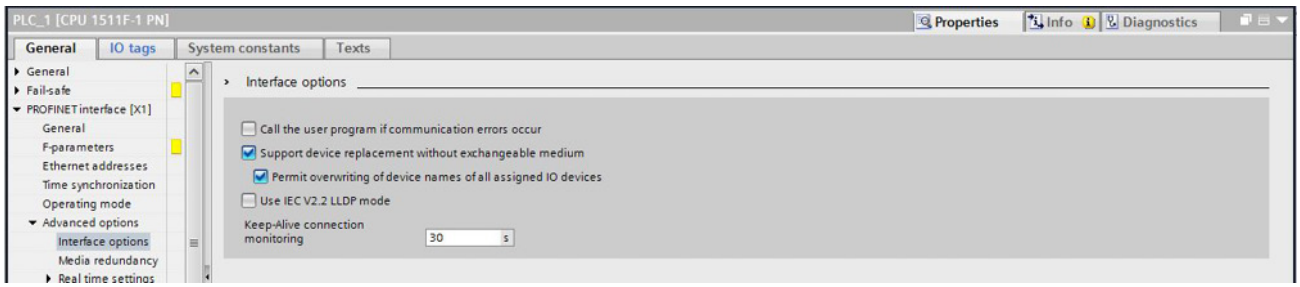


Fig. 79: Support device replacement without exchangeable medium

2. Create the PROFINET topology in the hardware configuration.

> **Note**
>
> The connections of the individual ports must match the hardware wiring. If the topology in the hardware configuration is not a match, errors can occur.

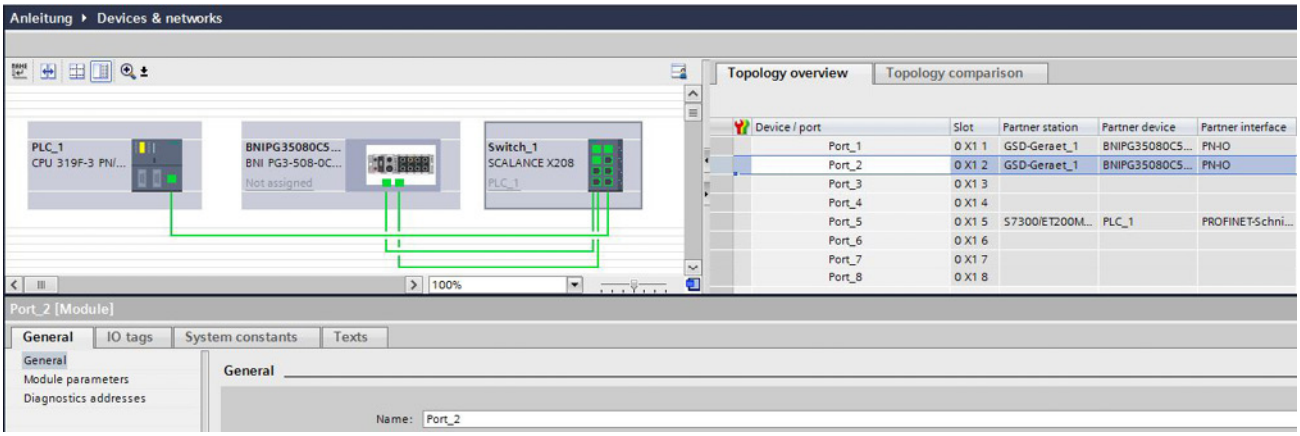


Fig. 80: Device replacement without exchangeable medium: Topology

9.10.5 Troubleshooting

This chapter lists common problems when integrating a BNI IO-Link master via PROFINET in an engineering tool such as the Siemens TIA Portal, their causes, and how to solve them. The table gives a quick overview. The sections below the table describe each problem in more detail.

Table 15: Common PROFINET problems

Problem	Explanation	Solution	References
BNI device does not communicate in the PLC program (bus error, no connection, no process data).	• PROFINET device relationship is not established. • Device name in the project differs from the device name in the field.	► Check that both device names are identical. ► Assign the device name again.	• *BNI device does not communicate in the PLC program* • *Assigning a PROFINET Device Name and IP Address* • *Establishing a PROFINET Device Connection*
BNI device is not found (not listed, not reachable, offline).	• Device is not reachable in the network. • PROFINET protocol is not active.	► Check power supply and Ethernet connection. ► Check the configured protocol.	• *BNI device is not found* • *Installation and connection* • *Protocols* • *Set Up Initial PROFINET Device Connection*
BNI device is not available in the hardware catalog, or the GSDML does not fit the device (device not listed, firmware incompatible).	• GSDML file is not installed. • GSDML version is outdated and not compatible with the firmware.	► Install the GSDML file in the engineering tool. ► Use a GSDML version that matches the device firmware.	• *BNI device is not available in the hardware catalog* • *Installing the GSDML File*
Pin 2/4 signals of a port show no data (no input or output bytes).	• Module on slot 1 is a variant without IO data (w/o IO). • Digital Input/Output submodules provide no process data on this module.	► Plug the Pin 2/4 submodules in slot 2. ► Or use the slot 1 module with IO data.	• *Pin 2/4 signals of a port show no data* • *Port Modules* • *Extended Modules*
ISDU parameters are not written to the IO-Link device.	• Parameter entry has length 0. • ISDU submodule has too few entries. • ISDU subslot does not match the port.	► Enter index, subindex, length and data for each parameter. ► Select an ISDU submodule with enough entries. ► Plug the ISDU submodule into the subslot with the port number.	• *ISDU parameters are not written to the IO-Link device* • *ISDU Module*
Safety Hub safe channel submodule cannot be plugged or used.	• Wrong module on slot 1. • Safe submodules fit only the Safety Hub module with 16 subslots.	► Plug the *IO-Link I/O Ports (w/o IO) with Safety Hub and ISDU* module on slot 1. ► Assign the secure and standard I/O submodule to the port. ► Restart the master.	• *Safety Hub safe channel submodule cannot be plugged or used* • *Integrating Safety-Hub* • *Placing the Safety Hub Module on Slot 1* • *Assigning a*

BNI device does not communicate in the PLC program

Symptom

- After going online in TIA Portal, the PROFINET device does not show a green checkmark.
- The PROFINET device reports a bus error.
- The PLC does not exchange process data with the BNI IO-Link master.

Cause

The PROFINET device relationship is not established. The PLC addresses the BNI device via its PROFINET device name. If the name configured in the project does not match the name stored in the device, the connection cannot be established.

Instructions

- *Assigning a PROFINET Device Name and IP Address*
- *Establishing a PROFINET Device Connection*
- *Testing the PROFINET Device Configuration*

BNI device is not found

Symptom

- The BNI device is not listed after clicking *Update list* in the *Assign PROFINET device name* dialog.
- The BNI device is not found when scanning the network.
- The BNI device is not reachable (offline).

Cause

The BNI device is not reachable in the network, or it is not operating with the PROFINET protocol.

Instructions

- *Installation and connection*
- *Protocols*
- *Set Up Initial PROFINET Device Connection*

BNI device is not available in the hardware catalog

Symptom

- The BNI device is not listed in the hardware catalog under *Other field devices > PROFINET IO > IO*.
- Modules or submodules expected for the firmware version are missing.

Cause

The GSDML file of the BNI device is not installed. Outdated GSDML versions may not be compatible with the latest firmware version.

Instructions

- *Installing the GSDML File*

Pin 2/4 signals of a port show no data

Symptom

- The *Digital Input* or *Digital Output* submodule of a port provides no input or output bytes.
- Pin 2 and Pin 4 states cannot be read or written in the PLC program.

Cause

The module on slot 1 is a variant without IO data (*IO-Link I/O Ports (w/o IO)*). Neither the module nor the *Digital Input* and *Digital Output* submodules provide process data. Pin 2 and Pin 4 must be read or written via the Pin 2/4 submodules in slot 2.

Instructions

- *Port Modules*
- *Extended Modules*

ISDU parameters are not written to the IO-Link device

Symptom

- IO-Link device parameters are not changed after the connection is established.
- The IO-Link device keeps its previous parameter values.

Cause

Only ISDU parameter entries with a length greater than 0 are written to the IO-Link device. The ISDU submodule must provide enough entries for all parameters. The subslots of the ISDU Parameter Configuration module (slot 3) map directly to the ports, without the offset that slot 1 has.

Instructions

- *ISDU Module*

Safety Hub safe channel submodule cannot be plugged or used

Symptom

- The *Safety I/O* submodules (PROFIsafe 2.4 or 2.6) from the *Safety Hub* folder cannot be assigned to the port subslot.

Cause

The safe submodules of the Safety Hub are only available for the *IO-Link I/O Ports (w/o IO) with Safety Hub and ISDU* module on slot 1. This module provides 16 port subslots: a secure and a standard subslot per port. With any other module on slot 1, the submodules cannot be assigned.

Instructions

- *Integrating Safety-Hub*
- *Placing the Safety Hub Module on Slot 1*
- *Assigning a Safety Hub Device to a Port*

9.10.6 Diagnosis and Ident Number Reference

This chapter lists the numbers that the device reports or expects on the bus: the values of a diagnosis alarm, the error codes and their meaning, and the identification numbers (ident numbers) of all modules and submodules.

Use this chapter to look up the meaning of an alarm or error code in the PLC, or to find the ident number of a module or submodule, for example when you compare the expected and the actual configuration.

> **Note**
>
> All numbers are given in hexadecimal notation (`0x…`).

Diagnosis Alarm

The diagnosis alarm that the module generates in the event of an error is usually read out from the PLC and processed. It is also possible for the diagnosis to be read out and evaluated from the module using function modules.

IO-Link events are mapped to PROFINET diagnosis as follows:

- An IO-Link event of type *Error* is reported as diagnosis with the priority *Fault*.
- An IO-Link event of type *Warning* is reported as diagnosis with the priority *Maintenance demanded*.
- An IO-Link event of type *Notification* (single shot) is not a diagnosis. It is reported as a process alarm (see *Process Alarms*).
- A disappearing event removes the diagnosis again and generates the alarm type *Diagnosis disappears*.

Alarm Values

The following table lists the values that the fields of a diagnosis alarm can have.

Table 16: Values of the diagnosis alarm

Field	Value	Meaning
AlarmType	0x0001	
	0x0002	
	0x0003	
	0x0004	
	0x000C	Diagnosis
	Process alarm (see *Process Alarms*)	
	Pull (see *Enable Pull/Plug* below)	
	Plug (see *Enable Pull/Plug* below)	
	Diagnosis disappears	
API	0x00004E01	Administrative number. The API is the same for all modules and submodules.
SlotNumber	0x0001	Slot 1, IO-Link Blocks. All slots are listed in *Slots and Subslots*.
SubslotNumber	0x0002 – 0x0009	Port 1 to port 8 of the port module. With the Safety Hub module, the port subslots are 0x0002, 0x0004, … 0x0010 (see *Subslots of Slot 1*). The subslots of all slots are listed in *Slots and Subslots*.
ModuleIdentNumber	–	Module in the slot, see *Module Ident Numbers*.
SubmoduleIdentNumber	–	Submodule in the subslot, see *Submodule Ident Numbers*.
User Structure Identifier	0x8000	
	0x8002	
	0x8320	Channel diagnosis (module-related errors and Safety Hub errors)
	Extended channel diagnosis (IO-Link events)	
	Process alarm reason	
ChannelNumber	0x8000	Submodule (the diagnosis refers to the entire submodule).
Priority	Fault	
	Maintenance demanded	IO-Link event of type *Error*
	IO-Link event of type *Warning*	
ChannelErrorType	–	Type of the error, see *Error Codes*.
ExtChannelErrorType	–	Subtype of the error. For IO-Link events it is the IO-Link EventCode, see *Error Codes*. The field is only available with the User Structure Identifier 0x8002.
ExtChannelAddValue	0x00000000	Not used.

The alarm types *Pull* and *Plug* are used if the port parameter *Enable Pull/Plug* is active (see *Parameters*).

Process Alarms

IO-Link events of type *Notification* are not reported as diagnosis. If the port parameter *Enable process alarms* is active (see *Parameters*), the device reports them as a process alarm (AlarmType 0x0002) instead.

The reason of the process alarm is coded like the error code of a diagnosis: the reason is 0x9500 or 0x9501 and the extended reason contains the IO-Link EventCode as described in *IO-Link Device Events*.

Error Codes

The error code of a diagnosis alarm consists of the ChannelErrorType and, for IO-Link events, the ExtChannelErrorType. The following table gives an overview of the ChannelErrorType values of the device.

Table 17: ChannelErrorType overview

ChannelErrorType	Meaning	Section
0x0002	Undervoltage	*Module-Related Errors*
0x0003	Overvoltage	*Module-Related Errors*
0x0040 – 0x004B	Safety Hub: F-parameter errors	*Safety Hub Errors*
0x0104 – 0x0107	Actuator supply	*Module-Related Errors*
0x1000 – 0x1035	Safety Hub: discrepancy and short circuit errors	*Safety Hub Errors*
0x9500	IO-Link device events in the lower range (0x0000-0x7FFF)	*IO-Link Device Events*
0x9501	IO-Link device events in the upper range (0x8000-0xFFFF)	*IO-Link Device Events*
0x9502	IO-Link port events in the lower range (0x0000-0x7FFF)	*IO-Link Port Events*

Note

The BNI XG1 reports only the error types 0x0104 to 0x0107 and 0x9500 to 0x9502. The Safety Hub error types apply to the BNI XG3 and BNI XG5.

Module-Related Errors

If *User Structure Identifier* has the value 0x8000, the module-related errors are displayed in the ChannelErrorType:

Table 18: Module-related errors

ChannelErrorType	Meaning
0x0002	Undervoltage
0x0003	Overvoltage
0x0104	No actuator supply
0x0105	Undervoltage of the actuator supply
0x0106	Overvoltage of the actuator supply
0x0107	An IO-Link device is already plugged in slot 1 in the same subslot, the submodule is not used

Safety Hub Errors

The error types of the Safety Hub are available for the BNI XG3 and BNI XG5. They are reported for a connected Safety Hub (BNI IOF-329-P02-Z038 or BNI IOF-329-P02-Z092), see *Integrating Safety-Hub*.

F-Parameter Errors

Table 19: Safety Hub F-parameter errors

ChannelErrorType	Meaning
0x0040	Mismatch of safety destination address (F_Dest_Add)
0x0041	Safety destination address not valid (F_Dest_Add)
0x0042	Safety source address not valid
0x0043	Safety watchdog time value is 0 ms
0x0044	Parameter F_SIL exceeds SIL from specific device application
0x0045	Parameter F_CRC_Length does not match the generated values
0x0046	Version of F-Parameter set incorrect
0x0047	CRC1-Fault
0x004B	Inconsistent iParameters (iParCRC error)

Input Errors

The ports are numbered as in the error text, starting with port 0. Safe inputs are available at the ports 0 to 3, 6 and 7.

Table 20: Safety Hub input errors

Port	Discrepancy error	Short circuit to P, Safe_Input1	Short circuit to M, Safe_Input1	Short circuit to P, Safe_Input2	Short circuit to M, Safe_Input2
0	0x1000	0x1008	0x1010	0x1018	0x1020
1	0x1001	0x1009	0x1011	0x1019	0x1021
2	0x1002	0x100A	0x1012	0x101A	0x1022
3	0x1003	0x100B	0x1013	0x101B	0x1023
6	0x1006	0x100E	0x1016	0x101E	0x1026
7	0x1007	0x100F	0x1017	0x101F	0x1027

Output Errors

Safe outputs are available at the ports 4 and 5.

Table 21: Safety Hub output errors

Port	Short circuit to P, Safe_Output	Short circuit to M, Safe_Output
4	0x102C	0x1034
5	0x102D	0x1035

IO-Link Device Events

The IO-Link events of a connected IO-Link device are mapped to the ChannelErrorType 0x9500 and 0x9501. The ExtChannelErrorType depends on the IO-Link EventCode:

- 0x9500: IO-Link EventCodes 0x0000 to 0x7FFF are transferred unchanged to the ExtChannelErrorType.
- 0x9501: IO-Link EventCodes 0x8000 to 0xFFFF are transferred to the ExtChannelErrorType with the most significant bit set to 0. For example, the EventCode 0x8C00 is reported as ExtChannelErrorType 0x0C00.

The EventCodes are defined by the IO-Link device. For the meaning of vendor-specific EventCodes, refer to the documentation of the IO-Link device.

Table 22: IO-Link device events in the lower range (ChannelErrorType 0x9500)

ExtChannelErrorType (EventCode)	Error text	Help text
0x1000	General malfunction	unknown error
0x1800 – 0x180A	IO_Link EventCode 0x1800 – 0x180A	check IO-Link device manual
0x4000	Temperature fault	Overload
0x4210	Device temperature over-run	Clear source of heat
0x4220	Device temperature under-run	Insulate Device
0x5000	Device hardware fault	Device exchange
0x5010	Component malfunction	Repair or exchange
0x5011	Non volatile memory loss	Check batteries
0x5012	Batteries low	Exchange batteries
0x5100	General power supply fault	Check availability
0x5101	Fuse blown/open	Exchange fuse
0x5110	Primary supply voltage over-run	Check tolerance
0x5111	Primary supply voltage under-run	Check tolerance
0x5112	Secondary supply voltage fault (Port Class B)	Check tolerance
0x6000	Device software fault	Check firmware revision
0x6320	Parameter error	Check data sheet and values
0x6321	Parameter missing	Check data sheet
0x6350	Parameter changed	Check configuration
0x7700	Wire break of a subordinate device	Check installation
0x7701 – 0x770F	Wire break of subordinate device 1 – 15	Check installation
0x7710	Short circuit	Check installation
0x7711	Ground fault	Check installation

In the range 0x7701 to 0x770F, the number of the subordinate device is the ExtChannelErrorType minus 0x7700.

Table 23: IO-Link device events in the upper range (ChannelErrorType 0x9501)

ExtChannelErrorType	IO-Link EventCode	Error text	Help text
0x0C00	0x8C00	Technology specific application fault	Reset Device
0x0C01	0x8C01	Simulation active	Check operational mode
0x0C10	0x8C10	Process variable range over-run	Process Data uncertain
0x0C20	0x8C20	Measurement range over-run	Check application
0x0C30	0x8C30	Process variable range under-run	Process Data uncertain
0x0C40	0x8C40	Maintenance required - Cleaning	Clean device
0x0C41	0x8C41	Maintenance required - Refill	Refill device
0x0C42	0x8C42	Maintenance required - Wear and tear	Exchange wear and tear parts

IO-Link Port Events

The events of the IO-Link port of the network module are mapped to the ChannelErrorType 0x9502. The ExtChannelErrorType is the IO-Link event code of the port (see the table below).

Table 24: IO-Link port events (ChannelErrorType 0x9502)

ExtChannelErrorType (EventCode)	Error text	Help text
0x17FF	Process data mismatch	check submodule configuration
0x1800	No Device	–
0x1801	Startup parametrization error	check parameter
0x1802	Incorrect vendor ID	Inspection Level mismatch
0x1803	Incorrect device ID	Inspection Level mismatch
0x1804	Short circuit at C/Q	check wire connection
0x1805	IO-Link PHY over temperature	–
0x1806	Short circuit at L+	check wire connection
0x1807	Undervoltage at L+	check power supply (e.g. L1+)
0x1808	Device event overflow	–
0x1809	Backup inconsistency	memory out of range (2k)
0x180A	Backup inconsistency	Data storage index not available
0x180B	Backup inconsistency	Data Storage unspecific error
0x180C	Backup inconsistency	upload fault
0x180D	Backup inconsistency	download fault
0x180E	P24 (Class B) missing or undervoltage	check wire connection (e.g. L2+)
0x180F	Short circuit at P24 (Class B)	check wire connection (e.g. L2+)
0x1810	Short circuit at I/Q	check wire connection
0x1811	Short circuit at C/Q (if digital output)	check wire connection
0x1812	Overcurrent at I/Q	check load
0x1813	Overcurrent at C/Q (if digital output)	check load
0x1883	S7-PCT configuration error (wrong or not consistent parameterization)	Check parameterization
0x1888	Module defect	exchange module
0x6000	Invalid cycle time	check cycle time
0x6001	Revision fault	incompatible protocol version
0x6002	ISDU batch failed	parameter inconsistency

For example, the combination of the ChannelErrorType 0x9502 and the ExtChannelErrorType 0x1804 in an alarm of the subslot 0x0004 means: short circuit at C/Q at port 3 (X03).

Ident Numbers

PROFINET identifies the device and each of its modules and submodules by ident numbers. The PLC compares them with the configured project, and the device reports them in every alarm (see *Alarm Values*).

Device Identification

The device is identified by the VendorID and the DeviceID. The head module (DAP) of each product has its own ModuleIdentNumber.

Table 25: Device identification

Product	Order code	VendorID	DeviceID	DAP ModuleIdentNumber
BNI XG1-505-0A5-R067	BNI00L1	0x0378	0x5500	0x00000001
BNI XG3-508-0B5-R067	BNI00L3	0x0378	0x5510	0x00000001
BNI XG3-302-1B5-Z067	BNI00L8	0x0378	0x5510	0x00000002
BNI XG3-302-0B5-R067	BNI00L7	0x0378	0x5510	0x00000003
BNI XG5-538-1B5-Z067	BNI00K7	0x0378	0x5530	0x00000001
BNI XG5-508-1B5-Z067	BNI00K6	0x0378	0x5530	0x00000002
BNI XG5-538-0B5-R067	BNI00KJ	0x0378	0x5530	0x00000003
BNI XG5-508-0B5-R067	BNI00KH	0x0378	0x5530	0x00000004
BNI XG5-508-0B5-P067	BNI00L9	0x0378	0x5530	0x00000005
BNI XG5-508-1B5-Z067-C17	BNI00ML	0x0378	0x5530	0x00000006

The tables in the following sections show the availability for these product groups:

- **XG1**: BNI XG1-505-0A5-R067
- **XG3-508**: BNI XG3-508-0B5-R067
- **XG3-302**: BNI XG3-302-0B5-R067 and BNI XG3-302-1B5-Z067 (I/O ports without IO-Link)
- **XG5-508**: BNI XG5-508-0B5-R067, BNI XG5-508-0B5-P067, BNI XG5-508-1B5-Z067 and BNI XG5-508-1B5-Z067-C17 (IO-Link Class A ports)
- **XG5-538**: BNI XG5-538-0B5-R067 and BNI XG5-538-1B5-Z067 (IO-Link Class A and Class B ports)

Slots and Subslots

The device model of the device uses four slots. The slot and the subslot in an alarm locate the source of the alarm. For the structure of the device model, see *Device Model*.

Table 26: Slots

Slot	Content
0	Head module (BNI device), PROFINET interface and Ethernet ports
1	Port modules (IO-Link I/O Ports or I/O Ports)
2	Extended Modules
3	ISDU Parameter Configuration

Subslots of Slot 0

Table 27: Subslots of slot 0

Subslot	Description
0x0001	Head module (BNI device)
0x8000	PN-IO (PROFINET interface, X1)
0x8001	Port XF1 (X1 P1)
0x8002	Port XF2 (X1 P2)

Subslots of Slot 1

Subslot 0x0001 is the IO-Link Proxy (BALLUFF 8 Port IO-Link Master) and represents the network module itself. For each port, one subslot is available, starting at subslot 0x0002.

With the module *IO-Link I/O Ports (w/o IO) with Safety Hub and ISDU*, each port has two subslots, because a Safety Hub device uses one submodule for the secure and one for the standard communication. The port subslots are the even numbers, the following odd numbers are the Safety Hub subslots (X01.1 to X08.1).

Table 28: Subslots of slot 1

Port	Subslot	Subslot with Safety Hub module: Port	Subslot with Safety Hub module: Safety Hub
IO-Link Proxy	0x0001	0x0001	–
Port 1 (X01)	0x0002	0x0002	0x0003
Port 2 (X02)	0x0003	0x0004	0x0005
Port 3 (X03)	0x0004	0x0006	0x0007
Port 4 (X04)	0x0005	0x0008	0x0009
Port 5 (X05)	0x0006	0x000A	0x000B
Port 6 (X06)	0x0007	0x000C	0x000D
Port 7 (X07)	0x0008	0x000E	0x000F
Port 8 (X08)	0x0009	0x0010	0x0011

Subslots of Slot 2

The extended modules use one subslot per submodule (*Balluff Ext_Sub_Mod 1* to *Balluff Ext_Sub_Mod n*), starting at subslot 0x0001. The number of subslots depends on the product:

- XG1, XG3-508, XG5-508: 16 subslots (0x0001 to 0x0010)
- XG3-302: 13 subslots (0x0001 to 0x000D)
- XG5-538: 17 subslots (0x0001 to 0x0011)

Subslots of Slot 3

The ISDU parameter configuration uses one subslot per port: subslot 0x0001 to 0x0008 for the ports X01 to X08. Slot 3 is not available for XG3-302.

Module Ident Numbers

The ModuleIdentNumber is part of every diagnosis alarm and identifies the module in the slot. The Class A/B variants of the XG5-538 have their own module ident numbers.

Table 29: Module ident numbers

Slot	ModuleIdent-Number	Module	XG1	XG3-508	XG3-302	XG5-508	XG5-538
1	0x00004E01	IO-Link I/O Ports	✓	✓	✕	✓	✕
1	0x00004E04	IO-Link I/O Ports (w/o IO)	✓	✓	✕	✓	✕
1	0x0000005E	IO-Link I/O Ports (w/o IO) with Safety Hub and ISDU	✕	✓	✕	✓	✕
1	0x00004E05	I/O Ports	✕	✕	✓	✕	✕
1	0x00004E06	I/O Ports (w/o IO)	✕	✕	✓	✕	✕
1	0x00005E01	IO-Link I/O Ports (Class A/B)	✕	✕	✕	✕	✓
1	0x00005E04	IO-Link I/O Ports (w/o IO) (Class A/B)	✕	✕	✕	✕	✓
1	0x0000505E	IO-Link I/O Ports (w/o IO) with Safety Hub and ISDU (Class A/B)	✕	✕	✕	✕	✓
2	0x00004E03	Extended Modules	✓	✓	✕	✓	✕
2	0x00004E07	Extended Modules	✕	✕	✓	✕	✕
2	0x00004E09	Extended Modules	✕	✕	✕	✕	✓
3	0x00004E02	ISDU Parameter Configuration	✓	✓	✕	✓	✓

Submodule Ident Numbers

The SubmoduleIdentNumber is part of every diagnosis alarm and identifies the submodule in the subslot. The tables are sorted by the slot and the function of the submodule.

Slot 0

Table 30: Submodule ident numbers of slot 0

SubmoduleIdentNumber	Subslot	Submodule
0x00000001	0x0001	Head module (BNI device)
0x00000002	0x8000	PN-IO (PROFINET interface)
0x00000003	0x8001	Port XF1
0x00000004	0x8002	Port XF2

Slot 1: Port Modules

IO-Link Proxy

The IO-Link Proxy is the fixed submodule in subslot 0x0001 of the port module.

Table 31: Submodule ident numbers of the IO-Link Proxy

SubmoduleIdentNumber	Submodule	Port module
0xFFFF0000	BALLUFF 8 Port IO-Link Master	IO-Link I/O Ports
0xFFFF0004	BALLUFF 8 Port IO-Link Master	IO-Link I/O Ports (w/o IO)
0xFFFFAAAA	BALLUFF 8 Port IO-Link Master	IO-Link I/O Ports (w/o IO) with Safety Hub and ISDU
0xFFFFAAAB	BALLUFF 8 Port IO Master	I/O Ports (XG3-302)
0xFFFFAAAC	BALLUFF 8 Port IO Master	I/O Ports (w/o IO) (XG3-302)

Digital Input and Output

See *Port Modules* for the description of the submodules. The submodules *w/o IO* belong to the port modules *w/o IO*.

Table 32: Submodule ident numbers of the digital submodules

SubmoduleIdent-Number	Submodule	Input bytes	Output bytes
0x00000081	Digital Input	1	0
0x00008100	Digital Output	0	1
0x00000082	Digital Input with IO-Link Parametrization	1	0
0x00004002	Digital Input w/o IO	0	0
0x00004001	Digital Output w/o IO	0	0
0x00004003	Digital Input with IO-Link Parametrization w/o IO	0	0
0x4FFF0000	Port deactivated	0	0
0x4FFFAAAA	Port deactivated (XG3-302)	0	0

The submodule *Digital Input with IO-Link Parametrization* is not available for XG3-302.

IO-Link Generic Devices

See *IO-Link Generic Devices Submodules* for the description of the submodules.

The SubmoduleIdentNumber of a generic IO-Link submodule is derived from the length of the input and output data (in bytes, hexadecimal):

- Without PQI: `0x4000OOII`, where `OO` is the number of output bytes and `II` is the number of input bytes.
- With PQI: `0x0000OOII`, where `OO` is the number of output bytes and `II` is the number of input bytes plus 1 (the PQI byte).

Table 33: Submodule ident numbers of the IO-Link generic devices

Input bytes	Output bytes	With PQI	Without PQI
1	0	0x00000002	0x40000001
2	0	0x00000003	0x40000002
4	0	0x00000005	0x40000004
6	0	0x00000007	0x40000006
8	0	0x00000009	0x40000008
10	0	0x0000000B	0x4000000A
16	0	0x00000011	0x40000010
24	0	0x00000019	0x40000018
32	0	0x00000021	0x40000020
0	1	0x00000101	0x40000100
0	2	0x00000201	0x40000200
0	4	0x00000401	0x40000400
0	6	0x00000601	0x40000600
0	8	0x00000801	0x40000800
0	10	0x00000A01	0x40000A00

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Table 33 – continued from previous page

Input bytes	Output bytes	With PQI	Without PQI
0	16	0x00001001	0x40001000
0	24	0x00001801	0x40001800
0	32	0x00002001	0x40002000
1	1	0x00000102	0x40000101
2	2	0x00000203	0x40000202
2	4	0x00000403	0x40000402
2	8	0x00000803	0x40000802
4	2	0x00000205	0x40000204
4	4	0x00000405	0x40000404
4	8	0x00000805	0x40000804
4	32	0x00002005	0x40002004
8	2	0x00000209	0x40000208
8	4	0x00000409	0x40000408
8	8	0x00000809	0x40000808
10	10	0x00000A0B	0x40000A0A
16	16	0x00001011	0x40001010
24	24	0x00001819	0x40001818
32	4	0x00000421	0x40000420
32	32	0x00002021	0x40002020

IO-Link Devices

See *IO-Link Devices Submodules* for the description of the submodules.

Table 34: Submodule ident numbers of the IO-Link devices

SubmoduleIdent-Number	Device	Input bytes	Output bytes
0xFFFF0001	BNI IOL-101-000-XXXX	1	0
0xFFFF0002	BNI IOL-102-00X-XXXX	1	0
0xFFFF0003	BNI IOL-102-S01-XXXX	2	0
0xFFFF0FFF	BNI IOL-104-00X-XXXX	2	0
0xFFFF0005	BNI IOL-104-002-X046	2	0
0xFFFF0006	BNI IOL-104-002-X046 extended	4	0
0xFFFF0007	BNI IOL-104-S02-XXXX extended with BNI IOL-104-S02-XXXX	8	0
0xFFFF0008	BNI IOL-104-S02-ZXXX extended with BNI IOL-751-VXX-K007	4	4
0xFFFF0009	BNI IOL-104-S02-RXXX extended with BNI IOL-751-VXX-K007	4	4
0xFFFF000A	BNI IOL-104-S0X-XXXX	4	0

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Table 34 – continued from previous page

SubmoduleIdent-Number	Device	Input bytes	Output bytes
0xFFFF000B	BNI IOL-252-000-XXXX	0	1
0xFFFF000C	BNI IOL-252-S01-XXXX	4	1
0xFFFF000D	BNI IOL-256-000-XXXX	0	2
0xFFFF000E	BNI IOL-256-S01-XXXX	7	2
0xFFFF000F	BNI IOL-302-00X-XXXX	2	2
0xFFFF0010	BNI IOL-302-002-X046	2	2
0xFFFF0011	BNI IOL-302-002-XXXX extended	4	4
0xFFFF0012	BNI IOL-302-002-X046 extended with BNI IOL-104-002-X046	4	2
0xFFFF0013	BNI IOL-302-S01-XXXX	8	2
0xFFFF0014	BNI IOL-302-S01-XXXX Input and output only	2	2
0xFFFF0015	BNI IOL-302-S01-XXXX Output only	0	2
0xFFFF0016	BNI IOL-302-S01-XXXX-C01	10	2
0xFFFF0017	BNI IOL-302-S02-XXXX	8	2
0xFFFF0018	BNI IOL-302-S02-X026	6	2
0xFFFF0019	BNI IOL-309-00X-XXXX	1	1
0xFFFF001A	BNI IOL-310-000-XXXX	2	2
0xFFFF001B	BNI IOL-355-S02-XXXX	3	1
0xFFFF001C	BNI IOL-719-002-XXXX	22	1
0xFFFF001D	BNI IOL-771-000-XXXX	2	2
0xFFFF001E	BNI IOL-772-000-XXXX	1	1
0xFFFF001F	BNI IOL-800-000-Z036	0	1
0xFFFF0020	BNI IOL-800-000-Z037	0	1
0xFFFF0021	BNI IOL-801-000-Z036	0	2
0xFFFF0022	BNI IOL-801-000-Z037	0	3
0xFFFF0023	BNI IOL-802-000-Z036	0	3
0xFFFF0024	BNI IOL-802-000-Z037	0	3
0xFFFF0025	BIS M-4XX-045	10	10
0xFFFF0026	BIS M-4XX-072	32	32
0xFFFF0027	BIS L-4XX-045	8	8
0xFFFF0028	BNI IOL-709-000-XXXX	10	0
0xFFFF0029	BNI IOL-710-000-XXXX	10	0
0xFFFF002A	BNI IOL-727-S51-XXXX	16	1
0xFFFF002B	BNI IOL-728-S51-XXXX	23	0
0xFFFF002C	BNI IOL-314-S52-P0xx	12	2

Safety Hub

See *Integrating Safety-Hub* for the description of the submodules. The submodules are only available for the port module *IO-Link I/O Ports (w/o IO) with Safety Hub and ISDU*. The secure I/O submodules are plugged in the port subslots, the other submodules are plugged in the Safety Hub subslots (see *Subslots of Slot 1*).

Table 35: Submodule ident numbers of the Safety Hub

SubmoduleIdent-Number	Submodule	Subslot	Input bytes	Output bytes
0x00000004	BNI IOF-329-P02-Z0xx Safety I/O (PROFIsafe 2.4)	Port subslot	2 + 4 (PROFIsafe)	1 + 4 (PROFIsafe)
0x00000008	BNI IOF-329-P02-Z0xx Safety I/O (PROFIsafe 2.6)	Port subslot	2 + 5 (PROFIsafe)	1 + 5 (PROFIsafe)
0x00020002	BNI IOF-329-P02-Z0xx Standard I/O	Safety Hub subslot	1	2
0x00020003	Empty submodule	Safety Hub subslot	0	0

Slot 2: Extended Modules

See *Extended Modules* for the description of the submodules. The availability depends on the product group (see *Device Identification*).

Table 36: Submodule ident numbers of the extended modules

SubmoduleIdentNumber	Submodule	Input bytes	Output bytes	XG1	XG3-508	XG3-302	XG5-508	XG5-538
0x00004500	Input Pin 4	1	0	✓	✓	✓	✓	✓
0x00004600	Input Pin 2	1	0	✓	✓	✓	✓	✓
0x00004700	Output Pin 4	0	1	✓	✓	✓	✓	✓
0x00004800	Output Pin 2	0	1	✕	✓	✓	✓	✓
0x00004900	IO-Link Device Diagnosis Disable	0	1	✓	✓	✕	✓	✓
0x00005000	IO-Link Communication	1	0	✓	✓	✕	✓	✓
0x00005100	IO-Link PD Valid	1	0	✓	✓	✕	✓	✓
0x00005200	Module Diagnosis Disable	0	1	✓	✓	✓	✓	✓
0x00005300	Pin 1 Short Circuit Detection	1	0	✓	✓	✓	✓	✓
0x00005400	Port Event Pending	1	0	✓	✓	✓	✓	✓
0x00005500	Pin 4/2 Actuator Warning Detection	2	0	✓	✓	✓	✓	✓
0x00005600	IO-Link Device Event Pending	1	0	✓	✓	✕	✓	✓
0x00005700	Pin 4/2 Actuator Ground Short Circuit Detection	2	0	✓	✓	✓	✓	✓
0x00005800	Pin 4 IO-Link Short Circuit Detection	1	0	✓	✓	✕	✓	✓
0x00005900	Detection for Short Circuit and Actuator Warning	1	0	✓	✓	✓	✓	✓
0x00006000	Station Diagnosis	3	0	✓	✓	✓	✓	✓
0x00006100	Network Module Settings	4	0	✕	✕	✕	✕	✓
0x00006200	Outputs Pin 4 / Pin 2 - Port Mapping	0	2	✓	✓	✓	✓	✓
0x00006300	Inputs Pin 4 / Pin 2 - Port Mapping	2	0	✓	✓	✓	✓	✓
0x00006400	IoT Settings	5	0	✓	✓	✓	✓	✓
0x00006500	Usermanagement Settings	9	0	✓	✓	✓	✓	✓
0x00006600	Port Device Alias Configuration	8	0	✓	✕	✓	✓	✓
0x00006700	Pin1 Control	0	1	✓	✓	✓	✓	✓

Slot 3: ISDU Parameter Configuration

See *ISDU Module* for the description of the submodules. The submodules are available for all products except XG3-302. They have no input and no output data. The number in the name is the number of ISDU parameter entries that the submodule provides.

Table 37: Submodule ident numbers of the ISDU parameter configuration

SubmoduleIdentNumber	Submodule
0x40011701	ISDU 1 Parameter
0x40011702	ISDU 4 Parameter
0x40011703	ISDU 8 Parameter
0x40011704	ISDU 16 Parameter
0x40011705	ISDU 32 Parameter
0x40011706	ISDU 64 Parameter

9.11 Ethernet/IP integration

9.11.1 Integration in RSLogix EIP development tool

Example of how the module can be integrated into the RSLogix EIP development tool:

1. Go offline.

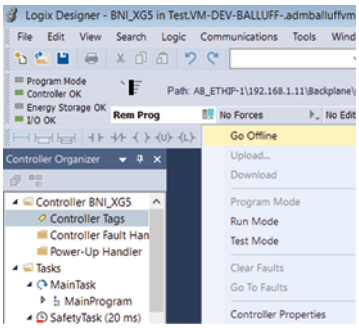


Fig. 81: Go offline

2. Right click on *Ethernet* (the correct scanner card) and select *New Module…*.

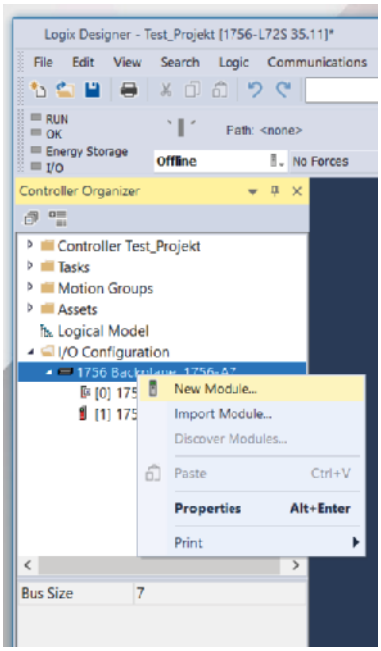


Fig. 82: Select New Module

3. Select the *Generic Ethernet Module* as Ethernet module in the communication path.

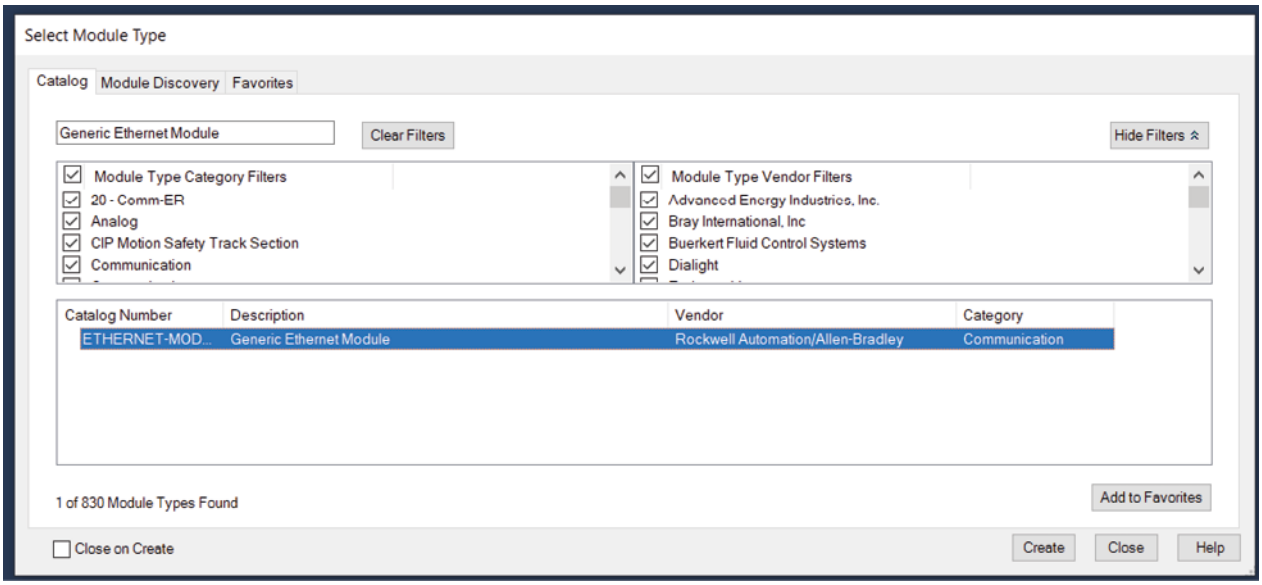


Fig. 83: Select Generic Ethernet Module

4. Enter tag name (user-defined), select the general format *Data SINT*, enter the IP address of the module and the correct connection parameters and confirm with *OK*.

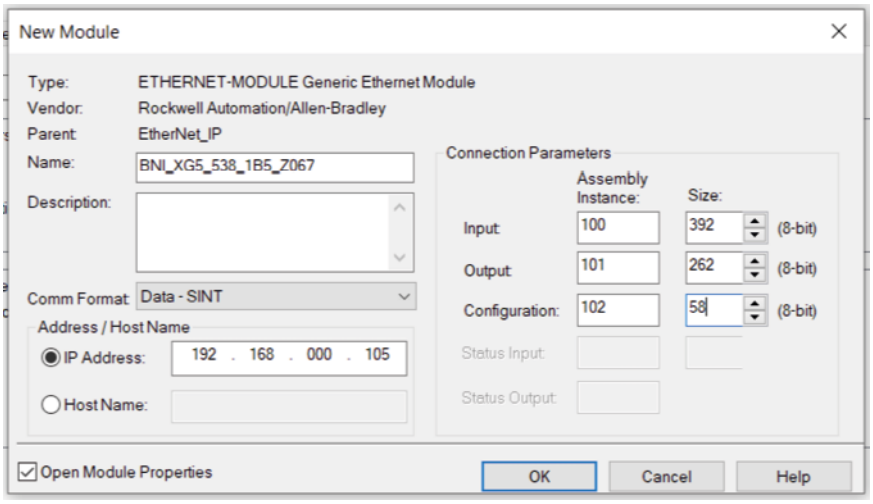


Fig. 84: New Module dialog

⇒ The new module and the corresponding controller tags are automatically generated.

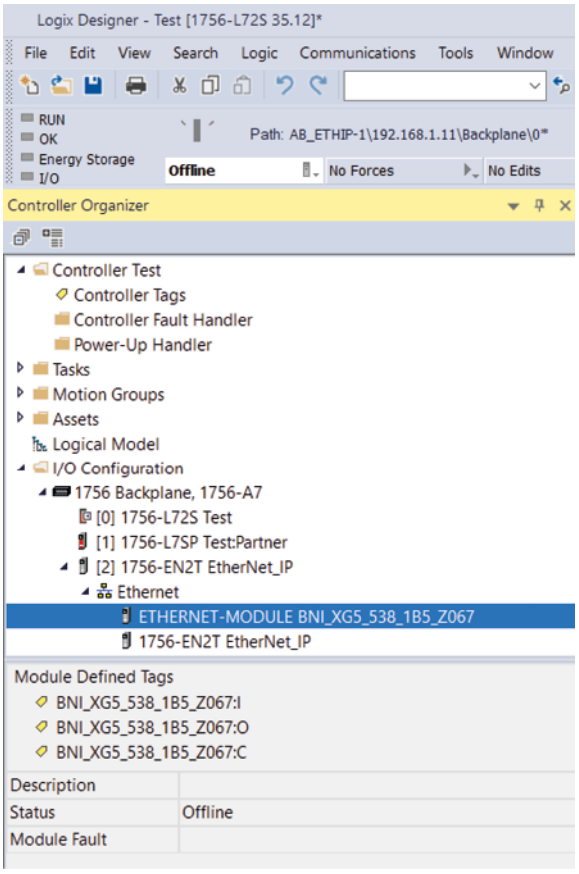


Fig. 85: Controller tags

5. Download the configuration with Download.

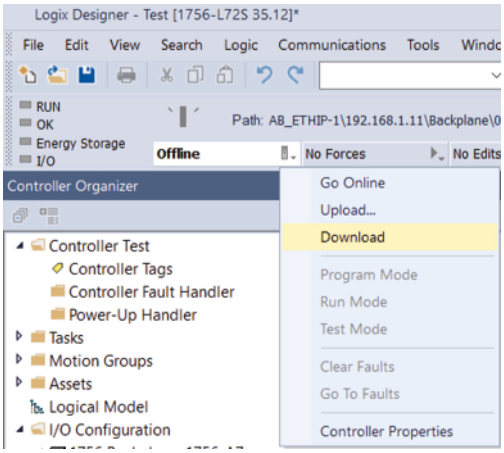


Fig. 86: Download configuration

After the download is completed the tags can be monitored and activated using the Controller tags option.

Note

Make sure to select the previously configured correct tag name.

The entry, output and configuration data are described on the following pages.

Note

These tags can also be used for programming.

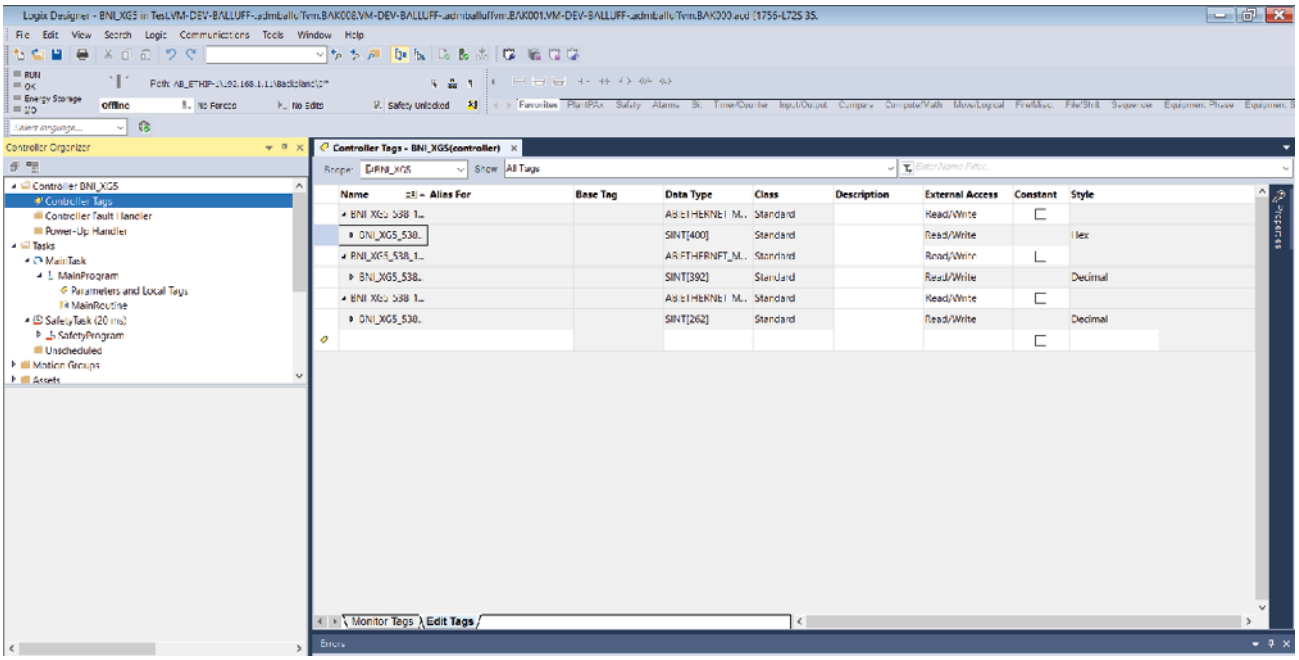


Fig. 87: Tag creation completed

9.11.2 Integration

Data configuration

Note

Please check whether IO-Link is supported by your module before using this function. For more information on product variants that support IO-Link, see *Supported product variants*.

Enter the values from *Data configuration for variant BNI XG3-302…* and *Data configuration for all other variants* in the control system. They describe the data sizes of the entry, output and configuration data.

For variant BNI XG3-302… where only I/O (SIO) ports are available but IO-Link is not available, only I/O assemblies are provided.

Table 38: Data configuration for variant BNI XG3-302…

Data size	Instance ID	Length of data
Configuration	104	2
Producing / Input Assembly	126	8
Consuming / Output Assembly	127	8

For all other variants where I/O (SIO) ports and IO-Link ports are available, the following assemblies are provided.

Table 39: Data configuration for all other variants

Data size	Instance ID	Length of data
Input with 32 bytes of IO-Link process data	100	392
Output with 32 bytes of IO-Link process data	101	262
Configuration	102	58/0
Automatic IO-Link	103	0 (adjustable, see Automatic IO-Link – Adjustable IO-Link process data length)
Input with 24 bytes of IO-Link process data	110	328
Output with 24 bytes of IO-Link process data	111	198
Input with 16 bytes of IO-Link process data	112	264
Output with 16 bytes of IO-Link process data	113	134
Input with 10 bytes of IO-Link process data	114	216
Output with 10 bytes of IO-Link process data	115	86
Input with 8 bytes of IO-Link process data	116	200
Output with 8 bytes of IO-Link process data	117	70
Input with 6 bytes of IO-Link process data	118	184
Output with 6 bytes of IO-Link process data	119	54
Input with 4 bytes of IO-Link process data	120	168
Output with 4 bytes of IO-Link process data	121	38
Input with 2 bytes of IO-Link process data	122	152
Output with 2 bytes of IO-Link process data	123	22
Input with 1 byte of IO-Link process data	124	144
Output with 1 byte of IO-Link process data	125	14
Input with 0 bytes of IO-Link process data	126	8
Output with 0 bytes of IO-Link process data	127	6

Automatic IO-Link – Adjustable IO-Link process data length

Note

Please check whether IO-Link is supported by your module before using this function. For more information on product variants that support IO-Link, see *Supported product variants*.

The Ethernet/IP master offers a variety of configurations for IO-Link process data lengths, ranging from 0 to 32 bytes. The EDS file (Electronic Data Sheet) contains several predefined connections under the Connection *Manager section*. One of these connections is, for example, *Connection2* with the name *Exclusive Owner Connections – 32 IOL Data*. A connection is a compilation of a configuration. Part of this is the definition of the data from the control unit to the device (O->T), the data from the device to the control unit (T->O) and the device configuration. These definitions can be found in the EDS file under the *Assembly* section. *Assem101* (a consuming module with 32 bytes of IO-Link output process data) is used for *Connection2* and the direction _O->T. *Assem100* (a producing module with 32 bytes of IO-Link input process data) is used for the direction *T->O* and *Assem102* is used for the configuration.

For example, if 10 bytes of IO-Link input and output data are required, the path *20 04 2C 73 2C 72 (hex)* can be used, where the assembly sizes are *T->O 216*, *O->T 86* and the configuration assembly is 0 or 58 bytes.

Configuration modules

The Ethernet/IP master contains two configuration assemblies for managing the IO-Link settings. These are *Assem102* and *Assem103*, which each serve different purposes:

- **Assem102**: The assignment of this module is described in detail in the EDS file and can be configured to a size of either 58 bytes or 0 bytes. If it is set to 0 bytes, the existing configuration is retained and is not overwritten.
- **Assem103**: This module is set to a length of 0 bytes and was specially developed to automatically set all ports to IO-Link mode.

If the configuration module is not included in the connection path, the device operates as if module 103 is being used. This means that all ports are automatically set to IO-Link mode.

Configuration data

Assignment of configuration data sequence shows an assignment of the configuration data sequence. The stated standard values describe a configuration with the IO-Link function on Pin 4 and standard I/O functions on Pin 2 and 4 of every port. The input and output functions of the configured standard I/O ports are set using the process data.

Table 40: Assignment of configuration data sequence

Byte	Module part	Description
0…1	Module	Configuration of the pin functions for ports X01 to X08 (pin 4 and pin 2 functions for each port)
2…8	IO-Link Port X01	Configuration of the IO-Link Port X01
9…15	IO-Link Port X02	Configuration of the IO-Link Port X02
16…22	IO-Link Port X03	Configuration of the IO-Link Port X03
23…29	IO-Link Port X04	Configuration of the IO-Link Port X04
30…36	IO-Link Port X05	Configuration of the IO-Link Port X05
37…43	IO-Link Port X06	Configuration of the IO-Link Port X06
44…50	IO-Link Port X07	Configuration of the IO-Link Port X07
51…57	IO-Link Port X08	Configuration of the IO-Link Port X08

Module configuration

Note

Please check whether IO-Link is supported by your module before using this function. For more information on product variants that support IO-Link, see *Supported product variants*.

Table 41: Module configuration

Bit	Description
0	Port X01 Pin 4 function (0x00: Standard-I/O, 0x01: IO-Link)
1	Port X01 Pin 2 function (0x00: Standard-I/O, 0x01: Power)
2	Port X02 Pin 4 function (0x00: Standard-I/O, 0x01: IO-Link)
3	Port X02 Pin 2 function (0x00: Standard-I/O, 0x01: Power)
4	Port X03 Pin 4 function (0x00: Standard-I/O, 0x01: IO-Link)
5	Port X03 Pin 2 function (0x00: Standard-I/O, 0x01: Power)
6	Port X04 Pin 4 function (0x00: Standard-I/O, 0x01: IO-Link)
7	Port X04 Pin 2 function (0x00: Standard-I/O, 0x01: Power)
8	Port X05 Pin 4 function (0x00: Standard-I/O, 0x01: IO-Link)
9	Port X05 Pin 2 function (0x00: Standard-I/O, 0x01: Power)
10	Port X06 Pin 4 function (0x00: Standard-I/O, 0x01: IO-Link)
11	Port X06 Pin 2 function (0x00: Standard-I/O, 0x01: Power)
12	Port X07 Pin 4 function (0x00: Standard-I/O, 0x01: IO-Link)
13	Port X07 Pin 2 function (0x00: Standard-I/O, 0x01: Power)
14	Port X08 Pin 4 function (0x00: Standard-I/O, 0x01: IO-Link)
15	Port X08 Pin 2 function (0x00: Standard-I/O, 0x01: Power)

IO-Link Port configuration

Note

Please check whether IO-Link is supported by your module before using this function. For more information on product variants that support IO-Link, see *Supported product variants*.

Table 42: IO-Link Port configuration

Byte	Description
2	Port X01 Cycle time
3	Port X01 Validation type and parameter server
4, 5	Port X01 Vendor ID
6…8	Port X01 Device ID
…	

Cycle settings

Note

Please check whether IO-Link is supported by your module before using this function. For more information on product variants that support IO-Link, see *Supported product variants*.

With this parameter, the IO-Link communication speed can be set. The IO-Link cycle time can be increased calculated by the multiplier and the time base.

The time base is described in the table below, the multiplier is entered as a decimal number from 0…63.

The cycle-time byte is structured as follows:

- **Bits 0…5 (Multiplier):** These bits contain a 6-bit multiplier for calculating *MasterCycleTime* or *MinCycleTime*. The valid range is 0…63.
- **Bits 6…7 (Time base):** These bits define the time base used to calculate *MasterCycleTime* or *MinCycleTime*.

Bit position	Description
7	Time base bit 1
6	Time base bit 0
5	Multiplier bit 5
4	Multiplier bit 4
3	Multiplier bit 3
2	Multiplier bit 2
1	Multiplier bit 1
0	Multiplier bit 0

Possible values for *MasterCycleTime* and *MinCycleTime*:

Table 43: Possible values for MasterCycleTime and MinCycleTime

Time base coding	Time base value	Calculation	Cycle Time
00	0.1 ms	Multiplier x time base	0.41[1] …6.3 ms
01	0.4 ms[1]	6.4 ms + multiplier x time base	6.4…31.6 ms
10	1.6 ms	32 ms + multiplier x time base	32…132.8 ms
11	reserved	reserved	reserved

Validation settings

No validation : Validation deactivated, every device is accepted.

Compatibility : Manufacturer ID and Device ID are compared with the data of the IO-Link device.

Parameter server

Switched on : Data retention functions active, parameter data and identification data of the IO-Link device are saved in a remanent memory.

Switched off : Data retention functions deactivated, saved parameter data and identification data of the IO-Link devices remain in the memory.

Enable download : If only the download is enabled, in each case the master starts a download of the parameter data. In this case the download is also performed irrespective of the upload flag of the IO-Link device. If there are no data in the

1 The value 0.4 is the result of the minimum possible transmission time according to the IO-Link Interface and System Specification|

master port, an upload takes place first (e.g. after deletion of the data or before the first data upload). Upload and download enabled: If the upload and download are enabled, a distinction is made for different parameter records depending on the upload flag of the IO-Link device. If there are no data in the IO-Link master port, an initial upload takes place (e.g. after deletion of the data or before the first data upload). If the upload flag is set at the IO-Link device, the parameter data are uploaded in each case. If no upload flag is set and parameter data have already been stored, a download of the parameter data takes place in each case.

Note

After uploading the parameter data, the Vendor ID and Device ID of the connected IO-Link device remain stored until the data records are deleted.
When the connected IO-Link device is started a validation takes place and then only an IO-Link device of the same type can be used for the data retention.
If a different type of IO-Link device should be used, the content of the parameter server must be deleted.
The data storage is only supported by IO-Link devices with IO-Link Revision 1.1.

Values for validation type and parameter server

Table 44: IO-Link Port configuration

Value	Description
0	No device check
1	Type-compatible device V1.0
2	Type-compatible device V1.1
3	Type-compatible device V1.1+ Backup + Restore
4	Type-compatible device V1.1, Restore

Upload flag at IO-Link device

Note

Please check whether IO-Link is supported by your module before using this function. For more information on product variants that support IO-Link, see *Supported product variants*.

The upload flag is required in order to overwrite data already saved in the parameter server with new parameter data of the same IO-Link device.

In order to activate the upload flag of an IO-Link device, the data value 0x05 must be entered in the index 0x02, subindex 0.

(For information on setting parameters via IO-Link, see *I/O ports* or *IO-Link device parameterization*.

9.11.3 Configuration via Explicit Messages

PLC program

Note

Information about the PLC program and *Add Application Logic* , see Allen Bradley Ethernet/IP QuickConnect Application Technique.

Fault State

For each output at the port pins, a safe state can be predefined, which should be adopted in the case of a loss of bus communication.

The *Fault State* settings can be implemented via the following Class Instance Attribute of the *Explicit Messages*.

Activate / deactivate Fault State

Class	Instance	Attribute	Value
9 (0x09)	1 – m[2]	6	"0": Fault State disabled "1": Fault State enabled

Fault State Action

Class	Instance	Attribute	Value
9 (0x09)	1 – m[2]	5	"0": Output on"1": Hold last state

Note

The *Fault State* settings are only stored temporarily in the module. They are deleted again after a power reset. In order to ensure a permanent *Fault State* configuration, the configuration must be programmed via the PLC so that it can be transferred to the module again when the system is restarted.

UA Configurable behavior

Note

This setting is only available for the XG5-538-...-variants.

The output power loss behavior can be configured via the vendor-specific CIP Module Settings object (**Class 0x151, Instance 1, Attribute 1**), using Get_Attribute_Single and Set_Attribute_Single.

The attribute defines what happens to active outputs on Pin 2 and Pin 4 when UA voltage is lost. It is an 8-bit enumeration with the following options:

- Value 0 – US Outputs shutdown on UA powerloss

  All active outputs on Pin 2 and Pin 4 are automatically switched off in the event of a UA voltage drop. This matches the behavior of a XG5-508-... master, even though Pin 2 and Pin 4 of Class A output ports are supplied by US, and Pin 4 of Class B ports are supplied by UA.

- Value 1 – Hardware Defined

  US powered outputs will not be switched off in the event of a UA voltage drop. All outputs remain in their current state. Only Class B Pin 2 outputs are physically supplied by UA and will therefore be shut down.

The configured setting is **saved permanently** — it can be written once and will be retained after a power reset.

IO-Link device parameterization

Note

Please check whether IO-Link is supported by your module before using this function. For more information on product variants that support IO-Link, see *Supported product variants*.

There are two ways to parameterize an IO-Link device connected to the IO-Link Port.

- Parameterization via the web server (see *I/O ports*)
- Parameterization via *Explicit Messages*

The following section describes, for example, how via Rockwell RSLogix 5000 an IO-Link device can be parameterized via *Explicit Messages*.

The *MSG* modules are used in the PLC program (see *MSG modules*).

2 m Number of outputs

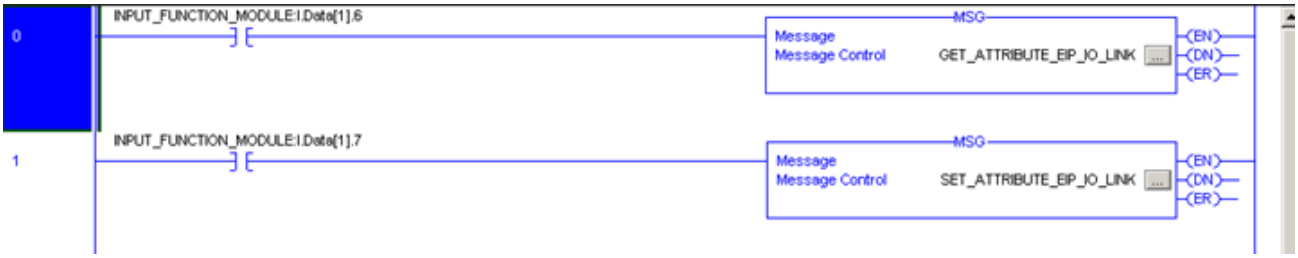


Fig. 88: MSG modules

Read IO-Link parameters

Note

Please check whether IO-Link is supported by your module before using this function. For more information on product variants that support IO-Link, see *Supported product variants*.

Table 45: Values for read IO-Link parameters

Service code	Class	Instance	Attribute
0x32	0x96	1…n[3]	0x03 (Read parameters)

Source Length must at least correspond to the read parameters, but can also be bigger (in this example 100 bytes).

1. As a *Source Element* (Write) and as a *Destination Element* (Read), create a SINT[100] Array and select the first row [0].

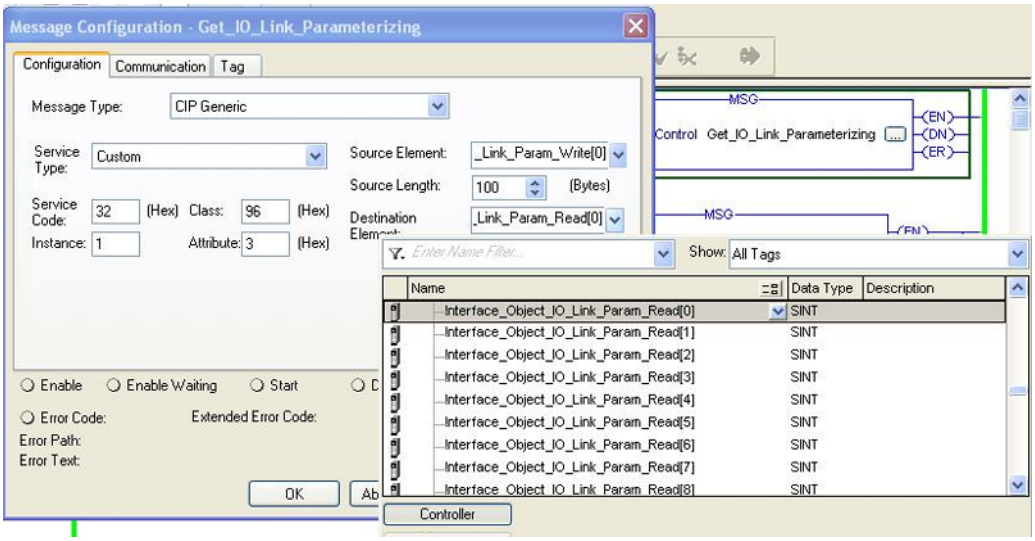


Fig. 89: Create SINT[100] Arrays

2. In the *Source Element* Array (Write) enter which index should be read (in this example Index 0x4E).

3 n: Number of ports

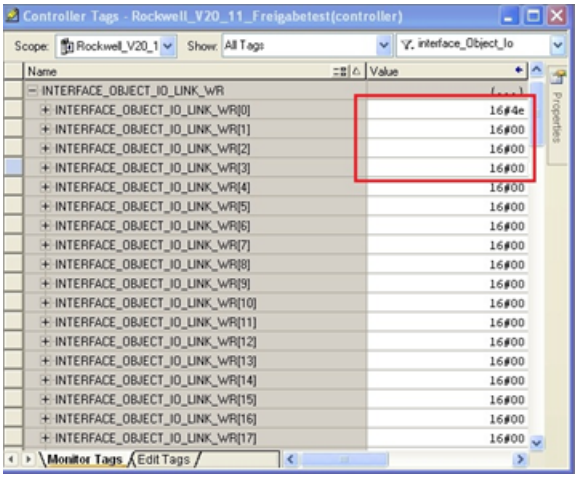


Fig. 90: Enter Source Element Array

⇒ The read value is displayed in the *Destination Element* Array (Read).
⇒ The error code is also displayed there in the event of a parameterization error.

3. In the *Communication* window select the Ethernet module for which parameters should be set.

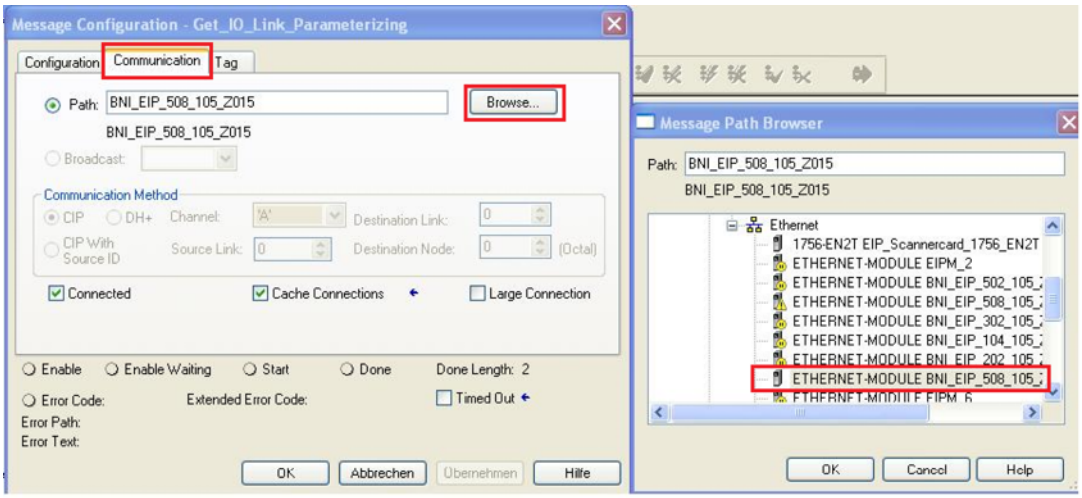


Fig. 91: Select Ethernet module

Write IO-Link parameters

Note

Please check whether IO-Link is supported by your module before using this function. For more information on product variants that support IO-Link, see *Supported product variants*.

Table 46: Values for write IO-Link parameters

Service code	Class	Instance	Attribute
0x32	0x96	1 - n[Page 162, 3]	0x02 (Write parameters)

1. Select *Source Element* and *Destination Element* as described in the example *Values for read IO-Link parameters*.

The *Source Length* must be the same length as the parameter data to be written. In this example the index 0x4E, subindex 0, value 0x02 are written in the *Source Element Array* (Write).

In the event of a parameterization error an error code is displayed in the *Destination Element Array* (Read).

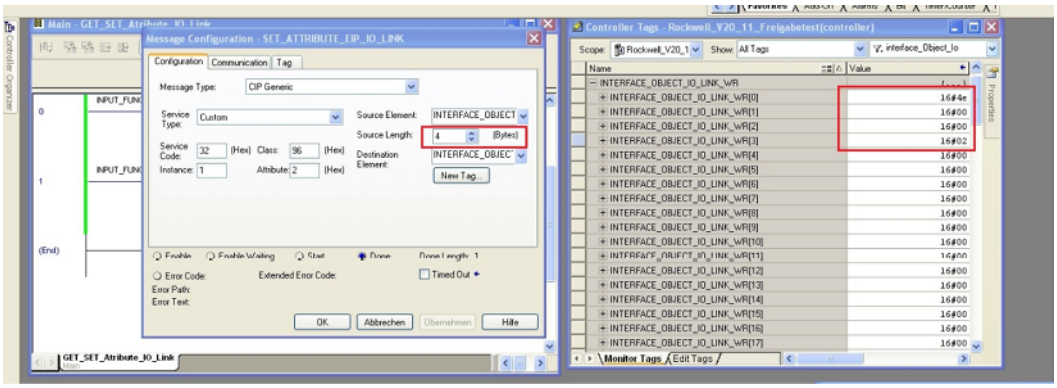


Fig. 92: Configuration

2. In the *Communication* tab select the Ethernet module for which parameters should be set.

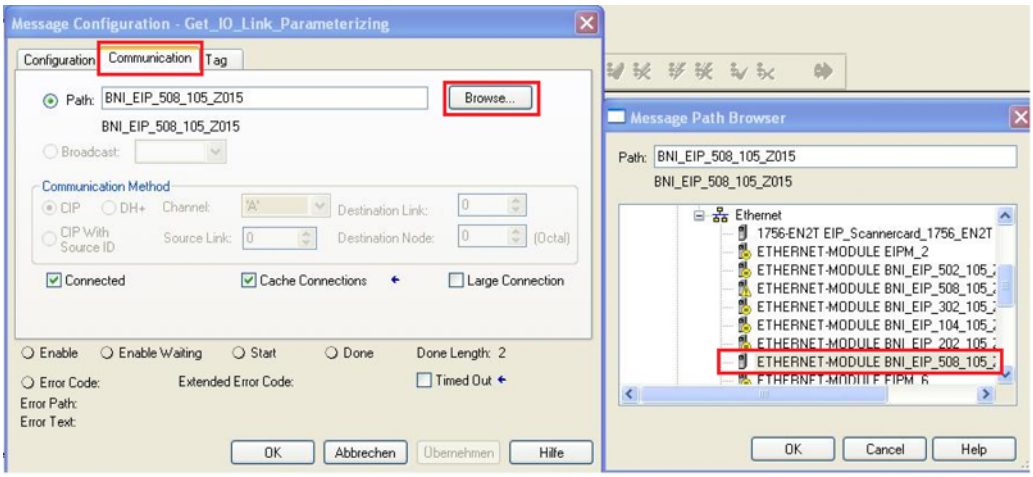


Fig. 93: Select Ethernet module

Note

The Explicit Messages functions are implemented according to Volume 1: Common Industrial Protocol Specification and Volume 2: Ethernet/IP Adaption of CIP.

9.11.4 Process data

Process data inputs

Note

Please check whether IO-Link is supported by your module before using this function. For more information on product variants that support IO-Link, see *Supported product variants*.

The input data have a size of 392 bytes. The table below shows the assignment of the process data inputs.

Table 47: Process data inputs

Byte	Module part	Description
0…7	Standard I/O ports	Process data inputs for the standard inputs
8…55	IO-Link Port 0	Process data inputs for the IO-Link Port 0
56…103	IO-Link Port 1	Process data inputs for the IO-Link Port 1
104…151	IO-Link Port 2	Process data inputs for the IO-Link Port 2
152…199	IO-Link Port 3	Process data inputs for the IO-Link Port 3
200…247	IO-Link Port 4	Process data inputs for the IO-Link Port 4
248…295	IO-Link Port 5	Process data inputs for the IO-Link Port 5
296…343	IO-Link Port 6	Process data inputs for the IO-Link Port 6
344…391	IO-Link Port 7	Process data inputs for the IO-Link Port 7

Standard input data

Byte	Bit								Description
	7	6	5	4	3	2	1	0	
0	I32	I34	I22	I24	I12	I14	I02	I04	Input data I04: Input for Port 0, Pin 4 The result is only 0 when the port is configured as an IO-Link Port.
1	I72	I74	I62	I64	I52	I54	I42	I44	
2	S3		S2		S1		S0		Short circuit status Short circuit between Pin 1 and 3 at reported port
3	S7		S6		S5		S4		
4	O32	O34	O22	O24	O12	O14	O02	O04	Overload status O04: Overload at Port 0, Pin 4 Only if the port is configured as an output.[4]
5	O72	O74	O62	O64	O52	O54	O42	O44	
6	0	0	0	0	0	NA	PS	PA[4]	Status of power supply • NA: No actuator supply • PS: Power supply of sensor • PA: Power supply of actuator
7	0	0	0	0	0	0	0	reserved	

IO-Link input data

Note

Please check whether IO-Link is supported by your module before using this function. For more information on product variants that support IO-Link, see *Supported product variants*.

4 not available for BNI XG1-…

Table 48: IO-Link Port data and status

Byte	Bit								Description
	7	6	5	4	3	2	1	0	
8...39									IO-Link Port 0 input data
40	0	0	0	0	0	0	DC	IOL	IO-Link status • IOL: Port in IO-Link mode • DC: Device connected • 0: reserved
41	SC	0	0	0	PLI	PDI	DF	VF	IO-Link error • VF: Validation failed • SC: IO-Link short-circuit • DF: Data storage validation failed • PDI: Process data invalid • PLI: Process Data Length Incorrect
42	Manufacturer code 1								Manufacturer code
43	Manufacturer code 2								
44	Device code 1								Device code
45	Device code 2								
46	Device code 3								

Table 49: IO-Link Port events

Byte	Bit								Description	
	7	6	5	4	3	2	1	0		
47	Mode		Type		0				Event 1	Mode: • 0: reserved • 1: Single event • 2: Event outgoing • 3: Event incoming Type: • 0: reserved • 1: Message • 2: Warning • 3: Error
48	Event code high									
49	Event code low									
50	Mode		Type		0				Event 2	
51	Event code high									
52	Event code low									
53	Mode		Type		0				Event 3	
54	Event code high									
55	Event code low									
...	The data of the other IO-Link Ports are structured identically and described below.									

Process data outputs

Note

Please check whether IO-Link is supported by your module before using this function. For more information on product variants that support IO-Link, see *Supported product variants*.

The output data have a size of 262 bytes. The table below shows the assignment of the process data outputs.

Byte	Module part	Description
0…5	Standard I/O ports	Process data outputs for the standard inputs
6…37	IO-Link Port 0	Process data output for the IO-Link Port 0
38…69	IO-Link Port 1	Process data output for the IO-Link Port 1
70…101	IO-Link Port 2	Process data output for the IO-Link Port 2
102…133	IO-Link Port 3	Process data output for the IO-Link Port 3
134…165	IO-Link Port 4	Process data output for the IO-Link Port 4
166…197	IO-Link Port 5	Process data output for the IO-Link Port 5
198…229	IO-Link Port 6	Process data output for the IO-Link Port 6
230…261	IO-Link Port 7	Process data output for the IO-Link Port 7

Standard output data

Byte	Bit								Description
	7	6	5	4	3	2	1	0	
0	O32	O34	O22	O24	O12	O14	O02	O04	Output data O04: Output at Port 0, Pin 4 The port must be configured as an output in order to use this function at an IO-Link Port.[5]
1	O72	O74	O62	O64	O52	O54	O42	O44	*see above*
2	R32	R34	R22	R24	R12	R14	R02	R04	Restart Restart of output after identified short-circuit
3	R72	R74	R62	R64	R52	R54	R42	R44	*see above*
4	0	0	0	0	0	0	0	0	reserved
5	0	0	0	0	0	DL	GO	RO	Display control[6] **DL**: Display locked / PLC lock **GO**: Green display LED lights up **RO**: Red display LED lights up

IO-Link output data

Note

Please check whether IO-Link is supported by your module before using this function. For more information on product variants that support IO-Link, see *Supported product variants*.

Table 50: IO-Link Port output data

Byte	Bit								Description
	7	6	5	4	3	2	1	0	
6…37									IO-Link Port 0 output data
…	The data of the other IO-Link Ports are structured identically and described below.								

5 not available for BNI XG1-…
6 only valid for devices with display

9.11.5 Quick Connect mode

The following points must be observed in *Quick Connect* operating mode:

- **Ethernet port settings**
  - Ethernet port 1: The connection must be set to a fixed speed of 100 Mbit/s in full duplex mode.
  - Ethernet port 2: The connection must be set to a fixed speed of 100 Mbit/s in full duplex mode.
- **Device configuration**: Quick Connect mode must be activated.

Auto-MDIX is not available in Quick Connect mode. Therefore, the automatic configuration of the ports at fixed speed and activated Quick Connect is as follows:

- Port 1: MDI
- Port 2: MDIX

This configuration is crucial, as port 2 can be connected to port 1 of another device with a non-crossover cable, but not to port 2. If the connection is incorrect, no Ethernet connection (link) can be established.

For more information, see *Ethernet/IP Specification Volume 2: EtherNet/IP Adaption of CIP, Appendix E: EtherNet/IP Quick Connect™*.

9.12 EtherCAT integration

Note

The following instructions and screenshots are based on Beckhoff TwinCAT and illustrate the general procedure for configuring an EtherCAT device. Many engineering tools follow the same basic principles (device scan/selection, topology and node configuration, ESI/device parameters, mapping of process data), but menu structures, terminology, and individual steps may differ. If you are using a different tool, apply the described concepts accordingly and consult the vendor-specific documentation as needed.

9.12.1 EtherCAT Device Basics

The Networking Module is a modular EtherCAT device.

The devices which feature IO-Link (see *Supported product variants*) follow the EtherCAT specification *EtherCAT Modular Device Profile Part 6220: IO-Link Master (ETG.5001.6220 S (D) V1.0.5)*.

The variants which do not feature IO-Link do follow this specification as close as possible, trying to inherit the majority of features to make the variants function similarly.

Device Model

All the data in the device is arranged in the *Object Dictionary* (see *Object Dictionary*), which is a collection of *Objects*. Each Object has a unique 16-bit *Index* and may contain one or more *Sub-Objects*, which are identified by an additional 8-bit *Sub-Index*.

Some of these objects can be mapped in cyclic data exchange.

Every variant of the Networking Module has the same structure of the Object Dictionary and data which is exchanged through the cyclic data exchange.

Data which is received from the EtherCAT device (to the PLC) is typically called Input Data or TxPDO, while data which is sent to the device (from the PLC) is called Output Data or RxPDO.

Some cyclic data is fixed and will always be present in the data exchange, while other data is variable and can be configured to be present or not.

Table 51: Data configuration

Configurable/ Fixed	Name	Direction	Note and Description
Fixed	*Device Status*	TxPDO	Not available for variants without IO-Link
Fixed	*Port Qualifier*	TxPDO	Not available for variants without IO-Link
Fixed	*Input Pin 2*	TxPDO	
Fixed	*Power Status*	TxPDO	
Fixed	*New Message Available*	TxPDO	
Fixed	*Timestamp*	TxPDO	
Fixed	*Output Pin 2*	RxPDO	Not available for variants without Output on Pin 2
Configurable as Slots 1…8	Channel/ Slot 1…8	TxPDO/ RxPDO	Representation of Port 1…8. Can be configured to the desired functionality.

The Slots 1…8 are the modular slots of the device. Each slot can be configured to a specific functionality which also assigns the functionality to the corresponding port and will influence the data which is exchanged through the cyclic data exchange. For possible configurations see *EtherCAT configuration*.

Failsafe values

If the EtherCAT connection fails or if the EtherCAT status is not Operate, the IO-Link Ports use these values:

- If a port is in the IO-Link state Operate, the process data displayed is switched to invalid.
- If Pin 2 or Pin 4 are in the digital output mode, zero (low level) is displayed.

9.12.2 Set up initial EtherCAT device connection

As an example, the connection of the BNI to a Beckhoff TwinCAT control is shown with the TwinCAT System Manager. The exact procedure depends on the project planning software used.

Installing ESI files

The device description has the following name: Balluff BNI XG5-538-1B5-Z067 ECS V.x.x.x.xml

► Copy the file to the corresponding TwinCAT directory (in the standard: `C:\TwinCAT\3.1\Config\Io\EtherCAT`).

⇒ Installed devices are available when the TwinCAT System Manager starts again.

Adding the Network Module as EtherCAT Device

You can either choose to automatically scan the EtherCAT network for devices or manually add a device. Both methods are described below.

Automatic scanning

Prerequisite

Before connecting devices to the EtherCAT network, the EtherCAT system must be in a secure, de-energized state.

1. Switch on the operating voltage and start the TwinCAT System Manager in Config mode.
2. Select *Scan* in the context menu of the EtherCAT master.

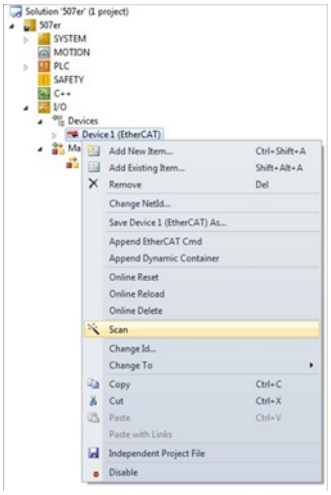


Fig. 94: Automatic scanning

Manually adding a device

Prerequisite

Before connecting devices to the EtherCAT network, the EtherCAT system must be in a secure, de-energized state.

1. Switch on the operating voltage and start the TwinCAT System Manager in Config mode.
2. Attach an EtherCAT Slave by selecting “Add New Item” in the context menu of the EtherCAT master.

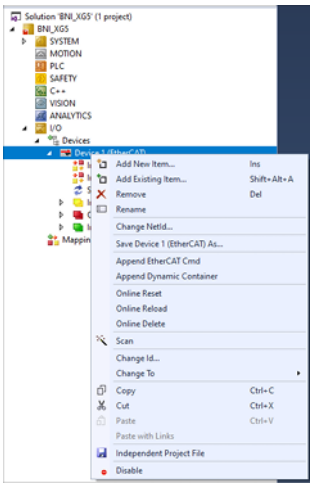


Fig. 95: Manually adding a device

3. Select the EtherCAT Device you want to add.

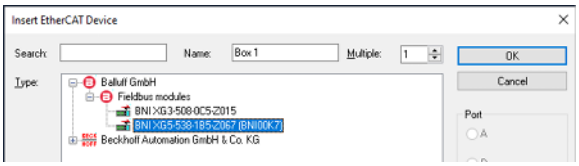


Fig. 96: Select a box

9.12.3 EtherCAT configuration

With the EtherCAT integration, the system is made up of the following components:

- Bus master
- Bus modules/slaves (here the bus module BNI)

Configuration

Note

Please check whether IO-Link is supported by your module before using this function. For more information on product variants that support IO-Link, see *Supported product variants*.

During the project planning the BNI bus module is displayed as a modular device. The device data required for the project planning is stored in the ESI files. The data modules of the inputs/outputs, the IO-Link Port and any additional modules are shown in the project planning software in relation to the slot.

The ESI files make available the possible data modules (inputs/outputs, IO-Link Ports of varying data width and other additional modules).

The appropriate data modules are assigned to a certain slot for the configuration of the BNI.

After automatic scanning or manual adding of the device, the device appears in the tree structure of TwinCAT.

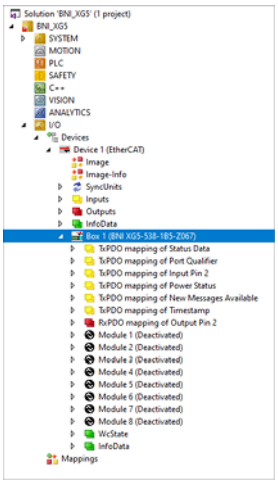


Fig. 97: Device in tree structure

Configuring the ports

Note

Please check whether IO-Link is supported by your module before using this function. For more information on product variants that support IO-Link, see *Supported product variants*.

The BNI is a modular EtherCAT device. It features 8 modular slots which can be configured to a specific functionality (see *EtherCAT Device Basics*). The configuration of the slots is done in the project planning software. The configuration is transferred to the device during the transfer of the configuration.

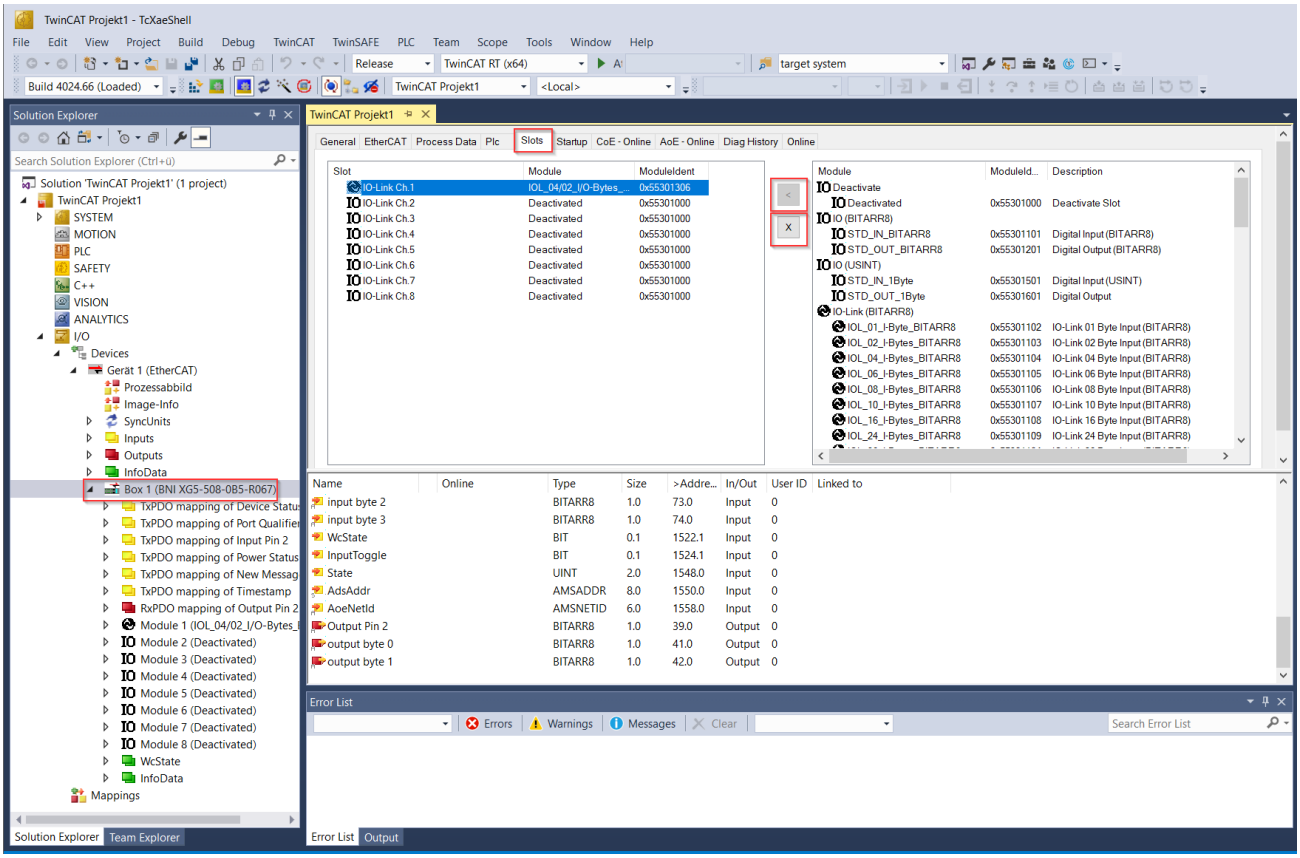


Fig. 98: Configuring the network module

In order to configure the IO-Link Ports, a defined number of process data (buffer size) must be assigned to the EtherCAT slots. In the TwinCAT System Manager this works as follows:

1. Delete assignment of IO-Link channel (or port) with *x*.
2. Place the channel selected on the left side with < the module configuration selected on the right.
3. Transfer configuration to the EtherCAT slave with a *restart of TwinCAT in Config mode*.

This will assign the selected function to Pin 4 of the port. The IQ (Pin 2) functions are configured by the startup parameters.

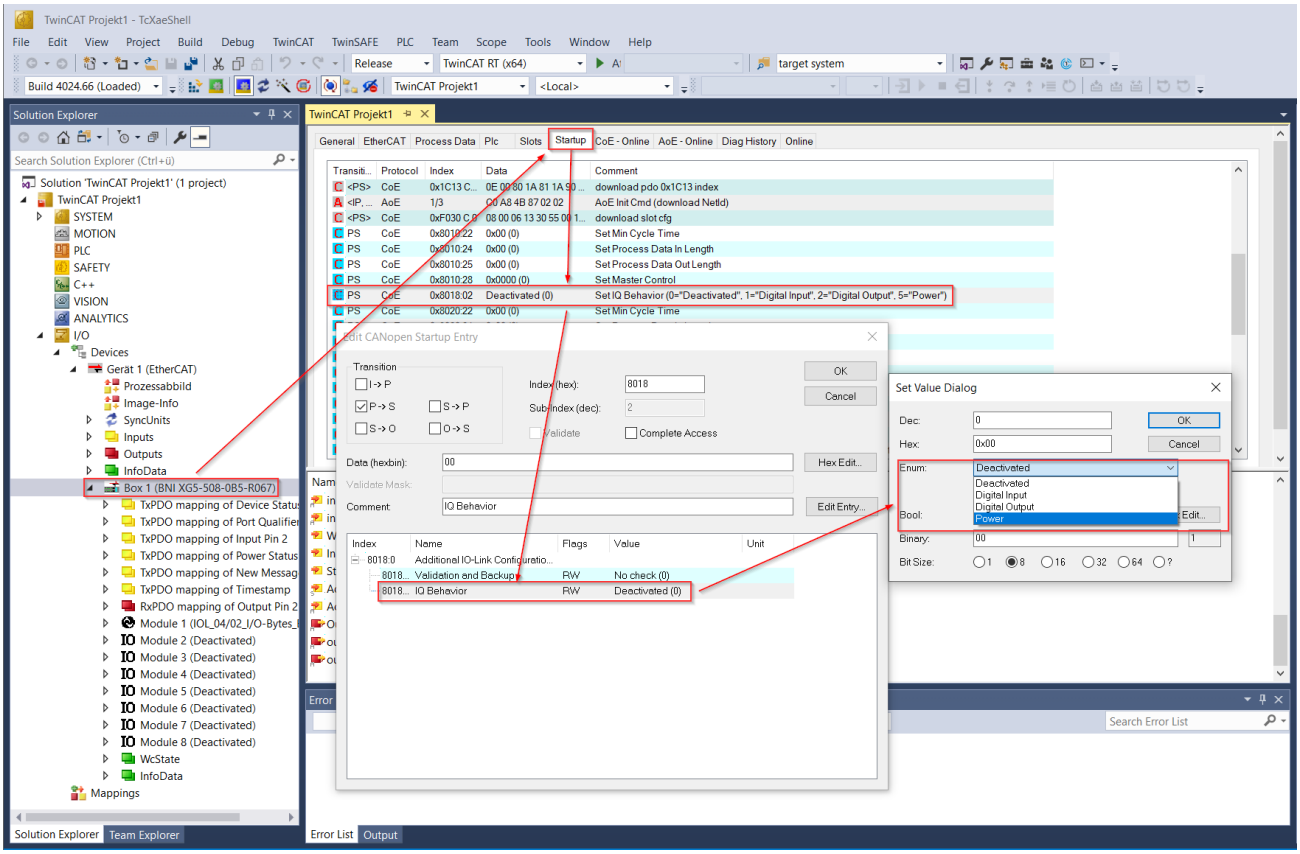


Fig. 99: IQ (Pin 2) configuration

1. Click open the EtherCAT device in the tree structure.
2. Switch to the *Startup* tab.
3. Double click on the *Startup Parameter* entry.
4. In the new Dialog double click on *IQ Behavior*.
5. From the Dropdown select the desired function for Pin 2.
6. Save the configuration by clicking *OK*.

In the Startup List the selected function will now be visible in the *Data* column. Repeat those steps for each port of the device you want to configure.

Note

If the slot configuration is changed and another module is placed in the slot, this configuration will be lost.

Available Modules

Each port of the device can be configured to a specific functionality. For the Pin 4 configuration the following modules are available:

- Deactivated
- Digital Input
- Digital Output
- IO-Link

Modules are available in three different datatypes:

- USINT (all modules)
- BITARR8 (all modules)
- BOOL (some IO-Link modules)

Both datatypes function the same way and only differ in the representation of the data in the engineering tool. The *USINT* datatype is represented as a single byte, while the *BITARR8* datatype is represented as an array of 8 bits. Some of the IO-Link modules are also available with datatype *BOOL* for an even broader compatibility with engineering tools. It is up to the user to decide which datatype is more suitable for the application.

Deactivated Module

If the module *Deactivated* is selected, the corresponding Pin 4 is not used/deactivated. No process data is reserved for this Pin.

Digital Input or Digital Output Modules

Digital input and digital output modules each use 1 byte of process data.

If the port is configured as a digital input, only bit 0 of the input byte is used: `1` means the input is high, and `0` means the input is low. The remaining bits are not used.

If the port is configured as a digital output, the user can write to all 8 bits of the output byte. If at least one bit is set to `1`, the output is high. The output is low only when all bits are `0`.

IO-Link Modules

Note

Please check whether IO-Link is supported by your module before using this function. For more information on product variants that support IO-Link, see *Supported product variants*.

If an IO-Link module is selected, the corresponding port is configured as an IO-Link port.

Naming of IO-Link Modules

All module names follow a naming convention that encodes process data direction, length, and data type.

Naming pattern (byte-based)

- Input only Name: `IO-Link <in> Byte Input (<datatype>)` Type: `IOL_<in>_I-Byte_<datatype>`
- Output only Name: `IO-Link <out> Byte Output (<datatype>)` Type: `IOL_<out>_O-Byte_<datatype>`
- Input and output Name: `IO-Link <in> Byte Input - <out> Byte Output (<datatype>)` Type: `IOL_<in>/<out>_I/O-Bytes_<datatype>`

Where:

- `<in>` / `<out>` = process data length in bytes
- `<datatype>` = `USINT` or `BITARR8`

Naming pattern (bit-based, BOOL)

- Input only Name: `IO-Link <in> BIT Input (BOOL)` Type: `IOL_<in>_I-BIT_BOOL`
- Output only Name: `IO-Link <out> BIT Output (BOOL)` Type: `IOL_<out>_O-BIT_BOOL`
- Input and output Name: `IO-Link <in> BIT Input - <out> BIT Output (BOOL)` Type: `IOL_<in>/<out>_I/O-BIT_BOOL`

Where:

- `<in>` / `<out>` = process data length in bits

Note

Not all process data lengths are available as *BOOL* modules.

Validation and Backup

Note

Please check whether IO-Link is supported by your module before using this function. For more information on product variants that support IO-Link, see *Supported product variants*.

Validation of the connected IO-Link device and backup of its parameter data in the network module's parameter server are configured together via a single setting: subindex 0x01 (Validation and Backup) of the *Additional IO-Link Configuration Data Ch. x* object. See *Additional IO-Link Configuration Data Ch. x (IO-Link variants)* for the object details and the full list of values.

For enabling, the objects need to be added to the *Startup Parameter List*.

For this, the corresponding objects must be added.

1. Add all subindices to the list by clicking the *New...* button and selecting them from the list.

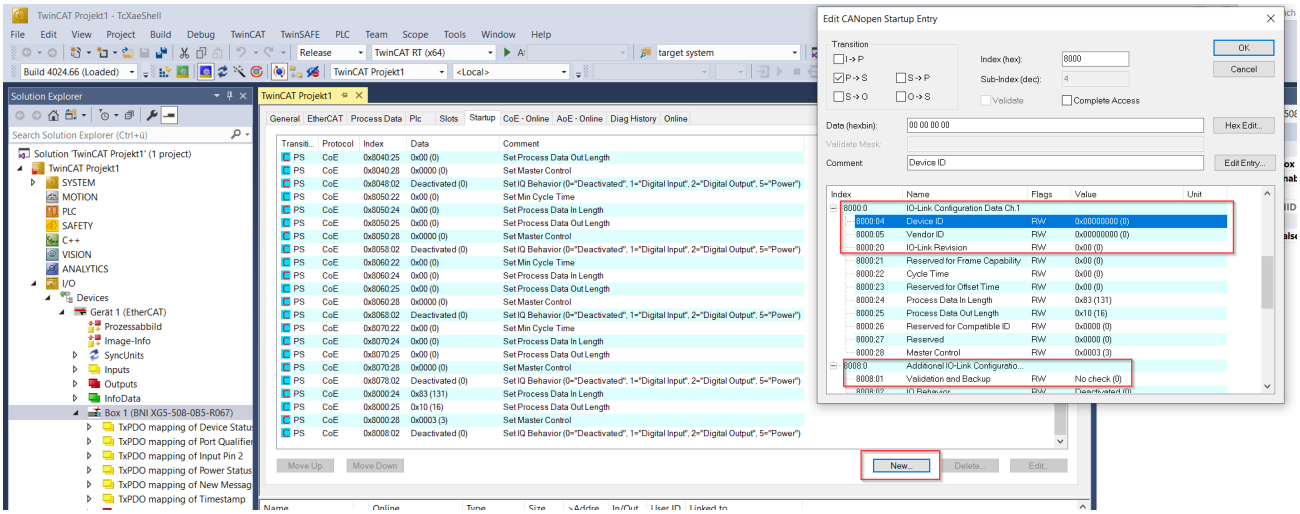


Fig. 100: Backup and Validation configuration

The subindices 0x04 (Device ID), 0x05 (Vendor ID) and 0x20 (IO-Link Revision) from index 0x80n0 (IO-Link Configuration Data Ch. n) need to be added and the subindex 0x01 (Validation and Backup) from index 0x80n8 (Additional IO-Link Configuration Data Ch. n) needs to be added to the list.

2. Configure the subindex 0x01 (Validation and Backup) from index 0x80n8 (Additional IO-Link Configuration Data Ch. n) with the desired value.

3. Input the expected Vendor ID, Device ID and IO-Link protocol version.

Validation checks the Vendor ID and Device ID of the connected IO-Link device, as well as its IO-Link protocol version (V1.0 or V1.1). The expected Vendor ID and Device ID must be configured in subindex 0x05 (Vendor ID) and subindex 0x04 (Device ID) of the *IO-Link Configuration Data Ch. x* object, see *IO-Link Configuration Data Ch. x (0x8000 – 0x8FFF)*.

No check: Validation is deactivated and every device is accepted.

V1.0 Device, no Datastorage: Only devices of IO-Link protocol version V1.0 matching the configured Vendor ID and Device ID are accepted. No data storage, only validation active.

V1.1 Device, no Datastorage: Only devices of IO-Link protocol version V1.1 matching the configured Vendor ID and Device ID are accepted. No data storage, only validation active.

V1.1 Device, Backup + Restore: Only devices of IO-Link protocol version V1.1 matching the configured Vendor ID and Device ID are accepted. The parameter data of the connected device is additionally saved in the network module's parameter server (remanent memory). As soon as a device requests an upload (upload flag set), or no data is stored yet, the master uploads

and backs up the device's parameter data. If the stored parameter data differs from a newly connected device, the master downloads and restores it to the device.

V1.1 Device, Restore: Only devices of IO-Link protocol version V1.1 matching the configured Vendor ID and Device ID are accepted. The parameter server only downloads and restores previously stored parameter data to the connected device. No upload or backup of new parameter data is performed.

Note

After uploading the parameter data, the Vendor ID and Device ID of the connected IO-Link device remain stored until the data records are deleted.
Validation takes place when the connected IO-Link device is started up. Only an IO-Link device of the same type can be used for data storage.
In order to use a different type of IO-Link device, the content of the parameter server must be deleted. There is no read or write access to the content of the parameter server via EtherCAT.

Note

Upload flag at IO-Link device
The upload flag is required in order to overwrite data already saved in the parameter server with new parameter data of the same IO-Link device.
In order to activate the upload flag of an IO-Link device, the value `0x05` must be entered in the parameter Index `0x02`, Subindex `0`.

9.12.4 Object Dictionary

The object directory is largely shared across the EtherCAT variants, with a small set of variant-specific objects.

This section is organized by object groups and marks variant-specific behavior explicitly.

Variant coverage overview

Table 52: Objects by variant

Object	Index	BNI XG1-505-0A5-R067	BNI XG3-302-0B5-R067	BNI XG3-302-1B5-Z067	BNI XG3-508-0B5-R067	BNI XG5-508-0B5-P067	BNI XG5-508-0B5-R067	BNI XG5-538-0B5-R067	BNI XG5-508-1B5-Z067	BNI XG5-508-1B5-Z067-C17	BNI XG5-538-1B5-Z067
Device type	0x1000	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Error register	0x1001	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Device Name	0x1008	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Hardware Version	0x1009	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Software Version	0x100A	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

continues on next page

Table 52 – continued from previous page

Object	Index	BNI XG1-505-0A5-R067	BNI XG3-302-0B5-R067	BNI XG3-302-1B5-Z067	BNI XG3-508-0B5-R067	BNI XG5-508-0B5-P067	BNI XG5-508-0B5-R067	BNI XG5-538-0B5-R067	BNI XG5-508-1B5-Z067	BNI XG5-508-1B5-Z067-C17	BNI XG5-538-1B5-Z067
Identity Object	0x1018	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Error Settings	0x10F1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Diagnosis History	0x10F3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Timestamp Object	0x10F8	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
RxPDO mapping Ch. x	0x160n[1]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
RxPDO mapping of Output Pin 2	0x1690	✕	✓	✓	✓	✓	✓	✓	✓	✓	✓
TxPDO mapping Ch. x	0x1A0n[1] Page 180, 1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
TxPDO mapping of Device Status	0x1A80[2]	✓	✕	✕	✓	✓	✓	✓	✓	✓	✓
TxPDO mapping of Input Pin 2	0x1A90	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
TxPDO mapping of Power Status	0x1A91	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
TxPDO mapping of New Messages Available	0x1A92 (object 0x10F3:04)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

continues on next page

Table 52 – continued from previous page

Object	Index	BNI XG1-505-0A5-R067	BNI XG3-302-0B5-R067	BNI XG3-302-1B5-Z067	BNI XG3-508-0B5-R067	BNI XG5-508-0B5-P067	BNI XG5-508-0B5-R067	BNI XG5-538-0B5-R067	BNI XG5-508-1B5-Z067	BNI XG5-508-1B5-Z067-C17	BNI XG5-538-1B5-Z067
TxPDO mapping of Timestamp	0x1A93 (object 0x10F8:00)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Sync manager type	0x1C00	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
SyncManager 2 Assign (RxPDO)	0x1C12	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
SyncManager 3 Assign (TxPDO)	0x1C13	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
SM output parameter	0x1C32	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
SM input parameter	0x1C33	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
ISDU read/write Ch. x	0x40n0[3]	✓	✗	✗	✓	✓	✓	✓	✓	✓	✓
Input Data Ch. x	0x60n0[Page 180, 3]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Output Data Ch. x	0x70n0[Page 180, 3]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
IO-Link Configuration Data Ch. x	0x80n0[Page 180, 3]	✓	✗	✗	✓	✓	✓	✓	✓	✓	✓

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Table 52 – continued from previous page

Object	Index	BNI XG1-505-0A5-R067	BNI XG3-302-0B5-R067	BNI XG3-302-1B5-Z067	BNI XG3-508-0B5-R067	BNI XG5-508-0B5-P067	BNI XG5-508-0B5-R067	BNI XG5-538-0B5-R067	BNI XG5-508-1B5-Z067	BNI XG5-508-1B5-Z067-C17	BNI XG5-538-1B5-Z067
Configuration Data Ch. x (XG3-302)	0x80n0 Page 180, 3	✗	✓	✓	✗	✗	✗	✗	✗	✗	✗
Additional IO-Link Configuration Data Ch. x	0x80n8 Page 180, 3	✓	✗	✗	✓	✓	✓	✓	✓	✓	✓
Additional Configuration Data Ch. x (XG3-302)	0x80n8 Page 180, 3	✗	✓	✓	✗	✗	✗	✗	✗	✗	✗
IO-Link Information Data Ch. x	0x90n0 Page 180, 3	✓	✗	✗	✓	✓	✓	✓	✓	✓	✓
IO-Link Diagnosis Data Ch. x	0xA0n0 Page 180, 3	✓	✗	✗	✓	✓	✓	✓	✓	✓	✓
Modular Device Profile	0xF000	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Configured Module Ident List	0xF030	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Detected Module Ident List	0xF050	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

continues on next page

Table 52 – continued from previous page

Object	Index	BNI XG1-505-0A5-R067	BNI XG3-302-0B5-R067	BNI XG3-302-1B5-Z067	BNI XG3-508-0B5-R067	BNI XG5-508-0B5-P067	BNI XG5-508-0B5-R067	BNI XG5-538-0B5-R067	BNI XG5-508-1B5-Z067	BNI XG5-508-1B5-Z067-C17	BNI XG5-538-1B5-Z067
Device Status	0xF100 (Tx-PDO 0x1A80[2])	✓	×	×	✓	✓	✓	✓	✓	✓	✓
Port Qualifier	0xF101 (Tx-PDO 0x1A81[2])	✓	×	×	✓	✓	✓	✓	✓	✓	✓
Firmware Build Information	0xF500	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Product Identification	0xF501	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Fieldbus Information	0xF502	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Module Reboot	0xF503	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Module Settings	0xF510	×	×	×	×	×	×	✓	×	×	✓
IOT Settings	0xF511	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Input Pin 2	0xF600	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Power Status	0xF601	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Output Pin 2	0xF700	×	✓	✓	✓	✓	✓	✓	✓	✓	✓

Note

Object naming is identical across variants wherever possible. Index and subindex definitions for a concrete product code always follow the corresponding ESI.

1 n = 0…7 (channel-specific index offset, step size 0x01)
2 Only present on variants that support IO-Link.
3 n = 0…7 (channel-specific index offset, step size 0x10)

Detailed Objects Description

The following section will describe all the Objects mentioned in *Variant coverage overview* in detail.

Device type (0x1000)

Subindex	Name	DataType	Access
0x00	Device type	UDINT	RO

Error register (0x1001)

Subindex	Name	DataType	Access
0x00	Error register	USINT	RO

Device Name (0x1008)

Subindex	Name	DataType	Access
0x00	Device Name	STRING(20)	RO

Hardware Version (0x1009)

Subindex	Name	DataType	Access
0x00	Hardware Version	STRING(5)	RO

Software Version (0x100A)

Subindex	Name	DataType	Access
0x00	Software Version	STRING(5)	RO

Identity Object (0x1018)

Subindex	Name	DataType	Access
0x00	Number of entries	USINT	RO
0x01	Vendor ID	UDINT	RO
0x02	Product Code	UDINT	RO
0x03	Revision Number	UDINT	RO
0x04	Serial number	UDINT	RO

Error Settings (0x10F1)

Subindex	Name	DataType	Access
0x00	Number of entries	USINT	RO
0x01	Local Error Reaction	UDINT	RO
0x02	Sync Error Counter Limit	UINT	RW

Diagnosis History (0x10F3)

Subindex	Name	DataType	Access
0x00	Number of entries	USINT	RO
0x01	Maximum Messages	USINT	RO
0x02	Newest Message	USINT	RW
0x03	Newest Acknowledged Message	USINT	RO
0x04	New Messages Available	BOOL	RO
0x05	Flags	UINT	RW
0x06…0x0D	Diagnosis Message	each ARRAY [0…25] OF BYTE	RO
0x0E…0x45	Diagnosis Message (unused, bitlength 0)	each ARRAY [0…0] OF BYTE	RO

Subindex 0x04 (New Messages Available) is also mapped to the process data via *Map TxPDO New Messages Available (0x1A92)*.

Timestamp Object (0x10F8)

Index	Subindex	Name	DataType	Access
0x10F8	0x00	Timestamp Object	ULINT	RW

This object is mapped to TxPDO via *Map TxPDO Timestamp (0x1A93)*.

RxPDO mapping Ch. x (0x160n)

This generic mapping object links the channel-specific slot module to the raw process data object *Output Data Ch. x* and applies to all variants.

Index	Name	Access
0x160n[Page 180, 1]	RxPDO mapping of Ch. x	RO, wInPreOp

RxPDO mapping of Output Pin 2 (0x1690)

This mapping object applies to variants with output pin 2 (all listed variants except BNI XG1-505-0A5-R067).

Index	Subindex	Name	DataType	Access
0x1690	0x00	Subindex 000	USINT	RO
0x1690	0x01	Subindex 001	UDINT	RO
0x1690	0x02	Subindex 002	UDINT	RO

TxPDO mapping Ch. x (0x1A0n)

This generic mapping object links the channel-specific slot module to the raw process data object *Input Data Ch. x* and applies to all variants.

Index	Name	Access
0x1A0n[Page 180, 1]	TxPDO mapping of Ch. x	RO, wInPreOp

TxPDO mapping of Device Status (0x1A80)

Note

Please check whether IO-Link is supported by your module before using this function. For more information on product variants that support IO-Link, see *Supported product variants*.

Index	Subindex	Name	DataType	Access
0x1A80	0x00	Number of mapped entries	USINT	RO
	0x01	Mapped object 1	UDINT	RO
	0x02	Mapped object 2	UDINT	RO
	0x03	Mapped object 3	UDINT	RO
	0x04	Mapped object 4	UDINT	RO
	0x05	Mapped object 5	UDINT	RO
	0x06	Mapped object 6	UDINT	RO
	0x07	Mapped object 7	UDINT	RO
	0x08	Mapped object 8	UDINT	RO

Subindices `0x01` to `0x08` map *Device Status* subindices `0x01` to `0x08` (one status byte per port) into the TxPDO.

For the status byte value coding, see *Device Status (0xF100)*.

Map TxPDO input pin 2 (0x1A90)

This TxPDO mapping object applies to all listed variants.

Index	Subindex	Name	DataType	Access
0xF600	0x00	Input Pin 2	BITARR8	RO

This object maps *Input Pin 2 (0xF600)* to TxPDO.

Map TxPDO pin 4 (0x1A0n)

Index range	Subindex	Name	DataType	Access
0x6xxx	module-specific	Module-specific TxPDO input data (pin 4 mapping)	Variable, see ESI module	RO
0x7xxx	module-specific	Module-specific RxPDO output data (pin 4 mapping)	Variable, see ESI module	RW

The following index range applies in a modular EtherCAT device:

- 0x6xxx is a module-specific input range for TxPDO data.

- 0x7xxx is a module-specific output range for RxPDO data.

IO-Link data is up to 32 bytes for input and output.

If a connection is configured as a digital input or digital output, the value of pin 4 is mapped to data byte 0, bit 0.

Map TxPDO PowerStatus (0x1A91)

This TxPDO mapping object applies to all listed variants.

Index	Subindex	Name	DataType	Access
0xF601	0x01	Global status, see *Global status values (Subindex 0x01)*	UDINT	RO
	0x02	Short circuit in the sensor supply; one bit for each port	UDINT	RO
	0x03	Short circuit at pin 4 of the actuator supply, one bit for each port	UDINT	RO
	0x04	Short circuit at pin 2 of the actuator supply, one bit for each port	UDINT	RO

This object maps *Power Status (0xF601)* to TxPDO.

Global status values (Subindex 0x01)

Bit	Description
0	Sensor supply low (1 = low, 0 = OK)
1	Actuator supply low (1 = low, 0 = OK)

Map TxPDO New Messages Available (0x1A92)

Index	Subindex	Name	DataType	Access
0x10F3	0x04	New Messages Available	BOOL	RO

Map TxPDO Timestamp (0x1A93)

Index	Subindex	Name	DataType	Access
0x10F8	0x00	Timestamp Object	ULINT	RO

This object maps *Timestamp Object (0x10F8)* to TxPDO.

Sync manager type (0x1C00)

Sync manager objects are configured automatically by the EtherCAT master during PDO assignment and normally do not need to be accessed directly.

Index	Name
0x1C00	Sync manager type

SyncManager 2 Assign / RxPDO (0x1C12)

Sync manager objects are configured automatically by the EtherCAT master during PDO assignment and normally do not need to be accessed directly.

Index	Name
0x1C12	SyncManager 2 Assign (RxPDO)

SyncManager 3 Assign / TxPDO (0x1C13)

Sync manager objects are configured automatically by the EtherCAT master during PDO assignment and normally do not need to be accessed directly.

Index	Name
0x1C13	SyncManager 3 Assign (TxPDO)

SM output parameter (0x1C32)

Sync manager objects are configured automatically by the EtherCAT master during PDO assignment and normally do not need to be accessed directly.

Index	Name
0x1C32	SM output parameter

SM input parameter (0x1C33)

Sync manager objects are configured automatically by the EtherCAT master during PDO assignment and normally do not need to be accessed directly.

Index	Name
0x1C33	SM input parameter

ISDU read/write Ch. x (0x4000 – 0x4FFF)

Note

Please check whether IO-Link is supported by your module before using this function. For more information on product variants that support IO-Link, see *Supported product variants*.

Index	Sub-index	Name	DataType	Access
0x40n0	0x00	Number of entries	USINT	RO
	0x01	Control	USINT	RW
	0x02	Status	USINT	RO
	0x03	Index	UINT	RW
	0x04	Subindex	USINT	RW
	0x05	Length	USINT	RW
	0x06	Data	ARRAY [0…231] OF BYTE	RW
n = 0…7	0x07	Error Code	UINT	RW

Control values (Subindex 0x01)

Value	Function
0	no control action
2	write
3	read

Status values (Subindex 0x02)

Value	Status
0	no activity
1	busy
2	success
4	error
0xFF	failure

Input Data Ch. x (0x60n0)

This object holds the raw input process data for each channel, referenced by *TxPDO mapping Ch. x (0x1A0n)*.

Index	Name	DataType	Access
0x60n0[Page 180, 3]	Input Data Ch. x	See ESI	RO

Output Data Ch. x (0x70n0)

This object holds the raw output process data for each channel, referenced by *RxPDO mapping Ch. x (0x160n)*.

Index	Name	DataType	Access
0x70n0[Page 180, 3]	Output Data Ch. x	See ESI	RW

IO-Link Configuration Data Ch. x (0x8000 – 0x8FFF)

Note

Please check whether IO-Link is supported by your module before using this function. For more information on product variants that support IO-Link, see *Supported product variants*.

Index	Sub-index	Name	DataType	Access	Value/Description
0x80n0, n = 0…7	0x00	Number of entries	USINT	RO	
	0x04	Device ID	UDINT	RW	
	0x05	Vendor ID	UDINT	RW	
	0x20	IO-Link Revision	USINT	RW	0x10 or 0x11
	0x21	Reserved for Frame Capability	USINT	RW	Not in use
	0x22	Cycle Time	USINT	RW	Cycle time
	0x23	Reserved for Offset Time	USINT	RW	Not in use
	0x24	Process Data In Length	USINT	RW	Maximum length
	0x25	Process Data Out Length	USINT	RW	Maximum length
	0x26	Reserved for Compatible ID	UINT	RW	Not in use
	0x27	Reserved	UINT	RW	Not in use
	0x28	Master Control	UINT	RW	

Additional IO-Link Configuration Data Ch. x (IO-Link variants)

Note

Please check whether IO-Link is supported by your module before using this function. For more information on product variants that support IO-Link, see *Supported product variants*.

Index	Sub-index	Name	DataType	Access	Value/Description
0x80n8, n = 0…7	0x00	Number of entries	USINT	RO	
	0x01	Validation and Backup	USINT	RW	See values below
	0x02	IQ Behavior	DT0802EN08	RW	See values below

Values for Validation and Backup (Subindex 0x01, Datatype DT0800EN08)

Underlying Datatype is USINT.

Value	Function
0	No check
1	V1.0 Device, no Datastorage
2	V1.1 Device, no Datastorage
3	V1.1 Device, Backup + Restore
4	V1.1 Device, Restore

Values for Pin 2 Behavior (Subindex 0x02, Datatype DT0802EN08)

Value	Status of IO-Link Port
0	Deactivated
1	Digital Input
2	Digital Output
5	Power

Available values depend on hardware variant.

Configuration Data Ch. x (XG3-302)

Index	Sub-index	Name	DataType	Access	Value/Description
0x8000, 0x8010, ..., 0x8070	0x01	Pin 4 Behavior	UINT	RW	One object per channel (Ch.1 ... Ch.8)

Additional Configuration Data Ch. x (XG3-302)

This object group contains additional channel-specific configuration.

Index	Sub-index	Name	DataType	Access	Value/Description
0x8008, 0x8018, ..., 0x8078	0x01	Pin 2 Behavior	DT0802EN08	RW	One object per channel (Ch.1 ... Ch.8)

Values for Pin 2 Behavior (Subindex 0x01, Datatype DT0802EN08)

Value	Status of IO-Link Port
0	Deactivated
1	Digital Input
2	Digital Output
5	Power

IO-Link Information Data Ch. x (0x9000 – 0x9FFF)

Note

Please check whether IO-Link is supported by your module before using this function. For more information on product variants that support IO-Link, see *Supported product variants*.

Index	Subindex	Name	DataType	Access
0x90n0, n = 0…7	0x04	Device ID	UDINT	RO
	0x05	Vendor ID	UDINT	RO
	0x20	IO-Link revision	USINT	RO
	0x22	Cycle Time	USINT	RO
	0x24	Process Data In Length	USINT	RO
	0x25	Process Data Out Length	USINT	RO

IO-Link Diagnosis Data Ch. x (0xA000 – 0xAFFF)

Note

Please check whether IO-Link is supported by your module before using this function. For more information on product variants that support IO-Link, see *Supported product variants*.

Index	Subindex	Name	DataType	Access
0xA0n0, n = 0…7	0x01	IO-Link state	DT0801EN08	RO
	0x02	Lost Frames	USINT	RO

Values for IO-Link state (Subindex 0x01, Datatype DT0801EN08)

Value	Status of IO-Link Port
0	Deactivated
1	Digital Input
2	Digital Output
3 – 7	Reserved
8	IO-Link Operate
9	IO-Link Stop

Values for Lost Frames (Subindex 0x02)

This parameter counts lost IO-Link Frames (M sequence repeats).

Two repeat attempts are generally added when changing the device. This value is only reset to zero during the start. The value is updated regularly, for example once a second.

Modular Device Profile (0xF000)

Contains the information needed to interpret the module-specific objects (e.g. index distance and maximum number of modules). See the EtherCAT specification *EtherCAT Modular Device Profile Part 1: General MDP Device Model (ETG.5001.1 S ® V1.0.0)* for the full entry description.

Index	Name	Access
0xF000	Modular Device Profile	RO

Configured Module Ident List (0xF030)

Holds the module ident numbers of the configured modules. See the EtherCAT specification *EtherCAT Modular Device Profile Part 1: General MDP Device Model (ETG.5001.1 S ® V1.0.0)* for the full entry description.

Index	Name	Access
0xF030	Configured Module Ident List	RW

Detected Module Ident List (0xF050)

Holds the module ident numbers detected during power-up or after a Detect Modules command. See the EtherCAT specification *EtherCAT Modular Device Profile Part 1: General MDP Device Model (ETG.5001.1 S ® V1.0.0)* for the full entry description.

Index	Name	Access
0xF050	Detected Module Ident List	RO

Device Status (0xF100)

Note

Please check whether IO-Link is supported by your module before using this function. For more information on product variants that support IO-Link, see *Supported product variants*.

Index	Subindex	Name	DataType	Access
0xF100	0x01	Status of IO-Link Port 1	USINT	RO
	0x02	Status of IO-Link Port 2	USINT	RO
	0x03	Status of IO-Link Port 3	USINT	RO
	0x04	Status of IO-Link Port 4	USINT	RO
	0x05	Status of IO-Link Port 5	USINT	RO
	0x06	Status of IO-Link Port 6	USINT	RO
	0x07	Status of IO-Link Port 7	USINT	RO
	0x08	Status of IO-Link Port 8	USINT	RO

The CoE object Device Status (0xF100) is mapped as TxPDO mapping of status data (TxPDO 0x1A80) to the process data.

Device status coding

The lower nibble (`0x_?`) encodes the port mode/state.

Value	Meaning
0x_0	Port disabled
0x_1	Port in standard digital input
0x_2	Port in standard digital output
0x_3	Port in communication OP
0x_4	Port in communication COMSTOP

The upper nibble (`0x?_`) encodes diagnostic/error information.

Value	Meaning
0x0_	No error
0x3_	Invalid device ID
0x4_	Invalid vendor ID
0x5_	Invalid IO-Link version
0x7_	Invalid cycle time
0x8_	Invalid process data input length
0x9_	Invalid process data output length
0xA_	No device detected

Port Qualifier (0xF101)

Note

Please check whether IO-Link is supported by your module before using this function. For more information on product variants that support IO-Link, see *Supported product variants*.

Index	Subindex	Name	DataType	Access
0xF101	0x01	Port Qualifier Port 1	USINT	RO
	0x02	Port Qualifier Port 2	USINT	RO
	0x03	Port Qualifier Port 3	USINT	RO
	0x04	Port Qualifier Port 4	USINT	RO
	0x05	Port Qualifier Port 5	USINT	RO
	0x06	Port Qualifier Port 6	USINT	RO
	0x07	Port Qualifier Port 7	USINT	RO
	0x08	Port Qualifier Port 8	USINT	RO

The CoE object Port Qualifier (0xF101) is mapped as TxPDO mapping of port qualifier (TxPDO 0x1A81) to the process data.

Port qualifier bits

Port Qualifier (0xF101) is 1 byte long and uses the same bit layout for every port.

The “Port Qualifier Information” (PQI) is a 1-byte status value that reports the status of an IO-Link port and the connected device.

Table 53: Port Qualifier Information (PQI) – Bits

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Device Process Data validity	Port/Device error indication	Device communication	Port operation (“1”)	Reserved (“0”)			
PQ	DevErr	DevCom	Port active	–			

The flags have the following meaning:

PQ

Value	Description
0	Process data from device invalid
1	Process data from device valid

DevErr

Value	Description
0	No errors/warnings
1	Errors/warnings occurred.

DevCom

Value	Description
0	No device available
1	Device available

PortActive

Value	Description
0	Port deactivated.
1	Port activated.

Note

Specification coverage: PQI is implemented according to *IO-Link Integration for PROFINET* (PI Order No. 2.832, Version 1.1 Edition 2, clause 7.3.4.2, Table 22). That specification additionally defines bit 2 (*NewPar* – a new Data Storage backup object became available after a Device parameter upload) and bit 3 (*SubstDev* – a substitute Device with a different serial number was detected). Both flags are currently not supported by this device family and are therefore always reported as reserved (“0”).

Firmware Build Information (0xF500)

Index	Subindex	Name	DataType	Access
0xF500	0x00	Number of entries	USINT	RO
	0x01	Build Number	UDINT	RO
	0x02	Build Hash Id	STRING(8)	RO
	0x03	Firmware Version	STRING(12)	RO

Product Identification (0xF501)

Index	Subindex	Name	DataType	Access
0xF501	0x00	Number of entries	USINT	RO
	0x01	Product Name	STRING(24)	RO
	0x02	Serial Number	STRING(16)	RO
	0x03	Order Code	STRING(8)	RO

Fieldbus Information (0xF502)

Index	Subindex	Name	DataType	Access
0xF502	0x00	Number of entries	USINT	RO
	0x01	Current Protocol	DT0803EN08	RO
	0x02	Protocol After Reboot	DT0803EN08	RW

Subindex `0x01` reports the currently active fieldbus protocol. Subindex `0x02` selects the fieldbus protocol that the device will use after a restart.

Protocol values

Value	Meaning
0	AUTODETECT
1	ETHERCAT
2	ETHERNET_IP
3	PROFINET
4	MODBUS_TCP
6	IOT
7	ETHERCAT_FHC

Module Reboot (0xF503)

The requested action is written to subindex `0x01` and executed through the trigger bit at subindex `0x02`.

Index	Subindex	Name	DataType	Access
0xF503	0x00	Number of entries	USINT	RO
	0x01	Action	DT0804EN08	RW
	0x02	Trigger	BOOL	RW

Subindex `0x01` selects the reboot action. Subindex `0x02` triggers execution of the selected action.

Action values

Value	Meaning
0	NO ACTION
1	REBOOT

Module Settings (0xF510)

Using CoE object 0xF510 (Module Settings), it is possible to modify the output power loss behavior.

Note

Only available for the XG5-538-... variants.

Index	Subindex	Name	DataType	Access	Value/Description
0xF510	0x00	Number of entries	USINT	RO	
	0x01	Output Powerloss Behavior	USINT	RW	See values below

The parameter defines what happens to active outputs on Pin 2 and Pin 4 when UA voltage is lost.

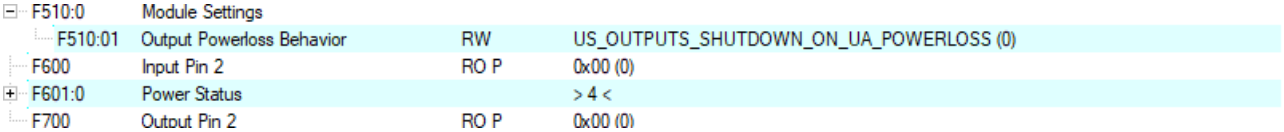
- Value 0 – US Outputs shutdown on UA powerloss

  All active outputs on Pin 2 and Pin 4 are automatically switched off in the event of a UA voltage drop. This matches the behavior of a XG5-508-... master, even though Pin 2 and Pin 4 of Class A output ports are supplied by US, and Pin 4 of Class B ports are supplied by UA.

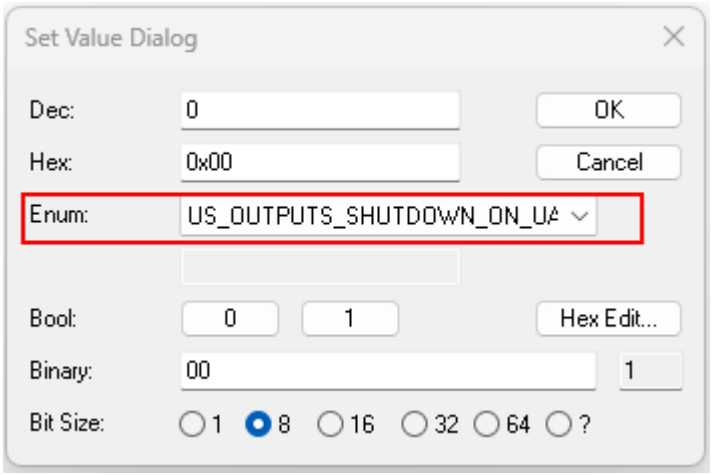
- Value 1 – Hardware Defined

  US powered outputs will not be switched off in the event of a UA voltage drop. All outputs remain in their current state. Only Class B Pin 2 outputs are physically supplied by UA and will therefore be shut down.

First step



Second step



IOT Settings (0xF511)

Index	Subindex	Name	DataType	Access	Value/Description
0xF511	0x00	Number of entries	USINT	RO	
	0x01	WebUI Settings	DT0806EN08	RW	See values below
	0x02	REST API Settings	DT0807EN08	RW	See values below
	0x03	HTTP/HTTPS Mode	DT0808EN08	RW	See values below

Values for WebUI Settings (Subindex 0x01, Datatype DT0806EN08)

Value	Function
0	WebUI disabled
1	WebUI enabled

Values for REST API Settings (Subindex 0x02, Datatype DT0807EN08)

Value	Function
0	REST API disabled
1	REST API enabled

Values for HTTP/HTTPS Mode (Subindex 0x03, Datatype DT0808EN08)

Value	Function
0	None
1	HTTP
2	HTTPS
3	HTTPS and HTTP

Input Pin 2 (0xF600)

Index	Name	DataType	Access
0xF600	Input Pin 2	BITARR8	RO

Power Status (0xF601)

Index	Subindex	Name	DataType	Access
0xF601	0x01	Global status, see *Global status values (Subindex 0x01)*	BITARR8	RO
	0x02	Short circuit in the sensor supply; one bit for each port	BITARR8	RO
	0x03	Short circuit at pin 4 of the actuator supply, one bit for each port	BITARR8	RO
	0x04	Short circuit at pin 2 of the actuator supply, one bit for each port	BITARR8	RO

Output Pin 2 (0xF700)

This CoE object applies to variants with output pin 2 (all listed variants except BNI XG1-505-0A5-R067).

Index	Name	DataType	Access
0xF700	Output Pin 2	BITARR8	RO

9.12.5 Advanced configuration

This chapter describes various additional features of the EtherCAT Slave. Besides the function description, step-by-step guides on how to configure those features are also included.

Configuring Station Alias

The Station Alias can be selected under the EtherCAT tab, Advanced Settings.

1. Open ESC Access.
2. Open E²PROM.
3. Select *Configured Station*.

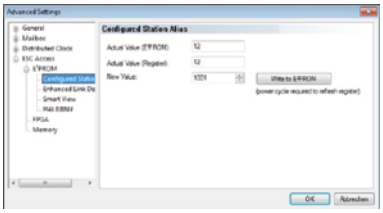


Fig. 101: Configuring Station Alias

Note

The new value is only valid after a reset.

Ethernet over EtherCAT (EoE)

EtherCAT does not transfer any IP packets in normal operation. If IT protocols like MQTT, REST API and OPC UA shall be available when the Network Module is configured to EtherCAT, Ethernet over EtherCAT (EoE) needs to be enabled.

After the successful configuration of EoE the EtherCAT frames will tunnel Ethernet in the EtherCAT protocol thus making it possible to use the IT protocols and WebUI.

Set up

In order to be able to access the web server of the BNI module, access via EoE (Ethernet over EtherCAT) must be configured first.

1. Select the *Advanced Settings…* button.

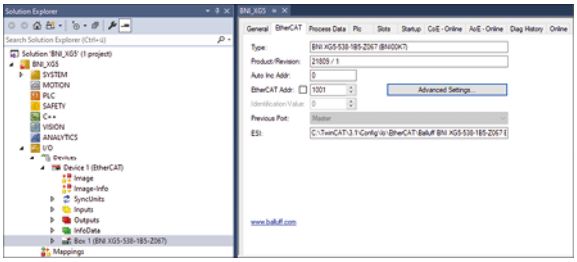


Fig. 102: *Advanced Settings…* button

2. Enter valid DNS name and valid IP address.

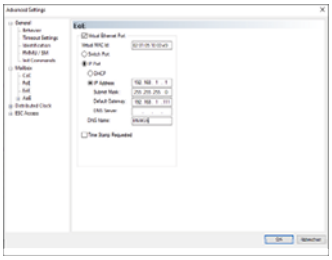


Fig. 103: Enter valid DNS name and valid IP address

Preparing network

Before the WebUI or any IT protocols can be reached via EoE, the network of the Beckhoff control must be configured.

Configuring Beckhoff control

A static IP address must be assigned to both network cards.

1. On the Beckhoff control select *Start* > *Control Panel* > *Network and dial-up connections* > *PCI…Settings*.
2. Assign IP address.



Fig. 104: *Advanced Settings…* button

3. Under *Start* > *Control Panel* > *Beckhoff CX Configuration Tool* > *Miscellaneous* activate the setting *IP Routing*.

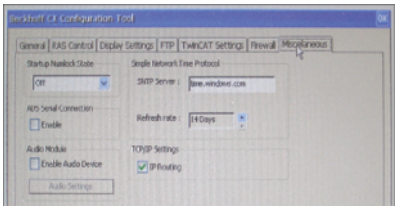


Fig. 105: Advanced Settings… button

EoE and PC networks

For the EoE settings in TwinCAT, the IP address of the second network card of the Beckhoff control must be entered as a default gateway.

As a default gateway for the network configuration of the PC, the IP address of the first network card of the Beckhoff control must be entered.

File over EtherCAT (FoE)

File over EtherCAT (FoE) allows transferring files through the EtherCAT protocol to the EtherCAT slave.

The Network Modules use this mechanism to update the device firmware.

Download Firmware File/ Carry out a firmware update

WARNING

During active download and installation of the firmware update a continuous power supply needs to be ensured. If power is cut during a firmware update it could damage the device and make it unusable.

For a successful firmware update, the device first needs to be put into *Bootstrap* state.

1. Open the *Online* tab by selecting it.

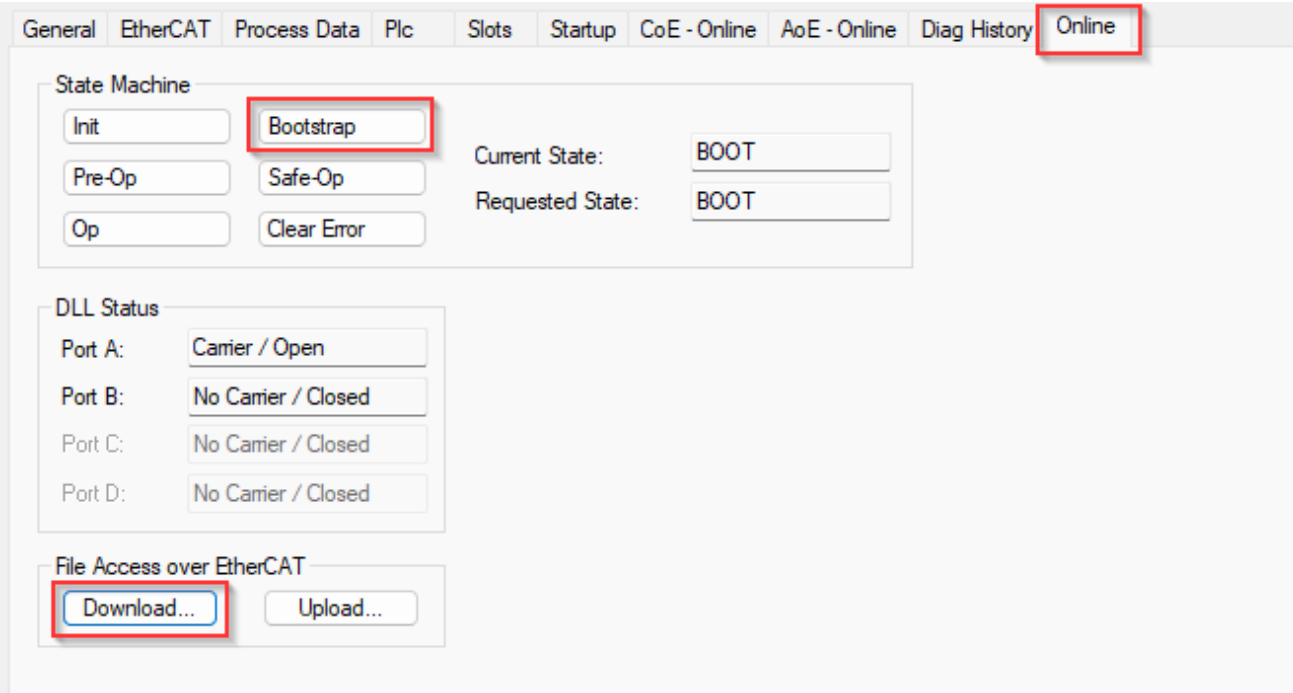


Fig. 106: Online Tab in TwinCAT

2. Bring the device into *Bootstrap* state by clicking the button.

   ⇒ Current State and Requested State show *BOOT*

   Note

   Bootstrap state can only be switched to if the device is in *Init* state. Also if the device shall be put into operation mode again it first needs to be switched back into *Init*.

3. Select *Download* in *File Access over EtherCAT*
4. Navigate to the folder which holds the firmware file you want to download to the device.
5. In the extension selection select *.*

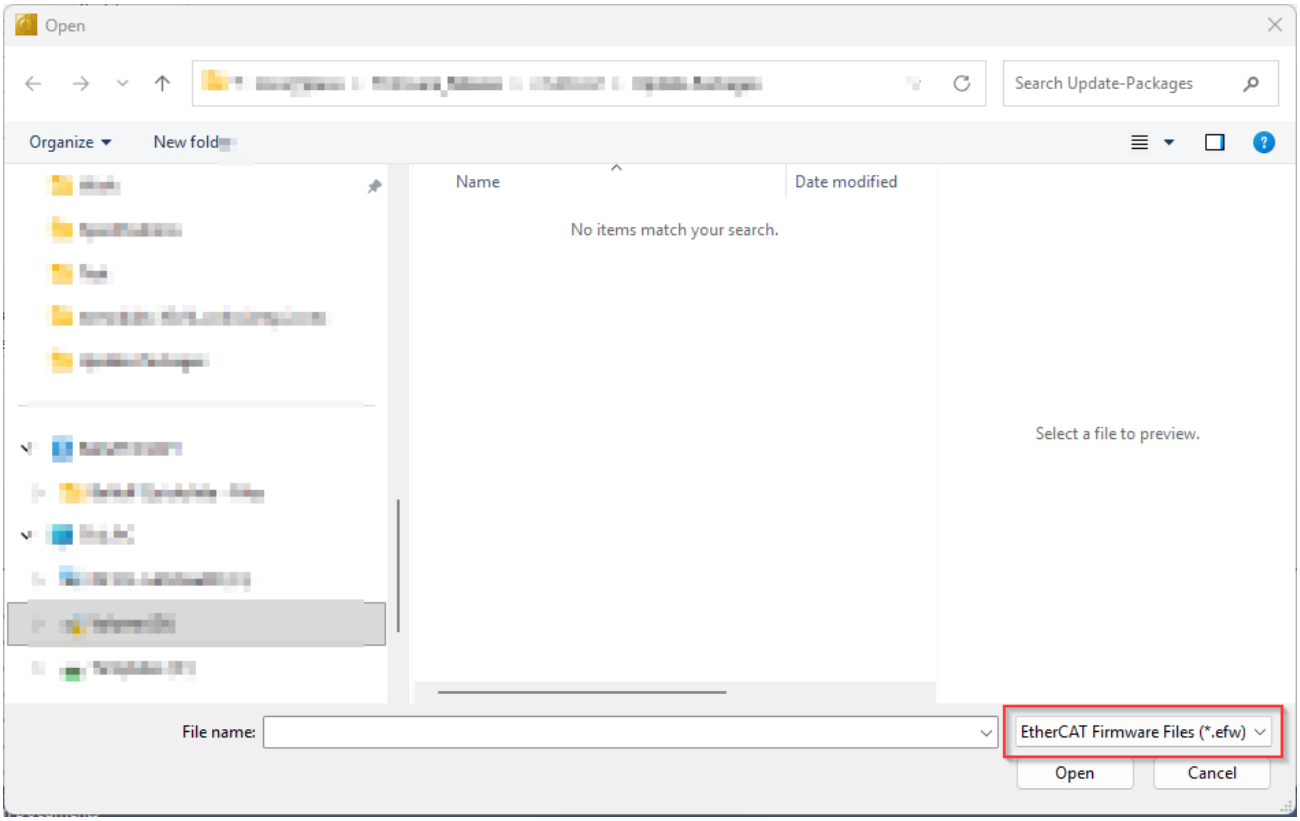


Fig. 107: File Selection Dialog

⇒ The firmware file with extension *.bff* should now be selectable in the dialog.

6. Select the desired firmware file and click Open.
7. In the *Edit FoE Filename* Dialog no changes are needed. FoE does not require a password. Click on *Ok*

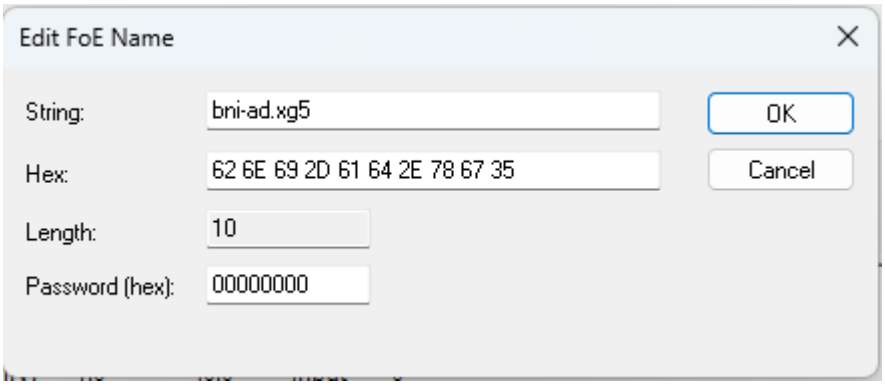


Fig. 108: Edit FoE Filename Dialog

The firmware will now be downloaded to the device. A running light on the ports indicates the active download and installation. After successful download the device will automatically reboot and boot with the new firmware. Through the CoE object *Firmware Build Information* the current running version can be inspected and checked if the update was successful.

IO-Link Device parameterization

Connected IO-Link devices can be parameterized in two ways via EtherCAT.

CAN over EtherCAT (CoE)

Note

Please check whether IO-Link is supported by your module before using this function. For more information on product variants that support IO-Link, see *Supported product variants*.
“”

Via the object `0x4000` (ISDU read/write Ch. X), IO-Link ISDU parameters can be read from or written to the IO-Link device. For this purpose, the corresponding index and subindex must be entered and for writing the corresponding length and data must be entered. The read or write operation is started via the control object. The result is displayed in the status object.

Values for the control

Table 54: Values for the control

Value	Function
`0x00`	No function
`0x02`	Write
`0x03`	Read

Values for the status

Table 55: Values for the status

Value	Status
`0x00`	No status
`0x01`	Active/Busy
`0x02`	Access
`0x04`	Error
`0xFF`	Fail

Example of CoE setting

This example shows how the index 0x40 of Smartlight (mode) is changed by reading and writing.

1. Select module.
2. Open CoE - Online.
3. Activate the setting *Auto Update*.
4. Under *Advanced* select the setting *Online - via SDO Information*.

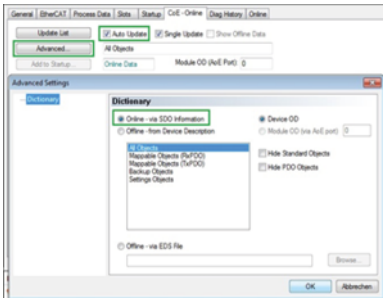


Fig. 109: Activate settings

5. In port, select 4030:0(here channel 4).
6. Read index by double clicking 4030:3 and specifying the respective ISDU Index (here 0x0040).
7. In control write the command 0x03.

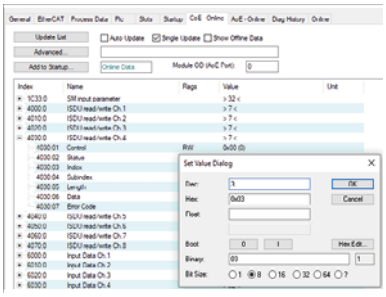
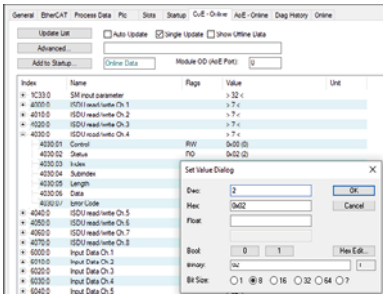


Fig. 110: Read

⇒ Content of the index is read and displayed in data.

8. Change data, specify length and use the command `0x02`.



⇒ The data is written and the parameter is changed in the device.

ADS over EtherCAT Acyclic (AoE)

The ETG.5001.6220 describes AoE instead of CoE for the ISDU read/write access to IO-Link device parameters. Details on ADS can be found in the Beckhoff TwinCAT documentation and in ETG.1020. In contrast to CoE, AoE permits non-blocking processing.

AoE ISDU access uses these definitions (all are 32 bit):

- AoE IndexGroup = `0x0000F302`
- AoE PortNumber = `0x00001000` + IO-Link port number, starting with 0.
- AoE IndexOffset

  - 16 Bit IO-Link Index
  - 8 Bit always zero
  - 8 Bit IO-Link Subindex
- Return error code
  - 16 Bit additional information about the error code, which is 0x0700 (ADS device error).
  - 16 Bit error code via IO-Link

Function blocks ADSREAD and ADSWRITE

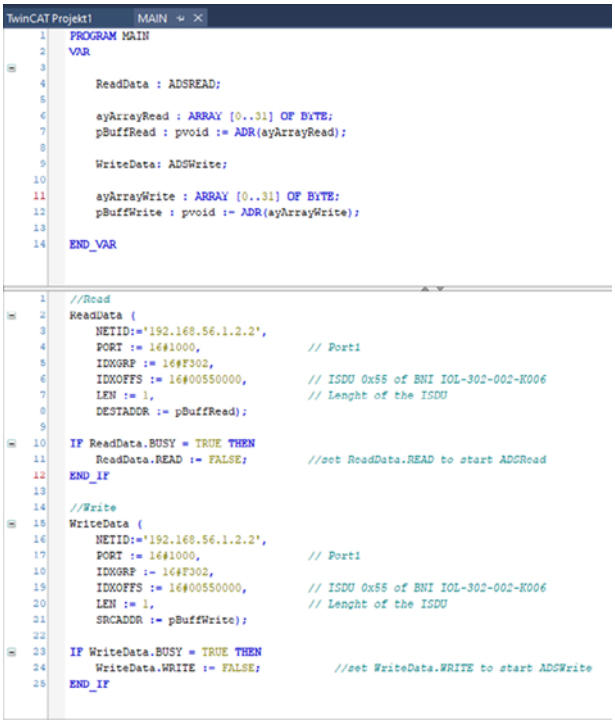


Fig. 111: Function blocks ADSREAD and ADSWRITE

Function block ADSREAD in TwinCAT

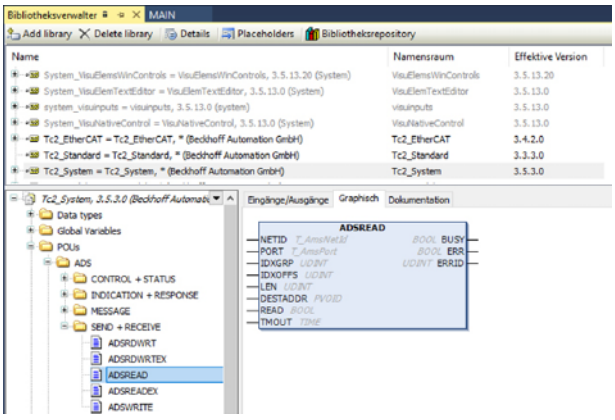


Fig. 112: TwinCAT – ADSREAD

ADSREAD commands

Name	Type	Inherited from	Address	Initial	Comment
NETID	T_AmsNetId	–	–	–	AMS NetId
PORT	T_AmsPort	–	–	–	ADS communication port
IDXGRP	UDINT	–	–	–	Index group
IDXOFFS	UDINT	–	–	–	IndexOffset
LEN	UDINT	–	–	–	Maximum number of the data bytes to be read (LEN ≤ maximum size of target buffer)
DESTADDR	PVOID	–	–	–	Pointer to target buffer
READ	BOOL	–	–	–	Rising edge starts command execution.
TMOUT	TIME	–	–	DEFAULT_ADS_TIMEOUT	Maximum permissible time for the execution of this ADS command
BUSY	BOOL	–	–	–	Busy-Flag
ERR	BOOL	–	–	–	Error-Flag
ERRID	UDINT	–	–	–	ADS error code

Function block ADSWRITE in TwinCAT

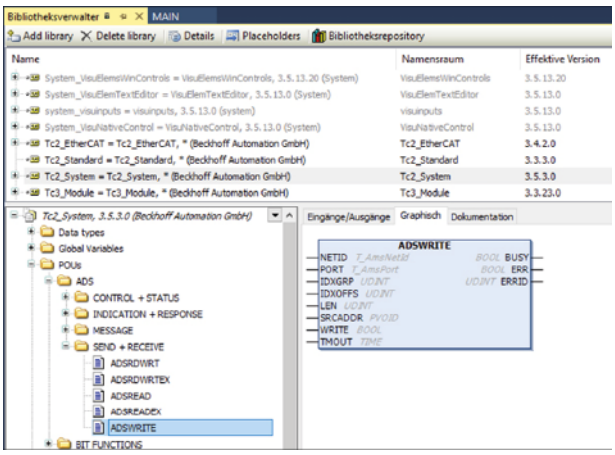


Fig. 113: TwinCAT – ADSWRITE

ADSWRITE commands

Name	Type	Inherited from	Address	Initial	Comment
NETID	T_AmsNetId	–	–	–	AMS NetId
PORT	T_AmsPort	–	–	–	ADS communication port
IDXGRP	UDINT	–	–	–	Index group
IDXOFFS	UDINT	–	–	–	IndexOffset
LEN	UDINT	–	–	–	Maximum number of the data bytes to be written (LEN ≤ maximum size of source buffer)
SRCADDR	PVOID	–	–	–	Pointer to source buffer
WRITE	BOOL	–	–	–	Rising edge starts command execution.
TMOUT	TIME	–	–	DEFAULT_ADS_TIMEOUT	Maximum permissible time for the execution of this ADS command
BUSY	BOOL	–	–	–	Busy-Flag
ERR	BOOL	–	–	–	Error-Flag
ERRID	UDINT	–	–	–	ADS error code

9.13 Modbus/TCP configuration

Note

The following instructions and screenshots are based on CODESYS and illustrate the general procedure for configuring a Modbus/TCP device. Many engineering tools follow the same basic principles (adding the device, configuring the IP address and port, mapping registers), but menu structures, terminology, and individual steps may differ. If you are using a different tool, apply the described concepts accordingly and consult the vendor-specific documentation as needed.

9.13.1 Modbus/TCP Module Basics

Description

Modbus is available in masters as an interface with the following features:

- Read/write process data
- Port configuration
- Port/device diagnostics
- Read/write ISDU data

Access is via the TCP/IP interface using the IP address of the device and Port 502 (example: 192.168.1.1:502). The response time depends on the data written/read.

Structure of a Modbus/TCP message

A Modbus/TCP message is structured as follows:

Table 56: Modbus/TCP message structure

Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8	Byte 9…n
Transaction ID		Protocol ID		Length		Unit ID	Function Code	Databyte 1	Databyte 2…n
MBAP header							PDU		
Modbus/TCP message									

The protocol ID must be 0, as it indicates that the message is a Modbus message.

The Unit ID can be arbitrary. It is not used because the IP address already identifies a device. But its value will be echoed back in the response.

General

- All numbers are decimal numbers, unless they are specified with 0x = hexadecimal, e.g.: 0x1B.
- All data is organized as UINT16 unless otherwise specified.
- The length is organized in UINT16 by default, unless otherwise specified, e.g. length in [bytes] or bit length.
- The mapping of the byte sequence uses Big Endianness, see example in Index 10.

Function Codes

The following function codes are implemented:

- Read holding register (0x03)
- Write several registers (0x10)

Error Responses

The following responses are reported in the event of an error:

Error Code	Description
0x00	No error. Last command successful.
0x01	Bad Function Code
0x02	Wrong Register Address
0x03	Invalid value
0x04	Slave error (IO-Link fails)

Even if the start register is valid, reading too many registers leads to Bad Register Address.

Slave errors occur when the IO-Link interface triggers errors.

9.13.2 Initial Modbus/TCP device configuration

As an example, the connection of the BNI to a CODESYS control is shown. The exact procedure depends on the project planning software used.

Add the Network Module as Modbus/TCP device

Before you begin

Make sure that:

- A new, empty CODESYS project has been created.
- The module is connected to the PLC via Ethernet and is powered up.

- The module has been assigned a unique IP address.
  - See: *Make network settings*.
- The module's bus type has been switched to Modbus/TCP via the WebUI.
  - See: *Change protocol*.

Steps

To add the Modbus/TCP device in CODESYS:

1. Add an Ethernet device.

   Right-click the device in the tree and select *Add Device…* from the context menu.

   In the *General* section of the Ethernet adapter, click *Browse…* and select the network adapter to use.

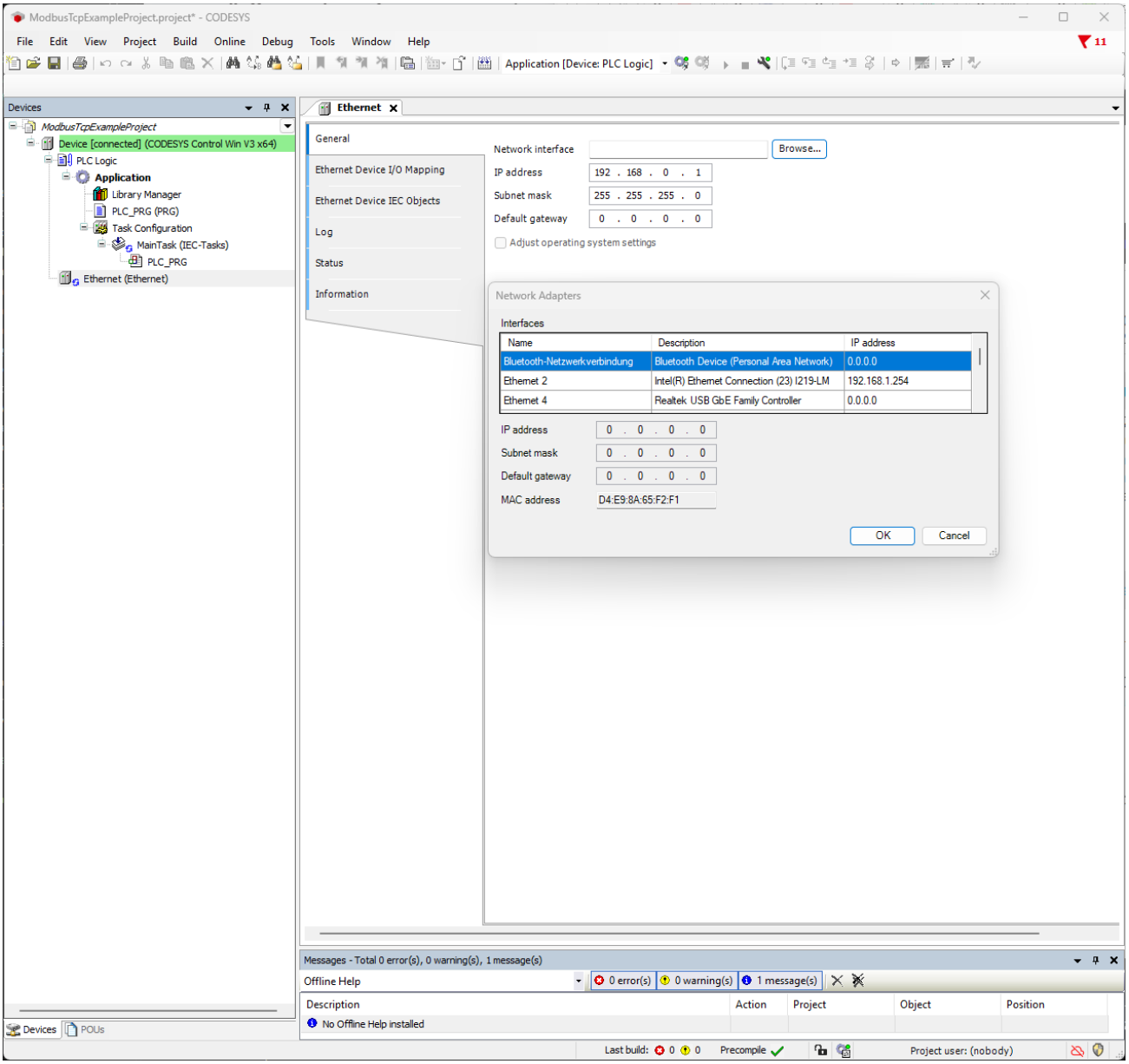


Fig. 114: Selecting the network adapter for the Ethernet device

2. Add a Modbus client.

Below the Ethernet adapter, right-click and select *Add Device…* from the context menu.

3. Add a Modbus server.

   Below the Ethernet adapter, right-click and select *Add Device…* from the context menu. The Modbus server represents the network module.

4. Optional: Rename the device.

   Right-click the device in the tree and select *Refactoring* > *Rename* from the context menu.

5. Set the IP address of the network module.

   Open the Modbus server device, select *General*, and enter the IP address of the network module. Make sure that the Port is set to 502 (default).

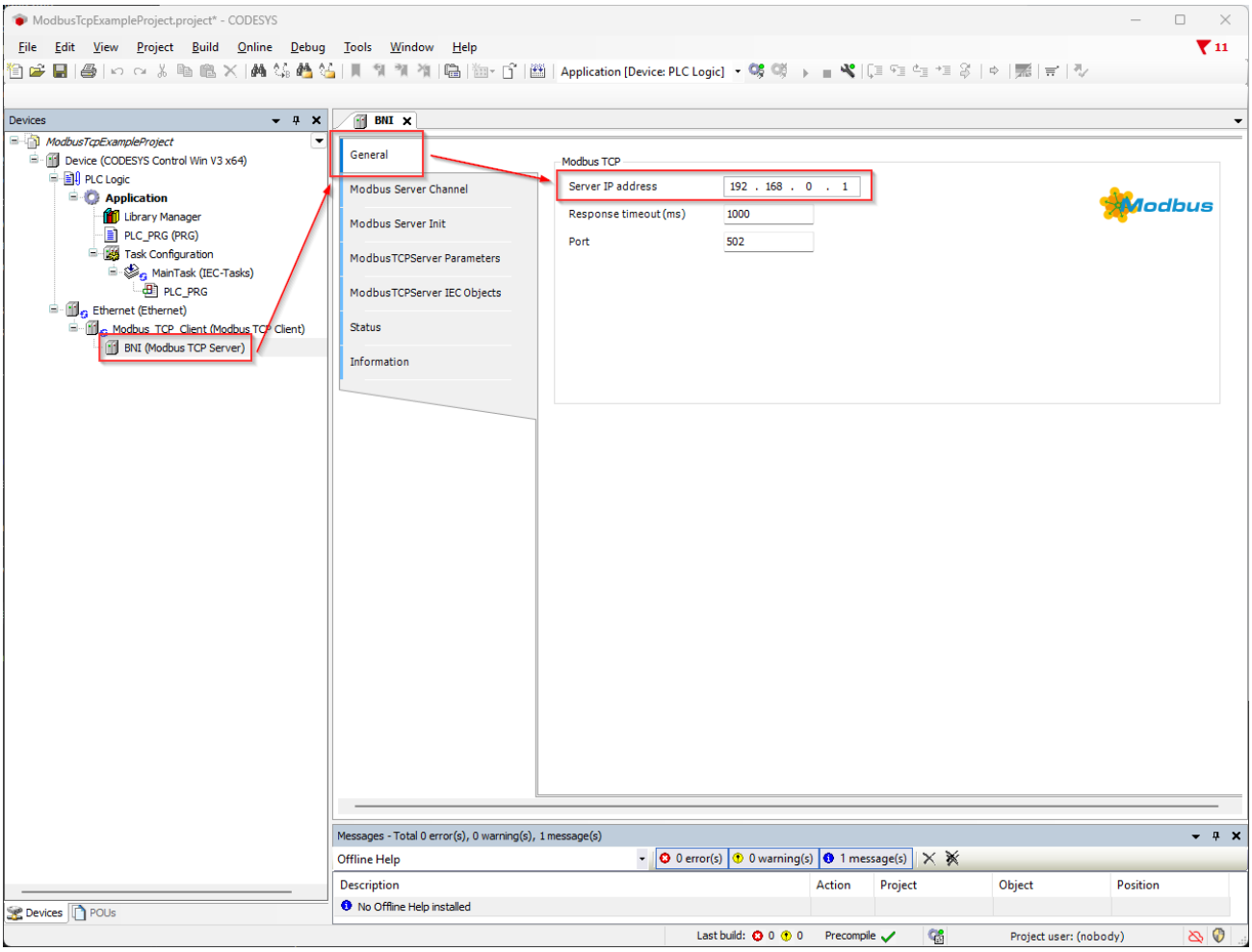


Fig. 115: Setting the IP address of the Modbus server/ BNI

6. Download the program to the PLC and start it.

   ⇒ CODESYS reports an active connection.

Configure ports

Configure the port settings of the network module via the Port Configuration registers, see *Registers 9100…9800 – Port Configuration* for the register layout.

Note

The port settings can also be configured directly via the WebUI, see *I/O ports*. However, if the device is replaced, the port modes must then be applied manually again on the new device.
If the port settings are configured in CODESYS instead, they are written to the device automatically every time the PLC program starts.

Set port mode

Configure the port settings (e.g. Pin 2 / Pin 4 port mode) of the network module so that connected IO-Link devices and digital signals are set up as required.

Before you begin

Make sure that:

- The Modbus/TCP device has been added successfully. See *Add the Network Module as Modbus/TCP device*.

Steps

As an example, Port 4 Pin 4 is configured as IO-Link and Pin 2 as Digital Output. Adapt the register offset and value to the desired port and configuration.

To configure the ports in CODESYS:

1. Select the Modbus server (network module) in the device tree.
2. Navigate to *Modbus Server Init*.
3. Click *New...*.
4. In the *Initialization Value* dialog, select *Write Multiple Registers (Function Code 16)* as the access type, and enter the register offset and the desired value.

   For example, to set port 4 to IO-Link and Pin 2 to Digital Output, use register offset `9401` (Port Configuration register for port 4, see *Registers 9100…9800 – Port Configuration* for the register layout 9100…9800), length `1`, and initialization value `514` (hex `0x0202`).

   Multiple ascending registers can also be set with an initial value each. For this, set the desired number of registers in the *Length* field and enter the corresponding initialization value.
5. Optional: Enter a comment describing the configured value.
6. Click *OK*.

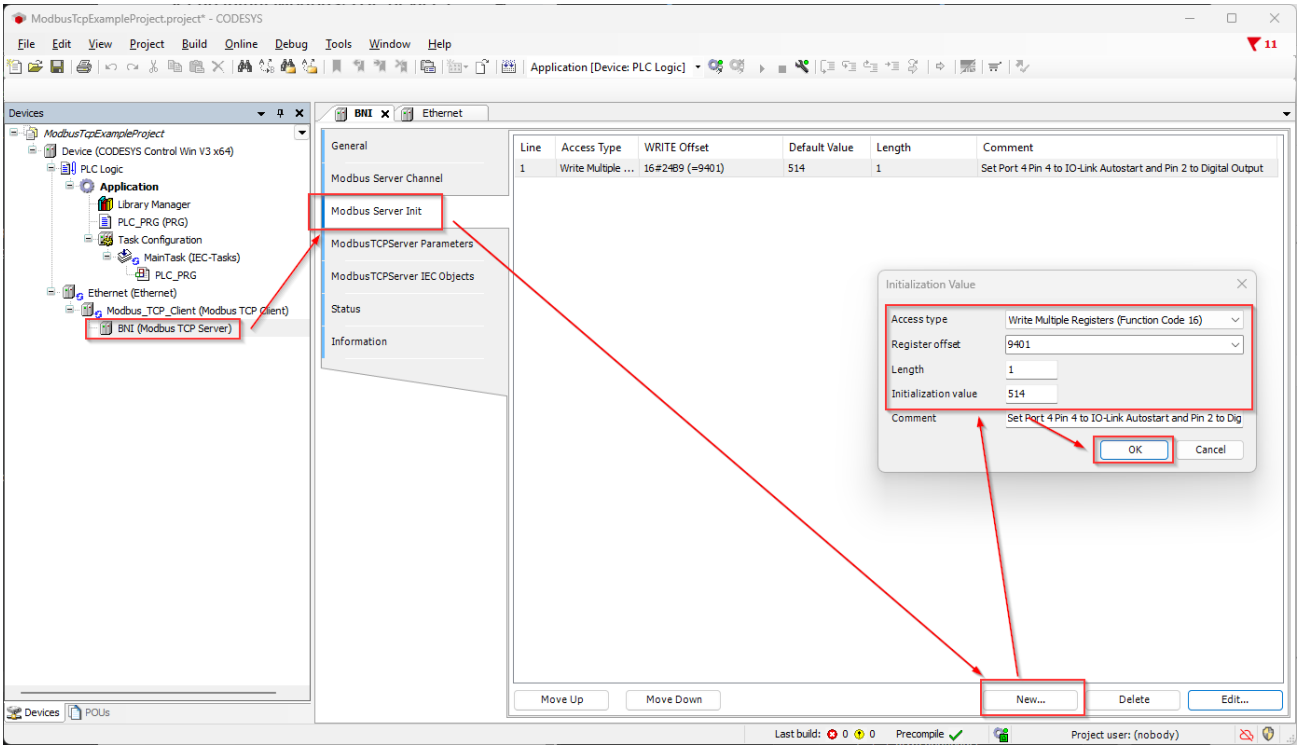


Fig. 116: Configuring a port via Modbus Server Init

7. Download the program to the PLC and start it.

   ⇒ The port is set to the configured port mode.

Configure Validation and Backup

Configure the Validation and Backup behavior of an IO-Link port so that the network module checks the connected IO-Link device against the expected Vendor ID and Device ID, and backs up its parameters as required.

Before you begin

Make sure that:

- The Modbus/TCP device has been added successfully. See *Add the Network Module as Modbus/TCP device*.
- Pin 4 of the port is configured as IO-Link. See *Set port mode*.
- The Vendor ID and Device ID of the expected IO-Link device are known, e.g. from the device's datasheet or IODD.

> **Note**
>
> The Vendor ID and Device ID of the currently connected IO-Link device can be read from the IO-Link Port Diagnostic registers `3n01` (Vendor ID), `3n02` and `3n03` (Device ID), see *Registers 3010…3080 – IO-Link Port Diagnostic*.

Steps

As an example, Port 4 is configured with Validation and Backup mode Backup + Restore, together with the Vendor ID and Device ID of the expected IO-Link device. Adapt the register offset and values to the desired port and device.

To configure Validation and Backup in CODESYS:

1. Select the Modbus server (network module) in the device tree.
2. Navigate to *Modbus Server Init*.
3. Click *New...*.

4. In the *Initialization Value* dialog, select *Write Multiple Registers (Function Code 16)* as the access type, and enter the register offset and the desired value.

   For example, to set the Vendor ID and Device ID of the expected IO-Link device for port 4, use register offset `9403` (Vendor ID) and `9404` (Device ID MSB, as the low byte of the register value), followed by register offset `9405` (Device ID LSB) (Port Configuration registers for port 4, see *Registers 9100…9800 – Port Configuration* for the register layout `9100...9800`).

   Multiple ascending registers can also be set with an initial value each. For this, set the desired number of registers in the *Length* field and enter the corresponding initialization value.

5. Repeat step 4 to set port 4 to Validation and Backup mode Backup + Restore, using register offset `9402`, length `1`, and initialization value `3`.
6. Optional: Enter a comment describing the configured value.
7. Click *OK*.
8. Download the program to the PLC and start it.

   ⇒ The Validation and Backup mode is applied to the configured port, and the connected IO-Link device is checked against the configured Vendor ID and Device ID.

Configure process data channels

Configure cyclic process data channels in CODESYS so that the registers described in *Register Description* are read and written cyclically and mapped to PLC variables.

Before you begin

Make sure that:

- The Modbus/TCP device has been added successfully. See *Add the Network Module as Modbus/TCP device*.
- The relevant ports are configured with the desired port mode. See *Set port mode*.

Steps

As an example, register `2000` (Digital Input State) is read cyclically and register `2001` (Digital Output State) is configured for writing. Adapt the register offset and access type to the desired registers.

To map the registers in CODESYS:

1. Select the BNI in the device tree.
2. Select *Modbus Server Channel*.
3. Click *Add Channel…*.
4. In the *Modbus Server Channel* dialog, enter the values for the digital input channel.

   For example, to read register `2000` (Digital Input State, see *Registers 2000, 2001 and 2047, 2048 – Digital Input / Output State* for the register layout), enter a name (e.g. `Digital Inputs`), select *Read Holding Registers (Function Code 3)* as the access type, select *Cyclic* as trigger with a valid cycle time, and set the READ Register *Offset* to `2000` and *Length* to `1`.

5. Click *OK*.

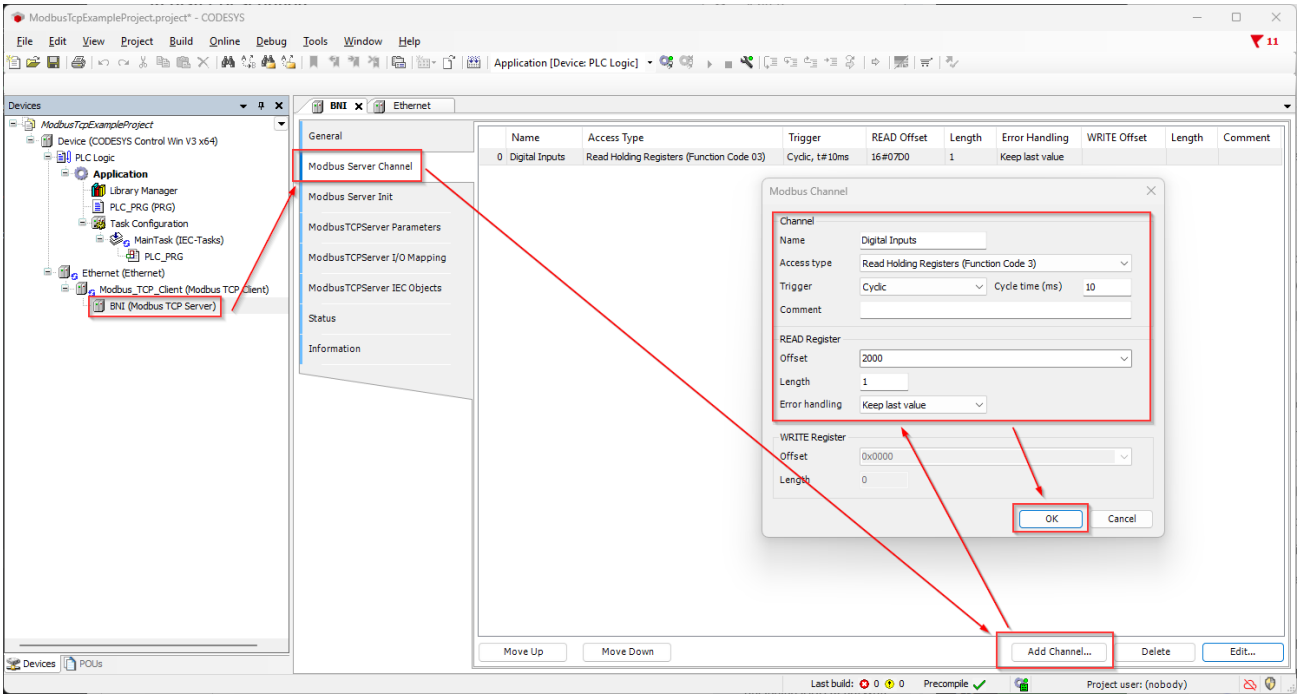


Fig. 117: Adding a channel for the digital input register

6. Navigate to *ModbusTCPServer I/O Mapping*.

   ⇒ The added channel is shown here as process data and can be mapped to a PLC variable.

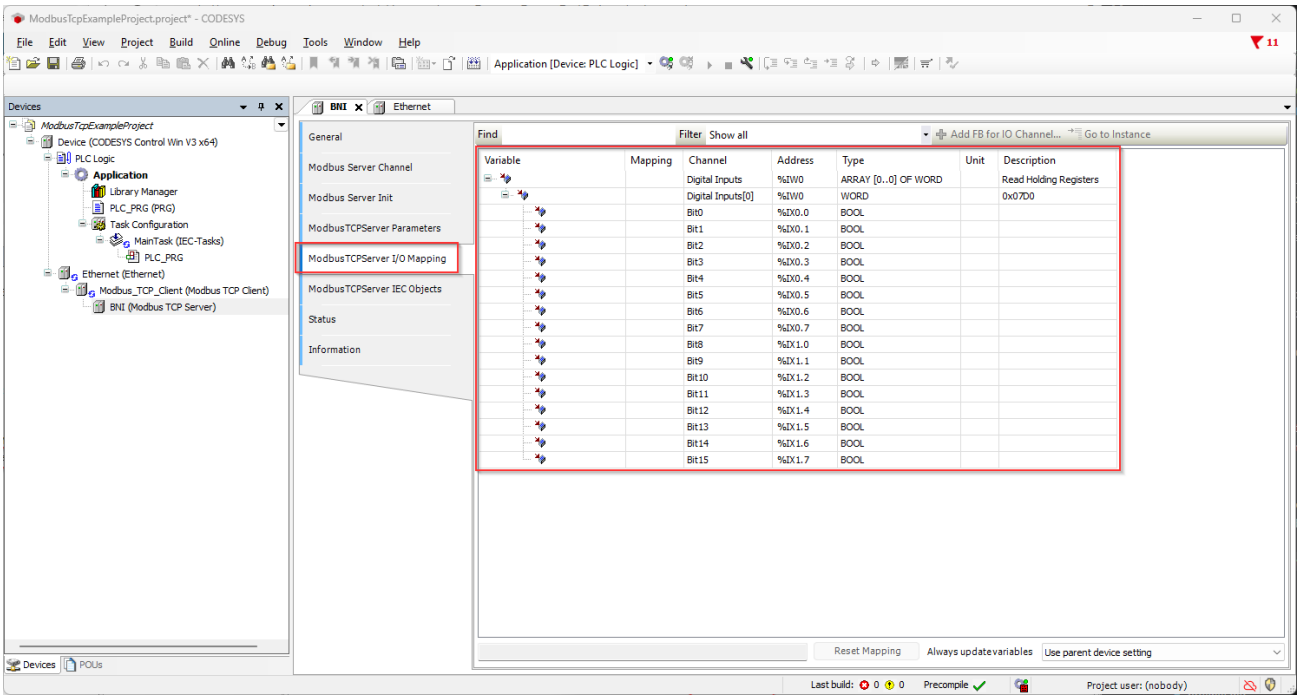


Fig. 118: The digital input channel shown as process data in the I/O mapping

7. Click *Add Channel...* again to add a channel for the digital output register.

8. In the *Modbus Server Channel* dialog, enter the values for the digital output channel.

   For example, to write register `2001` (Digital Output State), enter a name (e.g. `Digital Outputs`), select *Write Multiple Registers (Function Code 16)* as the access type, select *Cyclic* as trigger with a valid cycle time, and set the WRITE Register *Offset* to `2001` and *Length* to `1`.

9. Click *OK*.

   ⇒ The digital output word is now available in *ModbusTCPServer I/O Mapping* with the mapped PLC addresses.

10. Download the program to the PLC and start it.

    ⇒ The mapped PLC variables cyclically reflect the register values; writing to the output variable sets the corresponding digital output.

9.13.3 Register Description

Note

Please check whether IO-Link is supported by your module before using this function. For more information on product variants that support IO-Link, see *Supported product variants*.

Index overview

- Profile ID = 2
- Available from Firmware 1.3.1

Index	Description	Access
0	Profile ID (Register Mapping Version)	RO
1…99	Device (Module) Identification	RO
100	IO-Link ISDU Command Request	RW
300	IO-Link ISDU Command Response	RO
1100…1800	IO-Link Process Data Input/Output	RO/RW
2000	SIO Digital Input State	RO
2001	SIO Digital Output State	RW
2047	Digital Input State (Mirrored to 2000)	RO
2048	Digital Output State (Mirrored to 2001)	RW
3000	Device (Module&Port) Diagnostic	RO
3100…3800	IO-Link Port Diagnostic	RO
9100…9800	Port Configuration	RW
11000	Variable Processdata Register	RW
20000	Module Settings	RW

Note

The Register Mapping Version (list of registers, names and their content) is identified with the **Profile ID** which is a similar version number to HW or FW version number. Due to the content of the registers may be subject to change in the future, with keeping the compatibility and consistency, this Profile ID should be checked first when a new application is developed.

Identification

Index	Length	Description	Access	Default (example)
0	1	Register Mapping Version (ProfileID)	RO	0x0001
1…9	-	reserved	-	-
10…13	4	Product Order Code (ASCII, 7 chars)	RO	BNI00KH
14…29	16	Product Name (TEXT)	RO	BNI XG5-508-0B5-R067
30…99	-	reserved	-	-

The byte array from/to IO-Link is converted as follows in the MODBUS index:

Note

Please check whether IO-Link is supported by your module before using this function. For more information on product variants that support IO-Link, see *Supported product variants*.

UINT16	LSB	Bit(0…7)	= IO-Link Byte[n]
UINT16	MSB	Bit(8…15)	= IO-Link Byte[n+1]

Example

The ASCII coded text of the manufacturer nameBalluff(length = 7) is converted into four (4) Word UINT16 indices as follows:

Index	0	1	2	3	4	5	6
Byte [0…6]	42h,	41h,	4Ch,	4Ch,	55h,	46h,	46h

Word[0…3]	4142h,	4C4Ch,	4655h,	0046h
Index	0	1	2	3

Digital Input / Output State

When a port (X01…X08) is configured as SIO mode (Standard Input or Output) following Digital Input / Output State can be accessed.

Registers 2000, 2001 and 2047, 2048 – Digital Input / Output State

There are two register locations which can be used for Digital Input and Output. Those are working completly the same and are just mirrored location for compatibility.

Index	Byte	Bit	Name	Data Type	Access	Value
2000 (2047)	-	0…7	Digital Input Port n Pin 4	BOOL	RO	0 = off, 1 = on
		8…15	Digital Input Port n Pin 2	BOOL	RO	0 = off, 1 = on
2001 (2048)	-	0…7	Digital Output Port n Pin 4	BOOL	R/W	0 = off, 1 = on
		8…15	Digital Output Port n Pin 2	BOOL	R/W	0 = off, 1 = on

The digital output works if the port is configured as an *output*.

Values – Digital Input / Output State (data)

Value	Description
0	off, de-energized, 0 V
1	on, under power, 24 V

Bits – Digital Input / Output State (data)

Bit	Port n
0, 8	X01
1, 9	X02
2, 10	X03
3, 11	X04
4, 12	X05
5, 13	X06
6, 14	X07
7, 15	X08

Detailed view – Digital Input / Output State (data)

Index	Byte	Bit	Name	Data Type	Access	Value
2000 (2047)	0	0	X01 Pin4 Digital Input State	BOOL	RO	0 = off, 1 = on
		1	X02 Pin4 Digital Input State	BOOL	RO	0 = off, 1 = on
		2	X03 Pin4 Digital Input State	BOOL	RO	0 = off, 1 = on
		3	X04 Pin4 Digital Input State	BOOL	RO	0 = off, 1 = on
		4	X05 Pin4 Digital Input State	BOOL	RO	0 = off, 1 = on
		5	X06 Pin4 Digital Input State	BOOL	RO	0 = off, 1 = on
		6	X07 Pin4 Digital Input State	BOOL	RO	0 = off, 1 = on
		7	X08 Pin4 Digital Input State	BOOL	RO	0 = off, 1 = on
	1	0	X01 Pin2 Digital Input State	BOOL	RO	0 = off, 1 = on
		1	X02 Pin2 Digital Input State	BOOL	RO	0 = off, 1 = on
		2	X03 Pin2 Digital Input State	BOOL	RO	0 = off, 1 = on
		3	X04 Pin2 Digital Input State	BOOL	RO	0 = off, 1 = on
		4	X05 Pin2 Digital Input State	BOOL	RO	0 = off, 1 = on
		5	X06 Pin2 Digital Input State	BOOL	RO	0 = off, 1 = on
		6	X07 Pin2 Digital Input State	BOOL	RO	0 = off, 1 = on
		7	X08 Pin2 Digital Input State	BOOL	RO	0 = off, 1 = on
2001 (2048)	0	0	X01 Pin4 Digital Output State	BOOL	RW	0 = off, 1 = on
		1	X02 Pin4 Digital Output State	BOOL	RW	0 = off, 1 = on

continues on next page

Table 57 – continued from previous page

Index	Byte	Bit	Name	Data Type	Access	Value
		2	X03 Pin4 Digital Output State	BOOL	RW	0 = off, 1 = on
		3	X04 Pin4 Digital Output State	BOOL	RW	0 = off, 1 = on
		4	X05 Pin4 Digital Output State	BOOL	RW	0 = off, 1 = on
		5	X06 Pin4 Digital Output State	BOOL	RW	0 = off, 1 = on
		6	X07 Pin4 Digital Output State	BOOL	RW	0 = off, 1 = on
		7	X08 Pin4 Digital Output State	BOOL	RW	0 = off, 1 = on
	1	0	X01 Pin2 Digital Output State	BOOL	RW	0 = off, 1 = on
		1	X02 Pin2 Digital Output State	BOOL	RW	0 = off, 1 = on
		2	X03 Pin2 Digital Output State	BOOL	RW	0 = off, 1 = on
		3	X04 Pin2 Digital Output State	BOOL	RW	0 = off, 1 = on
		4	X05 Pin2 Digital Output State	BOOL	RW	0 = off, 1 = on
		5	X06 Pin2 Digital Output State	BOOL	RW	0 = off, 1 = on
		6	X07 Pin2 Digital Output State	BOOL	RW	0 = off, 1 = on
		7	X08 Pin2 Digital Output State	BOOL	RW	0 = off, 1 = on

IO-Link Process Data

When a port (X01…X08) is configured as IO-Link mode following Process Data Input and Output can be accessed.

There are two ways of handling the Process Data

- Using **fixed length** 32 Bytes, accessing port-by-port allows simple, port organized access, however it requires multiple commands to perform
- Using customizable **variable lenght** provides accessing content in one step, but pre-configuration is required

Note

Please check whether IO-Link is supported by your module before using this function. For more information on product variants that support IO-Link, see *Supported product variants*.

Registers 1100...1800 - IO-Link Process Data (fixed length)

Read out an IO-Link port once.

Reading back the process data output is used for feedback (control).

Index	Length	Description	Access
1100	34	Port X01 IO-Link Process Data Input/Output	RO
1200	34	Port X02 IO-Link Process Data Input/Output	RO
1300	34	Port X03 IO-Link Process Data Input/Output	RO
1400	34	Port X04 IO-Link Process Data Input/Output	RO
1500	34	Port X05 IO-Link Process Data Input/Output	RO
1600	34	Port X06 IO-Link Process Data Input/Output	RO
1700	34	Port X07 IO-Link Process Data Input/Output	RO
1800	34	Port X08 IO-Link Process Data Input/Output	RO

Details – IO-Link Process Data 1100...1800

Index	Length	Description	Access	Value
1n00[5]	1	Port n IO-Link Process Data Input Valid (flag)	RO	0 = invalid, 1 = valid
1n01…1n16[5]	16	Port n IO-Link Process Data Input (Byte 1…32)	RO	–
1n17[5]	1	Port n IO-Link Process Data Output Valid (flag)	RW	0 = invalid, 1 = valid
1n18…1n33[5]	16	Port n IO-Link Process Data Output (Byte 1…32)	RW	–

Note

In other words, 'valid' is a synonym to reliable. For more information on Technical abbreviations and Terminology, please refer to chapter *Terminology*

Port numbers – IO-Link Process Data 1100...1800

n[5]	Port
1	X01
2	X02
3	X03
4	X04
5	X05
6	X06
7	X07
8	X08

Registers 11000...11257 - Variable Processdata Registers

The registers mirror the registers 1100…1800. While the standard processdata registers are always 32-Bytes long for input and output processdata the variable processdata register adapt to the configured length.

Index	Byte	Name	DataTyp	Access	Value / Description	Note
11000	0	IO-Link Process Data Input Valid	UINT16	RO	Each bit represents a port (Bit 0 → Port 1, etc.)	
	1	Reserved	UINT16	RO	Always zero	
11001	0	IO-Link Process Data Output Valid	UINT16	RW	Each bit represents a port (Bit 0 → Port 1, etc.)	
	1	Reserved	UINT16	RW	Write zero	
11002…11257		Variable Processdata Input/Output		RW	See port configuration for size and layout	See below for Layout

- The variable processdata registers mirror the standard processdata registers (1100…1800), but adapt to the configured input/output length per port.
- Input and output data lengths are defined by the port configuration.

5 n = Port number

- Reserved bytes must be zero when written and will always read as zero.
- If a port is not configured to IO-Link the complete processdata will be omitted in this registers (see example).

Variable Processdata Layout

The variable processdata registers are organized as follows:

1. **Input Processdata for Ports 1–8** (read-only)
2. **Output Processdata for Ports 1–8** (read/write)

If the configured processdata length for a port does not align to a full word (2 bytes), a padding byte is added to ensure the next port's processdata starts at the correct word boundary.

Note

The Input Processdata section is read-only. Any write attempt will result in an error.

Section	Port Number	Access
Input Processdata	1	Read-only
Input Processdata	2	Read-only
Input Processdata	3	Read-only
Input Processdata	4	Read-only
Input Processdata	5	Read-only
Input Processdata	6	Read-only
Input Processdata	7	Read-only
Input Processdata	8	Read-only
Output Processdata	1	Read/Write
Output Processdata	2	Read/Write
Output Processdata	3	Read/Write
Output Processdata	4	Read/Write
Output Processdata	5	Read/Write
Output Processdata	6	Read/Write
Output Processdata	7	Read/Write
Output Processdata	8	Read/Write

For a step-by-step guide including a worked example of the layout calculation, see *Advanced configuration*.

IO-Link ISDU Data

Note

Please check whether IO-Link is supported by your module before using this function. For more information on product variants that support IO-Link, see *Supported product variants*.

For a step-by-step guide on how to read and write ISDU data, see *Advanced configuration*.

Registers 100, 300 – Acyclic Command Channel (including ISDU Read/Write Request)

Index	Length	Description	Access	Default
100	4…121	IO-Link ISDU Command Request	RW	-
300	5…122	IO-Link ISDU Command Response	RO	-

Details – Registers 100...220 Command Request Channel = ISDU Read/Write Request

Index	Byte	Name	Data Type	Access	Needed?	Value
100	-	Command	UINT16	RW	M[1]	1 = read, 2 = write
101	-	Port No.	UINT16	RW	M[1]	1…8
102	-	Index	UINT16	RW	M[1]	0…0xFFFF
103	-	Subindex	UINT16	RW	M[1]	0…255
104[3]	-	Data Length [Byte]	UINT16	RW	O[2]	1…232
105…220[4]	0	Data Byte n	UINT8	RW	O[2]	-
105…220[4]	1	Data byte n1	UINT8	RW	O[2]	-

Details - Registers 300...421 Command Response Channel = ISDU Read/Write Response

Index	Byte	Bit	Name	Data Type	Access	Value
300	-	-	Command (last sent)	UINT16	RO	1 = read, 2 = write
301	-	-	Port No.	UINT16	RO	1…8
302	-	-	Index	UINT16	RO	0…0xFFFF
303	-	-	Subindex	UINT16	RO	0…255
304	-	-	Error Code	UINT16	RO	0 = no error other values = see Tab. 6-15
305		-	Data Length [Bytes]	UINT16	RO	1…232
306…421	0	-	Data Byte n	UINT8	RO	-
306…421	1	-	Data Byte n+1	UINT8	RO	-

1 M = mandatory
3 optional, only required for Write Request
2 O = optional
4 optional, only required for Write Request, depending on the desired length of the data to be written

Error codes

Error Code	Description
0x0000	No error, command was successful
0x4001	ARGBLOCK_NOT_SUPPORTED
0x4002	ARGBLOCK_INCONSISTENT
0x4003	DEVICE_NOT_SUPPORTED
0x4004	SERVICE_NOT_AVAILABLE
0x4005	DEVICE_NOT_IN_OPERATE
0x4006	MEMORY_OVERRUN
0x4011	PORT_NUM_INVALID
0x4034	ARGBLOCK_LENGTH_INVALID
0x4036	SERVICE_TEMP_UNAVAILABLE
0x8000…0x80FF	IO-Link error code from the connected device, see IO-Link specification

Diagnostic

Note

Please check whether IO-Link is supported by your module before using this function. For more information on product variants that support IO-Link, see *Supported product variants*.

Index	Length	Description	Access
3000	10	Module and Port Diagnostic	RO
3100	10	X01 IO-Link Info & Events	RO
3200	10	X02 IO-Link Info & Events	RO
3300	10	X03 IO-Link Info & Events	RO
3400	10	X04 IO-Link Info & Events	RO
3500	10	X05 IO-Link Info & Events	RO
3600	10	X06 IO-Link Info & Events	RO
3700	10	X07 IO-Link Info & Events	RO
3800	10	X08 IO-Link Info & Events	RO

Details – Diagnostic

Registers 3000...3009 – Module and Port Diagnostic

Index	Byte	Bit	Name	Data Type	Access	Value
3000	0	0…3	reserved	–	RO	–
3000	0	4	Sensor Voltage Short Circuit	BOOL	RO	–
3000	0	5	Actuator Short Circuit	BOOL	RO	–
3000	0	6	Actuator Warning	BOOL	RO	–
3000	0	7	IO-Link Short Circuit	BOOL	RO	–
3001	0	0…7	Port n: IO-Link Communication Established	BOOL	RO	–
3001	1	8…15	Port n: IO-Link PD Input Valid	BOOL	RO	–
3002	0	0…7	Port n: IO-Link Valid Device Connected	–	–	–
3002	1	8…15	reserved	–	–	–
3003	–	–	reserved	–	–	–
3004	0	0…7	Port n: Actuator shutdown (Pin 2)	BOOL	RO	–
3004	1	8…15	Port n: Actuator shutdown (Pin 4)	BOOL	R	–
3005	0	0…7	Port n: Actuator Warning (Pin 2)	BOOL	RO	–
3005	1	8…15	Port n: Actuator Warning (Pin 4)	BOOL	RO	–
3006	–	–	reserved	–	–	–
3007	–	–	reserved	–	–	–
3008	–	–	reserved	–	–	–
3009	–	–	reserved	–	–	–

BOOL value	Meaning
0	false, status not available
1	true, status available

Bit	Port n
0, 8	X01
1, 9	X02
2, 10	X03
3, 11	X04
4, 12	X05
5, 13	X06
6, 14	X07
7, 15	X08

Registers 3010...3080 – IO-Link Port Diagnostic

Note

Please check whether IO-Link is supported by your module before using this function. For more information on product variants that support IO-Link, see *Supported product variants*.

Detailed information about the connected IO-Link device.

Index	Byte	Bit	Name	Data Type	Access	Value
3n00 Page 217, 5	0	0	IO-Link Mode	BOOL	RO	–
		1	Device Connected	BOOL	RO	–
		2	Valid PD IN Data	BOOL	RO	–
		3	Wrong Vendor ID or Device ID	BOOL	RO	–
		4	Wrong Cycle Time	BOOL	RO	–
		5	Wrong Length PD IN	BOOL	RO	–
		6	Wrong Length PD OUT	BOOL	RO	–
		7	reserved	–	RO	–
	1	–	reserved	–	RO	–
3n01 Page 217, 5	–	–	Vendor ID	UINT16	RO	–
3n02 Page 217, 5	0	–	Device ID (MSB)	UINT8	RO	–
	1	–	reserved	–	RO	–
3n03 Page 217, 5	–	–	Device ID (LSB)	UINT16	RO	–
3n04 Page 217, 5	0	–	Entry #1 Event Qualifier	IOL coded	RO	IOL coded
	1	–	reserved	–	RO	–
3n05 Page 217, 5	–	–	Entry #1 Event Code	UINT16	RO	IOL coded
3n06 Page 217, 5	0	–	Entry #2 Event Qualifier	Enum	RO	IOL coded
	1	–	reserved	–	RO	–
3n07 Page 217, 5	–	–	Entry #2 Event Code	UINT16	RO	IOL coded
3n08 Page 217, 5	0	–	Entry #3 Event Qualifier	Enum	RO	IOL coded
	1	–	reserved	–	RO	–
3n09 Page 217, 5	–	–	Entry #3 Event Code	UINT16	RO	IOL coded

Port numbers – Registers 3010...3080

n[Page 217, 5]	Port
1	X01
2	X02
3	X03
4	X04
5	X05
6	X06
7	X07
8	X08

IOL coded Event Qualifier – Registers 3010...3080

Bit	Description
0...2	Instance
3	Source
4...5	Type
6, 7	Mode

Configuration

Registers 9100...9800 – Port Configuration

Note

Please check whether IO-Link is supported by your module before using this function. For more information on product variants that support IO-Link, see *Supported product variants*.

Index	Length	Name
9100	7	X01 Port Configuration
9200	7	X02 Port Configuration
9300	7	X03 Port Configuration
9400	7	X04 Port Configuration
9500	7	X05 Port Configuration
9600	7	X06 Port Configuration
9700	7	X07 Port Configuration
9800	7	X08 Port Configuration

Please see the following tables for information on the structure of the port configuration.

Index	Byte	Bit	Name	Data Type	Access	Value	Note
9n00[6]	0	–	Master Cycle Time	UINT8	RW	IO-Link coded	7
	1	–	reserved		–	–	8
9n01[6]	0	–	Pin 2 Port Mode	UINT8	RW	0 = deactivated 1 = Digital Input 2 = Digital Output	9 10
	1	–	Pin 4 Port Mode	UINT8	RW	0 = deactivated 1 = IOL Manual 2 = IOL Autostart 3 = Digital input 4 = Digital Output	9
9n02[6]	0	–	Validation ID	UINT8	RW	0 = No device check 1 = Compatible V1.0 2 = Compatible V1.1 3 = Backup Restore 4 = Restore	7
	1	–	reserved	–	–	–	8
9n03[6]	–	–	Vendor ID	UINT16	RW	–	7
9n04[6]	0	–	Device ID (MSB)	UINT8	RW	–	7
	1	–	reserved	–	–	–	8
9n05[6]	–	–	Device ID (LSB)	UINT16	RW	–	7
9n06[6]	–	–	Input Processdata Length	UINT16	RW	0…32	7
9n07[6]	–	–	Output Processdata Length	UINT16	RW	0…32	7

Notes

Note

Automatic Shutdown of Pin 1 Power on Port Deactivation:
If a port is configured to deactivate Pin 2 and Pin 4, the power supply on Pin 1 is automatically shut down.

Port numbers – Registers 9100…9800

6 n = Port number
7 Needs to be zero (0x00) for BNI XG3-302-..., else register write will be rejected
8 Needs to be always zero, else register write will be rejected
9 For XG3-302-... only Digital Input, Digital Output and Deactivated are valid
10 For XG1-505-... Digital Output and Power is *not* supported for Pin 2

n[Page 217, 5]	Port
1	X01
2	X02
3	X03
4	X04
5	X05
6	X06
7	X07
8	X08

Coding of the master cycle time of the IO-Link specification

Note

Please check whether IO-Link is supported by your module before using this function. For more information on product variants that support IO-Link, see *Supported product variants*.

Time Base Encoding	Time Base Value	Calculation	Cycle Time
0	0.1 ms	Multiplier × Time base	0.4…6.3 ms
1	0.4 ms	6.4 ms + Multiplier × Time Base	6.4…31.6 ms
10	1.6 ms	32.0 ms + Multiplier × Time Base	32.0…132.8 ms
11	reserved	reserved	reserved

Register 20000 - Module Settings

Note

This setting is only available for the XG5-538-…-variants.

Global configuration registers for the Module (Device).

Index	Byte	Bit	Name	DataType	Access	Value
20000			Output Powerloss Behavior	UINT16	RW	See below

The parameter defines what happens to active outputs on Pin 2 and Pin 4 when UA voltage is lost. The configured setting is **saved permanently** — it can be written once and will be retained after a power reset.

- Value 0 – US Outputs shutdown on UA powerloss

  All active outputs on Pin 2 and Pin 4 are automatically switched off in the event of a UA voltage drop. This matches the behavior of a XG5-508-… master, even though Pin 2 and Pin 4 of Class A output ports are supplied by US, and Pin 4 of Class B ports are supplied by UA.

- Value 1 – Hardware Defined

  US powered outputs will not be switched off in the event of a UA voltage drop. All outputs remain in their current state. Only Class B Pin 2 outputs are physically supplied by UA and will therefore be shut down.

9.13.4 Advanced configuration

This chapter describes various additional features of the Modbus/TCP interface. Besides the function description, step-by-step guides on how to configure those features are also included.

Configure variable processdata

Determine the register addresses of the *variable processdata registers*, which adapt to the input/output processdata lengths configured per port. See *Registers 11000…11257 - Variable Processdata Registers* for the layout of the input and output processdata sections.

Before you begin

Make sure that:

- The desired ports are configured as IO-Link. See *Set port mode*.

Steps

To determine the variable processdata register addresses:

▶ Configure the input and output processdata length (in bytes) for each port by writing to registers `9n06` (Input Processdata Length) and `9n07` (Output Processdata Length), where `n` is the port number. See *Registers 9100…9800 – Port Configuration*.

For example:

- Port 1 Input: 3 bytes
- Port 3 Input: 2 bytes
- Port 4 Input: 5 bytes
- Port 1 Output: 4 bytes
- Port 3 Output: 1 byte

⇒ Starting at register `11002`, the input processdata of ports 1…8 is listed first in ascending order, followed directly by the output processdata of ports 1…8, with a padding byte added after a port's data whenever needed so that the next port's data starts on a word boundary.

For the example configuration, the resulting layout is:

Address	Section	Port	Data Length	Padding	Word Boundary
11002 + 0	Input Processdata	1	3 bytes	1 byte	2 words
11002 + 2	Input Processdata	3	2 bytes	0	1 word
11002 + 3	Input Processdata	4	5 bytes	1 byte	3 words
11002 + 6	Output Processdata	1	4 bytes	0	2 words
11002 + 8	Output Processdata	3	1 byte	1 byte	1 word

Ports which have zero length configured or are not in IO-Link mode do not reserve space in the register.

IO-Link ISDU data

Note

Please check whether IO-Link is supported by your module before using this function. For more information on product variants that support IO-Link, see *Supported product variants*.

Read and write acyclic IO-Link ISDU (Indexed Service Data Unit) data, e.g. to access parameters of a connected IO-Link device, via the Acyclic Command Channel registers, see *Registers 100, 300 – Acyclic Command Channel (including ISDU Read/Write Request)* for the register layout.

Before you begin

Make sure that:

- The Modbus/TCP device has been added successfully. See *Add the Network Module as Modbus/TCP device*.
- The port is configured as IO-Link. See *Set port mode*.
- An IO-Link device is connected to the port.

Read ISDU data

To read ISDU data via Modbus:

1. Write the port number (`101`), index (`102`) and subindex (`103`) of the desired IO-Link parameter to the Command Request registers.
2. Write the command `1` (read) to register `100`.

   ⇒ The requested data is available in the Command Response registers `300`…`305` (Data Length) and `306`…`421` (Data).

Write ISDU data

To write ISDU data via Modbus:

1. Write the port number (`101`), index (`102`) and subindex (`103`) of the desired IO-Link parameter to the Command Request registers.
2. Write the data to registers `105`…`220` and the desired data length to register `104`.
3. Write the command `2` (write) to register `100`.

   ⇒ The Command Response registers report whether the write request was successful, see *Error codes*.

9.14 OPC-UA integration

Note

This BNI product provides a server compliant with the OPC Unified Architecture (OPC UA) standard, with data closely aligned to the “OPC UA for IO-Link Companion Specification (OPC 30120)”[1]
In this chapter you can find:
- Basics about OPC UA
- Initial configuration steps activating the OPC UA Server and using a popular application UaExpert by Unified Automation[2]
- References about OPC-UA objects
- Advanced configuration with scripting examples

1 https://reference.opcfoundation.org/specs/OPC-30120
2 https://www.unified-automation.com

9.14.1 OPC-UA Basics

Description

This BNI product provides a server compliant with the OPC Unified Architecture (OPC UA) standard, with data closely aligned to the “OPC UA for IO-Link Companion Specification (OPC 30120)”[1]

In this chapter you can find:

- Brief sumary about OPC UA
- First steps activating the OPC UA Server
- References about OPC UA object
- Useful PC app (tool) and scripting examples

1 https://reference.opcfoundation.org/specs/OPC-30120

Which IIoT fits for your application and/or Use Case, here is a comparison

	MQTT	REST	OPC UA
Communication type	Asynchronous (Publish/Subscribe)	Synchronous (Request/Response)	Client/Server
Bandwidth	very low	medium	high
Security	Medium	High	Very high
Complexity	Low	Medium	Medium
Area of Application	IIoT, Sensors, Edge Devcies	Cloud, Webservices, other APIs	Automation, Monitoring

Typical OPC UA architecture

The picture shows a typical OPC UA architecture.

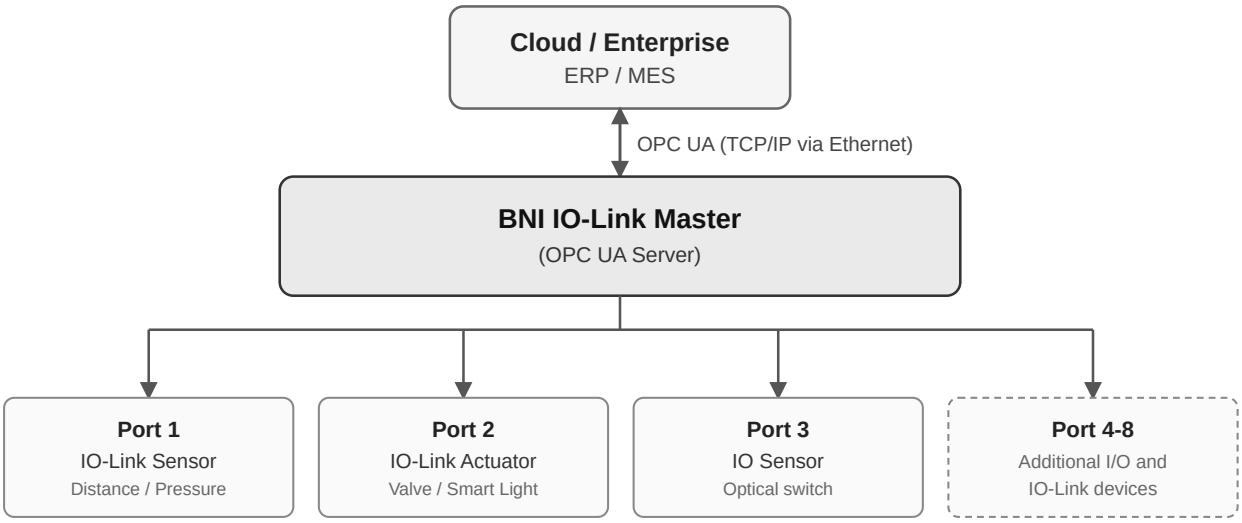


Fig. 119: OPC UA architecture

Supported data via OPC-UA

It provides access to the following data related to:

Master (module unit itself):

- Identification data

Ports:

- SIO Input and Output signal states
- Identification data of the connected IO-Link devices
- Process Data Input and Output of provided by the connected IO-Link devices
- Diagnostic and status information of the connected IO-Link devices

Note

Capabilities and Limitation

- OPC-UA Server provides data as read only (in firmware 1.4.0)
- Process Data Output can also be read back
- Login required (user: admin, password: lasered on the product)
- No anomymous login allowed
- User name and password are transmitted without encryption
- Data refresh rate: ~10 ms

Summary of terms used in OPC UA

Term	What it conveys in the sentence
Address Space	The browsed “location” or structure (the server’s entire tree-element system).
Information Model	The structure summarizing data meanings, types, and relationships.
Browse / Traverse	The official OPC UA term for retrieving nodes.
Node Metadata	Encompasses data types, Namespaces, and attributes.

9.14.2 Initial OPC-UA configuration

First steps

Before you begin

► Check if the **product variant** supports OPC UA

Currently BNI XG5-508-… and BNI XG5-538-… variants provide OPC UA Server

► Check if latest **firmware** update installed on the product.

OPC UA is available from firmware version **1.4.0** Further info on ‘How to update firmware via Balluff Update Platform’, please see chapter *Firmware*

Steps

1. Enabling the **OPC UA Server** via the Web UI

To access the data, the OPC UA server must first be enabled in the Web UI. To do this, log in to the device, navigate to **Settings**, and click on the **IoT** tab. At the bottom of the page, you will find the collapsed section “**OPC UA Server Settings**” Open this section to enable or disable the server.

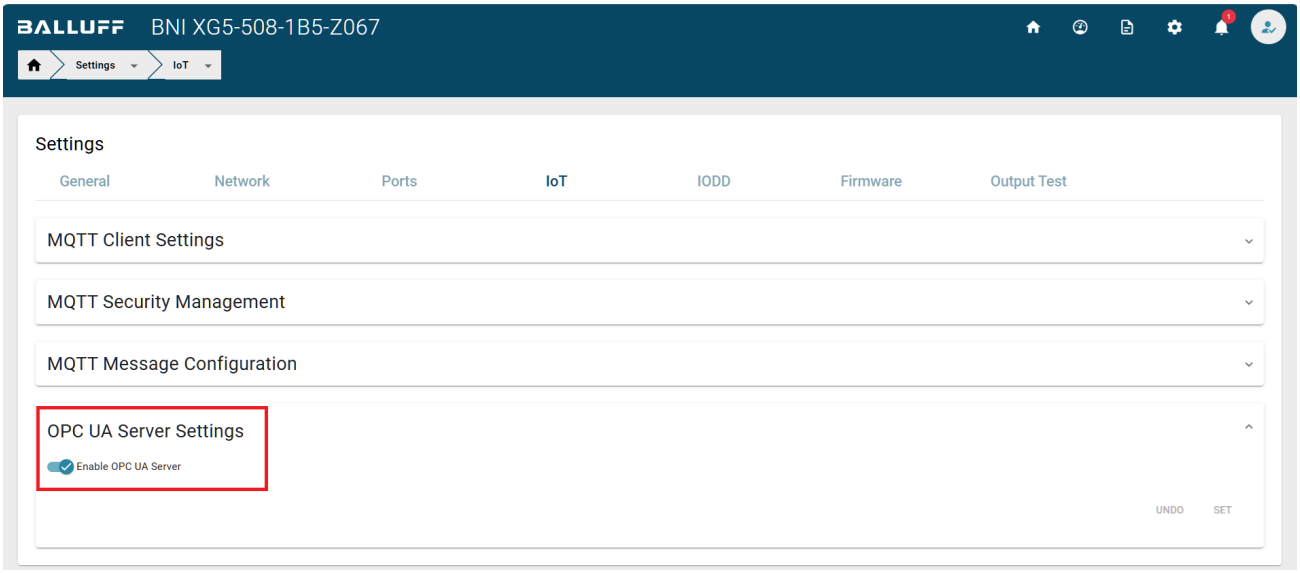


Fig. 120: Enable/disable OPC UA Server

⇒ By default, the OPC UA server is disabled. After changing the setting, the master must always be restarted for the change to take effect.

2. Access to the OPC UA server

⇒ Credentials: username and password are always identical to the credentials used in the WebUI ⇒ Endpoint URL: **opc.tcp://<IP-Address>:4840**

Tools

One possible application for accessing the data is the freely available **UaExpert** from Unified Automation[1].

Before you begin

Make sure that:

- The BNI module is connected to a laptop or the PC via Ethernet cable correctly
- Accessing the WebUI via web browser is successful (proofing the connection is alive) See *WebUI/web interface*

Steps

1. After starting the tool, you need to add a new server.

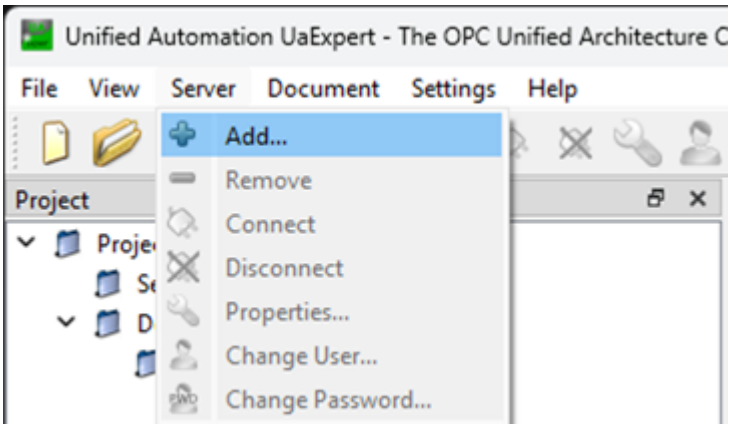


Fig. 121: Steps in the tool UaExpert

1 https://www.unified-automation.com/

2. After double-clicking the + under Custom Discovery, you can specify the endpoint URL shown below.

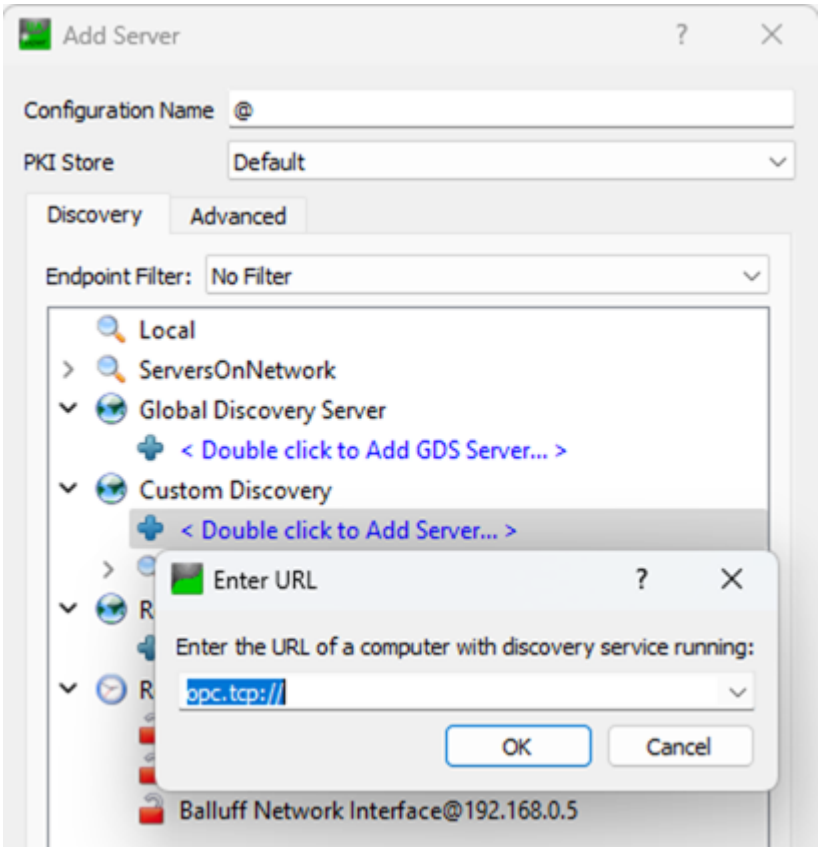


Fig. 122: Steps in the tool UaExpert

3. In the lower section, you then select the field with username and password and enter the same data as when logging into the WebUI. Anonymous login is denied.

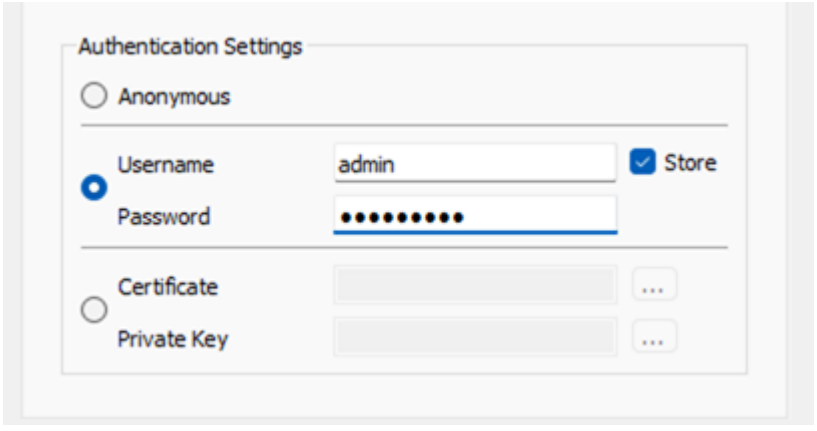


Fig. 123: Steps in the tool UaExpert

WARNING

Username, password and data are always transmitted unencrypted due to the currently used security mode settings!

4. If the server is running and the input data was correct, the available address space will appear in the bottom left corner.

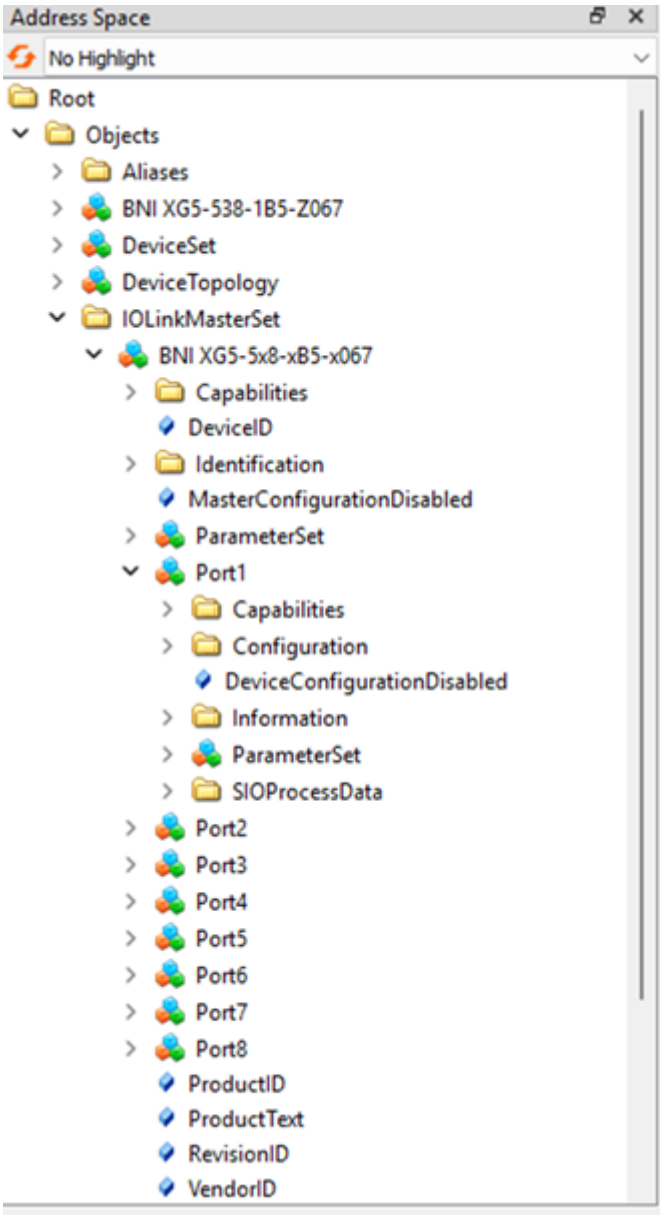


Fig. 124: Steps in the tool UaExpert

5. These nodes can then be dragged into the center (Data Access View) to display the corresponding values.

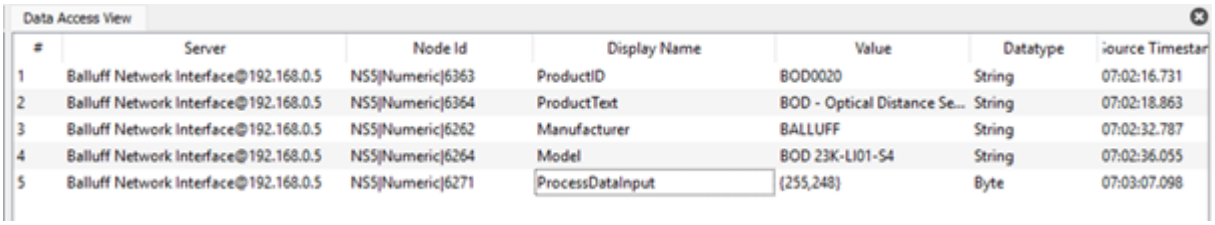


Fig. 125: Steps in the tool UaExpert

9.14.3 OPC UA Information Model

What is available via OPC-UA?

Due to OPC UA is a self-describing protocol:

- Self-describing architecture / model
- Built-in information modeling
- Address space discovery
- Meta-data driven protocol

therefore no full list (reference) included in this manual. Instead of, a snippet listed in a table below.

The full list of available OPC UA nodes (Node ID) of this product can be read out with the

UaExpert tool (see *Tools*) or a

Python script (see *Example 2 - Script reading out the Information Model provided by the OPC UA server*).

The list below is not complete, it does not include all Nodes, it only includes typical examples.

Path	Name	Browse-Name	NodeId	Type
IDENTIFICATION of the Master				
Objects/DeviceSet/PlatformDevice/DeviceRevision	DeviceRevision	2:DeviceRevision	ns=3;i=6002	Variable
Objects/DeviceSet/PlatformDevice/HardwareRevision	HardwareRevision	2:HardwareRevision	ns=3;i=6003	Variable
Objects/DeviceSet/PlatformDevice/Manufacturer	Manufacturer	2:Manufacturer	ns=3;i=6004	Variable
Objects/DeviceSet/PlatformDevice/Model	Model	2:Model	ns=3;i=6005	Variable
Objects/DeviceSet/PlatformDevice/RevisionCounter	RevisionCounter	2:RevisionCounter	ns=3;i=6006	Variable
Objects/DeviceSet/PlatformDevice/SerialNumber	SerialNumber	2:SerialNumber	ns=3;i=6007	Variable
Objects/DeviceSet/PlatformDevice/SoftwareRevision	SoftwareRevision	2:SoftwareRevision	ns=3;i=6008	Variable
IO-LINK PROCESS DATA on Port 1				
Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/Device/General/ProcessDataInput	ProcessDataInput	4:ProcessDataInput	ns=5;i=6079	Variable
Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/Device/General/ProcessDataInput/ProcessDataLength	ProcessDataLength	4:ProcessDataLength	ns=5;i=6080	Variable
Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/Device/General/ProcessDataOutput	ProcessDataOutput	4:ProcessDataOutput	ns=5;i=6081	Variable
Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/Device/General/ProcessDataOutput/ProcessDataLength	ProcessDataLength	4:ProcessDataLength	ns=5;i=6082	Variable
SIO INPUT/OUTPUT SIGNAL STATE of Port 1				
Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/SIOProcessData/Pin2ProcessData	Pin2ProcessData	4:Pin2ProcessData	ns=5;i=6295	Variable
Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/SIOProcessData/Pin4ProcessData	Pin4ProcessData	4:Pin4ProcessData	ns=5;i=6296	Variable
And so on for Port 2 … Port8				

9.14.4 Advanced configuration

This chapter describes additional features of the OPC-UA interface. Besides the function description, step-by-step guides on how to configure those features are also included.

A way to connect to the product's OPC UA Server is witing a Python[1] script.

Prerequisites

- Laptop or PC

1 https://www.python.org/

- Python 3.10.x or 3.11.x
- FreeOpcUa or AsyncUA library for Python
- pip install opcua or pip install asyncua

Examples

Example 1 - SIO Port Input and Output signal state

Task: reading all SIO ports' signal state.

Before you begin

Make sure that:

- Module is powered with Us and Ua +24 Volt
- The desired ports are configured as **Digital In/Out** (SIO mode) See *I/O ports*.
- Port 7 - Pin2 and Pin4 (for this example) is connected to Pin 1 (+24 Volt)

Steps

▶ To read out the SIO Input and Output signal state, the following Pytohon script should be called.

```
from opcua import Client
import time

client = Client("opc.tcp://192.168.1.1:4840")
client.set_user("admin")
client.set_password("your-password")
client.connect()

ports_data = [
    (1, 6295, 6296),  # Port 1 - Pin2, Pin4
    (2, 6026, 6027),  # Port 2 - Pin2, Pin4
    (3, 6297, 6298),  # Port 3 - Pin2, Pin4
    (4, 6299, 6300),  # Port 4 - Pin2, Pin4
    (5, 6343, 6344),  # Port 5 - Pin2, Pin4
    (6, 6301, 6302),  # Port 6 - Pin2, Pin4
    (7, 6303, 6304),  # Port 7 - Pin2, Pin4
    (8, 6293, 6294),  # Port 8 - Pin2, Pin4
]

# Header
print("SIO signal states of Port1..Port8")
print("")
print("-" * 24)
print(f"{'Port':<5} | {'Pin2':<6} | {'Pin4':<6}")
print("-" * 24)

# Read data and show them
for port_num, pin2_id, pin4_id in ports_data:
    # Pin2
    try:
        val2 = client.get_node(f"ns=5;i={pin2_id}").get_value()
        val2_str = str(val2).lower()
    except Exception:
        val2_str = "error"

    # Pin4
    try:
        val4 = client.get_node(f"ns=5;i={pin4_id}").get_value()
        val4_str = str(val4).lower()
    except Exception:
        val4_str = "error"
```

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```
    # One row in the table
    print(f"{port_num:<5} | {val2_str:<6} | {val4_str:<6}")


client.disconnect()
```

⇒ Ruinning the script abowe will get all SIO ports' (Port1…Port8) Pin2 and Pin4 state and write out on the consol the result. In this example the Port 7 - Pin2 and Pin4 ahould return with boolean True (1) value.

Result

```
SIO signal states of Port1..Port8

------------------------
Port  | Pin2   | Pin4
------------------------
1     | false  | false
2     | false  | false
3     | false  | false
4     | false  | false
5     | false  | false
6     | false  | false
7     | true   | true
8     | false  | false
```

Example 2 - Script reading out the Information Model provided by the OPC UA server

This Python script browses the entire OPC UA Address Space (including nodes, variables, data types, and methods) and exports the server's Information Model into a CSV file.

Terms and meanings see *Summary of terms used in OPC UA*

- To run the script provide appropriate info for
  - OPC_SERVER_URL
  - USERNAME
  - PASSWORD

```
import asyncio
import csv
from asyncua import Client, ua

OPC_SERVER_URL  = "opc.tcp://192.168.1.1:4840" # Set your IP!
USERNAME        = "admin"
PASSWORD        = "password"                   # Set your own password!
CSV_OUTPUT_FILE = "opcua_nodes_list.csv"

async def browse_recursive(node, current_path, node_list, depth=0, max_depth=8):
    if depth > max_depth:
        return

    try:
        browse_name = await node.read_browse_name()
        node_class = await node.read_node_class()
        node_id = node.nodeid.to_string()

        display_name_obj = await node.read_display_name()
        display_name = display_name_obj.Text

        node_path = f"{current_path}/{browse_name.Name}" if current_path else browse_name.Name
```

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```
        node_list.append({
            "Depth": depth,
            "Path": node_path,
            "Name": display_name,
            "BrowseName": f"{browse_name.NamespaceIndex}:{browse_name.Name}",
            "NodeId": node_id,
            "NodeClass": node_class.name
        })

        indent = "  " * depth
        print(f"{indent}|-- {display_name} [{node_id}] ({node_class.name})")

        # Get child references using the node-specific browse method
        children_refs = await node.get_children_descriptions()

        for child_ref in children_refs:
            # Traverse only forward/hierarchical references downwards
            child_node = client.get_node(child_ref.NodeId)

            # Avoid infinite loops and skip specific system nodes
            if child_ref.BrowseName.Name not in ["Server", "StaticData"]:
                await browse_recursive(child_node, node_path, node_list, depth + 1, max_depth)

    except Exception as e:
        # Ignore errors if reading a node is restricted due to permissions
        pass

async def main():
    global client
    print(f"Connecting to server: {OPC_SERVER_URL}...")

    client = Client(url=OPC_SERVER_URL)
    client.set_user(USERNAME)
    client.set_password(PASSWORD)

    async with client:
        print("Successfully connected and authenticated!\n")

        ns_array = await client.get_namespace_array()
        print("--- Registered Namespaces ---")
        for idx, uri in enumerate(ns_array):
            print(f"NS{idx}: {uri}")
        print("-" * 50 + "\n")

        objects_node = client.nodes.objects
        node_list = []

        print("--- Browsing Address Space ---")
        await browse_recursive(objects_node, "", node_list)

        with open(CSV_OUTPUT_FILE, mode="w", newline="", encoding="utf-8") as f:
            writer = csv.DictWriter(f, fieldnames=["Depth", "Path", "Name", "BrowseName", "NodeId",
↪"NodeClass"])
            writer.writeheader()
            writer.writerows(node_list)

        print(f"\nSuccess! List saved to: {CSV_OUTPUT_FILE}")

if __name__ == "__main__":
    asyncio.run(main())
```

Result

⇒ Ruinning the script abowe will create a CSV file containing more than 500 lines, a snippet can be seen below

```
Depth,Path,Name,BrowseName,NodeId,NodeClass
0,Objects,Objects,0:Objects,i=85,Object
1,Objects/Locations,Locations,0:Locations,i=31915,Object
1,Objects/Aliases,Aliases,0:Aliases,i=23470,Object
2,Objects/Aliases/FindAlias,FindAlias,0:FindAlias,i=23476,Method
3,Objects/Aliases/FindAlias/InputArguments,InputArguments,0:InputArguments,i=23477,Variable
3,Objects/Aliases/FindAlias/OutputArguments,OutputArguments,0:OutputArguments,i=23478,Variable
2,Objects/Aliases/LastChange,LastChange,0:LastChange,i=32852,Variable
2,Objects/Aliases/TagVariables,TagVariables,0:TagVariables,i=23479,Object
3,Objects/Aliases/TagVariables/FindAlias,FindAlias,0:FindAlias,i=23485,Method
4,Objects/Aliases/TagVariables/FindAlias/InputArguments,InputArguments,0:InputArguments,i=23486,
↪Variable
4,Objects/Aliases/TagVariables/FindAlias/OutputArguments,OutputArguments,0:OutputArguments,i=23487,
↪Variable
2,Objects/Aliases/Topics,Topics,0:Topics,i=23488,Object
3,Objects/Aliases/Topics/FindAlias,FindAlias,0:FindAlias,i=23494,Method
4,Objects/Aliases/Topics/FindAlias/InputArguments,InputArguments,0:InputArguments,i=23495,Variable
4,Objects/Aliases/Topics/FindAlias/OutputArguments,OutputArguments,0:OutputArguments,i=23496,
↪Variable
1,Objects/DeviceSet,DeviceSet,2:DeviceSet,ns=2;i=5001,Object
2,Objects/DeviceSet/DeviceFeatures,DeviceFeatures,2:DeviceFeatures,ns=2;i=15034,Object
2,Objects/DeviceSet/PlatformDevice,BNI XG5-508-1B5-Z067,3:PlatformDevice,ns=3;i=5001,Object
3,Objects/DeviceSet/PlatformDevice/DeviceManual,DeviceManual,2:DeviceManual,ns=3;i=6001,Variable
3,Objects/DeviceSet/PlatformDevice/DeviceRevision,DeviceRevision,2:DeviceRevision,ns=3;i=6002,
↪Variable
3,Objects/DeviceSet/PlatformDevice/HardwareRevision,HardwareRevision,2:HardwareRevision,ns=3;i=6003,
↪Variable
3,Objects/DeviceSet/PlatformDevice/Manufacturer,Manufacturer,2:Manufacturer,ns=3;i=6004,Variable
3,Objects/DeviceSet/PlatformDevice/Model,Model,2:Model,ns=3;i=6005,Variable
3,Objects/DeviceSet/PlatformDevice/RevisionCounter,RevisionCounter,2:RevisionCounter,ns=3;i=6006,
↪Variable
3,Objects/DeviceSet/PlatformDevice/SerialNumber,SerialNumber,2:SerialNumber,ns=3;i=6007,Variable
3,Objects/DeviceSet/PlatformDevice/SoftwareRevision,SoftwareRevision,2:SoftwareRevision,ns=3;i=6008,
↪Variable
1,Objects/NetworkSet,NetworkSet,2:NetworkSet,ns=2;i=6078,Object
1,Objects/DeviceTopology,DeviceTopology,2:DeviceTopology,ns=2;i=6094,Object
2,Objects/DeviceTopology/OnlineAccess,OnlineAccess,2:OnlineAccess,ns=2;i=6095,Variable
1,Objects/PlatformDevice,BNI XG5-508-1B5-Z067,3:PlatformDevice,ns=3;i=5003,Object
2,Objects/PlatformDevice/DeviceInfo,DeviceInfo,3:DeviceInfo,ns=3;i=5004,Object
3,Objects/PlatformDevice/DeviceInfo/BootloaderVersion,BootloaderVersion,3:BootloaderVersion,ns=3;
↪i=6030,Variable
...
3,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1,Port1,5:Port1,ns=5;i=5016,Object
4,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/Capabilities,Capabilities,4:Capabilities,ns=5;
↪i=5017,Object
5,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/Capabilities/MaxPowerSupply,MaxPowerSupply,
↪4:MaxPowerSupply,ns=5;i=6046,Variable
6,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/Capabilities/MaxPowerSupply/EngineeringUnits,
↪EngineeringUnits,0:EngineeringUnits,ns=5;i=6047,Variable
5,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/Capabilities/Pin2Support,Pin2Support,
↪4:Pin2Support,ns=5;i=6050,Variable
5,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/Capabilities/PortClass,PortClass,4:PortClass,
↪ns=5;i=6051,Variable
6,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/Capabilities/PortClass/EnumStrings,EnumStrings,
↪0:EnumStrings,ns=5;i=6052,Variable
4,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/Configuration,Configuration,4:Configuration,
↪ns=5;i=5018,Object
5,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/Configuration/ConfiguredDevice,
↪ConfiguredDevice,4:ConfiguredDevice,ns=5;i=5019,Object
```

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```
6,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/Configuration/ConfiguredDevice/DeviceID,
↪DeviceID,4:DeviceID,ns=5;i=6045,Variable
6,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/Configuration/ConfiguredDevice/VendorID,
↪VendorID,4:VendorID,ns=5;i=6062,Variable
5,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/Configuration/CycleTime,CycleTime,4:CycleTime,
↪ns=5;i=6044,Variable
5,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/Configuration/Pin2Configuration,
↪Pin2Configuration,4:Pin2Configuration,ns=5;i=6048,Variable
6,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/Configuration/Pin2Configuration/EnumStrings,
↪EnumStrings,0:EnumStrings,ns=5;i=6049,Variable
5,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/Configuration/PortMode,PortMode,4:PortMode,
↪ns=5;i=6053,Variable
6,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/Configuration/PortMode/EnumStrings,EnumStrings,
↪0:EnumStrings,ns=5;i=6054,Variable
5,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/Configuration/ValidationAndBackup,
↪ValidationAndBackup,4:ValidationAndBackup,ns=5;i=6060,Variable
6,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/Configuration/ValidationAndBackup/EnumStrings,
↪EnumStrings,0:EnumStrings,ns=5;i=6061,Variable
4,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/Device,Device,5:Device,ns=5;i=5007,Object
5,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/Device/DeviceID,DeviceID,4:DeviceID,ns=5;
↪i=6019,Variable
5,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/Device/General,General,4:General,ns=5;i=5009,
↪Object
6,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/Device/General/ApplicationSpecificTag,
↪ApplicationSpecificTag,4:ApplicationSpecificTag,ns=5;i=6073,Variable
6,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/Device/General/FunctionTag,FunctionTag,
↪4:FunctionTag,ns=5;i=6075,Variable
6,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/Device/General/LocationTag,LocationTag,
↪4:LocationTag,ns=5;i=6077,Variable
6,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/Device/General/ProcessDataInput,
↪ProcessDataInput,4:ProcessDataInput,ns=5;i=6079,Variable
7,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/Device/General/ProcessDataInput/
↪ProcessDataLength,ProcessDataLength,4:ProcessDataLength,ns=5;i=6080,Variable
6,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/Device/General/ProcessDataOutput,
↪ProcessDataOutput,4:ProcessDataOutput,ns=5;i=6081,Variable
7,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/Device/General/ProcessDataOutput/
↪ProcessDataLength,ProcessDataLength,4:ProcessDataLength,ns=5;i=6082,Variable
5,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/Device/HardwareRevision,HardwareRevision,
↪2:HardwareRevision,ns=5;i=6013,Variable
5,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/Device/Identification,Identification,
↪2:Identification,ns=5;i=5010,Object
6,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/Device/Identification/DeviceID,DeviceID,
↪4:DeviceID,ns=5;i=6019,Variable
6,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/Device/Identification/ApplicationSpecificTag,
↪ApplicationSpecificTag,4:ApplicationSpecificTag,ns=5;i=6073,Variable
6,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/Device/Identification/FunctionTag,FunctionTag,
↪4:FunctionTag,ns=5;i=6075,Variable
6,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/Device/Identification/LocationTag,LocationTag,
↪4:LocationTag,ns=5;i=6077,Variable
6,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/Device/Identification/SerialNumber,
↪SerialNumber,2:SerialNumber,ns=5;i=6177,Variable
6,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/Device/Identification/VendorID,VendorID,
↪4:VendorID,ns=5;i=6084,Variable
5,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/Device/Manufacturer,Manufacturer,
↪2:Manufacturer,ns=5;i=6020,Variable
5,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/Device/MinCycleTime,MinCycleTime,
↪4:MinCycleTime,ns=5;i=6071,Variable
5,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/Device/Model,Model,2:Model,ns=5;i=6072,Variable
5,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/Device/ParameterSet,ParameterSet,
↪2:ParameterSet,ns=5;i=5012,Object
6,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/Device/ParameterSet/ApplicationSpecificTag,
```

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```
↪ApplicationSpecificTag,4:ApplicationSpecificTag,ns=5;i=6073,Variable
6,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/Device/ParameterSet/FunctionTag,FunctionTag,
↪4:FunctionTag,ns=5;i=6075,Variable
6,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/Device/ParameterSet/LocationTag,LocationTag,
↪4:LocationTag,ns=5;i=6077,Variable
6,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/Device/ParameterSet/ProcessDataInput,
↪ProcessDataInput,4:ProcessDataInput,ns=5;i=6079,Variable
7,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/Device/ParameterSet/ProcessDataInput/
↪ProcessDataLength,ProcessDataLength,4:ProcessDataLength,ns=5;i=6080,Variable
6,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/Device/ParameterSet/ProcessDataOutput,
↪ProcessDataOutput,4:ProcessDataOutput,ns=5;i=6081,Variable
7,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/Device/ParameterSet/ProcessDataOutput/
↪ProcessDataLength,ProcessDataLength,4:ProcessDataLength,ns=5;i=6082,Variable
5,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/Device/ProductID,ProductID,4:ProductID,ns=5;
↪i=6074,Variable
5,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/Device/ProductText,ProductText,4:ProductText,
↪ns=5;i=6076,Variable
5,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/Device/ProfileCharacteristic,
↪ProfileCharacteristic,4:ProfileCharacteristic,ns=5;i=6078,Variable
5,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/Device/RevisionID,RevisionID,4:RevisionID,ns=5;
↪i=6083,Variable
5,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/Device/SerialNumber,SerialNumber,
↪2:SerialNumber,ns=5;i=6177,Variable
5,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/Device/SoftwareRevision,SoftwareRevision,
↪2:SoftwareRevision,ns=5;i=6204,Variable
5,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/Device/VendorID,VendorID,4:VendorID,ns=5;
↪i=6084,Variable
5,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/Device/VendorText,VendorText,4:VendorText,ns=5;
↪i=6206,Variable
4,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/DeviceConfigurationDisabled,
↪DeviceConfigurationDisabled,4:DeviceConfigurationDisabled,ns=5;i=6037,Variable
4,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/Information,Information,4:Information,ns=5;
↪i=5020,Object
5,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/Information/ActualCycleTime,ActualCycleTime,
↪4:ActualCycleTime,ns=5;i=6041,Variable
5,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/Information/Baudrate,Baudrate,4:Baudrate,ns=5;
↪i=6042,Variable
6,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/Information/Baudrate/EnumStrings,EnumStrings,
↪0:EnumStrings,ns=5;i=6043,Variable
5,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/Information/Quality,Quality,4:Quality,ns=5;
↪i=6055,Variable
6,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/Information/Quality/OptionSetValues,
↪OptionSetValues,0:OptionSetValues,ns=5;i=6056,Variable
5,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/Information/Status,Status,4:Status,ns=5;i=6057,
↪Variable
6,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/Information/Status/EnumStrings,EnumStrings,
↪0:EnumStrings,ns=5;i=6058,Variable
4,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/ParameterSet,ParameterSet,2:ParameterSet,ns=5;
↪i=5022,Object
5,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/ParameterSet/MaxPowerSupply,MaxPowerSupply,
↪4:MaxPowerSupply,ns=5;i=6046,Variable
6,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/ParameterSet/MaxPowerSupply/EngineeringUnits,
↪EngineeringUnits,0:EngineeringUnits,ns=5;i=6047,Variable
5,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/ParameterSet/Pin2Support,Pin2Support,
↪4:Pin2Support,ns=5;i=6050,Variable
5,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/ParameterSet/PortClass,PortClass,4:PortClass,
↪ns=5;i=6051,Variable
6,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/ParameterSet/PortClass/EnumStrings,EnumStrings,
↪0:EnumStrings,ns=5;i=6052,Variable
5,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/ParameterSet/DeviceID,DeviceID,4:DeviceID,ns=5;
↪i=6045,Variable
```

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```
5,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/ParameterSet/VendorID,VendorID,4:VendorID,ns=5;
↪i=6062,Variable
5,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/ParameterSet/CycleTime,CycleTime,4:CycleTime,
↪ns=5;i=6044,Variable
5,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/ParameterSet/Pin2Configuration,
↪Pin2Configuration,4:Pin2Configuration,ns=5;i=6048,Variable
6,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/ParameterSet/Pin2Configuration/EnumStrings,
↪EnumStrings,0:EnumStrings,ns=5;i=6049,Variable
5,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/ParameterSet/PortMode,PortMode,4:PortMode,ns=5;
↪i=6053,Variable
6,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/ParameterSet/PortMode/EnumStrings,EnumStrings,
↪0:EnumStrings,ns=5;i=6054,Variable
5,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/ParameterSet/ValidationAndBackup,
↪ValidationAndBackup,4:ValidationAndBackup,ns=5;i=6060,Variable
6,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/ParameterSet/ValidationAndBackup/EnumStrings,
↪EnumStrings,0:EnumStrings,ns=5;i=6061,Variable
5,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/ParameterSet/ActualCycleTime,ActualCycleTime,
↪4:ActualCycleTime,ns=5;i=6041,Variable
5,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/ParameterSet/Baudrate,Baudrate,4:Baudrate,ns=5;
↪i=6042,Variable
6,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/ParameterSet/Baudrate/EnumStrings,EnumStrings,
↪0:EnumStrings,ns=5;i=6043,Variable
5,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/ParameterSet/Quality,Quality,4:Quality,ns=5;
↪i=6055,Variable
6,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/ParameterSet/Quality/OptionSetValues,
↪OptionSetValues,0:OptionSetValues,ns=5;i=6056,Variable
5,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/ParameterSet/Status,Status,4:Status,ns=5;
↪i=6057,Variable
6,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/ParameterSet/Status/EnumStrings,EnumStrings,
↪0:EnumStrings,ns=5;i=6058,Variable
5,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/ParameterSet/Pin2ProcessData,Pin2ProcessData,
↪4:Pin2ProcessData,ns=5;i=6295,Variable
5,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/ParameterSet/Pin4ProcessData,Pin4ProcessData,
↪4:Pin4ProcessData,ns=5;i=6296,Variable
4,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/SIOProcessData,SIOProcessData,4:SIOProcessData,
↪ns=5;i=5023,Object
5,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/SIOProcessData/Pin2ProcessData,Pin2ProcessData,
↪4:Pin2ProcessData,ns=5;i=6295,Variable
5,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/SIOProcessData/Pin4ProcessData,Pin4ProcessData,
↪4:Pin4ProcessData,ns=5;i=6296,Variable
4,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/HardwareRevision,HardwareRevision,
↪2:HardwareRevision,ns=5;i=6013,Variable
4,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/SoftwareRevision,SoftwareRevision,
↪2:SoftwareRevision,ns=5;i=6204,Variable
4,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/ProductID,ProductID,4:ProductID,ns=5;i=6074,
↪Variable
4,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/ProductText,ProductText,4:ProductText,ns=5;
↪i=6076,Variable
4,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/ProfileCharacteristic,ProfileCharacteristic,
↪4:ProfileCharacteristic,ns=5;i=6078,Variable
4,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/SerialNumber,SerialNumber,2:SerialNumber,ns=5;
↪i=6177,Variable
4,Objects/IOLinkMasterSet/BNI XG5-5x8-xB5-x067/Port1/VendorText,VendorText,4:VendorText,ns=5;i=6206,
↪Variable
...
```

9.15 Terminology

This is a summary, glossary about technical terms and abbreviations used in this documentation. Meaning and typical usecases are added to help understanding them.

9.15.1 Process Data - Valid, Invalid flag

Value of the 'Valid'	Description / Meaning
0	Content of the Process Data is invalid
1	Content of the Process Data is valid

In other words, 'valid' is a synonym to reliable. Two valid flags are used:

1) Process Data Input valid
2) Process Data Output valid

Note

Process Data Input Valid (flag) This bit flag is provided by the connected IO-Link Device and received by the IO-Link Master **Routing:** `(flag) IO-Link Device --> IO-Link Master --> Application (PLC)`
When input data is invalid (this flag is 0) then the received Process Data shall not be evaulated by the Application. When this flag is set to 1, then the received data (the content) is valid, and can be evaluated by the Application.
UseCase: When the connected IO-Link Device is already established the IO-Link communication but the device still in calibration or teach mode or 'warm up' therefore the provided measured data shall be ignore, shall not be processed.

Note

Process Data Output Valid (flag) This bit flag is provided by the Application and transmitted via the IO-Link Master to the IO-Link Device **Routing:** `(flag) Application (PLC) --> IO-Link Master --> IO-Link Device` When output data is invalid (this flag is 0) then the sent out Process Data will not have any effect on the connected IO-Link Device. When this flag is set to 1 then the sent out Process Data will be evaluated (executed) by the connected IO-Link Device.
UseCase: If the Application is in teach mode or it went to a safe state, then Application may set this flag to 0 to force the connected IO-Link Device to ignore the Process Data Output. Some IO-Link device (eg: BNI IOL-302 Digital I/O Hub) is able to go set all output ports to a de-energized state based on this flag.

Example 1 - weight measurement sensor

Data Path is **Sensor –> PLC**

Table 59: Process Data Input valid flag example for a Digital I/O Hub

PD-OUT content	Valid flag	Result and Meaning for the Application
0x0000	1	Measured value is 0 gramm
0x0001		Measured value is 1 gramm
0x0009		Measured value is 9 gramm
0x00FF		Measured value is 255 gramm
0x0000	0	Measured value shall be ignored
0x0001		
0x0002		
0x000F		

Example 2 - Digital I/O Hub (actor)

Data Path is **PLC –> Actor**

Table 60: Process Data Output valid flag example for a Digital I/O Hub

PD-OUT content	Valid flag	Result and Meaning for the Application
0x0000	1	All outputs are OFF
0x0001		Output 1 is ON
0x0002		Output 2 is ON
0x000F		Output 1, 2, 3, and 4 are ON
0x0000	0	Outputs are de-energised, or go to a state based on the IO-Link Device configuration
0x0001		
0x0002		
0x000F		

10 Decommissioning

NOTICE

Exposure of sensitive data
If the device is not decommissioned properly, sensitive data may be exposed. This can lead to unauthorized access to the device and its data.
- ► Reset the device to factory settings to remove any remaining data and configurations.

10.1 Disassembly

- ► Only disassemble the device when it is de-energized!

10.2 Disposal

- ► Observe the national regulations for disposal.

Note

Additional information can be found at www.balluff.com on the product page.

11 Support

11.1 Repair

Repairs to the product may only be performed by Balluff. If the product is defective, contact our Service Center.

Headquarters and Technical Service Hubs

www.balluff.com/go/contact

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